

# The European Union One Health 2023 Zoonoses report

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The declarations of interest of all scientific experts active in EFSA's work are available at <https://open.efsa.europa.eu/experts>

## Abstract

This report by the European Food Safety Authority and the European Centre for Disease Prevention and Control presents the results of zoonoses monitoring and surveillance activities carried out in 2023 in 27 Member States (MSs), the United Kingdom (Northern Ireland) and 10 non-MSs. Key statistics on zoonoses and zoonotic agents in humans, food, animals and feed are provided and interpreted historically. In 2023, the first and second most reported zoonoses in humans were campylobacteriosis and salmonellosis, respectively. For both agents, an increase in the absolute number of cases was observed in comparison with 2022. Fifteen MSs and the United Kingdom (Northern Ireland) reached all the established targets in poultry populations with regard to the reduction in *Salmonella* prevalence for the relevant serovars. *Salmonella* samples from carcasses of various animal species, and samples for *Campylobacter* quantification from broiler carcasses, were more frequently positive when performed by the competent authorities than when own-checks were conducted. Shiga toxin-producing *Escherichia coli* (STEC) was the third most reported zoonotic agent in humans, followed by *Yersinia enterocolitica* and *Listeria monocytogenes*. *L. monocytogenes* and West Nile virus infections were the most severe zoonotic diseases, with the highest percentage of hospitalisations among cases and the highest case fatality rates. Twenty-seven MSs and the United Kingdom (Northern Ireland) reported a slight decrease in food-borne outbreaks in 2023 overall in comparison with 2022, although the overall number of reported human cases and hospitalisations increased. *Salmonella* Enteritidis remained the most frequently reported causative agent for reported cases and food-borne outbreaks. *Salmonella* in 'eggs and egg products' was the agent/food pair of most concern. In 2023 this combination caused the largest number of outbreaks and cases among all agent/food combination and ranked second in number of hospitalisations. *Salmonella* was also the causative agent associated with the majority of multi-country outbreaks reported in the EU in 2023. This report also provides updates on brucellosis, echinococcosis, Q fever, rabies, toxoplasmosis, trichinellosis, tuberculosis due to *Mycobacterium bovis* or *M. caprae*, and tularaemia.

## KEYWORDS

*Campylobacter*, food-borne outbreaks, *Listeria*, monitoring, parasites, *Salmonella*, West Nile, zoonoses

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## INTRODUCTION

### Legal basis of European Union-coordinated zoonoses monitoring

The European Union (EU) system for the monitoring and collection of information on zoonoses is based on Directive 2003/99/EC<sup>1</sup> which obliges EU Member States (MSs) to collect relevant and, when applicable, comparable data on zoonoses, zoonotic agents, antimicrobial resistance and food-borne outbreaks (FBOs). In addition, MSs shall assess the trends and sources of these agents, as well as outbreaks in their territory, submitting an annual report each year by the end of May to the European Commission (EC) covering the data collected. The EC should subsequently forward these reports to the European Food Safety Authority (EFSA). EFSA is assigned the tasks of examining these data and publishing the EU Annual Summary Reports. In 2004, the EC entrusted EFSA with setting up an electronic reporting system and database for monitoring zoonoses (EFSA Mandate No 2004–0178, prolonged by M-2015-0231<sup>2</sup>).

Data collection on human diseases from MSs is conducted in accordance with Decision 1082/2013/EU<sup>3</sup> on serious cross-border threats to health. In October 2013, this Decision replaced Decision 2119/98/EC on setting up a network for the epidemiological surveillance and control of communicable diseases in the EU. The case definitions to be followed when reporting data on infectious diseases to the European Centre for Disease Prevention and Control (ECDC) are described in Decision 2018/945/EU.<sup>4</sup> ECDC has provided data on zoonotic infections in humans and their analysis for the EU Summary Reports since 2005. Since 2008, data on human cases have been received via The European Surveillance System (TESSy), maintained by ECDC.

### Reporting requirements

In accordance with List A, Annex I of Directive 2003/99/EC, data on animals, food and feed must be reported for the following eight zoonotic agents: *Salmonella*, *Campylobacter*, *Listeria monocytogenes*, Shiga toxin-producing *Escherichia coli* (STEC), *Mycobacterium bovis*,<sup>5</sup> *Brucella*, *Trichinella* and *Echinococcus*. In addition, and based on the epidemiological situations in the MSs, data must be reported on the following agents and zoonoses (List B, Annex I of the Zoonoses Directive): (i) viral zoonoses: calicivirus, hepatitis A virus, influenza virus, rabies, viruses transmitted by arthropods; (ii) bacterial zoonoses: borreliosis and agents thereof, botulism and agents thereof, leptospirosis and agents thereof, psittacosis and agents thereof, tuberculosis due to agents other than *M. bovis*, vibriosis and agents thereof, yersiniosis and agents thereof; (iii) parasitic zoonoses: anisakiasis and agents thereof, cryptosporidiosis and agents thereof, cysticercosis and agents thereof, toxoplasmosis and agents thereof; and (iv) other zoonoses and zoonotic agents such as *Francisella* and *Sarcocystis*. Furthermore, MSs provided data on certain other microbiological contaminants in foods: histamine, staphylococcal enterotoxins and *Cronobacter sakazakii*, for which food safety criteria are set down in the EU legislation.

In accordance with Article 9 of the same Directive, MSs shall assess the trends and sources of zoonoses, zoonotic agents and antimicrobial resistance in their territories, and each MS shall send to the EC, every year by the end of May, a report on the trends in and sources of, zoonoses, zoonotic agents and antimicrobial resistance. Reports, and any summaries of them, shall be made publicly available.

### Terms of Reference

In accordance with Article 9 of Directive 2003/99/EC, EFSA shall examine the national reports and data submitted by the EU MSs regarding their zoonoses monitoring activities as described above, and publish an EU Summary Report on the trends and sources of zoonoses, zoonotic agents and antimicrobial resistance in the EU. Since 2019, the annual EU Summary Reports on zoonoses, zoonotic agents and foodborne outbreaks have been renamed the 'EU One Health Zoonoses Summary Report' (EUOHZ), which is co-authored by EFSA and ECDC. The 2023 MS data on antimicrobial resistance in zoonotic agents are published in a separate EU Summary Report.

### Data sources and report production

Since 2020, support for production of the annual EUOHZ report has been provided by the ZOE (Zoonoses under a One health perspective in the EU) Consortium's Work Package 1. The Consortium is composed of the *Istituto Superiore di Sanità* (Rome, Italy), the *Istituto Zooprofilattico Sperimentale delle Venezie* (Padua, Italy), the *French Agency for Food, Environmental and Occupational Health & Safety* (ANSES) (Maisons-Alfort, France), the *Istituto Zooprofilattico Sperimentale dell'Abruzzo e*

<sup>1</sup>Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC. OJ L 325, 12.12.2003 p. 31–40.

<sup>2</sup>See mandate M-2015-0231 in Open EFSA Questions: <https://open.efsa.europa.eu/questions/EFSA-Q-2020-00787>.

<sup>3</sup>Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC. OJ L 293, 5.11.2013, p. 1–15.

<sup>4</sup>Commission Implementing Decision 2018/945/EU on the communicable diseases and related special health issues to be covered by epidemiological surveillance as well as relevant case definitions. OJ L 170, 6.7.2018, p. 1–74.

<sup>5</sup>All cases of tuberculosis in cattle caused by the infectious *Mycobacterium tuberculosis* complex (MTBC) members (*M. bovis*, *M. caprae* or *M. tuberculosis*) were taken into account to summarise the EU situation on bovine tuberculosis.

del Molise (Teramo, Italy) and the *Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna* (Brescia, Italy), under the coordination of the *Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise* (Teramo, Italy).

We gratefully acknowledge the efforts made by the MSs, the reporting non-MSs and the EC for the reporting of zoonoses and FBO data, and in the preparation of this report.

The MSs, other reporting countries, the EC, members of EFSA's Scientific Panels on Biological Hazards (BIOHAZ) and Animal Health and Welfare (AHAW), and the relevant European Union Reference Laboratories (EURLs) were consulted while preparing the EUOHZ 2023 report.

This report focuses on the most relevant information on zoonoses, food-borne outbreaks and food microbiological safety criteria for the EU in 2023. Where substantial differences with regard to the previous years were observed, they have been reported.

On 1 February 2020, the United Kingdom withdrew from the EU and became a third country.<sup>6</sup> Data collection for the 2020 to 2023 period was therefore affected, since the number of EU MSs went from 28 to 27. In descriptive tables, data from the United Kingdom were included in the EU statistics for 2019 and previous years, whereas the 2020 statistical data from the United Kingdom, when available for EFSA data, were assigned to the non-MS group. As of 2020, human data from the United Kingdom have not been collected by ECDC. With regard to trend analyses for human data, only countries having contributed data for all the years of the considered period were taken into account. For trend analyses of the estimated prevalence at EU-level of *Salmonella* in poultry populations covered by National Control Programs, any data provided by the reporting MSs were taken into account in the model. The United Kingdom data were only included when available for 2019 and previous years.

Since 2021, the only United Kingdom data reported to EFSA were from Northern Ireland. **In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to Member States include the United Kingdom in respect of Northern Ireland.** Therefore, for the purpose of this report the European Union requirements on data sampling were also applicable to Northern Ireland (XI<sup>7</sup>) and data transmitted by the United Kingdom (Northern Ireland) have been assigned to the MSs group.

In accordance with Regulation (EU) 2017/625<sup>8</sup> on official controls, official samples collected by competent authorities (CAs) must be tested using methods complying with relevant internationally recognised rules or protocols (e.g. ISO methods). This requirement was technically implemented in data collection since the reporting year 2022. Consequently, in the context of verification of microbiological criteria, CAs cannot report alternative methods mentioned in Commission Regulation (EC) No 2073/2005<sup>9</sup> when they carry out official controls aimed at verifying the correct implementation of the provisions of this Regulation by Food Business Operators (FBOs). Therefore, the results collected in this context and shown in the present report for 2022 and 2023 should be interpreted with caution when comparing them with those from previous years.

## Human data collection for 2023

In the 2023 EUOHZ report, the analysis of data from human diseases was prepared by the Food- and Waterborne Diseases and Zoonoses (FWD) domain (brucellosis, campylobacteriosis, congenital toxoplasmosis, echinococcosis, listeriosis, salmonellosis, STEC infection, trichinellosis and yersiniosis), the Emerging and Vector-borne Diseases (EVD) domain (Q fever, rabies, tularaemia and West Nile virus (WNV) infection) and the tuberculosis (TB) domain (infection with *Mycobacterium tuberculosis* complex, focusing on *M. bovis* and *M. caprae*) at ECDC. TESSy is a software platform in which data on 56 diseases and special health issues are collected. Both aggregated and case-based data are reported to TESSy by the MSs and other European countries. Although aggregated data did not include individual case-based information, both reporting formats were included, when possible, to calculate the number of cases and country-specific case notification rates. **The human data used in this report were extracted from TESSy as of 23 July 2024 for EVD, as of 22 July 2024 for FWD and as of 30 September 2024 for TB due to *M. bovis* and *M. caprae*.** The denominators used for calculating notification rates were based on the human population data from Eurostat on 1 January 2024.

The reporting of data to TESSy is underpinned by specific standard definitions applicable to both cases and surveillance systems in place in the MSs and in other European countries,<sup>10</sup> which are also used to summarise the data in this report.

<sup>6</sup>Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community. OJ L 29, 31.1.2020, p. 7 ('Withdrawal Agreement').

<sup>7</sup>For the collection of data, EFSA has aligned itself with the guidelines of the Commission concerning customs registration that lays down abbreviations and terminology, and which are available at [https://taxation-customs.ec.europa.eu/system/files/2020-11/use\\_of\\_gb\\_and\\_xi\\_codes\\_guidance.pdf](https://taxation-customs.ec.europa.eu/system/files/2020-11/use_of_gb_and_xi_codes_guidance.pdf).

<sup>8</sup>Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products (...).

<sup>9</sup>Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs OJ L 338, 22.12.2005, p. 1–26.

<sup>10</sup>Current definitions are reported in section 'Key definitions'.

When interpreting statistics, data quality issues should be considered, as well as the differences between MS surveillance systems; comparisons between countries should therefore be undertaken with caution.

Data on human cases were received from the 27 MSs and from 3 non-MSs (Iceland, Liechtenstein and Norway). Switzerland reported its data on human cases directly to EFSA. In 2021, Liechtenstein resumed the reporting of human data for the first time since 2008; prior to this, they reported this data together with Switzerland.

Information provided in the EUOHZ 2023 report can be accessed via the interactive ECDC Surveillance Atlas of Infectious Diseases, although minor discrepancies may exist due to possible differences in the TESSy dataset at the time of data extraction and aggregation.

## Data collection on food, animals, feed and food-borne outbreaks for 2023

For the year 2023, the 27 MSs and the United Kingdom (Northern Ireland) submitted data and national zoonoses reports on monitoring results in food, animals, feed and food-borne outbreaks. In addition, data and reports were submitted by four non-MSs which are also the four European Free Trade Association (EFTA) countries: Iceland, Norway, Switzerland and Liechtenstein.<sup>11</sup> For some food, animal and feed matrices, and for FBOs, EFSA received data and reports from the following pre-accession countries: Albania, Bosnia and Herzegovina, Kosovo,<sup>12</sup> Republic of North Macedonia, Montenegro and Serbia.

Data were submitted electronically to the EFSA zoonoses database, through EFSA's Data Collection Framework (DCF). MSs could also update their data from previous years.

The deadline for data submission was 31 May 2024. Two data validation procedures were carried out, from 3 June to 12 June 2024 and from 1 July to 9 July 2024, respectively. **Final validated data on food, animals, feed and food-borne outbreaks used in the report were extracted from the EFSA zoonoses database on 19 July 2024.**

A detailed description of the terms used in the report is available in EFSA's manuals for reporting on zoonoses (EFSA, 2024a, 2024b).

The national zoonoses reports submitted in accordance with Directive 2003/99/EC are published on the EFSA website together with the EU One Health Zoonoses Report. They are available online [here](#).

To provide an overview of all the information reported by the MSs for the production of the EUOHZ 2023 report and to limit its volume, the following interactive communication tools were created:

- EFSA story maps for: food-borne outbreaks (FBOs), *Campylobacter*, *Salmonella*, *Listeria monocytogenes*, Shiga toxin-producing *E. coli*, *Brucella*, Zoonotic tuberculosis (focusing on *Mycobacterium bovis* and *M. caprae*), *Trichinella*, *Echinococcus*, rabies, *Yersinia*, *Toxoplasma gondii*, Q fever and tularaemia and
- EFSA dashboards for: food-borne outbreaks (FBOs), *Campylobacter*, *Salmonella*, *Listeria monocytogenes*, Shiga toxin-producing *E. coli*, *Brucella*, Zoonotic tuberculosis (focusing on *Mycobacterium bovis* and *M. caprae*), *Trichinella*, *Echinococcus*, rabies and West Nile virus

The EFSA story maps provide general information on FBOs and on each zoonosis and its epidemiology, including information on characteristics of the zoonotic agent, how people and animals get infected, the occurrence of the pathogen in different sources, the disease it causes and how to prevent infection. In addition, the story maps also illustrate the monitoring activities implemented in the EU and the role of EFSA with respect to these activities. The EFSA story maps include dynamic maps, images, text and multimedia features.

The EFSA dashboards on specific zoonoses are graphical user interfaces for searching and querying the large amount of data collected each year by EFSA from the MSs and other reporting countries based on the Zoonoses Directive. The EFSA dashboards show summary statistics for the monitoring results of the pathogen with regard to major food and animal categories. In the EFSA dashboards, data and related statistics can be displayed interactively through charts, graphs and maps using the online format. Moreover, the main statistics can also be viewed and downloaded in tabular format. Detailed information on the use and features of the dashboards can be found in the user guide available at EFSA Zenodo Knowledge Junction [here](#) and can also be downloaded from the online tool. Specific links to the EFSA story maps and dashboards are available at the beginning of each chapter. Some discrepancies between the data and statistics reported in the present report and those shown in the story maps and dashboards may occur. The reason for this is that the data underpinning the report were updated on 19 July 2024, whereas those in the story maps and dashboards were updated on 1 December 2024.

Moreover, for each zoonotic agent, additional information on related projects and internet sources are published for this report on the EFSA Knowledge Junction at Zenodo [here](#).

## Finalisation of the EUOHZ 2023 report

The draft EUOHZ 2023 report was sent to the MSs for consultation on 8 October 2024 and comments were collected by 23 October 2024. The utmost effort was made to incorporate comments within the available time frame. In general, data

<sup>11</sup>Based on the customs union treaty of the Principality of Liechtenstein with Switzerland, Liechtenstein is part of the Swiss customs territory. Due to the strong connection between the veterinary authorities of Liechtenstein and Switzerland, and Liechtenstein's integration into the Swiss system in the veterinary field, in principal, all legislation, rules and data on contagious diseases are identical for both Switzerland and Liechtenstein. If not mentioned otherwise, the Swiss data also include the data from Liechtenstein.

<sup>12</sup>This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

amended after the data correction deadline of 17 July 2024 have not been considered in the summary calculations or other analyses, and footnotes to tables and figures have been added to account for these late data corrections. The report was finalised on 11 November 2024 and published online by EFSA and ECDC on 10 December 2024.

## Data analysis and presentation

### Data comparability and quality







#### Humans

For data on human infections, please note that the numbers presented in this report may differ from those found in the national zoonoses reports due to differences in the case definitions used at the EU and national levels or because of differing dates of data submission and extraction. The latter may also result in some divergence in the case numbers and notification rates presented in the different ECDC reports and the reports produced in previous years. Results are not directly comparable among the MSs or between different years. Data collection on human cases of food-borne diseases reported to ECDC through TESSy and to EFSA within the European Union Foodborne Reporting System (EU-FORS, see chapter on Foodborne Outbreaks, section 2) is separate and independent. Comparability between the two systems is limited by the different context and purposes of cases reporting and also by the adoption of different case definitions.

#### Food, animals, feed and food-borne outbreaks

Comparability of data obtained by the EFSA DCF can vary depending on the levels of data quality and harmonisation. The types of data analysis carried out for each zoonosis and matrix (food, animals, feed or food-borne outbreaks) strongly depended on this level of harmonisation and may be: a descriptive summary of submitted data, the following-up of trends (trend watching) or the (quantitative) analysis of trends. Data analyses were carried out in accordance with the quality criteria described in Table 1 as adapted from Boelaert et al., 2016. Food, animals, feed and food-borne outbreak data can be classified into three categories depending on the zoonotic agent monitored and the way the monitoring or surveillance was carried out. It follows that the type of data analyses that can be implemented is conditioned by these three distinct categories.

**TABLE 1** Categorisation of the data used in the EU One Health Zoonoses 2023 Summary Report (adapted from Boelaert et al. (2016)).

Category	Type of analysis		Type/comparability between MSs	Examples
I	Descriptive summaries at the national and EU level		Programmed harmonised monitoring or surveillance	National <i>Salmonella</i> control programmes in poultry; tuberculosis caused by <i>M. bovis</i> or <i>M. caprae</i> ; <i>Brucella abortus</i> , <i>B. melitensis</i> and <i>B. suis</i> in bovine, caprine and ovine animal populations; <i>Trichinella</i> in domestic pigs, farmed wild boar and solipeds at the slaughterhouse
	EU trend watching (trend monitoring)		Comparable between MSs	
	Spatial and temporal trend analyses at the EU level		Results are interpretable at the EU level	
II	Descriptive summaries at the national and EU level		Monitoring or surveillance not fully harmonised	Food-borne outbreak data, official control samples related to process hygiene criteria for carcasses at the slaughterhouse for <i>Salmonella</i> and <i>Campylobacter</i> , and to food safety criteria for <i>L. monocytogenes</i> , <i>Salmonella</i> and STEC in the context of Commission Regulation (EC) No 2073/2005, passive rabies surveillance, West Nile virus
	EU trend watching (trend monitoring)		Not fully comparable between MSs	
	<b>No</b> EU trend analysis		Caution needed when interpreting results at the EU level	
III	Descriptive summaries at the national and EU level		Non-harmonised monitoring or surveillance data with no (harmonised) reporting requirements	<i>Yersinia</i> , Q fever, <i>Francisella tularensis</i> , <i>Taenia</i> spp., <i>Toxoplasma</i> and other zoonoses
	<b>No</b> EU trend watching (trend monitoring)		Not comparable between MSs; extreme caution needed when interpreting results at the EU level	
	<b>No</b> EU trend analysis			

## Rationale of the table of contents

The following table of contents has been adopted for the 2023 EUOHZ report and takes account of the zoonoses listed in Annex I of Directive 2003/99/EC, of the mandatory reporting of food-borne outbreaks, and of the above-mentioned categorisation of food, animal and feed data (Table 1).

Zoonoses and zoonotic agents included in compulsory annual monitoring (Directive 2003/99/EC List A)

1. *Campylobacter*
2. *Salmonella*
3. *Listeria*
4. Shiga toxin-producing *Escherichia coli*
5. *Mycobacterium tuberculosis* complex, focussing on *M. bovis*<sup>13</sup>
6. *Brucella*
7. *Trichinella*
8. *Echinococcus*

Food-borne and water-borne outbreaks (in accordance with Directive 2003/99/EC).

Zoonoses and zoonotic agents monitored according to the epidemiological situation (Directive 2003/99/EC List B).

1. *Yersinia*
2. *Toxoplasma gondii*
3. Rabies
4. Q fever
5. West Nile virus
6. Tularaemia
7. Other zoonoses and zoonotic agents

Microbiological contaminants subject to food safety criteria (Commission Regulation (EC) No 2073/2005).

## Chapter sections

The 2023 EUOHZ Report presents a harmonised structure for each chapter:

- 'Key facts',
- 'Monitoring and surveillance' in the EU for each specific disease,
- 'Results', summarising the major findings of 2023 as regards trends and sources, starting with a table displaying summary statistics for the last 5 years (2019–2023) for human cases, food matrices and major animal species, and followed by specific sections describing the main results in humans, food and/or animals.
- 'Discussion' section.

For food-borne outbreaks, the main findings are presented and discussed in a joint 'Results and discussion' section and key messages are summarised in the 'Conclusions' section.

For each chapter, overview tables present the data reported by each country. However, unless stated otherwise, the tables summarising MS-specific results and providing EU-level results for food, animals and feed, exclude data from industry own-check programmes, hazard analysis and critical control point (HACCP) sampling, as well as data from suspect sampling, selective sampling, and outbreak or clinical investigations. Moreover, regional data reported by countries for food, animals and feed without statistics at the national level, were also excluded from these tables. For *Yersinia*, *Francisella tularensis* and food-borne outbreaks, summary tables and figures can be found on the EFSA Knowledge Junction at Zenodo [here](#).

## Data analyses

Statistical trend analyses for humans were carried out to evaluate the significance of temporal variations in the EU over the 2019–2023 period. Further details can be found in the individual chapters. The number of confirmed cases for the EU by month is presented as a trend figure for the 2014–2023 period. All countries that consistently reported cases – or reported zero cases over the whole reporting period – were included. Where appropriate, the trend figure also shows a centred 12-month moving average over the last 5 years, illustrating the overall trend by smoothing seasonal and random variations. Moreover, the same trend analysis was carried out separately for each country (MS and non-MS countries). Analyses were

<sup>13</sup>All cases of tuberculosis in cattle caused by the infectious MTBC members (*M. bovis*, *M. caprae* or *M. tuberculosis*) were taken into account to summarise the EU situation on bovine tuberculosis.

carried out considering confirmed cases only, except for WNV infection, for which all locally acquired cases (i.e. probable and confirmed cases) were considered. Statistical methods for trend analysis were based on either the regression analysis or a non-parametric test (Cox-Stuart test), where appropriate. The time trend was considered statistically significant with the  $p$ -value  $< 0.01$  ( $p < 0.05$  for non-parametric tests).

The notification rates were calculated taking into account the coverage of the human population under surveillance (percentage of national coverage). For countries where surveillance did not cover the whole population, the estimated coverage – if provided – was used to calculate the country-specific rate. Cases and populations of those countries not providing information on national coverage or reporting incomplete data were excluded from the EU notification rate.

ESRI ArcMap 10.8.2 was used to map the data. Choropleth maps with graduated colours over five class scales of values using the natural breaks function proposed by the ArcGIS software, were produced to map the proportion of positive sample units across the EU and other reporting countries. In the maps included in this report, EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label and all the candidate countries were represented with an orange label.

Statistical trend analysis of food-borne outbreaks was performed to evaluate the significance of temporal variations at the single MS level over the 2014–2023 period.

Summary data and the figures for food, animals, feed and food-borne outbreaks used to produce this report, as well as additional information on related projects and internet sources, are published at the EFSA Knowledge Junction at Zenodo [here](#). All country-specific data on food, animals, feed and food-borne outbreaks, updated through 30 November 2024, are also available at this URL.

## Summary of human zoonoses data for 2023

The numbers of confirmed human cases of the zoonoses presented in this report are summarised in [Table 2](#). In 2023, campylobacteriosis was confirmed as the most commonly reported zoonosis (as it has been since 2005). It accounted for 58.9% of all the reported and confirmed human cases in 2023. After campylobacteriosis, salmonellosis, STEC infections, yersiniosis and listeriosis were the most frequently reported zoonoses. Among the disease data collected under the EVD domain, tularaemia was the most frequently reported, followed by Q fever and West Nile virus infection. One imported case of rabies from Morocco was also reported.

With regard to human cases involved in FBOs, *Salmonella* accounted for the highest number of outbreaks and cases ([Table 2](#)), followed by 'norovirus and other calicivirus' (statistics not displayed in [Table 2](#), but available in [Table 51](#)) and 'Bacillus cereus toxins' (statistics not displayed in [Table 2](#), but available in [Table 51](#)).

## Severity of zoonoses in the EU

The severity of zoonotic diseases was descriptively analysed based on the number and proportion (%) of hospitalisations and the outcomes of reported cases, i.e. number of deaths and case fatality (%). Information for all zoonoses is shown in [Table 2](#). Based on data provided to ECDC by the MSs, in 2023 listeriosis and West Nile virus infection were the two most severe diseases, with the highest case fatality and hospitalisation rates among reported cases. Almost all cases of listeriosis and West Nile virus infection with available data were hospitalised (96.5% of confirmed cases for listeriosis and 78.1% of locally acquired probable and confirmed cases for West Nile virus infection, respectively). Like in recent years, the highest number of deaths was associated with listeriosis ( $N = 335$ ), followed by salmonellosis ( $N = 88$ ) and West Nile virus infection ( $N = 75$ ). Listeriosis and West Nile virus infection were also the zoonoses with the highest case fatality rates, 19.7% and 11.2%, respectively.

Among FBOs, *Salmonella* was the agent associated with the largest number of hospitalisations and deaths. Overall, the highest case fatality rates among outbreak cases were observed in outbreaks caused by *L. monocytogenes* (8.3%) followed by 'Clostridium botulinum toxins' (7.1%) (Statistics not displayed in [Table 2](#), but available in [Table 51](#)) and STEC (0.37%).



**TABLE 2** Reported hospitalisations and deaths due to zoonoses in confirmed human cases and among food-borne outbreak cases in the EU, 2023.

Disease	Surveillance data on human cases (source: ECDC)											Food-borne outbreaks (source: EFSA)					
	Confirmed human cases	Hospitalisations					Deaths					Outbreaks	Cases	Hospitalisations and proportion of hospitalised cases		Deaths and case fatality	
		Status available	Reporting MSs <sup>a</sup>	Cases and proportion of hospitalised cases		Outcome available	Reporting MSs <sup>a</sup>	Deaths and case fatality		N	N			N	%	N	%
				N	%			N	%								
Campylobacteriosis	148,181	50,955	34.4	14	12,194	23.9	83,180	56.1	16	44	0.05	229	1174	90	7.7	0	0
Salmonellosis	77,486	36,129	46.6	17	14,801	41.0	44,911	58.0	17	88	0.20	1115	9210	1726	18.7	16	0.17
STEC infections	10,217	3285	32.2	17	1234	37.6	7819	76.5	22	31	0.40	66	270	48	17.8	1	0.37
Yersiniosis	8738	2554	29.2	15	651	25.5	4222	48.3	15	1	0.02	17	73	9	12.3	0	0
Listeriosis	2952	1551	52.5	18	1497	96.5	1701	57.6	19	335	19.7	19	133	84	63.2	11	8.3
Tularaemia	1185	217	18.3	12	105	48.4	325	27.4	11	2	0.62	0	0	0	–	0	–
Echinococcosis	929	406	43.7	15	153	37.7	563	60.6	15	3	0.53	0	0	0	–	0	–
Q fever	805	NA	NA	NA	NA	NA	554	68.8	14	4	0.72	0	0	0	–	0	–
West Nile virus infection <sup>b</sup>	713	365	51.2	5	285	78.1	669	93.8	6	75	11.2	NA	NA	NA	NA	NA	NA
Brucellosis	259	102	39.4	12	58	56.9	101	39.0	13	0	0	0	0	0	–	0	–
Tuberculosis caused by <i>M. bovis</i> , <i>M. caprae</i>	138	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1 <sup>c</sup>	3	0	–	0	–
Trichinellosis	76	56	73.7	6	14	25.0	42	55.3	6	0	0	3	31	5	16.1	0	0
Rabies <sup>d</sup>	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: Data on congenital toxoplasmosis are not shown, since 2023 data are not available yet.

Abbreviation: –, % not calculated; NA, not applicable, as information is not collected for this disease.

<sup>a</sup>Not all countries provided data for all diseases.

<sup>b</sup>For West Nile virus infection, the total number of locally acquired infection cases was used (includes probable and confirmed cases).

<sup>c</sup>No information on the *Mycobacterium* species was provided.

<sup>d</sup>In 2023 one case was reported by France, probably infected in Morocco.

## Comparison of human Zoonoses data for 2022 and 2023

In order to evaluate trends in human infections over the last 2 years, the 2023 data (number of cases and notification rates) were compared with those from 2022 (absolute and relative difference) (Table 3). Relative differences in notification rates have been calculated using exact numbers.

For all zoonoses but West Nile virus infection and tuberculosis caused by *M. bovis*, *M. caprae*, there was an increase in the number of cases and notification rates in 2023, as compared with 2022. The highest increases in the notification rate were seen for trichinellosis (+94.0%), tularaemia (+89.3%) and STEC infection (+30.0%), whereas for locally acquired West Nile virus infection the notification rate decreased by 37.2% as compared with 2022. For salmonellosis (+16.9%), brucellosis (+14.1%), yersiniosis (+13.5%) and Q fever (+11.5%), a noteworthy increase (> 10.0%) in the notification rate was also observed.

The total number of FBOs in 2023 ( $N=5691$ ) was rather stable as compared with 2022 ( $N=5763$ ), corresponding to a relative difference of  $-1.7\%$ . However, a relative increase in the number of cases ( $+7.2\%$ ), hospitalisations ( $+4.0\%$ ) and deaths ( $+1.6\%$ ) involved in outbreaks was observed in 2023 as compared with 2022.

**TABLE 3** Number of confirmed human cases and notification rates (per 100,000 population) in 2023, including the absolute and relative (%) difference as compared with 2022, by zoonosis, EU.

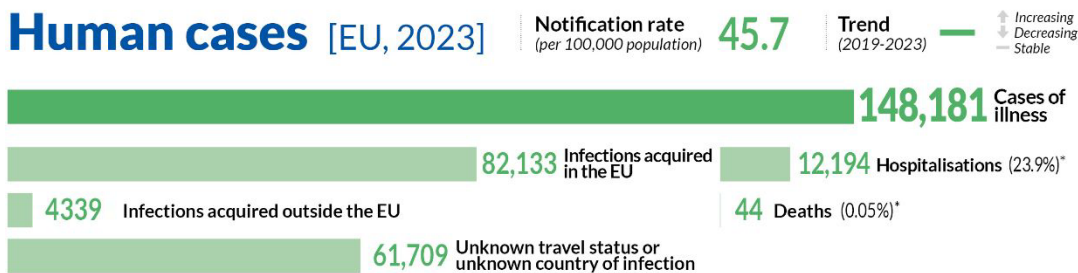
Zoonosis	Cases (N)		Notification rates (N of confirmed cases per 100,000 population)		
	2023	Absolute difference (compared with 2022)	2023	Absolute difference (compared with 2022)	Relative difference (%)
Campylobacteriosis	148,181	8956	45.7	1.9	+4.3
Salmonellosis	77,486	12,008	18.0	2.6	+16.9
STEC infections	10,217	2186	3.1	0.70	+30.0
Yersiniosis	8738	809	2.4	0.29	+13.5
Listeriosis	2952	174	0.66	0.04	+5.8
Tularaemia	1185	561	0.27	0.13	+89.3
Echinococcosis	929	190	0.21	0.02	+8.4
Q fever	805	86	0.19	0.02	+11.5
West Nile virus infection <sup>a</sup>	713	-403	0.16	-0.09	-37.2
Brucellosis	259	33	0.06	0.01	+14.1
Tuberculosis caused by <i>M. bovis</i> , <i>M. caprae</i>	138	-9	0.04	-0.002	-6.1
Trichinellosis	76	37	0.02	0.01	+94.0
Rabies <sup>b</sup>	1	1	-	-	-

<sup>a</sup>For West Nile virus infection, the total number of locally acquired infection cases was used (includes probable and confirmed cases).

<sup>b</sup>In 2023 one case was reported by France, probably infected in Morocco.

# ZONOOSES AND ZONOTIC AGENTS INCLUDED IN COMPULSORY ANNUAL MONITORING (DIRECTIVE 2003/99/EC LIST A)

## 1 | CAMPYLOBACTER





\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

■ ECDC data

### Foodborne outbreaks & related cases [EU, 2023]



\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

N of outbreaks	N of outbreaks per 100,000 population **	N of outbreak cases per 100,000 population	Implicated food vehicles (Strong-evidence outbreaks)
Austria 12	AT 0.132	AT 0.286	<b>Top food vehicles</b>  <b>Broiler meat (<i>Gallus gallus</i>) and products thereof</b> 15 Outbreaks  <b>Other or mixed red meat and products thereof</b> 3 Outbreaks Cheese Eggs and egg products Fish and fish products Meat and meat products, unspecified Milk Mixed food Other, mixed or unspecified poultry meat and products thereof Pig meat and products thereof Turkey meat and products thereof 1 Outbreak (each)
Belgium 4	BE 0.034	BE 0.085	
Bulgaria 0	BG 0	BG 0	
Croatia 3	HR 0.078	HR 0.156	
Cyprus 0	CY 0	CY 0	
Czechia 0	CZ 0	CZ 0	
Denmark 11	DK 0.185	DK 2.174	
Estonia 1	EE 0.073	EE 0.146	
Finland 0	FI 0	FI 0	
France 63	FR 0.092	FR 0.635	
Germany 42	DE 0.050	DE 0.145	
Greece 10	EL 0.096	EL 0.288	
Hungary 0	HU 0	HU 0	
Ireland 0	IE 0	IE 0	
Italy 15	IT 0.025	IT 0.088	
Latvia 0	LV 0	LV 0	
Lithuania 2	LT 0.070	LT 0.140	
Luxembourg 0	LU 0	LU 0	
Malta 15	MT 2.767	MT 6.457	
Netherlands 7	NL 0.039	NL 0.191	
Poland 2	PL 0.005	PL 0.035	
Portugal 0	PT 0	PT 0	
Romania 0	RO 0	RO 0	
Slovakia 10	SK 0.184	SK 1.216	
Slovenia 0	SI 0	SI 0	
Spain 29	ES 0.060	ES 0.424	
Sweden 3	SE 0.029	SE 0.076	
UK (N. Ireland) 0	XI 0	XI 0	

\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

■ EFSA data

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Campylobacter* and for the consultation of data collected, the following interactive tools are available:



## 1.1 | Key facts

- Campylobacteriosis was the most commonly reported food-borne gastrointestinal infection in humans in the European Union.
- In 2023, there were 148,181 confirmed cases of human campylobacteriosis, corresponding to a European Union notification rate of 45.7 cases per 100,000 population. This was an increase of 4.3% compared with the notification rate in 2022 (43.8 per 100,000 population).
- The overall trend for *Campylobacter* human infections did not show a statistically significant increase or decrease over the 2019–2023 period.
- Twenty-four Member States and the United Kingdom (Northern Ireland) reported data for 2023 in the context of the *Campylobacter* process hygiene criterion, set out in Commission Regulation (EC) No 2073/2005. Fifteen Member States reported 6686 test results from official controls, with 16.0% *Campylobacter*-positive samples exceeding the limit of 1000 CFU/g. Twenty Member States and the United Kingdom (Northern Ireland) reported 61,591 test results from the monitoring of food business operators, with 15.8% *Campylobacter*-positive samples exceeding the limit of 1000 CFU/g. Eleven Member States reported results from both samplers, showing that the number of samples exceeding the limit was significantly higher in official samples (16.6%) than in own-checks (9.0%).
- In 2023, 0.13% of 3070 'ready-to-eat' food sampling units reported by 11 Member States were positive for *Campylobacter*, with positive samples originating from oysters ( $N=3$ ) and unspecified ready-to-eat foods ( $N=1$ ). Of 8588 'non-ready-to-eat' sampling units reported by 15 Member States, 14.2% were positive, with the highest level of contamination (15.5%) found in 'meat and meat products'. *Campylobacter* was isolated from all fresh meat categories, with meat from broilers and turkeys showing the highest percentages of contamination, 21.6% and 19.4%, respectively.
- Data on *Campylobacter* spp. in different animal categories were reported by 16 Member States and the United Kingdom (Northern Ireland) and three non-Member States in 2023. The majority of units tested in the European Union were from broilers ( $N=6627$ ), cats and dogs ( $N=6301$ ), and cattle (bovine animals) ( $N=5939$ ), with positive rates of 4.6%, 1.4% and 6.8%, respectively. Fewer samples were tested for pigs ( $N=2055$ ) and small ruminants ( $N=2935$ ), but higher proportions of positives were observed, at 72.3% and 7.2%, respectively.

## 1.2 | Surveillance and monitoring of *Campylobacter* in the EU

### 1.2.1 | Humans

In 2023, all 27 EU MSs reported information on campylobacteriosis in humans. Surveillance of campylobacteriosis is mandatory in 23 EU MSs. In four MSs (Belgium, France, Italy and the Netherlands), notification is based on a voluntary system. The EU case definition was used by 23 MSs. Three MSs used a different case definition for reporting (France, Germany and Italy), and the Netherlands did not specify which case definition it used. All MSs, except three (Belgium, Italy and the Netherlands), had a comprehensive surveillance system.

The campylobacteriosis surveillance systems cover the whole population of all MSs except four (France, Italy, the Netherlands and Spain). The estimated coverage of the surveillance system was 20% in France, 64% in the Netherlands and 80% in Spain. These estimated proportions of population coverage were used in the calculation of notification rates for these three MSs. No estimated population coverage was provided for 2019–2020 in Spain, so notification rates were not calculated. No estimate of population coverage in Italy was provided for any year, so no notification rate was calculated for this MS. All countries reported case-based data, except Belgium, Bulgaria and Croatia, which reported aggregated data.

## 1.2.2 | Food and animals

*Campylobacter* is monitored along the food chain during primary production (farm animals), harvest/slaughter, manufacturing and distribution.

### ***Campylobacter* data in the context of Commission Regulation (EC) No 2073/2005**

A regulatory limit (microbiological process hygiene criterion (PHC)) of 1000 CFU/g of *Campylobacter* on the neck skins of chilled broiler carcasses was set by Commission Regulation (EC) No 2073/2005 (point 2.1.9 of Chapter 2 of Annex I). This limit applies to a set of 50 pooled samples from 10 consecutive sampling sessions. As of 2023, a maximum number of 15 samples with values exceeding this limit is considered acceptable. Food business operators (FBOs) failing to comply with this limit are required to carry out corrective actions involving validation and verification of their food safety management procedures based on Hazard Analysis and Critical Control Point (HACCP) principles and Good Manufacturing Practices (GMP). The PHC has been in force since 1 January 2018. On 14 December 2019, Commission Implementing Regulation (EU) 2019/627<sup>14</sup> came into force, harmonising sampling procedures for official controls. This legislation requires the Competent Authority (CA) to verify whether the FBO is correctly implementing and checking the PHC on broiler carcasses by choosing one of two approaches: implementing ad hoc official sampling<sup>15</sup> or collecting all the information from the samples taken by the FBO. The results obtained in official controls enable improved trend watching and trend analyses (Table 1).

### **Other monitoring data for food and animals**

*Campylobacter* monitoring data from food and animals submitted to EFSA in compliance with Chapter II 'Monitoring of zoonoses and zoonotic agents' of the Directive 2003/99/EC are collected without a harmonised procedure. These data allow descriptive summaries at the EU level, but they do not support EU-level trend analyses and trend watching and should be interpreted with caution (Table 1).

In 2023, general data on food and animals reported to EFSA by MSs and non-MSs were obtained mainly from official sampling, industry HACCP sampling and own-checks, as part of national monitoring and surveillance and/or organised surveys. In addition, for animal data, other reported samples were obtained from clinical investigations by private veterinarians and industry (e.g. artificial insemination centres).

The occurrence of *Campylobacter* reported in the main food categories for the year 2023 and for the 4-year period of 2019–2022 was descriptively summarised, making a distinction between 'ready-to-eat' (RTE) and non-RTE food. Data sets were extracted using the 'objective sampling' strategy, meaning that the reporting MSs collected the samples as part of a planned strategy based on the selection of random samples that are statistically representative of the population to be analysed.

In 2023, other *Campylobacter* monitoring data from livestock primary production were obtained from cattle under 1 year of age and fattening pigs. These additional data were collected through antimicrobial resistance (AMR) monitoring, following the harmonised sampling scheme and protocol for isolation set out in Commission Implementing Decision (EU) 2020/1729<sup>16</sup> that is focused on the species *Campylobacter jejuni* and *C. coli*. The results of AMR monitoring are published separately in an EU Summary Report.

The detection and confirmation of *Campylobacter* in food and animals is generally based on culture, with the use of international standards or equivalent validated methods. Species identification is carried out using biochemical and molecular methods (PCR-based), as well as matrix-assisted laser desorption/ionisation time-of flight mass spectrometry (MALDI-TOF MS).

## 1.3 | Data analyses

A comparison of the proportions of *Campylobacter*-positive samples collected from the neck skins of broiler carcasses after chilling that exceeded 1000 CFU/g was carried out, as obtained by the CAs and FBOs as part of the *Campylobacter* PHC, in compliance with Commission Regulation (EC) No 2073/2005. The significance of any differences was verified by a one-tailed Fisher's exact probability test in cases where the expected values of any of the cells in a contingency table were below 5; otherwise, the one-tailed z test was used. The official control sampling results by the CA and the own-check results by the FBOs were expressed as prevalence ratios with an exact binomial confidence interval of 95%. A *p*-value of < 0.10 (Clayton & Hills, 2013) was considered significant, in order to highlight every possible indication of differences between the data collected by the FBOs and the CAs. R software ([www.r-project.org](http://www.r-project.org), version 4.2.3) was used to conduct the above analyses.

<sup>14</sup>Commission Implementing Regulation (EU) 2019/627 of 15 March 2019, laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council and amending Commission Regulation (EC) No 2074/2005 as regards official controls. OJ L 131, 17.5.2019, p. 51–100.

<sup>15</sup>This means official sampling using the same method and sampling area as food business operators. At least 49 random samples shall be taken from each slaughterhouse each year. The number of samples may be reduced for small slaughterhouses and based on a risk evaluation.

<sup>16</sup>Commission Implementing Decision (EU) 2020/1729 of 17 November 2020 on the monitoring and reporting of antimicrobial resistance in zoonotic and commensal bacteria.

## 1.4 | Results

### 1.4.1 | Overview of key statistics, EU, 2019–2023

**Table 4** summarises EU statistics on human campylobacteriosis, and on the occurrence and percentage of positives for *Campylobacter* in food and animals for the period 2019–2023. In 2023, a slight increase was observed in the number of notified human cases and in the EU notification rate with respect to 2022. The food data of interest in this report were classified into two major categories: ‘meat and meat products’ and ‘milk and milk products’, aggregated by year to obtain an annual overview of the volume of data submitted. In the last 5 years, the number of sampling units reported for ‘meat and meat products’ has increased, probably owing to CIR (EU) 2019/627 establishing compulsory reporting of *Campylobacter* PHC monitoring data (see above). The animal data collected at the primary production stage were mostly from broilers, cattle and pigs. Results showed comparable and consistent test numbers over the considered period for cattle and pigs, alongside a decreasing trend in the reported sample sizes for broilers. More detailed descriptions of these statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

**TABLE 4** Summary of *Campylobacter* statistics relating to humans, major food categories and the main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	148,181	139,225	140,666	121,752	222,304	ECDC
Total number of confirmed cases/100,000 population (notification rates)	45.7	43.8	44.2	40.6	61.1	ECDC
Number of reporting MSs	27	27	27	27	28	ECDC
Infection acquired in the EU	82,133	78,499	81,975	70,769	109,937	ECDC
Infection acquired outside the EU	4339	3224	704	1586	6514	ECDC
Unknown travel status or unknown country of infection	61,709	57,502	57,987	49,397	105,853	ECDC
Number of food-borne outbreak-related cases	1174	1097	1051	1319	1770	EFSA
Total number of food-borne outbreaks	229	255	249	317	542	EFSA
<b>Food<sup>a</sup></b>						
<b>Meat and meat products<sup>b</sup></b>						
Number of sampling units	107,290	107,176	87,808	66,099	57,027	EFSA
Number of reporting MSs	26	27	25	25	25	EFSA
<b>Milk and milk products<sup>c</sup></b>						
Number of sampling units	1802	2633	2125	2145	2749	EFSA
Number of reporting MSs	13	14	11	11	11	EFSA
<b>Animals<sup>a</sup></b>						
<b>Cattle (bovine animals)</b>						
Number of sampling units	6305	5698	7529	4387	6850	EFSA
Number of reporting MSs	13	7	11	7	10	EFSA
<b>Gallus gallus (chickens)</b>						
Number of sampling units	6732	9817	10,162	13,628	10,472	EFSA
Number of reporting MSs	5	14	6	15	8	EFSA
<b>Pigs</b>						
Number of sampling units	2428	1820	4502	2110	4308	EFSA
Number of reporting MSs	12	5	14	4	11	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>The total number of sampling units was calculated by summing all reported sub-level entries for sampling units, stages, strategies and samplers, as listed in the EFSA Catalogue (EFSA and Ioannidou, 2019).

<sup>b</sup>‘Meat and meat products’ refers to carcasses and fresh meat/ready-to-eat (RTE), cooked and fermented products.

<sup>c</sup>‘Milk and milk products’ refers to raw and pasteurised milk and all dairy products including cheeses.

### 1.4.2 | Human campylobacteriosis

In 2023, 148,181 confirmed cases of human campylobacteriosis were reported by the 27 EU MSs, corresponding to an EU notification rate of 45.7 cases per 100,000 population (Table 4). This is an increase of 4.3% compared with the annual notification rate of 2022 (43.8 per 100,000 population). Austria, Belgium, Czechia, Germany, Ireland, Luxembourg and the

Netherlands reported lower rates in 2023 than in the previous year. The highest country-specific notification rates in 2023 were observed in Luxembourg (129.4 cases per 100,000 population), Czechia (125.2), Slovakia (104.4) and Malta (89.5). The lowest rates in 2023 were observed in Bulgaria, Greece, Poland and Romania ( $\leq 6.1$  per 100,000 population) (Table 5).

For most (95.0%) of the reported campylobacteriosis cases of known origin, the infection was acquired in the EU (including both domestic and travel-associated cases within the EU) (Table 4). This figure is slightly lower than in 2022 (96.1%), but still higher than the rate (94.4%) of the pre-pandemic year 2019. The proportion of domestic cases among the cases of known origin was 80%–100% in all reporting countries, except for three MSs, which reported the highest proportion of travel-associated cases: Finland (55.6%), Sweden (44.6%) and Denmark (31.3%). Nineteen MSs reported imported cases, and the proportion of travel-related cases was 11.4%, which was higher than in 2022 (9.7%).

**TABLE 5** Reported confirmed human cases of campylobacteriosis and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023		2022		2021		2020		2019			
	National Coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	Y	C	6271	68.9	6293	70.1	6019	67.4	5406	60.7	6572	74.2
Belgium	Y	A	5597	47.7	5647	48.6	5083	44.0	5693	49.4	7337	64.0
Bulgaria	Y	A	222	3.4	107	1.6	130	1.9	127	1.8	229	3.3
Croatia	Y	A	1913	49.7	1467	38.0	1148	28.4	1054	26.0	1722	42.2
Cyprus	Y	C	106	11.5	82	9.1	24	2.7	18	2.0	21	2.4
Czechia	Y	C	13,558	125.2	14,412	137.0	16,305	155.4	17,517	163.8	22,894	215.0
Denmark	Y	C	5197	87.6	5143	87.6	3740	64.0	3742	64.3	5402	93.0
Estonia	Y	C	270	19.8	211	15.8	185	13.9	265	19.9	347	26.2
Finland	Y	C	2587	46.5	2462	44.4	1798	32.5	2074	37.5	4382	79.4
France <sup>b</sup>	N	C	9255	67.9	9095	67.0	8875	65.6	7920	58.8	7712	57.4
Germany	Y	C	40,054	47.5	43,471	52.2	47,911	57.6	46,377	55.8	61,277	73.8
Greece	Y	C	635	6.1	302	2.9	260	2.4	218	2.0	366	3.4
Hungary	Y	C	5488	57.2	5050	52.1	5088	52.3	4461	45.7	6400	65.5
Ireland	Y	C	3736	70.9	3617	71.5	3147	62.9	2419	48.7	2776	56.6
Italy <sup>c</sup>	N	C	2363	–	1539	–	1541	–	1418	–	1632	–
Latvia	Y	C	176	9.3	172	9.2	158	8.3	104	5.5	133	6.9
Lithuania	Y	C	643	22.5	497	17.7	357	12.8	684	24.5	1221	43.7
Luxembourg	Y	C	855	129.4	912	141.3	589	92.8	729	116.4	271	44.1
Malta	Y	C	485	89.5	372	71.4	378	73.2	206	40.0	278	56.3
Netherlands <sup>d</sup>	N	C	4673	41.0	4758	42.3	4231	37.8	3758	37.2	5081	50.7
Poland	Y	C	843	2.3	527	1.4	616	1.6	414	1.1	715	1.9
Portugal	Y	C	1057	10.1	868	8.4	973	9.4	790	7.7	887	8.6
Romania	Y	C	1039	5.5	525	2.8	348	1.8	300	1.6	805	4.1
Slovakia	Y	C	5665	104.4	4777	87.9	6099	111.7	4921	90.2	7690	141.1
Slovenia	Y	C	995	47.0	938	44.5	856	40.6	811	38.7	1085	52.1
Spain <sup>e</sup>	N	C	28,822	74.9	20,816	60.1	20,748	60.0	6891	–	9658	–
Sweden	Y	C	5676	53.9	5165	49.4	4059	39.1	3435	33.3	6693	65.4
<b>EU Total 27</b>	–	–	<b>148,181</b>	<b>45.7</b>	<b>139,225</b>	<b>43.8</b>	<b>140,666</b>	<b>44.2</b>	<b>121,752</b>	<b>40.6</b>	<b>163,586</b>	<b>54.6</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	58,718	88.1
<b>EU Total</b>	–	–	<b>148,181</b>	<b>45.7</b>	<b>139,225</b>	<b>43.8</b>	<b>140,666</b>	<b>44.2</b>	<b>121,752</b>	<b>40.6</b>	<b>222,304</b>	<b>61.1</b>
Iceland	Y	C	155	40.0	104	27.6	58	15.7	95	26.1	136	38.1
Norway	Y	C	3034	55.3	2980	54.9	2049	38.0	2422	45.1	4154	78.0
Liechtenstein	Y	C	48	121.0	50	127.2	38	97.3	–	–	–	–
Switzerland <sup>f</sup>	Y	C	6756	76.6	7551	86.4	6759	78.0	6157	71.5	7165	83.5

Abbreviation: –, Data not reported.

<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

<sup>b</sup>Sentinel surveillance; notification rates calculated with estimated coverage of 20%.

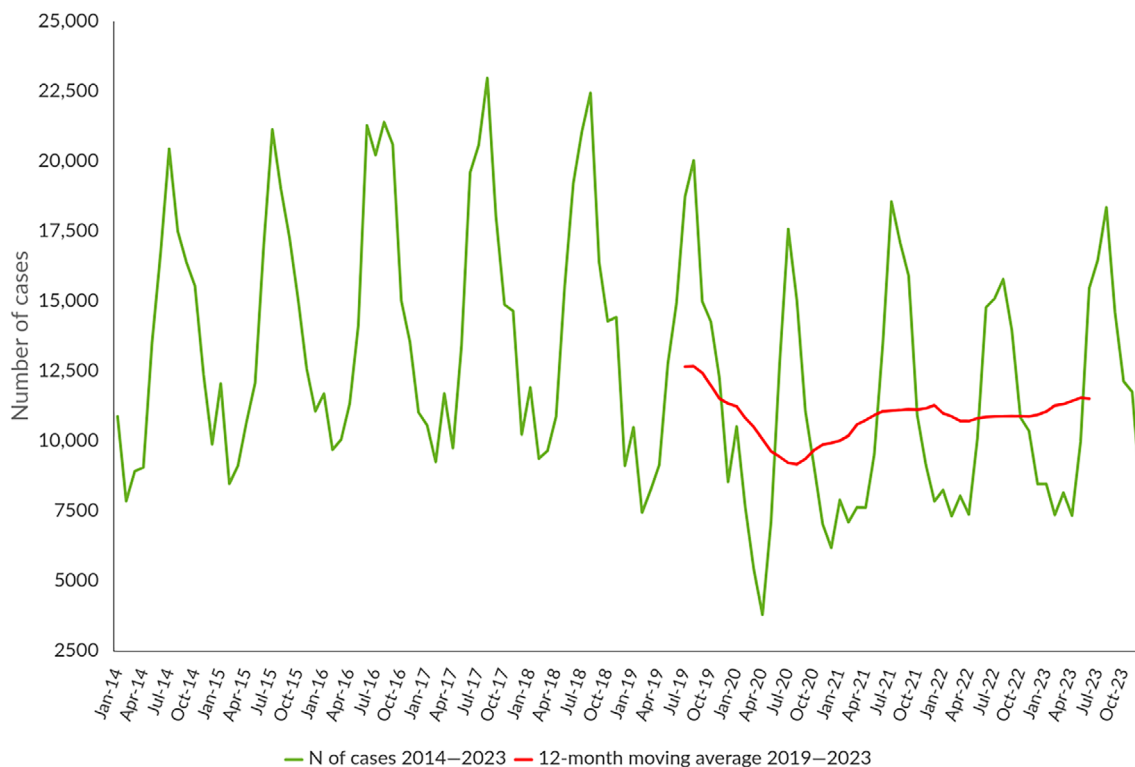
<sup>c</sup>Sentinel surveillance; no information on estimated coverage. Notification rate cannot be estimated.

<sup>d</sup>Sentinel surveillance; notification rates calculated with estimated coverage of 64% in 2021–2023 and 58% in 2019–2020.

<sup>e</sup>Sentinel surveillance; notification rates calculated with an estimated population coverage of 80% in 2023 and 73% in 2021–2022. No information on estimated coverage in 2019–2020, so notification rate cannot be estimated.

<sup>f</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

Between 2014 and 2023, the number of confirmed campylobacteriosis cases reported in the EU showed a clear seasonal trend, peaking in the summer months. Annual winter peaks were also observed in January from 2014 to 2023, although peak numbers were lower than those observed during the summer. However, the overall campylobacteriosis trend in 2019–2023 showed no statistically significant increase or decrease (Figure 1). Cyprus, Ireland, Latvia, Luxembourg, Malta and Spain reported a significantly increasing trend ( $p < 0.05$ ) during the period 2019–2023. No country recorded a significant decreasing trend.



**FIGURE 1** Trend in reported confirmed human cases of campylobacteriosis in the EU, by month, 2019–2023. Source: Austria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands, Poland, Romania, Slovakia, Slovenia, Spain and Sweden.

*Campylobacter* species information was provided by 22 MSs for 57.3% of confirmed cases reported in the EU, representing a slight decrease on 2022 (60.4%). Of these cases, 87.3% were *Campylobacter jejuni*, 11.0% *C. coli*, 0.21% *C. upsaliensis*, 0.20% *C. fetus* and 0.08% *C. lari*. Other *Campylobacter* species accounted for 1.3% of cases, but most of these were reported at the national level as '*C. jejuni* / *C. coli* / *C. lari* not differentiated'. Belgium, Bulgaria, Croatia, Denmark and Latvia provided no information on species.

### 1.4.3 | *Campylobacter* in food

#### ***Campylobacter* data in the context of Commission Regulation (EC) No 2073/2005**

The *Campylobacter* PHC monitoring data are presented in Table 6. Twenty-four Member States and the United Kingdom (Northern Ireland) reported data for 2023 in the context of the *Campylobacter* process hygiene criterion, set out in Commission Regulation (EC) No 2073/2005. Ad hoc official sampling results were reported by 15 MSs, while monitoring results from FBOs were reported by 20 MSs and the United Kingdom (Northern Ireland), and data from both samplers were provided by 11 MSs.

Concerning official control samples ( $N = 6686$ ), 16.0% exceeded the limit of 1000 CFU/g, showing a decrease from the 19.4% observed in 2022. Considerable variability was observed in the percentage of test results exceeding the limit. In particular, Romania and Estonia reported no positive samples exceeding 1000 CFU/g, while four MSs (Bulgaria, Hungary, the Netherlands and Poland) reported between 1.0% and 8.5% of samples exceeding the limit. Conversely, nine MSs reported a higher percentage of samples above the limit, ranging from 11.6% to 46.0%. Twelve out of fifteen MSs reported *Campylobacter*-positive samples both below and above the limit, with 2532 positive samples (39.3%) out of 6445 samples tested.

Concerning FBO results for neck skin samples from own-check sampling activities ( $N = 61,591$ ), 15.8% exceeded the limit of 1000 CFU/g, showing a decrease from 17.5% observed in 2022. No positive samples exceeding the limit were reported by Romania, while five MSs (Estonia, Finland, Greece, Poland and Sweden) recorded less than 3.2% of samples exceeding



the limit. The remaining 14 MSs reported a moderate range in the percentage of samples exceeding the limit, from 4.7% to 35.4%. Fifteen out of twenty MSs and the United Kingdom (Northern Ireland) reported *Campylobacter*-positive samples both below and above the limit, with 12,515 positive samples (42.0%) out of 29,757 samples tested. Three non-EU MSs (Iceland, Montenegro and Switzerland) reported 2.4%, 8.0% and 21.2% FBOp samples exceeding the limit, respectively.

Eleven MSs reported results from both samplers, showing that the overall percentage of samples exceeding the limit was significantly higher for official control samples (16.6%) than for own-checks (9.0%). A significantly higher percentage of samples above the limit was also observed in official samples compared to FBOp samples in seven MSs (Belgium, Greece, Ireland, Italy, Latvia, Poland and Spain), while in the Netherlands, FBOp results exceeding the limit were higher than official samples.

**TABLE 6** Comparison of proportions (%) of samples exceeding the *Campylobacter* PHC limit collected from the neck skins of chilled broiler carcasses sampled at slaughterhouses in accordance with Commission Regulation (EC) No 2073/2005, by sampler and reporting MS, EU, 2023.

Country	Competent Authority (CA)			Food business operator (FBOp)				
	N samples tested	N (%) samples above 1000 CFU/g	CI <sub>95</sub> samples above 1000 CFU/g	N samples tested	N (%) samples above 1000 CFU/g	CI <sub>95</sub> samples above 1000 CFU/g	p-value <sup>a</sup>	Interpretation <sup>b</sup>
Austria	–	–	–	978	134 (13.7)	[11.6; 16.0]	–	–
Belgium	567	66 (11.6)	[9.1; 14.6]	2817	190 (6.7)	[5.8; 7.7]	<0.001	CA > FBOp
Bulgaria	390	4 (1.0)	[0.28; 2.6]	–	–	–	–	–
Cyprus	165	74 (44.8)	[37.1; 52.8]	–	–	–	–	–
Czechia	–	–	–	3246	1149 (35.4)	[33.8; 37.1]	–	–
Denmark	–	–	–	1065	94 (8.8)	[7.2; 10.7]	–	–
Estonia	14	0	[0; 23.2] <sup>b</sup>	346	10 (2.9)	[1.4; 5.3]	NS	–
Finland	–	–	–	590	2 (0.34)	[0.04; 1.2]	–	–
France	–	–	–	18,191	4260 (23.4)	[22.8; 24.0]	–	–
Germany	11	2 (18.2)	[2.3; 51.8]	6266	616 (9.8)	[9.1; 10.6]	NS	–
Greece	90	40 (44.4)	[34.0; 55.3]	5010	94 (1.9)	[1.5; 2.3]	<0.001	CA > FBOp
Hungary	661	56 (8.5)	[6.5; 10.9]	–	–	–	–	–
Ireland	181	21 (11.6)	[7.3; 17.2]	1210	98 (8.1)	[6.6; 9.8]	0.058	CA > FBOp
Italy	1374	298 (21.7)	[19.5; 24.0]	5557	784 (14.1)	[13.2; 15.1]	<0.001	CA > FBOp
Latvia	100	46 (46.0)	[36.0; 56.3]	522	176 (33.7)	[29.7; 38.0]	0.0094	CA > FBOp
Lithuania	230	66 (28.7)	[22.9; 35.0]	–	–	–	–	–
Netherlands	323	12 (3.7)	[1.9; 6.4]	3335	213 (6.4)	[5.6; 7.3]	0.0282	CA < FBOp
Poland	1500	88 (5.9)	[4.7; 7.2]	1050	34 (3.2)	[2.3; 4.5]	0.0011	CA > FBOp
Portugal	–	–	–	3556	971 (27.3)	[25.8; 28.8]	–	–
Romania	15	0	[0; 21.8] <sup>b</sup>	1140	0	[0; 0.32] <sup>b</sup>	NS	–
Slovakia	–	–	–	466	22 (4.7)	[3.0; 7.1]	–	–
Slovenia	–	–	–	833	227 (27.3)	[24.3; 30.4]	–	–
Spain	1065	299 (28.1)	[25.4; 30.9]	3760	565 (15.0)	[13.9; 16.2]	<0.001	CA > FBOp
Sweden	–	–	–	1018	18 (1.8)	[1.1; 2.8]	–	–
United Kingdom (Northern Ireland)	–	–	–	635	50 (7.9)	[5.9; 10.2]	–	–
<b>EU Total (27 + XI)</b>	<b>6686</b>	<b>1072 (16.0)</b>	<b>[15.2; 16.9]</b>	<b>61,591</b>	<b>9707 (15.8)</b>	<b>[15.5; 16.1]</b>	<b>NS</b>	
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>5240</b>	<b>872 (16.6)</b>	<b>[15.6; 17.7]</b>	<b>31,013</b>	<b>2780 (9.0)</b>	<b>[8.6; 9.3]</b>	<b>&lt;0.001</b>	<b>CA &gt; FBOp</b>

Abbreviation: –, Data not reported.

<sup>a</sup>p-value: NS, not significant.<sup>b</sup>One-sided, 97.5% confidence interval.

## Other food monitoring data

In 2023, the occurrence of *Campylobacter* in sampling units from the main RTE and non-RTE food categories was 0.13% and 14.2%, respectively.

In 2023, most of the results from the 3070 RTE food sampling units reported by 11 MSs originated from 'fruit, vegetables and juices' (31.8%), followed by 'meat and meat products' (25.6%) and 'milk and milk products' (22.2%). In total, *Campylobacter* was detected in four RTE food samples: three from live bivalve molluscs (oysters) and one from unspecified RTE foods. During the period 2019–2022, the percentage of *Campylobacter*-positive sampling units in RTE food was very low, at 0.18%, of the 12,926 sampling units tested, consistently remaining below 1.0% across the main RTE categories. However, despite the small number of units tested, the 'fish and fishery products - RTE' category showed the highest percentage of positive samples, at 4.0% ( $N = 149$ ).

The results reported in 2023 by 15 MSs for non-RTE food ( $N = 8588$ ) showed that 'meat and meat products' was the most contaminated food category (15.5%), followed by 'other food' (9.3%). During the period 2019–2022, out of 82,903 sampling units tested, 'meat and meat products' (17.4%) was the most contaminated food category, followed by 'other food' (2.4%) and 'milk and milk products' (1.3%).

Twelve MSs reported 14.1% of sampling units as positive for fresh meat categories. The percentage of *Campylobacter*-positive units was higher for meat from broilers (21.6%) and turkeys (19.4%), followed by 'other fresh meat' (11.6%). The percentage for fresh meat from pigs and bovine animals remained very low at 0.37% and 0.11%, respectively. For 'other food' all the positive units were reported by a single MS from 'fish and fishery products - non-RTE'.

In 2023, a slight decrease was reported in the percentage of positive units compared with the period 2019–2022 for non-RTE food (14.2% compared with 15.9%) and fresh meat (14.1% compared with 16.9%).

### 1.4.4 | *Campylobacter* in animals

Table 7 shows the number of positive *Campylobacter* spp. samples detected during 2023 in the five main animal species, as well as in the 'other animals' category containing several different animal groups. In total, 16 MSs and the United Kingdom (Northern Ireland) and 3 non-MSs reported data, from broilers (30.1%,  $N = 9405$ ), followed by cats and dogs (24.5%,  $N = 7662$ ), bovine animals (20.2%,  $N = 6320$ ), small ruminants (9.5%,  $N = 2951$ ) and pigs (7.6%,  $N = 2365$ ).

The overall proportion of positive units in the EU was highest in pigs (72.3%) followed by small ruminants (7.2%), bovine animals (6.8%), broilers (4.6%), and cats and dogs (1.4%). For 'other animals', comprising around 50 animal categories, the proportion of positive samples was 11.7%, mostly coming from land game mammals (13.0%) and birds (9.3%).

**TABLE 7** Summary of *Campylobacter* statistics relating to major animal species, reporting EU MSs and non-MS countries, 2023.

Animals	EU MSs				Non-MS countries			
	N reporting countries	N tested <sup>a</sup> sampling units	Positive Sampling units		N reporting countries	N tested <sup>a</sup> sampling units	Positive sampling units	
			N	%			N	%
<i>Gallus gallus</i> (broilers)	3	6627	305	4.6	2	2778	145	5.2
Bovine animals <sup>b</sup>	12	5939	401	6.8	2	381	188	49.3
Pigs	11	2055	1486	72.3	1	310	243	78.4
Small ruminants	8	2935	210	7.2	1	16	1	6.3
Cats and dogs	4	6301	90	1.4	2	1361	122	9.0
Other animals <sup>c</sup>	7	2220	259	11.7	2	289	28	9.7
<b>Total</b>	<b>17</b>	<b>26,077</b>	<b>2751</b>	<b>10.5</b>	<b>3</b>	<b>5135</b>	<b>727</b>	<b>14.2</b>

Abbreviation: MSs, Member States.

<sup>a</sup>Summary statistics were obtained by totalling all sampling units (single samples, batch samples, animals, slaughter animal batches and herds or flocks).

<sup>b</sup>Animals from the sampling stage 'Artificial insemination stations' in 'sampling stage' were not included in the count of the units tested.

<sup>c</sup>Alpacas, Antelopes, Badgers, Bears, Birds, Bison, Budgerigars, Buffalos, Camels, Canaries, Cantabrian chamois, Capybaras, Cheetahs, Chinchillas, Crows, Deer, Doves, Dromedaries, Ducks, Foxes, *Gallus gallus* (other than broilers), Giraffes, Guinea pigs, Gulls, Hedgehogs, Jays, Kangaroos, Land game mammals, Lions, Llamas, Magpies, Mice, Monkeys, Mouflons, Okapis, Other animals, Other carnivores, Other mustelids, Owls, Parrots, Passeriformes, Peafowl, Penguins, Pheasants, Pigeons, Polar bears, Unspecified poultry, unspecified, Quails, Rabbits, Reptiles, Rodents, Rodents, Domestic solipeds, Squirrels, Steinbocks, Tigers, Turkeys, Turtles, Wallabies, Wild boars, Wolves, All zoo animals.

### 1.4.5 | Occurrence of *Campylobacter* in animals based on data from harmonised monitoring of antimicrobial resistance (Commission Implementing Decision (EU) 2020/1729)

In 2023, AMR monitoring provided data on the prevalence of positive samples of *C. jejuni* and *C. coli* for cattle under 1 year of age and fattening pigs.

Eleven MSs reported information on 3477 units tested for *Campylobacter* from cattle under 1 year of age. In the EU, 43.6% of samples were positive for *C. jejuni*, with positivity levels consistently above 20% among the MSs. Conversely, *C. coli* was found at a moderate level of 14%, with six MSs showing low prevalence of positive samples (< 8.0%).

Twenty-seven MSs reported data on 7041 units from fattening pigs tested for *Campylobacter*. Among these, *C. jejuni* was reported by 13 MSs, with a total of 47 positive units, showing a very low prevalence of positive samples (0.7%). Meanwhile, a very high proportion of *C. coli* in fattening pigs (66.4%) was reported in the EU. Twenty-two MSs showed very and extremely high levels of *C. coli* in samples from fattening pigs (> 50%).

## 1.5 | Discussion

Campylobacteriosis has been the most frequently reported zoonosis in humans across the EU since the beginning of EU level surveillance in 2007. Despite comprehensive surveillance and national coverage in most MSs, the number of reported cases is underestimated in the EU (Teunis et al., 2013). The number of campylobacteriosis cases confirmed in 2023 and the notification rate were slightly higher compared to 2022. It is noteworthy that, despite the relatively small increase observed, approximately half of EU MSs did not return to pre-pandemic notification rates. No specific causes have been reported to explain this phenomenon in the EU. The overall campylobacteriosis trend in 2019–2023 showed no statistically significant increase or decrease.

Most of the reported campylobacteriosis cases were acquired in the reporting country in the EU, as in previous years. However, the proportion and number of cases of travel-associated campylobacteriosis infections increased in 2023 compared with the period 2021–2022, reflecting a gradual resumption of international travel after the COVID-19 pandemic.

*Campylobacter* has characteristic seasonality, with cases increasing sharply in the summer. Campylobacteriosis cases have been positively associated with temperature and, to a lesser degree, precipitation (Austhof et al., 2024; Lake et al., 2019). Recent studies have even shown a possible association between campylobacteriosis and global climate change (Kuhn et al., 2020).

A smaller but distinct winter peak in the EU has become apparent in the past 10 years, including in 2023. Disease onset in cases that were notified during the winter peaks occurred predominantly in January. This points to exposure around the Christmas/New Year period. Reports indicate that meat fondues or table-top grilling, which are popular during the festive season, could promote the transmission of *Campylobacter* in some countries, causing the winter peak (Bless et al., 2017; Rosner et al., 2021).

As in previous years, *C. jejuni* and *C. coli* were the main species notified by MSs in 2023, although there was still a fairly high percentage of campylobacteriosis cases (42.7%) in which the species was not determined. Furthermore, the proportion of isolates characterised at the species level was lower than the previous year, indicating that further improvements and efforts are needed in species identification and reporting capacities. A One Health approach, using whole genome sequencing (WGS) for typing *Campylobacter* isolates in humans, food and animals will contribute to better species characterisation and enhance the monitoring of zoonotic transmission, improving public health surveillance.

In 2023, all EU MSs except for Croatia, reported information on the occurrence of *Campylobacter* in either animals, food or feed. Data were also reported by Iceland, Norway, Switzerland and the United Kingdom (Northern Ireland). As part of a food safety control strategy, 24 EU MSs and the United Kingdom (Northern Ireland) submitted *Campylobacter* PHC monitoring results, with 11 MSs reporting both results from official control samples and own-check samples. The PHC aims to decrease *Campylobacter* counts on broiler carcasses and to minimise human campylobacteriosis cases caused by consuming or handling contaminated chicken/broiler meat. A recent report showed that a 3-log<sub>10</sub> reduction in broiler caecal concentrations would lead to a significant 58.0% decrease in the campylobacteriosis risk from broiler meat across the EU (EFSA BIOHAZ Panel, 2020).

Both official control and FBOp monitoring data showed that about one in six samples exceeded the limit of 1000 CFU/g. For the MSs that submitted data from both samplers, 1 in 6 from the CA and 1 in 11 from FBOps exceeded the limit, highlighting discrepancies between the two sampling strategies for the fourth consecutive year. While the EU saw a slight decrease in samples exceeding the limit compared to 2022, individual MSs showed variable increases or decreases. In 2023, contamination levels varied widely across MSs, from very low to high. These variations can be partially explained by differences in geographical contexts and/or biosecurity farm management practices, and deserve more thorough investigation in order to identify the critical parameters and factors driving these differences.

Moreover, although not all MSs reported *Campylobacter*-positive samples below the limit of 1000 CFU/g in 2023, the contamination of broiler carcasses in the EU remained similar to 2022, at approximately 40%. Overall, the *Campylobacter* PHC monitoring results underlined poultry as a significant source of campylobacteriosis in the EU.

Monitoring of other food in the EU showed overall percentages of *Campylobacter*-positive units in RTE and non-RTE foods of 0.13% and 14.2%, respectively. Although the presence of *Campylobacter* in RTE foods was very low and has remained stable over the years, these findings are of concern given that contaminated RTE products directly expose consumers to infection.

Among RTE foods, it is noteworthy that three sample units of oysters were found to be contaminated with *Campylobacter*, confirming the positive results observed in bivalve molluscs for the third consecutive year. During the period 2019–2022, very low percentages of positivity were found for all the RTE meat products, milk, fruit, vegetables, juices and other RTE foods. However, the percentage of positive sample units was higher, at around 4.0%, in fish and fishery products,

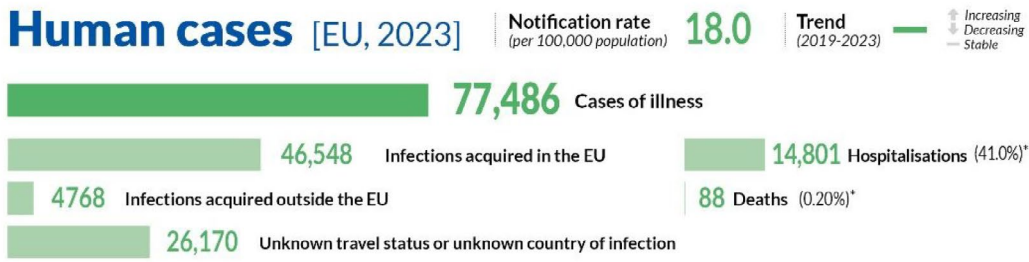
particularly bivalve molluscs. Given the common practice of consuming raw shellfish in certain European sub-regions, the risk of campylobacteriosis from these sources is noteworthy (Teunis et al., 1997). It should also be noted that these data originated from a single MS, highlighting the need to increase the sampling frequency for food products consumed raw (such as scallops, mussels and oysters) across regions in the EU. The generally small sample sizes may have led to imprecise estimates concerning the occurrence of *Campylobacter* in RTE food samples.

Monitoring data for non-RTE food showed positive results for one in six 'meat and meat products', while no positive results were observed for 'milk and milk products'. A moderate proportion of positive findings, specifically 14.8% ( $N=189$ ), was reported in bivalve molluscs (mussels) by a single MS, similar to the scenario observed in RTE foods. *Campylobacter* contamination in fresh meat categories remained moderate in 2023, with meats from broilers and turkeys being far more contaminated than those from pigs and cattle. Although caution is required when interpreting trend results, due to non-harmonised monitoring, the data still consistently underline the significant role of these products in spreading campylobacteriosis. This may occur either through direct handling or by cross-contaminating other foods (Wagenaar et al., 2013).

In 2023, 16 MSs, the United Kingdom (Northern Ireland) and 3 non-MSs reported data from several animal groups. *Campylobacter* spp. were detected in all the major animal categories: broilers, pigs, bovine animals, small ruminants, cats and dogs. Broilers, cats and dogs and bovine animals (cattle) were tested most frequently and accounted for 74.9% of test results. The highest percentage of positive units, however, was observed for pigs.

In 2023, prevalence data from EU AMR monitoring of bovine animals under 1 year of age and fattening pigs were analysed. A high percentage of samples from cattle under 1 year of age were positive for *C. jejuni* (>40.0%), being detected four times more often than *C. coli*. In contrast, a very high percentage of samples from fattening pigs was positive for *C. coli* (>60.0%), which was detected 50 times more frequently than *C. jejuni*. These data confirm that *Campylobacter* is commonly present in cattle and pigs, and highlight the ability of *C. coli* to colonise pigs more effectively than *C. jejuni*, which is more common in cattle. The data confirm that cattle and pigs are a potential source of human campylobacteriosis (Domingues et al., 2012).

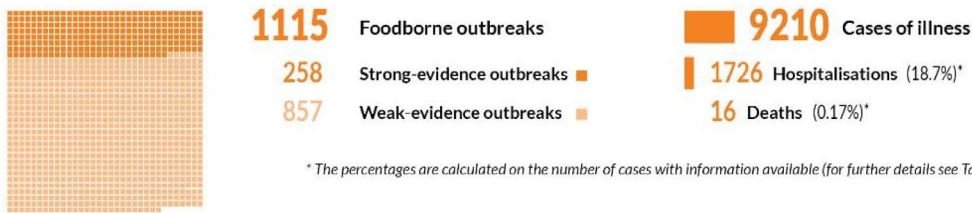
## 2 | SALMONELLA



\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

■ ECDC data

### Foodborne outbreaks & related cases [EU, 2023]



\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

#### N of outbreaks

Austria	21
Belgium	7
Bulgaria	0
Croatia	25
Cyprus	0
Czechia	17
Denmark	18
Estonia	6
Finland	1
France	143
Germany	74
Greece	37
Hungary	12
Ireland	5
Italy	60
Latvia	5
Lithuania	8
Luxembourg	0
Malta	10
Netherlands	14
Poland	269
Portugal	0
Romania	5
Slovakia	120
Slovenia	1
Spain	252
Sweden	4
UK (N. Ireland)	1

#### N of outbreaks per 100,000 population \*\*

AT	0.231
BE	0.060
BG	0
HR	0.649
CY	0
CZ	0.157
DK	0.303
EE	0.439
FI	0.018
FR	0.210
DE	0.088
EL	0.355
HU	0.125
IE	0.095
IT	0.102
LV	0.266
LT	0.280
LU	0
MT	1.845
NL	0.079
PL	0.732
PT	0
RO	0.026
SK	2.210
SI	0.047
ES	0.524
SE	0.038
XI	0.052

#### N of outbreak cases per 100,000 population

AT	1.549
BE	0.324
BG	0
HR	3.090
CY	0
CZ	4.683
DK	3.287
EE	2.709
FI	1.348
FR	1.707
DE	0.759
EL	1.988
HU	4.958
IE	0.474
IT	0.573
LV	5.682
LT	0.945
LU	0
MT	7.748
NL	1.319
PL	5.934
PT	0
RO	0.362
SK	8.750
SI	0.945
ES	4.136
SE	0.960
XI	0.105

#### Implicated food vehicles (Strong-evidence outbreaks)

##### Top food vehicles



\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

■ EFSA data

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Salmonella* and for the consultation of data collected, the following interactive tools are available:



## 2.1 | Key facts

- Salmonellosis was the second most commonly reported food-borne gastrointestinal infection in humans in the European Union.
- In 2023, there were 77,486 confirmed cases of human salmonellosis, corresponding to a European Union notification rate of 18.0 cases per 100,000 population. This was an increase of 16.9% compared with the rate in 2022 (15.4 cases per 100,000 population).
- The overall trend for *Salmonella* infections did not show any significant increase or decrease in the 2019–2023 period.
- The top five European Union-acquired *Salmonella* serovars involved in human infections were distributed as follows: *S. Enteritidis* (70.8%), *S. Typhimurium* (8.9%), monophasic *S. Typhimurium* (1,4,[5],12:i:-) (5.1%), *S. Infantis* (2.0%) and *S. Coeln* (0.77%).
- In the context of Commission Regulation (EC) No 2073/2005 on food safety criteria, ‘fresh poultry meat’ was the most contaminated matrix at the distribution stage with 9.0% *Salmonella*-positive official control samples, followed by ‘meat products made from poultry meat intended to be eaten cooked’ (8.1%), ‘mechanically separated meat’ (7.1%) and ‘minced meat and meat preparations made from poultry meat intended to be eaten cooked’ (6.6%).
- In the context of Commission Regulation (EC) No 2073/2005, Member States reported the highest proportions of *Salmonella*-positive samples during compliance checks for process hygiene criteria at slaughterhouses among those collected by the competent authorities for turkeys (18.9%) and for broilers (17.8%). Lower prevalence was observed in pigs (4.1%), goats (3.5%), cattle (1.4%) and sheep (1.4%). For samples collected by food business operators, the proportions of *Salmonella*-positive samples were significantly lower: 2.8% for turkeys, 2.6% for broilers, 1.0% for pigs, 1.3% for goats, 0.49% for cattle and 0.76% for sheep.
- In 2023, a very low (0.25%) *Salmonella* prevalence was found in ‘ready-to-eat’ food sampling units ( $N=86,115$ ) reported by 24 Member States, with the highest levels of contamination found in ‘sprouts (sprouted seeds)’ (1.4%;  $N=644$ ). Of 478,743 ‘non-ready-to-eat’ sampling units reported by 28 Member States, 2.2% were positive, with the highest levels of contamination found in ‘meat and meat products from turkeys’ (4.3%;  $N=16,533$ ) and ‘meat and meat products from broilers’ (4.1%;  $N=106,699$ ).
- Fifteen Member States and the United Kingdom (Northern Ireland) met all *Salmonella* reduction targets for poultry populations in their control programmes, indicating a worsening compared to previous years. Three Member States failed to meet targets for breeding *Gallus gallus*, seven for laying hens and two for broiler flocks. However, all Member States successfully met the targets for fattening turkeys and breeding turkeys.
- For broilers and fattening turkeys, the European Union-level prevalence of target *Salmonella* serovar-positive flocks reported by food business operators was significantly lower than that reported by competent authorities.
- Over the long-term period (2007–2023), a significant decrease in the European Union-level prevalence of target *Salmonella* serovar-positive flocks was observed in breeding *G. gallus*, laying hens and broilers. However, in the short term (2019–2023), no notable trends – either an increase or decrease – were detected in any of the poultry populations. Regarding *Salmonella* spp., a significant reduction in European Union-level flock prevalence was identified only in laying hens over the long-term period.
- *Salmonella* Enteritidis was the most commonly reported serovar in the ‘laying hens-eggs’ source and the third most common in both the ‘broilers-broiler meat’ and ‘bovine animals-bovine meat’ sources. *Salmonella* Infantis was by far the dominant serovar in the ‘broilers-broiler meat’ source and ranked among the top four serovars across all considered food-animal sources. In the ‘pigs-pig meat’ source, the most common serovars were the monophasic variant of *S. Typhimurium* and *S. Derby*. In the ‘bovine animals-bovine meat’ source, *S. Dublin* and *S. Typhimurium* were the most commonly reported serovars.

## 2.2 | Surveillance and monitoring of *Salmonella* in the EU

### 2.2.1 | Humans

For 2023, all 27 EU MSs reported information on non-typhoidal salmonellosis infections in humans. The notification of salmonellosis is mandatory in 24 EU MSs, whereas it is voluntary in 3 MSs (Belgium, France and the Netherlands). The EU case definition was used by 24 MSs, while 3 MSs (France, Germany and Italy) reported using other case definitions. All countries except the Netherlands had a comprehensive surveillance system. The surveillance systems for salmonellosis covered the whole population in all MSs except three: Belgium, the Netherlands and Spain. The estimated coverage of the surveillance system was 85% in Belgium, 64% in the Netherlands and 80% in Spain. These estimated proportions of population coverage were used in the calculation of notification rates for these MSs. No estimated population coverage was provided for 2019–2020 in Spain, so notification rates were not calculated. All countries reported case-based data except Bulgaria and Croatia, which reported aggregated data.

## 2.2.2 | Food, animals and feed

### **Salmonella data in the context of Commission Regulation (EC) No 2073/2005**

Commission Regulation (EC) No 2073/2005 lays down microbiological criteria, intended as food safety criteria (FSC) and process hygiene criteria (PHC), for *Salmonella* in specific food categories. Compliance with these criteria must be legally verified by the individual food business operator (FBOp) as part of their own Hazard Analysis and Critical Control Point (HACCP) programme.<sup>17</sup> In addition, the competent authority (CA), through official sampling or oversight of data, should verify compliance by the FBOp. The *Salmonella* FSC require that *Salmonella* spp. not be detected in different products during their shelf-life with the exception of fresh poultry meat (from species covered by national control programmes (NCPs)), whose FSC require the absence of target serovars (*S. Enteritidis* and *S. Typhimurium* including monophasic *S. Typhimurium* (1,4,[5],12:i:-)<sup>18</sup>). The *Salmonella* PHC are regulated for carcasses of pigs, cattle, sheep, goats, horses, broilers and turkeys, as sampled by the FBOp. Moreover, in accordance with CIR (EU) 2019/627, the CA has to verify whether the FBOp correctly implements and checks these PHC for carcasses.

### **Data from national control programmes for Salmonella in poultry populations**

In accordance with Regulation (EC) No 2160/2003<sup>19</sup> and its subsequent amendments, MSs have to set up national control programmes for *Salmonella* aimed at reducing the prevalence of *Salmonella* serovars that are considered relevant for public health (from this point forward, termed 'target serovars').

### **Other monitoring data for food, animals and feed including serovars**

Food, animal and feed data other than those described above are not collected in a harmonised way, because there are no specific legal requirements. The reported occurrence of *Salmonella* in the main food categories was descriptively summarised, with a distinction being made between 'ready-to-eat (RTE) and non-RTE food'. Data sets are extracted with 'objective sampling' being specified as the sampling strategy, which means that samples were representative of the population being analysed and were collected in accordance with a planned strategy.

The occurrence of *Salmonella* in animal populations is descriptively summarised considering all data collected in different sampling contexts and reported as different sampling units (e.g. 'holding', 'herd/flock', 'animal' and 'slaughter animal batch'), with the exception of data related to poultry populations covered by NCPs, which have been discussed separately.

The reported data on *Salmonella* serovars are also descriptively summarised. For this purpose, only isolates with the complete antigenic formula and/or serovar name were considered. MSs are required to report the target serovars as part of their NCPs for poultry, whereas for samples collected in different contexts, serotyping is not mandatory. Also, for the food sector, serotyping is only mandatory for fresh poultry meat, since for this category, the FSC is the absence of target serovars. The compulsory reporting of target serovars in these contexts guarantees the consistency of such data over the years and among MSs, but could result in the prevalence of these target serovars being overestimated compared with the other serovars.

## 2.3 | Data analyses

### 2.3.1 | Comparison between competent authority and food business operator sampling results

CA and FBOp *Salmonella* results in the context of NCPs for those poultry populations requiring separate reporting (i.e. broilers and fattening and breeding turkeys) were compared, as were *Salmonella* PHC monitoring data from carcasses. The significance of differences was verified by the one-tailed Fisher's exact probability test, in cases where the expected values in any of the cells of a contingency table were below five; otherwise, the z-statistic one-tailed test was performed. CA control sampling results and the own-check results of the FBOp were expressed as prevalence and exact binomial confidence interval (95% level). A *p*-value < 0.10 (Clayton & Hills, 2013) was considered significant, to include all possible evidence of differences between data collected by the FBOp and CA.

R software ([www.r-project.org](http://www.r-project.org), version 4.2.3) was used to conduct the above-mentioned analyses.

<sup>17</sup>Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. OJ L 139, 30.4.2004, p. 1–54.

<sup>18</sup>Commission Regulation (EU) No 1086/2011 of 27 October 2011 amending Annex II to Regulation (EC) No 2160/2003 of the European Parliament and of the Council and Annex I to Commission Regulation (EC) No 2073/2005 as regards *salmonella* in fresh poultry meat Text with EEA relevance. OJ L 281, 28.10.2011, p. 7–11.

<sup>19</sup>Regulation (EC) No 2160/2003 of the European Parliament and of the Council of 17 November 2003 on the control of *Salmonella* and other specified food-borne zoonotic agents. OJ L 325, 12.12.2003, p. 1–15.



### 2.3.2 | Statistical trend analyses for poultry monitoring data

Statistical trend analyses were carried out with the objective of evaluating the significance of temporal variations in the EU-level flock prevalence of *Salmonella* spp. and target *Salmonella* serovars in poultry since the start of NCP implementation.

The tested flocks can be either positive or negative for target serovars and *Salmonella* spp., and so the status of the flocks is a dichotomous outcome variable. Therefore, the binomial probability distribution for the response variable was assumed and the logit link function was computed in the model for the trend analysis. The logit is defined as the logarithm of  $p/(1 - p)$ , where  $p/(1 - p)$  is the odds of being positive for *Salmonella* spp.

Temporal flock prevalence trends in the MSs were analysed using both linear and B-spline models to estimate the probability of *Salmonella*-positive flocks across different poultry populations over the entire period of NCP implementation. This approach provided a comprehensive overview of trends. Special focus was placed on the last 5 years to identify any significant increase in the flock prevalence of *Salmonella* spp. or target *Salmonella* serovars. The trend analysis was conducted using generalised linear mixed models for repeated measures, accounting for the variability among MSs (EFSA, 2009a; EFSA, 2011). To take into account the different levels (baselines) of probability of MSs having positive flocks, yet with similar patterns over time, a random MS-specific intercept effect was included in the model. To evaluate the trend over time, the 'time' variable was included in the model as a fixed effect. The correlation between repeated observations in the same MS in subsequent years was considered using a first autoregressive or exchangeable structure of the correlation matrix for the residuals. To evaluate the significance of the overall effect of fixed factors specified in the model, Type III F-tests were applied, whereas the receiver operating characteristic (ROC) curve was used to assess the goodness of fit of the model. A  $p$ -value  $< 0.10$  was considered to be significant for both random and fixed effects.

GLIMMIX and SGPLOT procedures in SAS 9.4 software were used to fit the models and produce the graphical outputs, respectively.

Details about the estimated parameters of the models, odds ratios, prevalence rates and graphical analyses (conditional and marginal) are reported in the supporting information for this report ('*Salmonella* poultry outcome trend analyses' Excel file, at Zenodo [here](#)).

### 2.3.3 | Descriptive analyses of *Salmonella* serovars

With the aims of evaluating the distribution of *Salmonella* serovars across the food chain and identifying potential sources of human infections, a Sankey diagram was provided to link the food and food-producing animal sources to the five most commonly reported *Salmonella* serovars from human cases acquired within the EU (domestically or during travel within the EU). For animal categories covered by NCPs, only serovar data reported in the context of these programmes were presented. For cattle, meat-producing animals were considered, whereas for pigs, data from fattening animals were used. In addition to possible reporting biases as regards serovars, reporting for animal or food categories may also have been unbalanced and specific sources (e.g. cattle) may have been underrepresented.

## 2.4 | Results

### 2.4.1 | Overview of key statistics, EU, 2019–2023

#### Humans

In total, the number of reported human salmonellosis cases and the notification rate were higher than in 2022 (Table 8). The number of reported human salmonellosis cases acquired in the EU (i.e. by domestic infection and through travel within the EU), the number of outbreak-related cases and the total number of food-borne salmonellosis outbreaks were higher in 2023 than in 2022. More detailed descriptions of these statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

**TABLE 8** Summary of *Salmonella* statistics relating to humans, major food categories and the main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	77,486	65,478	62,161	52,690	87,907	ECDC
Total number of confirmed cases/100,000 population (notification rate)	18.0	15.4	15.9	13.7	19.5	ECDC
Number of reporting MSs	27	27	27	27	28	ECDC
Infection acquired in the EU	46,548	40,643	44,000	38,247	58,157	ECDC
Infection acquired outside the EU	4768	3219	925	973	6342	ECDC

(Continues)

TABLE 8 (Continued)

	2023	2022	2021	2020	2019	Data source
Unknown travel status or unknown country of infection	26,170	21,616	17,236	13,470	23,408	ECDC
Number of outbreak-related cases	9210	6632	6755	3686	10,240	EFSA
Total number of outbreaks	1115	1014	773	694	1284	EFSA
<b>Food<sup>a</sup></b>						
<b>Meat and meat products</b>						
Number of sampling units	874,106	951,540	976,616	557,272	552,586	EFSA
Number of reporting MSs	28	28	28	26	28	EFSA
<b>Milk and milk products</b>						
Number of sampling units	62,529	68,740	43,907	38,492	46,797	EFSA
Number of reporting MSs	25	24	25	24	25	EFSA
<b>Fish and fishery products</b>						
Number of sampling units	20,201	22,797	14,882	16,486	13,974	EFSA
Number of reporting MSs	25	25	25	23	24	EFSA
<b>Eggs and egg products</b>						
Number of sampling units	20,260	19,105	14,696	11,579	12,093	EFSA
Number of reporting MSs	20	22	22	18	21	EFSA
<b>Fruits and vegetables (and juices)</b>						
Number of sampling units	19,574	17,763	12,502	17,222	17,068	EFSA
Number of reporting MSs	25	25	23	23	22	EFSA
<b>Animals<sup>a</sup></b>						
<b>Gallus gallus (chickens)</b>						
Number of sampling units	745,671	742,299	811,823	619,772	752,145	EFSA
Number of reporting MSs	28	28	28	26	27	EFSA
<b>Turkeys</b>						
Number of sampling units	63,269	65,637	70,869	63,472	65,950	EFSA
Number of reporting MSs	26	26	25	22	23	EFSA
<b>Ducks and geese</b>						
Number of sampling units	2138	1187	3751	412	8700	EFSA
Number of reporting MSs	7	6	10	6	9	EFSA
<b>Pigs</b>						
Number of sampling units	24,133	15,283	16,689	17,234	18,619	EFSA
Number of reporting MSs	15	15	15	10	14	EFSA
<b>Cattle (bovine animals)</b>						
Number of sampling units	28,862	22,904	26,061	28,363	86,871	EFSA
Number of reporting MSs	15	13	14	11	14	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>The total number of sampling units was calculated by summing all reported sub-level entries for sampling units, stages, strategies and samplers, as listed in the EFSA Catalogue (EFSA and Ioannidou, 2019).

## Food categories

In 2023, there was a general decrease in the number of sampling units reported compared to 2022 for the food categories 'meat and meat products', 'milk and milk products' and 'fish and fishery products'. Conversely, a slight increase was observed for 'fruits and vegetables (and juices)' and 'eggs and egg products'. However, for the latter category, this increase was accompanied by a reduction in the number of reporting MSs (Table 8).

## Animal categories

Across all animal categories, except 'turkeys', there was a general increase in the number of reported sampling units between 2022 and 2023. Additionally, the number of reporting MSs also rose for 'ducks and geese' as well as 'cattle (bovine animals)' (Table 8). More detailed descriptions of the above statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

## 2.4.2 | Human salmonellosis

In total, 77,486 human salmonellosis cases were reported by 27 MSs in 2023, corresponding to an EU notification rate of 18.0 cases per 100,000 population (Table 9), which was higher (16.9%) than the rate in 2022.

As in the previous year, the highest notification rates in 2023 were reported by Slovakia (73.7 cases per 100,000 population) and Czechia (69.1 cases per 100,000 population), while the lowest rates were reported by Portugal, Italy, Latvia, Cyprus, Romania and Ireland ( $\leq 7.6$  cases per 100,000 population).

The proportion of domestic versus travel-associated cases varied markedly between countries, but most of the confirmed salmonellosis cases were acquired in the EU (60.1%); this rate was stable when compared with 2022 (62.3%). A relative decrease (11.5%) was observed when comparing the cases acquired in the EU with the mean for the years 2019–2022 (67.9%), even if the rate of the unknown travel status or unknown country of infection cases had a slight increase in 2019–2022. Considering all cases in EU MSs for which information on their importation status was available, the highest proportions of domestic cases were reported by Latvia (100%), Hungary (99.6%), Romania (99.4%) and Spain (99.3%). The highest proportions of travel-associated cases with known data were reported by three countries: the Netherlands (100%), Luxembourg (54.5%) and Sweden (53.3%).

However, with respect to the total number of cases of salmonellosis in these MSs, the proportion of unknown travel status accounted for 85.6%, 26.3% and 3.1%, respectively.

For travel-associated cases in the EU, the most probable countries of infection were Spain (22.7%), Greece (19.3%), Italy (12.2%) and Croatia (7.1%).

**TABLE 9** Reported confirmed human cases of salmonellosis and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate	
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Austria	Y	C	1279	14.0	1192	13.3	993	11.1	817	9.2	1866	21.1
Belgium <sup>b</sup>	N	C	2040	20.4	2375	24.1	2084	18.0	1595	13.8	2527	22.1
Bulgaria	Y	A	516	8.0	310	4.5	241	3.5	187	2.7	594	8.5
Croatia	Y	A	1269	33.0	1047	27.1	593	14.7	786	19.4	1308	32.1
Cyprus	Y	C	64	7.0	66	7.3	41	4.6	70	7.9	62	7.1
Czechia	Y	C	7482	69.1	7563	71.9	9894	94.3	10,516	98.3	13,009	122.2
Denmark	Y	C	1206	20.3	898	15.3	692	11.8	614	10.5	1119	19.3
Estonia	Y	C	168	12.3	134	10.1	112	8.4	91	6.8	150	11.3
Finland	Y	C	803	14.4	666	12.0	474	8.6	516	9.3	1175	21.3
France <sup>c</sup>	Y	C	11,848	17.4	11,162	16.4	9315	28.7	7071	21.9	8935	27.7
Germany	Y	C	10,599	12.6	9064	10.9	8144	9.8	8664	10.4	13,494	16.3
Greece	Y	C	936	9.0	640	6.1	284	2.7	381	3.6	643	6.0
Hungary	Y	C	4416	46.0	3249	33.5	3298	33.9	2964	30.3	4452	45.6
Ireland	Y	C	402	7.6	340	6.7	173	3.5	214	4.3	347	7.1
Italy	Y	C	3333	5.6	3572	6.1	3768	6.4	2713	4.5	3256	5.4
Latvia	Y	C	101	5.4	90	4.8	218	11.5	296	15.5	438	22.8
Lithuania	Y	C	344	12.0	234	8.3	281	10.1	419	15.0	736	26.3
Luxembourg	Y	C	167	25.3	161	24.9	133	21.0	93	14.9	131	21.3
Malta	Y	C	169	31.2	199	38.2	249	48.2	176	34.2	131	26.5
Netherlands <sup>d</sup>	N	C	1456	12.8	1027	9.1	862	7.7	695	6.2	1197	10.8
Poland	Y	C	9196	25.0	6054	16.1	7708	20.4	5192	13.7	8373	22.0
Portugal	Y	C	535	5.1	412	4.0	361	3.5	262	2.5	432	4.2
Romania	Y	C	1388	7.3	1010	5.3	518	2.7	408	2.1	1383	7.1
Slovakia	Y	C	3999	73.7	3669	67.5	4439	81.3	3385	62.0	4992	91.6
Slovenia	Y	C	297	14.0	384	18.2	185	8.8	214	10.2	362	17.4
Spain <sup>e</sup>	N	C	12,161	31.6	8832	25.5	6168	17.8	3526	–	5087	–
Sweden	Y	C	1312	12.5	1128	10.8	933	9.0	825	8.0	1990	19.5
<b>EU Total 27</b>			<b>77,486</b>	<b>18.0</b>	<b>65,478</b>	<b>15.4</b>	<b>62,161</b>	<b>15.8</b>	<b>52,690</b>	<b>13.7</b>	<b>78,189</b>	<b>20.4</b>
United Kingdom	Y	C	–	–	–	–	–	–	–	–	9718	14.6

(Continues)

TABLE 9 (Continued)

Country	2023		2022		2021	2020	2019					
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate					
			Cases	Rate	Cases	Rate	Cases	Rate				
<b>EU Total</b>			<b>77,486</b>	<b>18.0</b>	<b>65,478</b>	<b>15.4</b>	<b>62,161</b>	<b>15.8</b>	<b>52,690</b>	<b>13.7</b>	<b>87,907</b>	<b>19.5</b>
Iceland	Y	C	55	14.2	42	11.2	53	14.4	32	8.8	50	14.0
Norway	Y	C	757	13.8	712	13.1	389	7.2	441	8.2	1092	20.5
Liechtenstein	Y	C	8	20.2	5	12.7	7	17.9				
Switzerland <sup>f</sup>	Y	C	1823	20.7	1837	21.0	1476	16.9	1253	14.5	1534	17.9

Abbreviation: –, Data not reported.

<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

<sup>b</sup>In 2022 and 2023, notification rates were calculated with an estimated population coverage of 85%.

<sup>c</sup>Sentinel system until 2021; notification rates were calculated with an estimated population coverage of 48%. From 2022, voluntary system with population coverage of 100%.

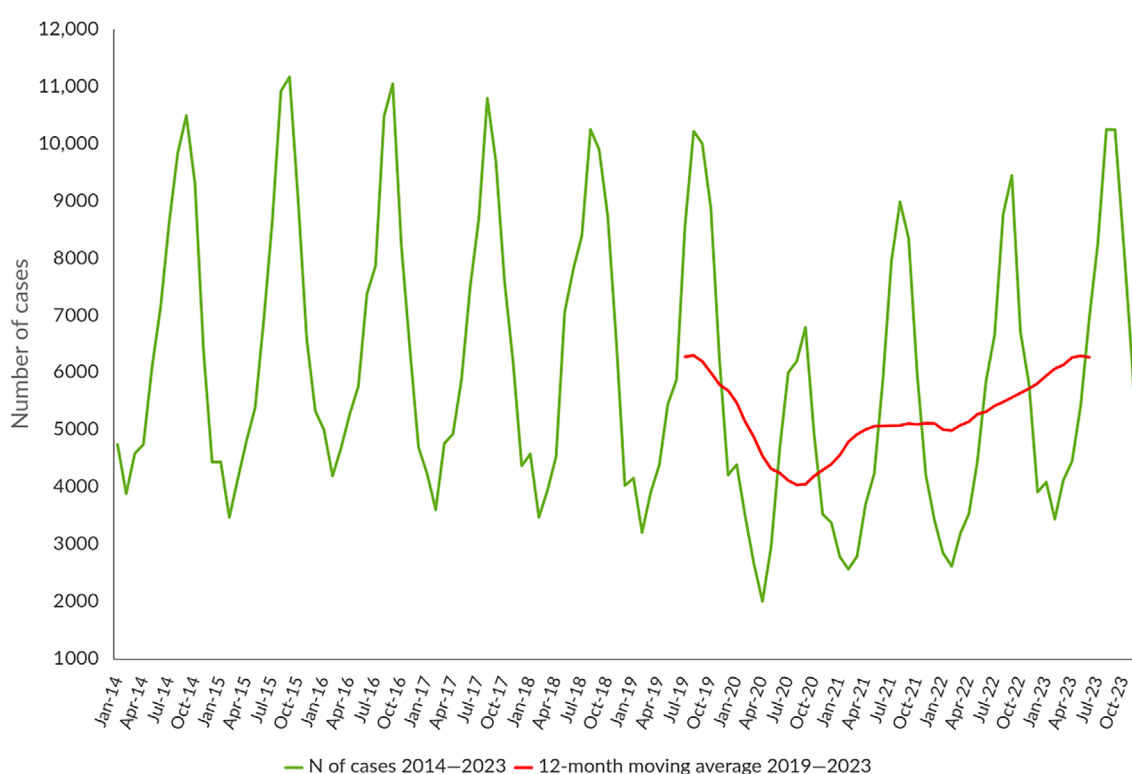
<sup>d</sup>Sentinel system; notification rates were calculated with an estimated population coverage of 64%.

<sup>e</sup>Sentinel system; notification rates were calculated with an estimated population coverage of 80% in 2023 and 73% in 2021–2022. No information on estimated coverage in 2019–2020, so notification rate cannot be estimated.

<sup>f</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

A seasonal trend was observed for confirmed salmonellosis cases in the EU in 2014–2023, with more cases reported during summer months (Figure 2). In 2023, a slight increase in notified human cases was registered compared with 2022. Notwithstanding, the overall trend for salmonellosis in 2019–2023 did not show any significant increase or decrease.

France, Spain and Luxembourg reported a significantly increasing trend ( $p < 0.05$ ) in the last 5 years (2019–2023). No MSs reported a significantly decreasing trend ( $p < 0.05$ ).



**FIGURE 2** Trend in reported confirmed human cases of non-typhoidal salmonellosis in the EU by month, 2019–2023. Source: Austria, Belgium, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Spain, Slovakia, Slovenia and Sweden.

### 2.4.3 | *Salmonella* in food

#### Data collected in the context of Commission Regulation (EC) No 2073/2005

##### Food safety criteria

The overall number of official single samples collected at the distribution stage ( $N=29,707$  samples, 15 MSs) was nearly three times higher than that at the manufacturing stage ( $N=10,313$  samples, 15 MSs) (Table 10). Compared with 2022, the percentage of *Salmonella*-positive samples at distribution remained stable (2.3% both in 2022 and in 2023), while positive samples at manufacturing decreased slightly (2.5% in 2023 and 3.4% in 2022).

'Fresh poultry meat' was the most contaminated matrix (9.0% at the distribution stage and 4.8% at manufacturing). 'Meat products made from poultry meat intended to be eaten cooked' ranked second (8.1% at distribution and 6.9% at manufacturing), followed by 'mechanically separated meat (MSM)' collected at distribution (7.1%) and 'minced meat and meat preparations made from poultry meat intended to be eaten cooked' (6.6% at distribution and 5.7% at manufacturing). Noteworthy percentages of *Salmonella*-positive samples were also observed in 'egg products' (3.6% at distribution), 'minced meat and meat preparations intended to be eaten raw' (2.6% at distribution) and 'sprouted seeds' (2.1% at distribution), all of which are RTE food products.

**TABLE 10** Proportion (%) of *Salmonella*-positive samples from official sampling as part of the verification of *Salmonella* FSC in accordance with Commission Regulation (EC) No 2073/2005, by stage in the food chain, EU, 2023.

Food matrices	Manufacturing stage (including processing)			Distribution stage (including retail)		
	N MSs	N tested samples	N (%) positive	N MSs	N tested samples	N (%) positive
Cheeses, butter and cream made from raw milk or milk that has undergone a lower heat treatment than pasteurisation	9	1087	0 (0)	7	4938	2 (0.04)
Cooked crustaceans and molluscan shellfish	6	182	0 (0)	9	1096	9 (0.82)
Dried follow-on formulae	–	–	–	–	–	–
Dried infant formulae and dried dietary foods for special medical purposes intended for infants below 6 months of age	–	–	–	7	1404	0 (0)
Egg products, excluding products where the manufacturing process or the composition of the product will eliminate the <i>Salmonella</i> risk	5	94	0 (0)	4	56	2 (3.6)
Fresh poultry meat	11	2915	139 (4.8)	13	4308	389 (9.0)
Gelatine and collagen	2	16	0 (0)	4	255	0 (0)
Ice cream, excluding products where the manufacturing process or the composition of the product will eliminate the <i>Salmonella</i> risk	5	148	0 (0)	7	1105	0 (0)
Live bivalve molluscs and live echinoderms, tunicates and gastropods	3	94	0 (0)	5	988	4 (0.40)
Meat products intended to be eaten raw, excluding products where the manufacturing process or the composition of the product will eliminate the <i>Salmonella</i> risk	8	1097	6 (0.55)	10	1450	24 (1.7)
Meat products made from poultry meat intended to be eaten cooked	4	684	47 (6.9)	4	406	33 (8.1)
Mechanically separated meat (MSM)	4	113	1 (0.88)	3	85	6 (7.1)
Milk powder and whey powder	7	402	0 (0)	7	314	0 (0)
Minced meat and meat preparations intended to be eaten raw	2	12	0 (0)	6	230	6 (2.6)
Minced meat and meat preparations made from other species than poultry intended to be eaten cooked	8	2939	32 (1.1)	15	6466	118 (1.8)
Minced meat and meat preparations made from poultry meat intended to be eaten cooked	8	488	28 (5.7)	13	2591	170 (6.6)
Pre-cut fruit and vegetables (ready-to-eat)	5	33	0 (0)	9	2352	1 (0.04)
Ready-to-eat foods containing raw egg, excluding products where the manufacturing process or the composition of the product will eliminate the <i>Salmonella</i> risk	–	–	–	1	260	0 (0)
Sprouted seeds (ready-to-eat)	2	9	0 (0)	5	327	7 (2.1)
Unpasteurised fruit and vegetable juices (ready-to-eat)	–	–	–	6	1076	1 (0.09)
<b>EU Total</b>	<b>15</b>	<b>10,313</b>	<b>253 (2.5)</b>	<b>15</b>	<b>29,707</b>	<b>772 (2.6)</b>

Abbreviations: MSs, Member States.

Four MSs (Belgium, Ireland, Malta and Croatia) reported a total of 58 sampling units collected under the 'EU increased control programme on imported food', as mandated by Commission Implementing Regulation (EU) 2019/1793,<sup>20</sup> which targets specific food categories imported from third countries. Of the 48 batches tested, 1 (2%) was found positive for *Salmonella*, involving dried seeds sampled by Ireland. Malta, out of 10 single samples, reported 2 *Salmonella*-positive cases (20%), also in dried seeds.

### Process hygiene criteria

The following tables (Tables 11–17) present PHC monitoring statistics for carcasses from various animal species, collected at slaughterhouses by both the CA and FBOp. The tables compare the proportions (%) of *Salmonella*-positive samples found by each sampler, along with the corresponding *p*-values and interpretations. Moreover, the proportions reported by countries with special guarantees in relation to *Salmonella* spp. on carcasses, as per Regulation (EC) No 853/2004,<sup>21</sup> are described.

For all species, except horses, the overall proportion of *Salmonella*-positive samples from official controls (CAs) was significantly higher than that from FBOp own-checks. Furthermore, regardless of the sampler, the overall proportions of *Salmonella*-positive neck skin samples from broilers and turkeys were notably higher than those reported for carcass surfaces of pigs, ruminants (cattle, sheep and goats) and horses.

### Pig carcasses

**TABLE 11** Comparisons of proportions (%) of *Salmonella*-positive single samples from pig carcasses after dressing, but before chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			<i>p</i> -value <sup>a</sup>	Interpretation
	<i>N</i> tested samples	<i>N</i> (%) positive samples	CI <sub>95</sub>	<i>N</i> tested samples	<i>N</i> (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	4199	6 (0.14)	[0.05; 0.31]	–	–
Belgium	824	56 (6.8)	[5.2; 8.7]	3724	9 (0.24)	[0.11; 0.46]	<0.001	CA > FBOp
Bulgaria	985	0	[0; 0.37] <sup>b</sup>	96	0	[0; 3.8] <sup>b</sup>	NS	–
Croatia	–	–	–	888	1 (0.11)	[0; 0.63]	–	–
Cyprus	20	0	[0; 16.8] <sup>b</sup>	240	0	[0; 1.5] <sup>b</sup>	NS	–
Czechia	4580	36 (0.79)	[0.55; 1.1]	–	–	–	–	–
Denmark	–	–	–	10,197	65 (0.64)	[0.49; 0.81]	–	–
Estonia	350	24 (6.9)	[4.4; 10.0]	670	2 (0.30)	[0.04; 1.1]	<0.001	CA > FBOp
France	–	–	–	13,194	685 (5.2)	[4.8; 5.6]	–	–
Germany	426	6 (1.4)	[0.52; 3.0]	20,008	149 (0.74)	[0.63; 0.87]	NS	–
Greece	56	0	[0; 6.4] <sup>b</sup>	480	0	[0; 0.77] <sup>b</sup>	NS	–
Hungary	3017	35 (1.2)	[0.81; 1.6]	–	–	–	–	–
Ireland	227	11 (4.8)	[2.4; 8.5]	2444	35 (1.4)	[1.0; 2.0]	0.0012	CA > FBOp
Italy	4399	176 (4.0)	[3.4; 4.6]	9686	122 (1.3)	[1.0; 1.5]	<0.001	CA > FBOp
Latvia	660	7 (1.1)	[0.43; 2.2]	590	0	[0; 0.62] <sup>b</sup>	0.0113	CA > FBOp
Luxembourg	–	–	–	245	0	[0; 1.5] <sup>b</sup>	–	–
Malta	60	10 (16.7)	[8.3; 28.5]	180	5 (2.8)	[0.91; 6.4]	<0.001	CA > FBOp
Netherlands	208	10 (4.8)	[2.3; 8.7]	5976	169 (2.8)	[2.4; 3.3]	0.0471	CA > FBOp
Poland	1753	33 (1.9)	[1.3; 2.6]	4	0	[–]	–	–
Portugal	–	–	–	7789	68 (0.87)	[0.68; 1.1]	–	–
Romania	1821	2 (0.11)	[0.01; 0.40]	5103	0	[0; 0.07] <sup>b</sup>	0.0691	CA > FBOp
Slovakia	–	–	–	2729	0	[0; 0.14] <sup>b</sup>	–	–
Slovenia	–	–	–	725	15 (2.1)	[1.2; 3.4]	–	–
Spain	2304	246 (10.7)	[9.4; 12.0]	8024	79 (0.98)	[0.78; 1.2]	<0.001	CA > FBOp

<sup>20</sup>Commission Implementing Regulation (EU) 2019/1793 of 22 October 2019 on the temporary increase of official controls and emergency measures governing the entry into the Union of certain goods from certain third countries implementing Regulations (EU) 2017/625 and (EC) No 178/2002 of the European Parliament and of the Council and repealing Commission Regulations (EC) No 669/2009, (EU) No 884/2014, (EU) 2015/175, (EU) 2017/186 and (EU) 2018/1660.

<sup>21</sup>Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin.

**TABLE 11** (Continued)

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
United Kingdom (Northern Ireland)	–	–	–	590	20 (3.4)	[2.1; 5.2]	–	–
<b>EU Total (27 + XI)</b>	<b>21,690</b>	<b>652 (3.0)</b>	<b>[2.8; 3.2]</b>	<b>97,781</b>	<b>1430 (1.5)</b>	<b>[1.4; 1.5]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>14,093</b>	<b>581 (4.1)</b>	<b>[3.8; 4.5]</b>	<b>57,225</b>	<b>570 (1.0)</b>	<b>[0.92; 1.1]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>

Abbreviations: –, Data not reported; [–], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

Finland, Sweden, Norway and Iceland, which are countries with special guarantees in relation to *Salmonella* on pig carcasses, reported the following monitoring results: 0 positive out of 2383 own-check samples in Finland, 5 positive out of 6908 official samples in Sweden (0.07%), 0 positive out of 2969 official samples in Norway and 13 positive out of 2020 official samples in Iceland (0.64%). Moreover, Switzerland reported 0 positive out of 925 samples collected by the FBOp and Montenegro 0 positive out of 5 official samples.

### Broiler carcasses

**TABLE 12** Comparisons of proportions (%) of *Salmonella*-positive single samples from broiler carcasses (neck skin samples) after chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	960	240 (25.0)	[22.3; 27.9]	–	–
Belgium	574	65 (11.3)	[8.8; 14.2]	2919	120 (4.1)	[3.4; 4.9]	< 0.001	CA > FBOp
Bulgaria	113	0	[0; 3.2] <sup>b</sup>	–	–	–	–	–
Croatia	–	–	–	210	19 (9.0)	[5.5; 13.8]	–	–
Cyprus	165	40 (24.2)	[17.9; 31.5]	1225	29 (2.4)	[1.6; 3.4]	< 0.001	CA > FBOp
Czechia	785	52 (6.6)	[5.0; 8.6]	–	–	–	–	–
Denmark	–	–	–	240	0	[0; 1.5] <sup>b</sup>	–	–
Estonia	–	–	–	280	0	[0; 1.3] <sup>b</sup>	–	–
France	–	–	–	15,253	208 (1.4)	[1.2; 1.6]	–	–
Germany	35	0	[0; 10.0] <sup>b</sup>	24,065	398 (1.7)	[1.5; 1.8]	NS	–
Greece	100	25 (25.0)	[16.9; 34.7]	14,190	0	[0; 0.03] <sup>b</sup>	< 0.001	CA > FBOp
Hungary	644	108 (16.8)	[14.0; 19.9]	–	–	–	–	–
Ireland	–	–	–	2236	29 (1.3)	[0.87; 1.9]	–	–
Italy	1286	409 (31.8)	[29.3; 34.4]	5105	493 (9.7)	[8.9; 10.5]	< 0.001	CA > FBOp
Latvia	100	0	[0; 3.6] <sup>b</sup>	696	64 (9.2)	[7.2; 11.6]	< 0.001	CA < FBOp
Malta	10	0	[0; 30.9] <sup>b</sup>	–	–	–	–	–
Netherlands	330	49 (14.8)	[11.2; 19.2]	3358	346 (10.3)	[9.3; 11.4]	0.0054	CA > FBOp
Poland	1770	249 (14.1)	[12.5; 15.8]	1434	9 (0.63)	[0.29; 1.2]	< 0.001	CA > FBOp
Portugal	–	–	–	2569	2 (0.08)	[0.01; 0.28]	–	–
Romania	667	58 (8.7)	[6.7; 11.1]	4401	40 (0.91)	[0.65; 1.2]	< 0.001	CA > FBOp
Slovakia	–	–	–	366	9 (2.5)	[1.1; 4.6]	–	–
Slovenia	–	–	–	833	37 (4.4)	[3.1; 6.1]	–	–
Spain	730	132 (18.1)	[15.4; 21.1]	3250	88 (2.7)	[2.2; 3.3]	< 0.001	CA > FBOp
United Kingdom (Northern Ireland)	–	–	–	445	0	[0; 0.83] <sup>b</sup>	–	–

(Continues)

TABLE 12 (Continued)

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
EU Total (27 + XI)	7309	1187 (16.2)	[15.4; 17.1]	84,035	2131 (2.5)	[2.4; 2.6]	<0.001	CA > FBOp
EU Total (27 + XI) providing CA and FBOp data	5757	1027 (17.8)	[16.9; 18.9]	60,643	1587 (2.6)	[2.5; 2.7]	<0.001	CA > FBOp

Abbreviation: –, Data not reported.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

A considerable reduction was observed in the number of broiler carcasses tested as official samples compared to the previous year, primarily driven by a substantial decrease in one MS. Poland, for instance, reported 8008 official samples in 2022, which dropped sharply to 1770 in 2023. Finland, Sweden and Iceland, which are countries with special guarantees in relation to *Salmonella* on broiler carcasses, reported the following monitoring results: Finland ( $N=1280$  collected by the FBOp) and Sweden ( $N=1934$  collected by the CA) did not report any positive samples, whereas Iceland reported 7 positive out of 759 official samples (0.92%). Moreover, Switzerland reported 0 positive out of 344 samples collected by the FBOp and Montenegro 0 positive out of 50 samples tested by the FBOp and 0 positive out of 10 tested by the CA.

### Turkey carcasses

TABLE 13 Comparisons of proportions (%) of *Salmonella*-positive single samples from turkey carcasses (neck skin samples) after chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	128	5 (3.9)	[1.3; 8.9]	–	–
Belgium	49	0	[0; 7.3] <sup>b</sup>	130	1 (0.77)	[0.02; 4.2]	NS	–
Croatia	–	–	–	55	0	[0; 6.5] <sup>b</sup>	–	–
Czechia	310	5 (1.6)	[0.53; 3.7]	–	–	–	–	–
France	–	–	–	2515	62 (2.5)	[1.9; 3.1]	–	–
Germany	–	–	–	1994	327 (16.4)	[14.8; 18.1]	–	–
Greece	–	–	–	2735	0	[0; 0.13] <sup>b</sup>	–	–
Hungary	534	34 (6.4)	[4.4; 8.8]	–	–	–	–	–
Ireland	–	–	–	1214	0	[0; 0.30] <sup>b</sup>	–	–
Italy	200	54 (27.0)	[21.0; 33.7]	1085	126 (11.6)	[9.8; 13.7]	<0.001	CA > FBOp
Latvia	–	–	–	5	0	[–]	–	–
Poland	265	29 (10.9)	[7.5; 15.3]	360	5 (1.4)	[0.45; 3.2]	<0.001	CA > FBOp
Portugal	–	–	–	872	5 (0.57)	[0.19; 1.3]	–	–
Romania	–	–	–	521	0	[0; 0.71] <sup>b</sup>	–	–
Slovakia	–	–	–	60	0	[0; 6.0] <sup>b</sup>	–	–
Slovenia	–	–	–	121	5 (4.1)	[1.4; 9.4]	–	–
Spain	80	29 (36.2)	[25.8; 47.8]	3475	10 (0.29)	[0.14; 0.53]	<0.001	CA > FBOp
United Kingdom (Northern Ireland)	–	–	–	5	0	[–]	–	–
EU Total (27 + XI)	1438	151 (10.5)	[9.0; 12.2]	15,275	546 (3.6)	[3.3; 3.9]	<0.001	CA > FBOp
EU Total (27 + XI) providing CA and FBOp data	594	112 (18.9)	[15.8; 22.2]	5050	142 (2.8)	[2.4; 3.3]	<0.001	CA > FBOp

Abbreviations: –, Data not reported; [–], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.



Finland, Sweden and Norway are countries with special guarantees in relation to *Salmonella* on turkey carcasses. Finland ( $N=265$  collected by the FBOp) and Sweden ( $N=123$  collected by the CA) did not report any positive samples, whereas Norway did not report any data for turkey carcasses. Moreover, Switzerland reported 0 positive out of 130 tested turkey samples collected by the FBOp.

### Bovine carcasses

**TABLE 14** Comparisons of proportions (%) of *Salmonella*-positive single samples from bovine carcasses after dressing but before chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	2871	5 (0.17)	[0.06; 0.41]	–	–
Belgium	882	6 (0.68)	[0.25; 1.5]	3447	62 (1.8)	[1.4; 2.3]	0.0086	CA < FBOp
Bulgaria	493	0	[0; 0.75] <sup>b</sup>	–	–	–	–	–
Croatia	–	–	–	1193	0	[0; 0.31] <sup>b</sup>	–	–
Cyprus	30	10 (33.3)	[17.3; 52.8]	120	13 (10.8)	[5.9; 17.8]	0.0045	CA > FBOp
Czechia	3782	25 (0.66)	[0.43; 0.97]	–	–	–	–	–
Denmark	–	–	–	2220	3 (0.14)	[0.03; 0.39]	–	–
Estonia	206	1 (0.49)	[0.01; 2.7]	354	0	[0; 1.0] <sup>b</sup>	NS	–
France	–	–	–	19,023	68 (0.36)	[0.28; 0.45]	–	–
Germany	–	–	–	8742	1 (0.01)	[0; 0.06]	–	–
Greece	50	0	[0; 7.1] <sup>b</sup>	322	0	[0; 1.1] <sup>b</sup>	NS	–
Hungary	252	1 (0.40)	[0.01; 2.2]	–	–	–	–	–
Ireland	–	–	–	6644	0	[0; 0.06] <sup>b</sup>	–	–
Italy	2878	25 (0.87)	[0.56; 1.3]	11,211	21 (0.19)	[0.12; 0.29]	< 0.001	CA > FBOp
Latvia	355	0	[0; 1.0] <sup>b</sup>	1580	0	[0; 0.23] <sup>b</sup>	NS	–
Luxembourg	–	–	–	335	1 (0.30)	[0.01; 1.7]	–	–
Malta	–	–	–	180	4 (2.2)	[0.61; 5.6]	–	–
Netherlands	262	4 (1.5)	[0.42; 3.9]	3049	21 (0.69)	[0.43; 1.1]	NS	–
Poland	595	3 (0.50)	[0.10; 1.5]	579	1 (0.17)	[0; 0.96]	NS	–
Portugal	–	–	–	2963	8 (0.27)	[0.12; 0.53]	–	–
Romania	1393	0	[0; 0.26] <sup>b</sup>	2843	0	[0; 0.13] <sup>b</sup>	NS	–
Slovakia	–	–	–	1863	0	[0; 0.20] <sup>b</sup>	–	–
Slovenia	–	–	–	1716	0	[0; 0.21] <sup>b</sup>	–	–
Spain	1296	62 (4.8)	[3.7; 6.1]	4584	21 (0.46)	[0.28; 0.70]	< 0.001	CA > FBOp
United Kingdom (Northern Ireland)	–	–	–	1572	2 (0.13)	[0.02; 0.46]	–	–
<b>EU Total (27 + XI)</b>	<b>12,474</b>	<b>137 (1.1)</b>	<b>[0.92; 1.3]</b>	<b>77,411</b>	<b>231 (0.30)</b>	<b>[0.26; 0.34]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>7947</b>	<b>111 (1.4)</b>	<b>[1.2; 1.7]</b>	<b>28,089</b>	<b>139 (0.49)</b>	<b>[0.42; 0.58]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>

Abbreviation: –, Data not reported.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

Finland, Sweden and Norway, which are countries with special guarantees in relation to *Salmonella* on bovine carcasses, reported 1 positive out of 2272 samples collected by the FBOp (0.04%) in Finland and 2 positives out of 3985 official samples (0.05%) in Sweden; Norway did not find any positive samples out of 3067 official controls. Moreover, Switzerland reported no positive out of 858 tested own-check samples, and Montenegro reported 0 positive out of 121 tested samples collected by the FBOp and 0 positive out of 22 collected by the CA.

## Sheep carcasses

**TABLE 15** Comparisons of proportions (%) of *Salmonella*-positive single samples from sheep carcasses after dressing but before chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	220	0	[0; 1.7] <sup>b</sup>	–	–
Belgium	288	2 (0.69)	[0.08; 2.5]	931	7 (0.75)	[0.30; 1.5]	NS	
Bulgaria	475	0	[0; 0.77] <sup>b</sup>	15	0	[0; 21.8] <sup>b</sup>	NS	
Croatia	–	–	–	305	0	[0; 1.2] <sup>b</sup>	–	–
Cyprus	–	–	–	192	0	[0; 1.9] <sup>b</sup>	–	–
Czechia	384	5 (1.3)	[0.42; 3.0]	–	–	–	–	–
Estonia	–	–	–	105	0	[0; 3.5] <sup>b</sup>	–	–
Finland	–	–	–	86	1 (1.2)	[0.03; 6.3]	–	–
France	–	–	–	6264	78 (1.2)	[0.99; 1.6]	–	–
Germany	–	–	–	842	6 (0.71)	[0.26; 1.5]	–	–
Greece	88	7 (8.0)	[3.3; 15.7]	335	0	[0; 1.1] <sup>b</sup>	< 0.001	CA > FBOp
Hungary	206	1 (0.49)	[0.01; 2.7]	–	–	–	–	–
Ireland	–	–	–	1542	0	[0; 0.24] <sup>b</sup>	–	–
Italy	448	2 (0.45)	[0.05; 1.6]	1568	8 (0.51)	[0.22; 1.0]	NS	
Latvia	–	–	–	204	0	[0; 1.8] <sup>b</sup>	–	–
Luxembourg	–	–	–	74	0	[0; 4.9] <sup>b</sup>	–	–
Malta	–	–	–	131	1 (0.76)	[0.02; 4.2]	–	–
Netherlands	108	8 (7.4)	[3.3; 14.1]	513	5 (0.97)	[0.32; 2.3]	< 0.001	CA > FBOp
Poland	17	0	[0; 19.5] <sup>b</sup>	120	0	[0; 3.0] <sup>b</sup>	NS	
Portugal	–	–	–	2106	3 (0.14)	[0.03; 0.42]	–	–
Romania	558	0	[0; 0.66] <sup>b</sup>	1035	0	[0; 0.36] <sup>b</sup>	NS	
Slovakia	–	–	–	304	0	[0; 1.2] <sup>b</sup>	–	–
Slovenia	–	–	–	161	0	[0; 2.3] <sup>b</sup>	–	–
Spain	470	16 (3.4)	[2.0; 5.5]	4673	50 (1.1)	[0.80; 1.4]	< 0.001	CA > FBOp
United Kingdom (Northern Ireland)	–	–	–	569	1 (0.18)	[0; 0.98]	–	–
<b>EU Total (27 + XI)</b>	<b>3042</b>	<b>41 (1.3)</b>	<b>[0.97; 1.8]</b>	<b>22,295</b>	<b>160 (0.72)</b>	<b>[0.61; 0.84]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>2452</b>	<b>35 (1.4)</b>	<b>[1.0; 2.0]</b>	<b>9190</b>	<b>70 (0.76)</b>	<b>[0.59; 0.96]</b>	<b>0.001</b>	<b>CA &gt; FBOp</b>

Abbreviation: –, Data not reported.

<sup>a</sup>p-value: NS, not significant.<sup>b</sup>One-sided, 97.5% confidence interval.

Switzerland reported 0 positive out of 236 tested sheep carcass samples collected by the FBOp, and Montenegro reported 0 positive out of 10 tested samples collected by the CA and 0 positive out of 7 tested samples collected by the FBOp.

## Goat carcasses

**TABLE 16** Comparisons of proportions (%) of *Salmonella*-positive single samples from goat carcasses after dressing but before chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Austria	–	–	–	6	0	[–]	–	–
Belgium	119	0	[0; 3.1] <sup>b</sup>	149	2 (1.3)	[0.16; 4.8]	NS	
Cyprus	10	0	[0; 30.8] <sup>b</sup>	178	0	[0; 2.1] <sup>b</sup>	NS	
Czechia	65	0	[0; 5.5] <sup>b</sup>	–	–	–	–	–
Estonia	–	–	–	15	0	[0; 21.8] <sup>b</sup>	–	–
France	–	–	–	206	0	[0; 1.8] <sup>b</sup>	–	–
Germany	–	–	–	19	0	[0; 17.6] <sup>b</sup>	–	–
Greece	43	3 (7.0)	[1.5; 19.1]	40	0	[0; 8.8] <sup>b</sup>	NS	
Italy	72	0	[0; 5.0] <sup>b</sup>	981	17 (1.7)	[1.0; 2.8]	NS	
Latvia	–	–	–	22	0	[0; 15.4] <sup>b</sup>	–	–
Luxembourg	–	–	–	3	0	[–]	–	–
Malta	–	–	–	49	4 (8.2)	[2.3; 19.6]	–	–
Netherlands	92	1 (1.1)	[0.03; 5.9]	57	0	[0; 6.3] <sup>b</sup>	NS	
Poland	–	–	–	7	0	[–]	–	–
Portugal	–	–	–	694	1 (0.14)	[0; 0.80]	–	–
Romania	20	0	[0; 16.8] <sup>b</sup>	15	0	[0; 21.8] <sup>b</sup>	NS	
Slovakia	–	–	–	3	0	[–]	–	–
Slovenia	–	–	–	22	0	[0; 15.4] <sup>b</sup>	–	–
Spain	152	14 (9.2)	[5.1; 15.0]	30	0	[0; 11.6] <sup>b</sup>	0.0724	CA > FBOp
<b>EU Total (27 + XI)</b>	<b>573</b>	<b>18 (3.1)</b>	<b>[1.9; 4.9]</b>	<b>2496</b>	<b>24 (0.96)</b>	<b>[0.62; 1.4]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>508</b>	<b>18 (3.5)</b>	<b>[2.1; 5.5]</b>	<b>1450</b>	<b>19 (1.3)</b>	<b>[0.79; 2.0]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>

Abbreviations: –, Data not reported; [–], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.<sup>b</sup>One-sided, 97.5% confidence interval.

## Horse carcasses

**TABLE 17** Comparisons of proportions (%) of *Salmonella*-positive single samples from horse carcasses before chilling, by sampler and reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Belgium	35	0	[0; 10.0] <sup>b</sup>	50	0	[0; 7.1] <sup>b</sup>	NS	
Czechia	7	0	[–]	–	–	–	–	–
France	–	–	–	40	0	[0; 8.8] <sup>b</sup>	–	–
Germany	–	–	–	14	1 (7.1)	[0.18; 33.9]	–	–
Ireland	–	–	–	65	5 (7.7)	[2.5; 17.0]	–	–
Italy	143	0	[0; 2.5] <sup>b</sup>	635	1 (0.16)	[0; 0.87]	NS	
Latvia	–	–	–	1	0	[–]	–	–
Netherlands	–	–	–	367	19 (5.2)	[3.1; 8.0]	–	–
Poland	45	0	[0; 7.9] <sup>b</sup>	125	0	[0; 2.9] <sup>b</sup>	NS	
Portugal	–	–	–	39	0	[0; 9.0] <sup>b</sup>	–	–
Romania	53	0	[0; 6.7] <sup>b</sup>	190	0	[0; 1.9] <sup>b</sup>	NS	

(Continues)

TABLE 17 (Continued)

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested samples	N (%) positive samples	CI <sub>95</sub>	N tested samples	N (%) positive samples	CI <sub>95</sub>		
Slovenia	–	–	–	35	0	[0; 10.0] <sup>b</sup>	–	–
Spain	20	0	[0; 16.8] <sup>b</sup>	200	1 (0.50)	[0.01; 2.8]	NS	
<b>EU Total (27 + XI)</b>	<b>303</b>	<b>0</b>	<b>[0; 1.2]<sup>b</sup></b>	<b>1761</b>	<b>27 (1.5)</b>	<b>[1.0; 2.2]</b>	<b>0.0134</b>	<b>CA &lt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>296</b>	<b>0</b>	<b>[0; 1.2]<sup>b</sup></b>	<b>1200</b>	<b>2 (0.17)</b>	<b>[0.02; 0.60]</b>	<b>NS</b>	

Abbreviations: –, Data not reported; [–], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

## Occurrence in food

Monitoring data reported for food sampling units, which do not fit with the criteria described in the previous paragraphs, were described by merging investigations from all sampling stages (primary production, manufacturing, distribution and others), all samplers except 'HACCP and own-checks' and 'private sampling', and all sampling units (single, batch and slaughter animal batch). Only sampling units collected through 'objective sampling' were considered in this context.

### RTE food and non-RTE food

For 2023, 86,115 RTE and 478,743 non-RTE food sampling units were reported from 24 and 28 MSs with very low (0.25%) and low (2.2%) proportions of positive samples, respectively.

Within the category of RTE food, the vast majority of the sampled matrices had very low proportions of *Salmonella*-positive units, with the exception of 'sprouts (sprouted seeds)', for which the prevalence of positive sampling units was low (1.4%; *N*=644).

Within the category of non-RTE food, the highest percentages of positive sampling units were reported for 'meat and meat products from turkeys' (4.3%; *N*=16,533), 'meat and meat products from broilers' (4.1%; *N*=106,699), 'other meat and meat products' (2.1%; *N*=108,988), 'meat and meat products from pigs' (1.8%; *N*=129,115), 'mixed meat products' (1.7%; *N*=9498) and 'milk and milk products' (1.1%; *N*=1566). *Salmonella* isolates were also reported from 'fish and fishery products' (0.81%; *N*=8896), 'meat and meat products from bovine animals' (0.50%; *N*=84,907), 'cereals, dried seeds' (0.47%; *N*=638), 'eggs and egg products' (0.21%; *N*=6828) and 'fruits, vegetables and juices' (0.16%; *N*=1262). Comparing the results for the year 2023 and the previous 3-year period (2020–2022), the overall percentage of *Salmonella*-positive sampling units was rather stable, both for RTE food sampling units (0.25% in 2023 and 0.21% in the previous 3 years) and for non-RTE food (2.2% in 2023 and 2.1% previously).

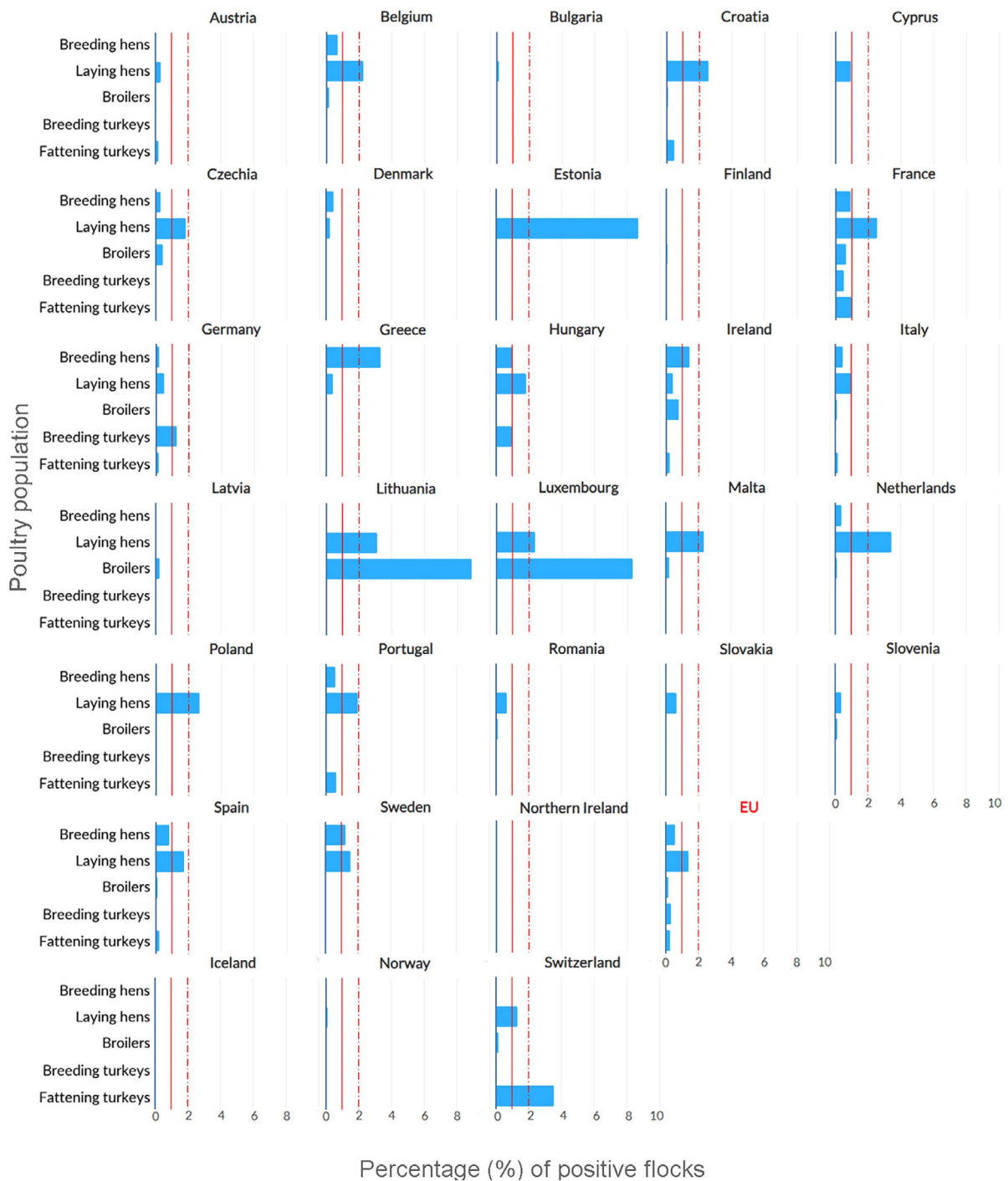
### Fresh meat

In 2023, 2.1% of fresh meat sampling units (*N*=396,548) tested positive for *Salmonella*. The highest percentages of positive samples were reported for 'fresh meat from turkeys' (*N*=16,110; 4.1%) and 'fresh meat from broilers' (*N*=98,929; 3.9%). Compared to the previous 3-year period (2020–2022), no important changes in prevalence were detected.

2.4.4 | *Salmonella* in animals

**Poultry monitoring data in accordance with the national control programmes for *Salmonella***

**Achievement of *Salmonella* reduction targets**



**FIGURE 3** Prevalence of poultry flocks (breeding flocks of *Gallus gallus*, laying hens, broilers, breeding turkeys and fattening turkeys) positive for target *Salmonella* serovars, EU MSs and non-MS countries, 2023. Vertical bars indicate the target to be reached, which was set at 1% for all poultry populations with the exception of laying hens, for which it was 2%. The solid red vertical lines indicate the target for all poultry populations except laying hens, while the dotted vertical lines denote the target specifically for laying hens. For laying hens, in accordance with Commission Regulation (EC) No 517/2011,<sup>22</sup> Lithuania and Luxembourg reached the reduction target (Article 1(b): one adult flock can remain positive for target *Salmonella* serovars for MSs with less than 50 flocks). For breeding turkeys, according to Commission Regulation (EU) No 1190/2012, Germany reached the reduction target (Article 1: one adult flock can remain positive for target *Salmonella* serovars for MSs with less than 100 flocks).

<sup>22</sup>Commission Regulation (EU) No 517/2011 of 25 May 2011 implementing Regulation (EC) No 2160/2003 of the European Parliament and of the Council as regards a Union target for the reduction of the prevalence of certain *Salmonella* serotypes in laying hens of *Gallus gallus* and amending Regulation (EC) No 2160/2003 and Commission Regulation (EU) No 200/2010. OJ L 138, 26.5.2011, p. 45–51.

### Breeding flocks of *Gallus gallus*

All MSs and the United Kingdom (Northern Ireland) (except Poland) reported *Salmonella* NCP data for breeding flocks of *G. gallus*. Luxembourg and Malta do not have such flocks. In 2023, the EU *Salmonella* flock prevalence was 2.3% (compared with 2.1% and 2.5% for 2022 and 2021, respectively), whereas the prevalence of flocks that were positive for any of the five target serovars (*S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium*, *S. Infantis*, *S. Virchow*, *S. Hadar*) was 0.58% (compared with 0.84% and 0.58% in 2022 and 2021, respectively) (Table 18). All reporting countries, except Greece, Ireland and Sweden, met the flock prevalence reduction target of 1% maximum (Figure 3).

**TABLE 18** *Salmonella* in breeding flocks of *Gallus gallus* during the production period (all types of breeding flocks, flock-based data) in countries running control programmes in accordance with Regulation (EC) No 2160/2003, 2023.

Country	N tested flocks	N (%) positive for <i>Salmonella</i> spp.	N (%) positive for target serovars	N (%) positive flocks for				
				<i>S. Enteritidis</i>	<i>S. Typhimurium</i> <sup>a</sup>	<i>S. Hadar</i>	<i>S. Infantis</i>	<i>S. Virchow</i>
Austria	176	2 (1.1)	0	0	0	0	0	0
Belgium	570	8 (1.4)	4 (0.70)	3 (0.53)	0	0	1 (0.18)	0
Bulgaria	327	3 (0.92)	0	0	0	0	0	0
Croatia	88	5 (5.7)	0	0	0	0	0	0
Cyprus	32	3 (9.4)	0	0	0	0	0	0
Czechia	649	4 (0.62)	2 (0.31)	2 (0.31)	0	0	0	0
Denmark	208	3 (1.4)	1 (0.48)	0	1 (0.48)	0	0	0
Estonia	4	0	0	0	0	0	0	0
Finland	142	0	0	0	0	0	0	0
France	1308	26 (2.0)	12 (0.92)	5 (0.38)	6 (0.46)	0	1 (0.08)	0
Germany	937	8 (0.85)	2 (0.21)	1 (0.11)	1 (0.11)	0	0	0
<b>Greece</b>	<b>209</b>	<b>13 (6.2)</b>	<b>7 (3.3)</b>	<b>5 (2.4)</b>	<b>1 (0.48)</b>	<b>0</b>	<b>0</b>	<b>1 (0.48)</b>
Hungary	507	5 (0.99)	5 (0.99)	2 (0.39)	3 (0.59)	0	0	0
<b>Ireland</b>	<b>138</b>	<b>3 (2.2)</b>	<b>2 (1.4)</b>	<b>1 (0.72)</b>	<b>1 (0.72)</b>	<b>0</b>	<b>0</b>	<b>0</b>
Italy	1228	36 (2.9)	6 (0.49)	0	3 (0.24)	0	3 (0.24)	0
Latvia	38	0	0	0	0	0	0	0
Lithuania	43	0	0	0	0	0	0	0
Netherlands	1487	11 (0.74)	6 (0.40)	3 (0.20)	1 (0.07)	0	2 (0.13)	0
Portugal	515	12 (2.3)	3 (0.58)	0	3 (0.58)	0	0	0
Romania	512	12 (2.3)	0	0	0	0	0	0
Slovakia	121	0	0	0	0	0	0	0
Slovenia	130	0	0	0	0	0	0	0
Spain	1651	102 (6.2)	14 (0.85)	4 (0.24)	4 (0.24)	1 (0.06)	5 (0.30)	0
<b>Sweden</b>	<b>160</b>	<b>2 (1.2)</b>	<b>2 (1.2)</b>	<b>2 (1.2)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
United Kingdom (Northern Ireland)	248	0	0	0	0	0	0	0
<b>EU Total (27 + XI)</b>	<b>11,428</b>	<b>258 (2.3)</b>	<b>66 (0.58)</b>	<b>28 (0.25)</b>	<b>24 (0.21)</b>	<b>1 (0.01)</b>	<b>12 (0.11)</b>	<b>1 (0.01)</b>
Iceland	45	0	0	0	0	0	0	0
Norway	252	0	0	0	0	0	0	0
Switzerland	125	0	0	0	0	0	0	0

Note: Countries not meeting the reduction target are highlighted in bold font.

<sup>a</sup>*Salmonella* Typhimurium, including monophasic *S. Typhimurium* (1,4,[5],12:i:-).

### Flocks of laying hens

All MSs and the United Kingdom (Northern Ireland) reported *Salmonella* NCP data for laying hen flocks (Table 19). In 2023, the EU *Salmonella* flock prevalence was 3.7% (compared with 3.4% and 3.3% in 2022 and 2021, respectively), whereas the EU prevalence of flocks positive for any of the two target serovars (*S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium*) was 1.4%, which was comparable with previous years (1.2% and 1.3% in 2022 and 2021, respectively).

Seven MSs (Belgium, Croatia, Estonia, France, Malta, the Netherlands and Poland) did not meet the reduction target of 2% or less (Figure 3). In 2022, the number of MSs not meeting the target was four.

**TABLE 19** *Salmonella* in laying hen flocks of *Gallus gallus* during the production period (flock-based data) in countries running control programmes in accordance with Regulation (EC) No 2160/2003, 2023.

Country	N tested flocks	N (%) positive for <i>Salmonella</i> spp.	N (%) positive for target serovars	N (%) positive flocks for	
				<i>S. Enteritidis</i>	<i>S. Typhimurium</i> <sup>a</sup>
Austria	3430	45 (1.3)	12 (0.35)	2 (0.06)	10 (0.29)
<b>Belgium</b>	<b>751</b>	<b>28 (3.7)</b>	<b>17 (2.3)</b>	<b>15 (2.0)</b>	<b>2 (0.27)</b>
Bulgaria <sup>b</sup>	1392	10 (0.72)	2 (0.14)	2 (0.14)	0
<b>Croatia</b>	<b>195</b>	<b>31 (15.9)</b>	<b>5 (2.6)</b>	<b>3 (1.5)</b>	<b>2 (1.0)</b>
Cyprus	106	14 (13.2)	1 (0.94)	1 (0.94)	0
Czechia	484	12 (2.5)	9 (1.9)	9 (1.9)	0
Denmark	378	7 (1.9)	1 (0.26)	1 (0.26)	0
<b>Estonia</b>	<b>23</b>	<b>2 (8.7)</b>	<b>2 (8.7)</b>	<b>1 (4.3)</b>	<b>1 (4.3)</b>
Finland	538	0	0	0	0
<b>France</b>	<b>6727</b>	<b>314 (4.7)</b>	<b>170 (2.5)</b>	<b>126 (1.9)</b>	<b>44 (0.65)</b>
Germany	6840	63 (0.92)	34 (0.50)	24 (0.35)	10 (0.15)
Greece	704	38 (5.4)	3 (0.43)	2 (0.28)	1 (0.14)
Hungary	813	15 (1.8)	15 (1.8)	14 (1.7)	1 (0.12)
Ireland	465	2 (0.43)	2 (0.43)	0	2 (0.43)
Italy	4606	368 (8.0)	48 (1.0)	36 (0.78)	12 (0.26)
Latvia	54	0	0	0	0
Lithuania	32	1 (3.1)	1 (3.1) <sup>c</sup>	1 (3.1)	0
Luxembourg	42	2 (4.8)	1 (2.4) <sup>c</sup>	1 (2.4)	0
<b>Malta</b>	<b>127</b>	<b>26 (20.5)</b>	<b>3 (2.4)</b>	<b>3 (2.4)</b>	<b>0</b>
<b>Netherlands</b>	<b>2516</b>	<b>112 (4.5)</b>	<b>87 (3.5)</b>	<b>83 (3.3)</b>	<b>4 (0.16)</b>
<b>Poland</b>	<b>1424</b>	<b>66 (4.6)</b>	<b>38 (2.7)</b>	<b>36 (2.5)</b>	<b>2 (0.14)</b>
Portugal	511	32 (6.3)	10 (2.0)	6 (1.2)	4 (0.78)
Romania	898	30 (3.3)	6 (0.67)	2 (0.22)	4 (0.45)
Slovakia	293	2 (0.68)	2 (0.68)	2 (0.68)	0
Slovenia	257	5 (1.9)	1 (0.39)	0	1 (0.39)
Spain	3399	208 (6.1)	59 (1.7)	37 (1.1)	22 (0.65)
Sweden	1024	17 (1.7)	16 (1.6)	16 (1.6)	0
United Kingdom (Northern Ireland)	737	2 (0.27)	0	0	0
<b>EU Total (27 + XI)</b>	<b>38,766</b>	<b>1452 (3.7)</b>	<b>545 (1.4)</b>	<b>423 (1.1)</b>	<b>122 (0.31)</b>
Iceland	50	0	0	0	0
Norway	863	2 (0.23)	1 (0.12)	0	1 (0.12)
Switzerland	821	11 (1.3)	11 (1.3)	8 (0.97)	3 (0.37)

Note: Countries not meeting the reduction target are highlighted in bold font.

<sup>a</sup>*Salmonella* Typhimurium, including monophasic *S. Typhimurium* with the antigenic formula 1,4,[5],12:i:-.

<sup>b</sup>During the final phase of report production, Bulgaria reported a correction, stating that the number of tested laying hen flocks was 226, of which 3 (1.33%) were positive for target serovars. Notably, all three positive cases were identified as *S. Enteritidis*.

<sup>c</sup>In accordance with Commission Regulation (EC) No 517/2011, Article 1.1(b) 'for Member States with less than 50 flocks of adult laying hens, not more than one adult flock may remain positive'. Lithuania and Luxembourg met the reduction target for laying hens.

### Broiler flocks

All MSs and the United Kingdom (Northern Ireland) reported *Salmonella* NCP data for broiler flocks (Table 20). *Salmonella* was found in 3.9% (3.5% in 2022 and 3.8% in 2021) of the tested flocks. The EU prevalence of flocks positive for any of the two target serovars (*S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium*) was 0.19%, which was similar to the prevalence in previous years (0.25% in 2022 and 0.28% in 2021). Lithuania and Luxembourg did not meet the reduction target of 1% or less (Figure 3), unlike in the previous year, when all MSs met the target.

**TABLE 20** *Salmonella* in broiler flocks of *Gallus gallus* before slaughter (flock-based data) in countries running control programmes in accordance with Regulation (EC) No 2160/2003, 2023.

Country	N tested flocks	N (%) positive for <i>Salmonella</i> spp.	N (%) positive for target serovars	N (%) positive flocks for	
				<i>S. Enteritidis</i>	<i>S. Typhimurium</i> <sup>a</sup>
Austria	6232	198 (3.2)	5 (0.08)	2 (0.03)	3 (0.05)
Belgium	11,294	244 (2.2)	19 (0.17)	3 (0.03)	16 (0.14)
Bulgaria	408	4 (0.98)	0	0	0
Croatia	3093	87 (2.8)	3 (0.10)	1 (0.03)	2 (0.06)
Cyprus	950	4 (0.42)	0	0	0
Czechia	4776	55 (1.2)	21 (0.44)	20 (0.42)	1 (0.02)
Denmark	3966	15 (0.38)	1 (0.03)	1 (0.03)	0
Estonia	685	0	0	0	0
Finland	3889	4 (0.10)	4 (0.10)	0	4 (0.10)
France	56,645	1431 (2.5)	360 (0.64)	187 (0.33)	173 (0.31)
Germany	20,486	204 (1.0)	6 (0.03)	2 (0.01)	4 (0.02)
Greece	8785	29 (0.33)	2 (0.02)	2 (0.02)	0
Hungary	7696	5 (0.06)	5 (0.06)	1 (0.01)	4 (0.05)
Ireland	3658	59 (1.6)	28 (0.77)	0	28 (0.77)
Italy	27,142	7364 (27.1)	30 (0.11)	24 (0.09)	6 (0.02)
Latvia	768	19 (2.5)	2 (0.26)	0	2 (0.26)
<b>Lithuania</b>	<b>191</b>	<b>18 (9.4)</b>	<b>17 (8.9)</b>	<b>17 (8.9)</b>	<b>0</b>
<b>Luxembourg</b>	<b>12</b>	<b>4 (33.3)</b>	<b>1 (8.3)</b>	<b>1 (8.3)</b>	<b>0</b>
Malta	449	16 (3.6)	1 (0.22)	0	1 (0.22)
Netherlands	15,605	428 (2.7)	17 (0.11)	4 (0.03)	13 (0.08)
Poland	49,342	11 (0.02)	3 (0.01)	3 (0.01)	0
Portugal	10,430	38 (0.36)	6 (0.06)	2 (0.02)	4 (0.04)
Romania	14,930	231 (1.5)	17 (0.11)	15 (0.10)	2 (0.01)
Slovakia	2481	46 (1.9)	2 (0.08)	2 (0.08)	0
Slovenia	2512	346 (13.8)	4 (0.16)	0	4 (0.16)
Spain	37,791	1006 (2.7)	40 (0.11)	18 (0.05)	22 (0.06)
Sweden	3912	1 (0.03)	1 (0.03)	0	1 (0.03)
United Kingdom (Northern Ireland)	7033	17 (0.24)	0	0	0
<b>EU Total (27 + XI)</b>	<b>305,161</b>	<b>11,884 (3.9)</b>	<b>595 (0.19)</b>	<b>305 (0.10)</b>	<b>290 (0.10)</b>
Iceland	676	11 (1.6)	0	0	0
Norway	4576	0	0	0	0
Switzerland	595	1 (0.17)	1 (0.17)	1 (0.17)	0

Note: Countries not meeting the reduction target are highlighted in bold font.

<sup>a</sup>*Salmonella* Typhimurium, including monophasic *S. Typhimurium* (1,4,[5],12:i:-).

In accordance with Commission Regulation (EU) No 200/2012,<sup>23</sup> MSs must separately report the results obtained by the FBOp and the CA for broiler flocks. Hungary provided data exclusively from the CA, while Croatia, Lithuania and the Netherlands, as in the previous year, did not meet this requirement by failing to submit broiler flock data differentiated by sampler. A comparison of the prevalence of flocks positive for either of the two target serovars, based on CA and FBOp data, along with the *p*-value and its interpretation, is presented in Table 21. The prevalence found for official controls was significantly higher than for own-checks, both considering overall EU data and for nine MSs.

<sup>23</sup>Commission Regulation (EU) No 200/2012 of 8 March 2012 concerning a Union target for the reduction of *Salmonella* Enteritidis and *Salmonella* Typhimurium in flocks of broilers, as provided for in Regulation (EC) No 2160/2003 of the European Parliament and of the Council.



**TABLE 21** Comparisons of the prevalence of target *Salmonella* serovar-positive broiler flocks, by sampler and by reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>		
Austria	123	0	[0; 3.0] <sup>b</sup>	6121	5 (0.08)	[0.03; 0.19]	NS	
Belgium	91	2 (2.2)	[0.27; 7.7]	11,280	17 (0.15)	[0.09; 0.24]	0.0099	CA > FBOp
Bulgaria	129	0	[0; 2.8] <sup>b</sup>	3752	0	[0; 0.10] <sup>b</sup>	NS	
Cyprus	10	0	[0; 30.8] <sup>b</sup>	950	0	[0; 0.39] <sup>b</sup>	NS	
Czechia	36	2 (5.6)	[0.68; 18.7]	4746	19 (0.40)	[0.24; 0.62]	0.0106	CA > FBOp
Denmark	274	0	[0; 1.3] <sup>b</sup>	3966	1 (0.03)	[0; 0.14]	NS	
Estonia	230	0	[0; 1.6] <sup>b</sup>	419	0	[0; 0.88] <sup>b</sup>	NS	
Finland	506	0	[0; 0.73] <sup>b</sup>	3383	4 (0.12)	[0.03; 0.30]	NS	
France	583	15 (2.6)	[1.4; 4.2]	56,062	345 (0.62)	[0.55; 0.68]	< 0.001	CA > FBOp
Germany	294	0	[0; 1.2] <sup>b</sup>	20,484	6 (0.03)	[0.01; 0.06]	NS	
Greece	101	2 (2.0)	[0.24; 7.0]	8785	0	[0; 0.04] <sup>b</sup>	< 0.001	CA > FBOp
Hungary	7696	0	[0; 0.05] <sup>b</sup>	–	–	–	–	–
Ireland	76	1 (1.3)	[0.03; 7.1]	3658	27 (0.74)	[0.49; 1.1]	NS	
Italy	441	16 (3.6)	[2.1; 5.8]	27,081	14 (0.05)	[0.03; 0.09]	< 0.001	CA > FBOp
Latvia	9	0	[–]	759	2 (0.26)	[0.03; 0.95]	–	–
Luxembourg	12	0	[0; 26.5] <sup>b</sup>	12	1 (8.3)	[0.21; 38.5]	NS	
Malta	5	1 (20.0)	[–]	444	0	[0; 0.83] <sup>b</sup>	–	–
Poland <sup>c</sup>	1199	50 (4.2)	[3.1; 5.5]	49,264	19 (0.04)	[0.02; 0.06]	< 0.001	CA > FBOp
Portugal	104	1 (0.96)	[0.02; 5.2]	10,421	5 (0.05)	[0.02; 0.11]	0.0579	CA > FBOp
Romania	327	2 (0.61)	[0.07; 2.2]	14,565	15 (0.10)	[0.06; 0.17]	0.0526	CA > FBOp
Slovakia	24	0	[0; 14.2] <sup>b</sup>	2477	2 (0.08)	[0.01; 0.29]	NS	
Slovenia	31	0	[0; 11.2] <sup>b</sup>	2481	4 (0.16)	[0.04; 0.41]	NS	
Spain	437	4 (0.92)	[0.25; 2.3]	37,751	36 (0.10)	[0.07; 0.13]	0.0011	CA > FBOp
Sweden	177	0	[0; 2.1] <sup>b</sup>	3912	1 (0.03)	[0; 0.14]	NS	
United Kingdom (Northern Ireland)	49	0	[0; 7.3] <sup>b</sup>	6984	0	[0; 0.05] <sup>b</sup>	NS	
<b>EU Total (27 + XI)</b>	<b>12,964</b>	<b>96 (0.74)</b>	<b>[0.60; 0.90]</b>	<b>279,757</b>	<b>523 (0.19)</b>	<b>[0.17; 0.20]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>5268</b>	<b>96 (1.8)</b>	<b>[1.5; 2.2]</b>	<b>279,757</b>	<b>523 (0.19)</b>	<b>[0.17; 0.20]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>

Abbreviations: –, Data not reported; [–], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

<sup>c</sup>The data reported by Poland in the context of Commission Regulation (EU) No 200/2012 (50 flocks positive for target serovars tested by the CA and 19 by the FBOp) are not consistent with the data reported for broiler flocks as overall merged data (Table 20) (three flocks positive for target serovars).

### Breeding flocks of turkeys

For breeding turkeys, 12 MSs and 2 non-MSs reported *Salmonella* NCP data, and the overall EU *Salmonella* flock prevalence was 6.4%, compared with 4.3% in 2022 and 3.9% in 2021. The prevalence of flocks positive for any of the two target serovars (*S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium*) was 0.35% (0.32% and 0.49% in 2022 and 2021, respectively). All MSs met the reduction target of 1% (Figure 3, Table 22).

**TABLE 22** *Salmonella* in breeding flocks of turkeys during the production period (flock-based data) in countries running control programmes in accordance with Regulation (EC) No 2160/2003, 2023.

Country	N tested flocks	N (%) positive for <i>Salmonella</i> spp.	N (%) positive for target serovars	N (%) positive flocks for	
				<i>S. Enteritidis</i>	<i>S. Typhimurium</i> <sup>a</sup>
Bulgaria	1	0	0	0	0
Finland	7	0	0	0	0
France	398	17 (4.3)	2 (0.50)	2 (0.50)	0
Germany	79	2 (2.5)	1 (1.3) <sup>b</sup>	0	1 (1.3)
Greece	4	2 (50.0)	0	0	0
Hungary	102	1 (0.98)	1 (0.98)	1 (0.98)	0
Ireland	4	0	0	0	0
Italy	279	41 (14.7)	0	0	0
Poland	122	1 (0.82)	0	0	0
Slovakia	53	0	0	0	0
Spain	99	10 (10.1)	0	0	0
Sweden	8	0	0	0	0
<b>EU Total (27 + XI)</b>	<b>1156</b>	<b>74 (6.4)</b>	<b>4 (0.35)</b>	<b>3 (0.26)</b>	<b>1 (0.09)</b>
Iceland	6	0	0	0	0
Norway	12	0	0	0	0

<sup>a</sup>*Salmonella* Typhimurium, including monophasic *S. Typhimurium* (1,4,[5],12:i:-).

<sup>b</sup>In accordance with Commission Regulation (EU) No 1190/2012, Article 1.1 'for Member States with less than 100 flocks of adult breeding or fattening turkeys, the Union target shall be that annually no more than one flock of adult breeding or fattening turkeys may remain positive', Germany met the reduction target for breeding turkeys.

In accordance with Commission Regulation (EC) No 1190/2012,<sup>24</sup> MSs are required to report breeding turkey flock results separately for the CA and FBOp, in addition to the overall merged data. Nine MSs complied with this requirement, whereas three MSs (Bulgaria, Hungary and Poland) did not report separate results from the CA and FBOp. A comparison of the prevalence of flocks positive for either of the two target serovars, based on the CA and FBOp data, along with the *p*-value and its interpretation, is presented in Table 23. There were no significant differences in prevalence found from official and own-check controls.

**TABLE 23** Comparisons of the prevalence of target *Salmonella* serovar-positive flocks of breeding turkeys, by sampler and by reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			<i>p</i> -value <sup>a</sup>	Interpretation
	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>		
Finland	7	0	[-]	7	0	[-]	-	-
France	34	0	[0; 10.3] <sup>b</sup>	358	2 (0.56)	[0.07; 2.0]	NS	
Germany	77	0	[0; 4.7] <sup>b</sup>	79	1 (1.3)	[0.03; 6.9]	NS	
Greece	2	0	[-]	4	0	[-]	-	-
Ireland	4	0	[-]	4	0	[-]	-	-
Italy	165	0	[0; 2.2] <sup>b</sup>	279	0	[0; 1.3] <sup>b</sup>	NS	
Slovakia	37	0	[0; 9.5] <sup>b</sup>	53	0	[0; 6.7] <sup>b</sup>	NS	
Spain	57	0	[0; 6.3] <sup>b</sup>	99	0	[0; 3.7] <sup>b</sup>	NS	
Sweden	8	0	[-]	8	0	[-]	-	-
<b>EU Total (27 + XI)</b>	<b>391</b>	<b>0</b>	<b>[0; 0.94]<sup>b</sup></b>	<b>891</b>	<b>3 (0.34)</b>	<b>[0.07; 0.98]</b>	<b>NS</b>	
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>391</b>	<b>0</b>	<b>[0; 0.94]<sup>b</sup></b>	<b>891</b>	<b>3 (0.34)</b>	<b>[0.07; 0.98]</b>	<b>NS</b>	

Abbreviations: -, Data not reported; [-], The confidence interval is not provided because of the small sample size.

<sup>a</sup>*p*-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

<sup>24</sup>Commission Regulation (EU) No 1190/2012 of 12 December 2012 concerning a Union target for the reduction of *Salmonella* Enteritidis and *Salmonella* Typhimurium in flocks of turkeys, as provided for in Regulation (EC) No 2160/2003 of the European Parliament and of the Council.

*Flocks of fattening turkeys*

For fattening turkey flocks, 22 MSs and the United Kingdom (Northern Ireland) provided data (Table 24). The overall EU *Salmonella* flock prevalence for fattening turkey flocks was 8.0%, compared with 9.2% and 9.1% in 2022 and 2021, respectively. The EU prevalence of flocks positive for any of the two target serovars (*S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium*) was 0.28%, compared with 0.32% in 2022 and 0.31% in 2021. All reporting countries met the reduction target of 1% or less (Figure 3).

**TABLE 24** *Salmonella* in fattening flocks of turkeys before slaughter during the production period (flock-based data) in countries running control programmes in accordance with Regulation (EC) No 2160/2003, 2023.

Country	N tested flocks	N (%) positive for <i>Salmonella</i> spp.	N (%) positive for target serovars	N (%) positive flocks for	
				<i>S. Enteritidis</i>	<i>S. Typhimurium</i> <sup>a</sup>
Austria	498	12 (2.4)	1 (0.20)	0	1 (0.20)
Belgium	193	0	0	0	0
Croatia	426	6 (1.4)	2 (0.47)	1 (0.23)	1 (0.23)
Cyprus	5	3 (60.0)	0	0	0
Czechia	236	1 (0.42)	0	0	0
Denmark	151	1 (0.66)	0	0	0
Finland	286	0	0	0	0
France	4953	164 (3.3)	48 (0.97)	30 (0.61)	18 (0.36)
Germany	3819	18 (0.47)	7 (0.18)	1 (0.03)	6 (0.16)
Greece	53	1 (1.9)	0	0	0
Hungary	1314	0	0	0	0
Ireland	461	9 (2.0)	1 (0.22)	0	1 (0.22)
Italy	4792	1882 (39.3)	8 (0.17)	0	8 (0.17)
Lithuania	7	0	0	0	0
Netherlands	443	4 (0.90)	0	0	0
Poland	6348	1 (0.02)	0	0	0
Portugal	1254	66 (5.3)	8 (0.64)	0	8 (0.64)
Romania	250	3 (1.2)	0	0	0
Slovakia	125	2 (1.6)	0	0	0
Slovenia	105	7 (6.7)	0	0	0
Spain	3857	193 (5.0)	9 (0.23)	1 (0.03)	8 (0.21)
Sweden	119	0	0	0	0
United Kingdom (Northern Ireland)	58	0	0	0	0
<b>EU Total (27 + XI)</b>	<b>29,753</b>	<b>2373 (8.0)</b>	<b>84 (0.28)</b>	<b>33 (0.11)</b>	<b>51 (0.17)</b>
Iceland	31	0	0	0	0
Norway	286	0	0	0	0
Switzerland	28	1 (3.6)	1 (3.6)	1 (3.6)	0

<sup>a</sup>*Salmonella* Typhimurium, including monophasic *S. Typhimurium* (1,4,[5],12:i:-).

In accordance with Commission Regulation (EU) No 1190/2012, MSs are required to report fattening turkey flock results separately for the CA and FBOp, in addition to the overall merged data. Seventeen MSs and the United Kingdom (Northern Ireland) complied with this reporting requirement, while Croatia and the Netherlands did not provide separate results for the CA and FBOp. Bulgaria and Hungary reported only CA data, and Denmark submitted solely own-check results. A comparison of the prevalence of flocks positive for either of the two target serovars, based on the CA and FBOp data, along with the *p*-value and its interpretation, is presented in Table 25. The prevalence found from official controls was significantly higher than that from own-checks, both considering overall EU data and for six MSs.

**TABLE 25** Comparisons of the prevalence of target *Salmonella* serovar-positive flocks of fattening turkeys, by sampler and by reporting MS, EU, 2023.

Country	Competent authority (CA)			Food business operator (FBOp)			p-value <sup>a</sup>	Interpretation
	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>	N tested flocks	N (%) flocks positive for target serovars	CI <sub>95</sub>		
Austria	22	0	[0; 15.4] <sup>b</sup>	492	1 (0.20)	[0.01; 1.1]	NS	
Belgium	4	0	[-]	193	0	[0; 1.9] <sup>b</sup>	-	-
Bulgaria	1	0	[-]	-	-	-	-	-
Cyprus	3	0	[-]	4	0	[-]	-	-
Czechia	10	0	[0; 30.8] <sup>b</sup>	226	0	[0; 1.6] <sup>b</sup>	NS	
Denmark	-	-	-	151	0	[0; 2.4] <sup>b</sup>	-	-
Finland	33	0	[0; 10.6] <sup>b</sup>	253	0	[0; 1.4] <sup>b</sup>	NS	
France	129	4 (3.1)	[0.85; 7.7]	4824	44 (0.91)	[0.66; 1.2]	0.0354	CA > FBOp
Germany	154	2 (1.3)	[0.16; 4.6]	3814	5 (0.13)	[0.04; 0.31]	0.0276	CA > FBOp
Greece	13	0	[0; 24.7] <sup>b</sup>	53	0	[0; 6.7] <sup>b</sup>	NS	
Hungary	1314	0	[0; 0.28] <sup>b</sup>	-	-	-	-	-
Ireland	13	1 (7.7)	[0.19; 36.0]	461	0	[0; 0.80] <sup>b</sup>	0.0274	CA > FBOp
Italy	135	4 (3.0)	[0.81; 7.4]	4779	4 (0.08)	[0.02; 0.21]	< 0.001	CA > FBOp
Poland <sup>c</sup>	168	12 (7.1)	[3.7; 12.1]	6293	3 (0.05)	[0.01; 0.14]	< 0.001	CA > FBOp
Portugal	18	0	[0; 18.5] <sup>b</sup>	1251	8 (0.64)	[0.28; 1.3]	NS	
Romania	23	0	[0; 14.8] <sup>b</sup>	250	0	[0; 1.5] <sup>b</sup>	NS	
Slovakia	9	0	[-]	123	0	[0; 3.0] <sup>b</sup>	-	-
Slovenia	3	0	[-]	102	0	[0; 3.6] <sup>b</sup>	-	-
Spain	75	2 (2.7)	[0.32; 9.3]	3850	7 (0.18)	[0.07; 0.37]	0.0119	CA > FBOp
Sweden	26	0	[0; 13.2] <sup>b</sup>	119	0	[0; 3.1] <sup>b</sup>	NS	
United Kingdom (Northern Ireland)	5	0	[-]	53	0	[0; 6.7] <sup>b</sup>	-	-
<b>EU Total (27 + XI)</b>	<b>2158</b>	<b>25 (1.2)</b>	<b>[0.75; 1.7]</b>	<b>27,291</b>	<b>72 (0.26)</b>	<b>[0.21; 0.33]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>
<b>EU Total (27 + XI) providing CA and FBOp data</b>	<b>843</b>	<b>25 (3.0)</b>	<b>[1.9; 4.3]</b>	<b>27,140</b>	<b>72 (0.27)</b>	<b>[0.21; 0.33]</b>	<b>&lt; 0.001</b>	<b>CA &gt; FBOp</b>

Abbreviations: -, Data not reported; [-], The confidence interval is not provided because of the small sample size.

<sup>a</sup>p-value: NS, not significant.

<sup>b</sup>One-sided, 97.5% confidence interval.

<sup>c</sup>Poland's data reported under Commission Regulation (EU) No 1190/2012 (12 flocks positive for target serovars tested by the CA and three by the FBOp) conflict with the merged fattening turkey flock data displayed in Table 24, which shows zero flocks positive for target serovars.

### Achievement of final *Salmonella* reduction targets since the start of the NCPs

Final *Salmonella* reduction targets have been applied for breeding *G. gallus* since 2010, for laying hens since 2011, for broilers since 2012 and for breeding and fattening turkeys since 2013. From 2010 to 2019, the United Kingdom was included in the EU-level assessment, while from 2021 onwards, only Northern Ireland was included (see Introduction).

For breeding *G. gallus*, during the NCP implementation period (2010–2023), the number of reporting countries fluctuated between 24 and 26. The lowest compliance rates were recorded in 2012 (76.0%) and 2019 (79.2%), while the highest rates were observed in 2015 and 2016, with 92.0% of MSs meeting their reduction targets. In the last 3 years (2021–2023), compliance steadily improved, with 80.8%, 84.6% and 88.0% of MSs meeting their targets, respectively.

For laying hens (2011–2023), 26 to 28 countries reported data. The lowest compliance rates, where fewer than 80% of MSs met the target, were observed in 2021 (71.4%), 2020 (73.1%), 2023 (75.0%) and 2018 (77.8%). In contrast, in 2013, all reporting countries met their targets. Overall, compliance rates have been lower in recent years compared to the initial years of NCP implementation.

In the case of broilers (2012–2023), 26 to 28 countries submitted reports. Annual compliance rates consistently exceeded 88.5%. Notably, all reporting countries met the target in 2022. In years such as 2013, 2017, 2018 and 2019, only one country failed to meet the target, while the highest number of non-compliant countries (three) was observed in 2012, 2014, 2020 and 2021.

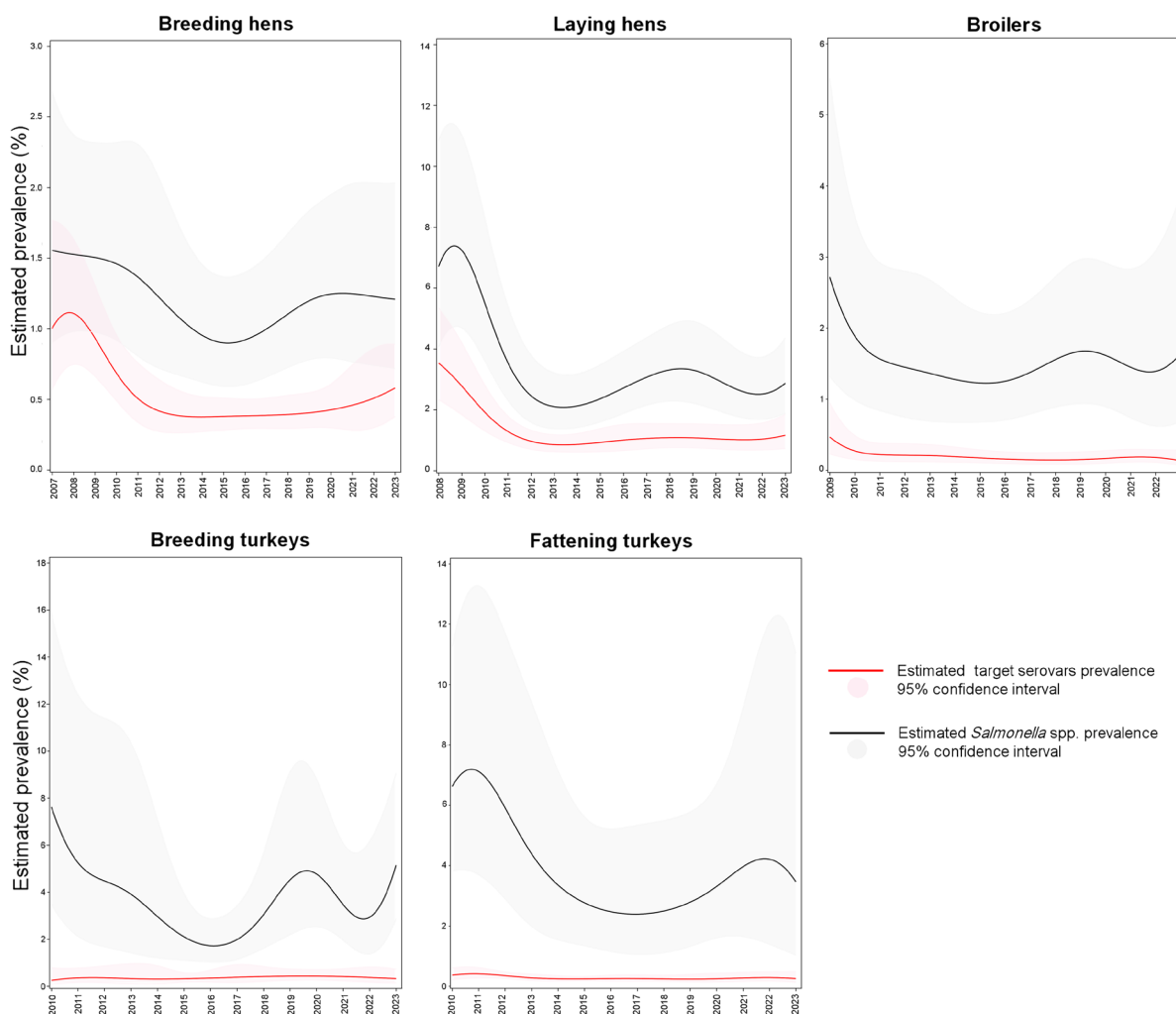
For breeding turkeys (2013–2023), 12 to 15 reporting countries provided data. The highest non-compliance occurred in 2017, with three reporting countries not meeting the target. However, in six separate years (2013, 2014, 2015, 2019, 2022 and 2023), all reporting MSs met their targets.

Regarding fattening turkeys (2013–2023), 21 to 24 countries reported data. The greatest number of reporting countries failing to meet the target (three) occurred in 2018 and 2020. By 2023, all reporting countries successfully met the final reduction target.

The results for all poultry populations, reporting MSs and years are available at Zenodo [here](#).

### Salmonella prevalence trends in poultry flocks

Trends in the estimated EU prevalence of poultry flocks positive for *Salmonella* spp. and target *Salmonella* serovars, for different poultry populations, since the implementation of the EU-wide 2007–2023 NCPs, are displayed in Figure 4.

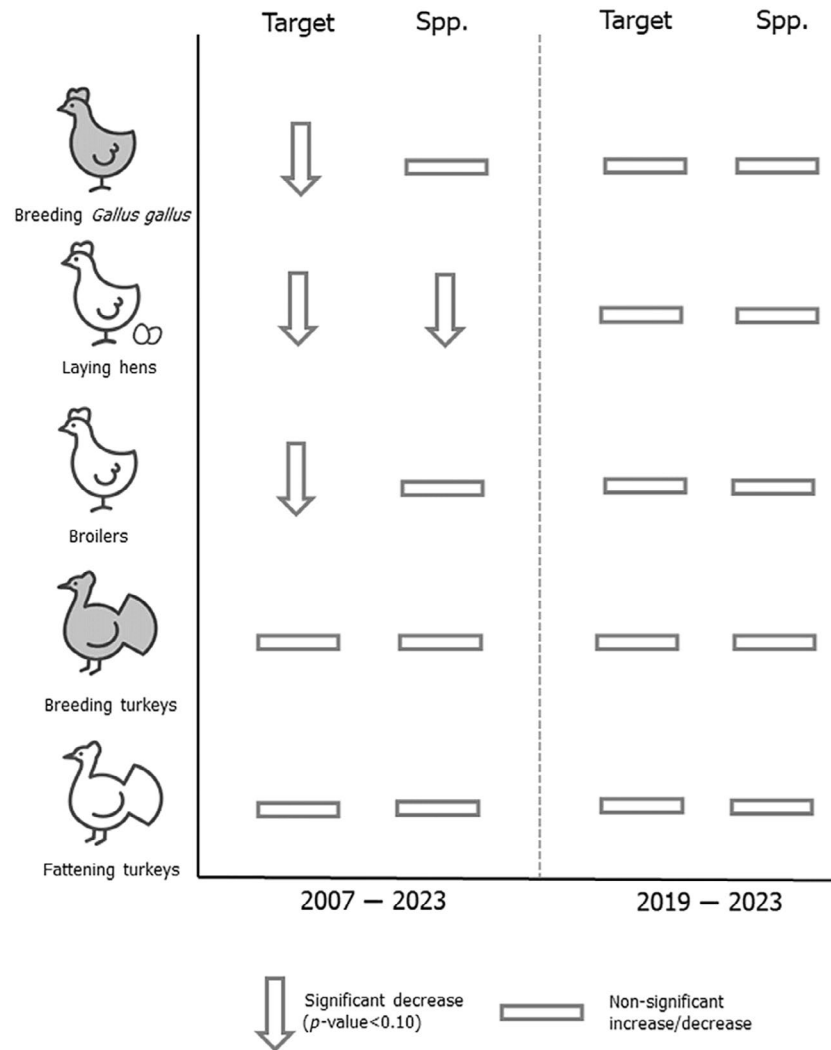


**FIGURE 4** Trend in the estimated prevalence of poultry flocks positive for *Salmonella* spp. and target *Salmonella* serovars, at EU level for different poultry populations, 2007–2023. The apparent discrepancy between the proportion of positive flocks (both for target *Salmonella* serovars and for *Salmonella* spp., as described in the previous paragraphs) and the estimated prevalence shown above is due to the fact that the first value is the ratio of all positive to all tested flocks, whereas the estimated prevalence is obtained by modelling the ratio of positive to all tested flocks in each reporting country, taking into account inter-country variability and the correlation between years.

In the supporting information for this report (*Salmonella* poultry outcome trend analyses, available at Zenodo [here](#)), trends in EU level percentages of flocks positive for *Salmonella*, for target and for non-target serovars, as well as for *S. Enteritidis*, are presented and compared across the poultry populations covered by the NCPs. Moreover, figures show the modelling results for trends in prevalence for *Salmonella* spp. and target *Salmonella* serovars in poultry flocks. Detailed outputs of trend analyses (at subject level and population level) are reported.

Figure 5 provides a summary of the EU-wide prevalence of *Salmonella* spp.-positive and target *Salmonella* serovar-positive flocks across different poultry populations. This includes both the long-term trend from 2007 to 2023, covering the entire period of NCP implementation and the short-term trend from 2019 to 2023. A significant long-term decrease in the prevalence of target *Salmonella* serovar-positive flocks was observed in breeding *Gallus gallus*, laying hens and broilers. In contrast, no significant changes were detected in the short term for any of these populations. Regarding the prevalence

of *Salmonella* spp.-positive flocks, a significant long-term decrease was observed solely in laying hens over the NCP implementation period.



**FIGURE 5** Trends in EU level prevalence of target *Salmonella* serovars (Target)-positive or *Salmonella* spp. (Spp.)-positive flocks of poultry populations (2007–2023 and 2019–2023).

### **Salmonella data for other animals**

Excluding data from NCPs for poultry, 149,814 samples for *Salmonella* detection collected from animals of various species were reported by 18 MSs. Among these, 6.2% of the samples were positive for *Salmonella* spp. The largest number of samples came from pigs ( $N=75,621$  reported by 16 MSs, 50.5% of the total number of samples), of which 9.3% tested positive for *Salmonella*. The second largest number of samples was from cattle (bovine animals) ( $N=29,437$  reported by 16 MSs, 19.6%) and 3.7% of these were positive. Cats had the highest percentage, with 14.0% of samples testing positive, reported by six MSs. Also noteworthy was the prevalence of *Salmonella* spp.-positive wild boar, 8.0%, reported by two MSs. For solipeds, 3.7% of samples were positive for *Salmonella* and were reported by six MSs. These statistics should be interpreted with caution, as the reported prevalence may have been influenced by the sampling context and scope.

#### 2.4.5 | *Salmonella* in feed

In 2023, the overall EU-level occurrence of *Salmonella*-positive sampling units in any 'animal and vegetable-derived feed' was 0.48% ( $N=59,337$ ). In compound feed (finished feed for animals), the prevalence of *Salmonella*-positive sampling units was 0.54% for cattle feed ( $N=1120$ ), 0.38% for poultry feed ( $N=9267$ ) and 0.43% for pig feed ( $N=2824$ ). There were no noticeable isolates in 2023. The prevalence of *Salmonella*-positive sampling units for pet food was 1.0% ( $N=3163$ ).

## 2.4.6 | *Salmonella* serovars in humans, food and animals

### Humans

#### *Serovars acquired in the EU*

To estimate the impact of *Salmonella* infections acquired at the EU level, serovar data were analysed for domestic and travel-associated cases in which the probable country of infection was an EU MS. Information on *Salmonella* serovars with travel data (importation and/or probable country of infection) was available from 25 MSs (Bulgaria and Croatia did not report serovar data), representing 66.7% of cases with known serovar data in 2023. As in 2022, one country less (the Netherlands) reported domestic cases in 2023. Most cases (90.6%) with a known serovar and with travel data were infected within the EU. Most human salmonellosis cases acquired in the EU (72.8%) had information on *Salmonella* serovars. For the travel-associated cases, the most frequently reported travel destinations in the EU were Spain (22.3%), Greece (17.0%), Italy (12.5%) and Croatia (8.0%). For the reported cases of human salmonellosis acquired in the EU, *S. Enteritidis* dominated and 70.8% of these reported cases were infected with this serovar. *S. Enteritidis*, *S. Typhimurium* and monophasic *S. Typhimurium* (1,4,[5],12:i:-) together represented 84.8% of the confirmed human cases acquired in the EU in 2023 (Table 26) and were at the same level as in 2021–2022. In detail, the proportion of *S. Enteritidis* increased, while the proportion of *S. Typhimurium* decreased compared with 2022 and 2021 (Table 26). *S. Infantis* remained approximately at the same level, while *S. Chester*, *S. Thompson*, *S. Poona*, *S. Strathcona*, *S. Paratyphi B var. Java* and *S. Senftenberg* showed an increase during the entire period and *S. Coeln* increased only compared with 2022.

**TABLE 26** Distribution of reported cases of human salmonellosis acquired in the EU, 2021–2023, for the 20 most frequently reported serovars in 2023.

<i>Salmonella</i> Serovar	2023			2022			2021		
	Cases	MSs	%	Cases	MSs	%	Cases	MSs	%
Enteritidis	24,019	24	70.8	19,752	25	65.0	23,932	24	69.5
Typhimurium	3015	24	8.9	3793	24	12.5	4078	24	11.8
Monophasic Typhimurium 1,4,[5],12:i:-	1738	16	5.1	1684	15	5.5	1529	15	4.4
Infantis	682	22	2.0	717	22	2.4	669	24	1.9
Coeln	262	18	0.77	206	17	0.68	331	15	0.96
Chester	259	15	0.76	135	13	0.44	159	11	0.46
Derby	239	17	0.70	281	18	0.92	250	17	0.73
Thompson	193	13	0.57	55	14	0.18	59	15	0.17
Virchow	153	14	0.45	132	12	0.43	136	13	0.40
Newport	151	17	0.45	245	20	0.81	193	18	0.56
Bovismorbificans	144	19	0.42	162	16	0.53	156	14	0.45
Poona	125	11	0.37	67	11	0.22	52	10	0.15
Agona	123	16	0.36	177	16	0.58	70	13	0.20
Kentucky	105	16	0.31	104	15	0.34	70	13	0.20
Stanley	104	16	0.31	139	12	0.46	107	14	0.31
Strathcona	102	11	0.30	36	8	0.12	30	5	0.09
Paratyphi B var. Java	101	14	0.30	85	13	0.28	54	11	0.16
Senftenberg	101	13	0.30	64	14	0.21	41	11	0.12
Mikawasima	97	10	0.29	101	12	0.33	82	10	0.24
Mbandaka	92	15	0.27	140	14	0.46	77	11	0.22
Other	2102	–	6.2	2331	–	7.7	2345	–	6.8
<b>Total<sup>a,b</sup></b>	<b>33,907</b>	<b>24</b>	<b>100</b>	<b>30,406</b>	<b>25</b>	<b>100</b>	<b>34,420</b>	<b>24</b>	<b>100</b>

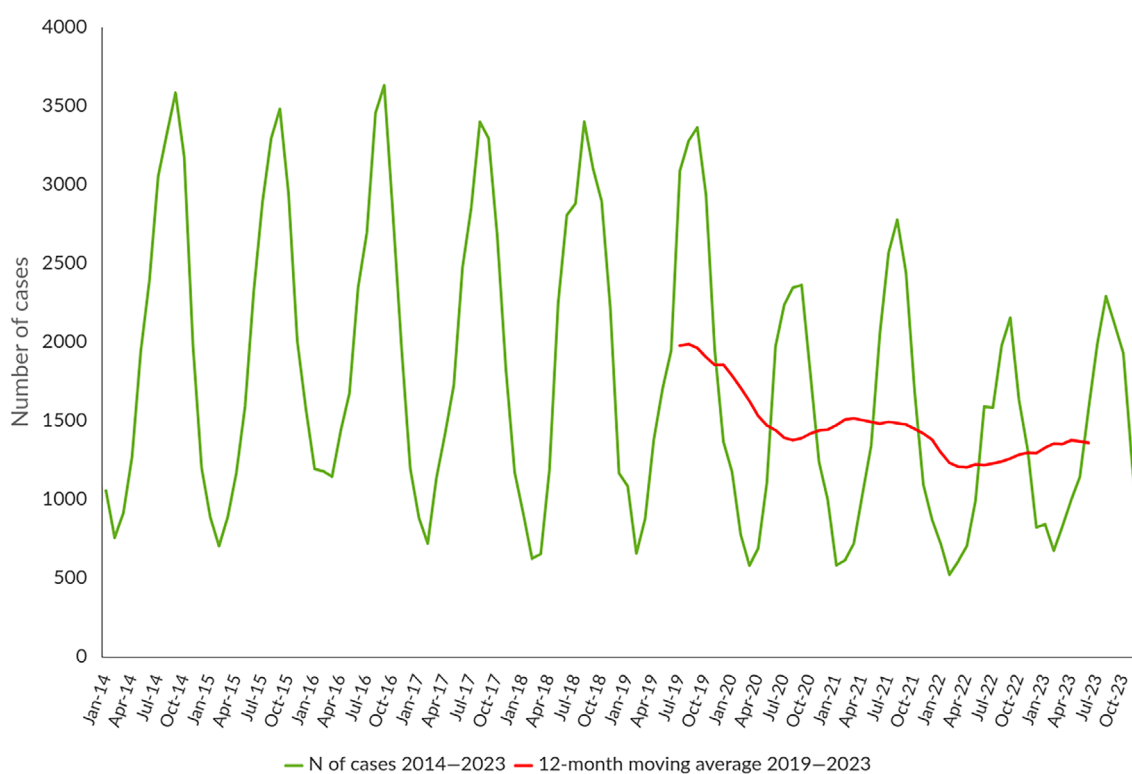
Abbreviations: MSs, Member States; –, Data not reported.

<sup>a</sup>Source(s): 2023–24 MSs: Austria, Belgium, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia and Slovakia. 2022–25 MSs: Austria, Belgium, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Sweden, Slovenia and Slovakia. 2021–24 MSs: Austria, Belgium, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Sweden, Slovenia and Slovakia.

<sup>b</sup>Only isolates with the complete antigenic formula and/or serovar name have been considered.

A seasonal trend was observed for confirmed *S. Enteritidis* infections acquired in the EU in 2019–2023, with more cases reported during summer months. A decrease in cases was observed in 2020, due to the COVID-19 pandemic; an increase was then registered in the following years, although without reaching the pre-pandemic number of cases. Notwithstanding, the overall

trend for *S. Enteritidis* in 2019–2023 did not show any significant increase or decrease (Figure 6). Latvia showed a significant decreasing ( $p < 0.05$ ) trend in *S. Enteritidis* infections within the EU over the last 5 years (2019–2023). A significant increasing trend in *S. Enteritidis* infections ( $p < 0.05$ ) was observed in Belgium, Denmark, France, Portugal, Spain and Sweden.



**FIGURE 6** Trend in reported confirmed human cases of *S. Enteritidis* infections acquired in the EU, by month, 2019–2023. Source: Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Spain, Hungary, Ireland, Italy, Latvia, Malta, Poland, Portugal, Slovakia, Slovenia and Sweden.

## Food and animals

Descriptive analyses were undertaken using serotyped isolates (isolates with the complete antigenic formula and/or serovar name) from food and animals. In this context, only isolates related to the most common food-producing animal species and food matrices thereof were considered and were aggregated into the following categories for further analysis: ‘broiler flocks – broiler meat’, ‘laying hen flocks – eggs’, ‘fattening turkey flocks – turkey meat’, ‘fattening pigs – pig meat’ and ‘cattle – bovine meat’. Overall, a total of 19,295 serotyped *Salmonella* isolates meeting the aforementioned inclusion criteria were obtained (Table 27).

**TABLE 27** Distribution of *Salmonella* isolates with and without serotype identification among the different selected sources (food and animals), EU, 2023.

Source	<i>Salmonella</i> -positive sampling units without serotyped isolates		<i>Salmonella</i> -positive sampling units with serotyped isolates	
	N	%	N	%
Broilers	1850	24.8	10,114	52.4
Broiler meat	2227	29.8	3984	20.6
Cattle	11	0.15	86	0.45
Cattle meat	290	3.9	214	1.1
Pigs	37	0.50	178	0.92
Pig meat	1771	23.7	1133	5.9
Turkeys	255	3.4	2164	11.2
Turkey meat	666	8.9	252	1.3
Layers	351	4.7	1145	5.9
Eggs and egg products	13	0.17	25	0.13
<b>Total</b>	<b>7471</b>	<b>100</b>	<b>19,295</b>	<b>100</b>

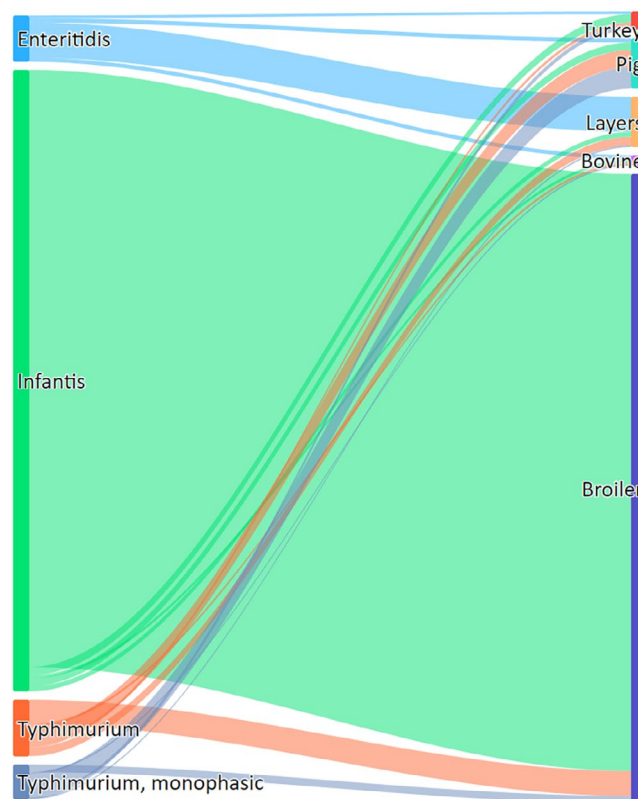


The large majority of the serotyped isolates were from 'broilers' (both animals (52.4%) and food (20.6%)). 'Turkey' sources (animals and food) accounted for 12.5% of the serotyped isolates, while 'pig' and 'laying hen' sources represented 6.8% and 6.0% of the serotyped isolates, respectively. Serotyped isolates from 'cattle' sources made up about 1.5% of the total.

Isolates belonging to the four most frequently reported *Salmonella* serovars involved in cases of human salmonellosis acquired in the EU in 2023 (*S. Enteritidis*, *S. Typhimurium*, monophasic *S. Typhimurium* (1,4,[5],12:i:-) and *S. Infantis*) were considered for further analysis. Unlike in previous years, in 2023 only the top four human serovars, rather than five, were considered. This change was made because the numbers of reported human cases for the next three serovars on the list (*S. Coeln*, *S. Chester* and *S. Derby*) were very similar ( $N=262$ ,  $N=259$  and  $N=239$ , respectively) (Table 26). From the above-mentioned food-animal sources, a total of 10,326 serotyped isolates were reported, of which *S. Infantis* accounted for 74.2%, *S. Enteritidis* 14.8%, *S. Typhimurium* 6.8% and monophasic *S. Typhimurium* (1,4,[5],12:i:-) 4.2%. Regarding *S. Infantis*, a consistent increase in the number of reported serotyped isolates was shown in 2023 (7665) compared to 2022 (6840) and these isolates were mainly from a single MS (Italy).

A Sankey diagram (Figure 7) illustrates how these top four EU-level *Salmonella* serovars involved in human salmonellosis cases acquired in the EU were linked with the major food-animal species.

*Salmonella* Enteritidis was primarily related to 'broiler' sources (62.6% of the *S. Enteritidis* isolates were from broiler flocks and meat) and also to 'layers and eggs' (28.4%). *S. Typhimurium* isolates were distributed among the different sources, although they were mainly related to 'broiler' and 'pig' sources (44.0% and 30.4% of the isolates were from these sources respectively), followed by 'laying hen', 'turkey' and 'bovine' sources (15.5%, 5.6% and 4.6% respectively). Monophasic *S. Typhimurium* (1,4,[5],12:i:-) was related mainly to 'pig' (60.0%), followed by 'broiler' (21.4%) and 'turkey' (21.4%) sources. Lastly, *S. Infantis* was strictly related to 'broiler' sources (96.1%). To interpret these data, it is important to be aware that the distribution of the serotyped isolates among the different sources is very unbalanced in terms of the number of isolates per source, and the large majority of the serotyped isolates for the subsets considered were from poultry populations covered by NCPs, especially broilers.



**FIGURE 7** Sankey diagram of the distribution of the top four EU-level *Salmonella* serovars involved in human salmonellosis cases acquired in the EU, reported from specified food-animal categories, by food-animal source, EU, 2023. The left side of the diagram shows the four most commonly reported *Salmonella* serovars involved in human salmonellosis cases acquired in the EU: *S. Enteritidis* (light blue), *S. Infantis* (green), *S. Typhimurium* (orange) and monophasic *S. Typhimurium* (1,4,[5],12:i:-) (Indigo). Animal and food data from the same source were merged: 'broiler' includes isolates from broiler flocks and broiler meat, 'bovine' includes isolates from bovine animals for meat production and from bovine meat, 'pig' includes isolates from fattening pigs and pig meat, 'turkey' includes isolates from fattening turkey flocks and turkey meat, and 'layers' includes isolates from laying hen flocks and eggs. The right side shows the five sources considered (broilers (blue), bovine animals (violet), pigs (light green), turkeys (red) and layers (light orange)). The width of the coloured bands linking the sources and serovars is proportional to the percentage of isolates of each serovar from each source.

Table 28 lists the top 20 serovars reported, based on all serotyped isolates from food and animals, including laying hens, broilers, turkeys, pigs and bovine animals. Among the isolates from the laying hens-eggs source, 48.0% were identified

as one of the three target serovars: *S. Enteritidis*, *S. Typhimurium*, including monophasic *S. Typhimurium* (1,4,[5],12:i:-). *S. Kentucky* and *S. Infantis* remained the second and fourth main serovars from this source (as in 2022). *S. Kentucky* was reported by seven Member States, with the vast majority of isolates coming from a single country, whereas *S. Infantis* was reported by 13 Member States, with a more balanced distribution of isolates across the reporting countries. In the broiler source ( $N = 14,098$ ), three serovars (*S. Infantis*, *S. Enteritidis* and *S. Mbandaka*) represented 66.7% of the serotyped isolates, with *S. Infantis* accounting for more than one out of two isolates reported. *S. Thompson* was the fourth main serovar notified from broiler sources. In the turkey source, two serovars (*S. Agona* and *S. Anatum*) were by far the most common ones, accounting for 68.8% of the isolates reported and confirming the scenario already described in 2022. *S. Infantis* was the third main serovar reported from turkey sources (4.2%). In the pig-pig meat source, monophasic *S. Typhimurium* (1,4,[5],12:i:-), *S. Derby* and *S. Typhimurium* represented 69.5% of the serotyped strains, with *S. Infantis* (6.7%) being another serovar frequently reported. In the bovine source, *S. Dublin* and *S. Typhimurium* were by far the most common ones, followed by *S. Enteritidis* and *S. Infantis*. The distribution of serovars among the different species reported for 2023 was very similar to that reported in 2022.

**TABLE 28** Distribution of the top 20 *Salmonella* serovars by food-animal source (laying hens, broilers, turkeys, pigs and bovine animals), EU, 2023.

<b>Poultry population</b>											
	<b>Serovar</b>	<b>N (%) positive samples</b>	<b>N MSs</b>		<b>Serovar</b>	<b>N (%) positive samples</b>	<b>N MSs</b>		<b>Serovar</b>	<b>N (%) positive samples</b>	<b>N MSs</b>
<b>Laying hens</b>	Enteritidis	433 (37.1)	23	<b>Broilers</b>	Infantis	7365 (52.2)	23	<b>Turkeys</b>	Agona	1206 (48.7)	9
	Kentucky	170 (14.6)	7		Mbandaka	1082 (7.7)	12		Anatum	499 (20.1)	3
	Typhimurium	108 (9.2)	17		Enteritidis	957 (6.8)	19		Infantis	104 (4.2)	9
	Infantis	62 (5.3)	13		Thompson	757 (5.4)	6		Newport	93 (3.8)	5
	Mbandaka	36 (3.1)	10		Livingstone	371 (2.6)	10		Typhimurium, monophasic	59 (2.4)	7
	Corvallis	29 (2.5)	4		Paratyphi B var. Java	347 (2.5)	2		Senftenberg	41 (1.6)	6
	Agona	23 (2.0)	6		Give	339 (2.4)	5		Typhimurium	40 (1.6)	9
	Typhimurium, monophasic	20 (1.7)	6		Kedougou	330 (2.3)	4		Derby	38 (1.5)	4
	Braenderup	19 (1.6)	6		Typhimurium	307 (2.2)	19		Enteritidis	38 (1.5)	6
	Coeln	17 (1.5)	6		Paratyphi B <sup>a</sup>	210 (1.5)	3		Coeln	33 (1.3)	7
	Newport	16 (1.4)	8		Montevideo	170 (1.2)	5		Bredeney	32 (1.3)	2
	Senftenberg	16 (1.4)	6		Agona	141 (1.0)	9		Mbandaka	27 (1.1)	4
	Thompson	16 (1.4)	5		Senftenberg	136 (0.96)	10		Saintpaul	27 (1.1)	2
	Ohio	15 (1.3)	3		Virchow	129 (0.92)	5		Kedougou	26 (1.0)	2
	Mikawasima	12 (1.0)	2		Napoli	111 (0.79)	2		Heidelberg	18 (0.73)	1
	Montevideo	12 (1.0)	6		Newport	95 (0.67)	11		Kentucky	17 (0.69)	4
	Hadar	11 (0.94)	3		Typhimurium, monophasic	74 (0.52)	8		Napoli	17 (0.69)	2
	Livingstone	11 (0.94)	4		Niloese	60 (0.43)	1		Give	14 (0.56)	2
	Rissen	10 (0.86)	6		Tennessee	57 (0.40)	8		Haifa	14 (0.56)	1
	Havana	9 (0.77)	4		Saintpaul	56 (0.40)	3		Goldcoast, Stanley	13 (0.52)	1, 3
Other serovars	122 (10.4)	26	Other serovars	1004 (7.1)	28	Other serovars	109 (4.4)	18			
<b>Total</b>	<b>1167</b>			<b>Total</b>	<b>14,098</b>			<b>Total</b>	<b>2478</b>		

(Continues)

TABLE 28 (Continued)

Pigs and cattle (bovine animals)							
	Serovar	N (%) positive samples	N MSs		Serovar	N (%) positive samples	N MSs
Pigs	Typhimurium, monophasic	394 (28.0)	18	Bovine animals	Dublin	386 (36.9)	12
	Derby	349 (24.8)	20		Typhimurium	352 (33.6)	13
	Typhimurium	235 (16.7)	20		Enteritidis	57 (5.4)	8
	Infantis	95 (6.7)	14		Infantis	40 (3.8)	4
	Rissen	67 (4.8)	12		Bovismorbificans	28 (2.7)	5
	Enteritidis	54 (3.8)	11		Derby	20 (1.9)	7
	Brandenburg	39 (2.8)	5		Agona	19 (1.8)	2
	London	30 (2.1)	8		Typhimurium, monophasic	19 (1.8)	6
	Choleraesuis	28 (2.0)	2		Bredeney	15 (1.4)	3
	Bovismorbificans	14 (0.99)	7		Indiana	13 (1.2)	1
	Agona	11 (0.78)	3		Mbandaka	11 (1.0)	5
	Give	9 (0.64)	4		Muenchen	10 (0.96)	1
	Goldcoast	9 (0.64)	3		Anatum	7 (0.67)	4
	Newport	8 (0.57)	1		Newport	6 (0.57)	4
	Livingstone	6 (0.43)	5		Muenster	5 (0.48)	2
	Goettingen	5 (0.35)	2		Coeln	4 (0.38)	2
	Ohio	5 (0.35)	5		Goldcoast	4 (0.38)	1
	Uganda	5 (0.35)	1		Kentucky	4 (0.38)	3
	Bredeney	4 (0.28)	1		Meleagridis	4 (0.38)	1
	Choleraesuis var., Panama	4 (0.28)	1, 3		Napoli, Rissen	4 (0.38)	1, 2
Other serovars	34 (2.4)	26	Other serovars	34 (3.2)	20		
<b>Total</b>		<b>1409</b>		<b>Total</b>		<b>1046</b>	

Abbreviation: MSs, Member States.

<sup>a</sup>*Salmonella* Paratyphi B is tartrate negative and causes typhoidal disease, with the exception of *S. Paratyphi B* var. Java which is tartrate positive and is non-typhoidal. Since the isolates reported were from food and animal sources, we can suppose that these isolates were *S. Paratyphi B* var. Java.

## 2.5 | Discussion

Salmonellosis remained the second most common food-borne zoonosis in humans in the EU in 2023 after campylobacteriosis. The notification rate increased in 2023 compared to 2022 (18.0 and 15.4 respectively), but the number of human salmonellosis cases was lower in 2023 than before the COVID-19 pandemic. The number of outbreak-related cases and the number of food-borne salmonellosis outbreaks increased compared with 2022. Notwithstanding, the overall EU trend for salmonellosis in 2019–2023 did not show any significant increase or decrease. Conversely, over the period 2019–2023, France, Spain and Luxembourg reported a significantly increasing trend.

In addition, notification rates for salmonellosis in humans varied between MSs, reflecting potential variations, for example, in the quality, coverage and disease-severity focus of the surveillance systems, in sampling and testing practices, in disease prevalence in food-producing animal populations and in food and animal trade between MSs.

The three most commonly reported human serovars, *S. Enteritidis*, *S. Typhimurium* and its monophasic variant (1,4,[5],12:i:-), continued to account for over 70% of human cases acquired in the EU, as has been observed since 2014. In 2023, these serovars were responsible for 84.8% of cases. The increase in *S. Enteritidis* in 2023 may at least partly be attributable to an increase in outbreaks including three distinct microbiological clusters of *S. Enteritidis* ST11 reported in 14 EU/EEA countries, as well as in the United Kingdom and the United States. These outbreaks were possibly linked to the consumption of chicken meat, including chicken kebabs (ECDC and EFSA, 2023e). *S. Infantis* has consistently remained the fourth most frequently reported serovar from humans and is by far the most common serovar found in the 'broilers' animal-food source. However, it also ranks among the top four serovars reported from 'laying hens', 'fattening turkeys', 'fattening pigs' and 'beef cattle', though the number of isolates from these non-broiler sources was markedly lower. Following *S. Infantis*, serovars such as *S. Coeln*, *S. Chester*, *S. Thompson*, *S. Poona* and *S. Strathcona* saw notable increases. These trends may also be linked to specific outbreaks: for instance, five outbreaks of *S. Coeln* were reported by three MSs, while an outbreak of *S. Thompson* in Czechia affected 135 people. The increase in *S. Strathcona* can be explained by a multi-country outbreak affecting nine countries (ECDC, 2023). In addition, increases were observed for *S. Paratyphi* B var. Java and *S. Senftenberg* throughout the entire period. The increase in *S. Paratyphi* B var. Java could be connected to four outbreaks that occurred in three MSs, although in all but one case, the reported serovar was *S. Paratyphi* B. This discrepancy may be due to an unclear option in TESSy to indicate the variant Java. Furthermore, *S. Paratyphi* B isolates from food and animal sources, especially from broilers, in which it was among the top 20 *Salmonella* serovars, may belong to the variant Java, which could explain the observed increase in human cases. The increase in *S. Senftenberg* can be linked to the multi-country outbreak that affected 11 MSs between August 2022 and July 2023 (ECDC and EFSA, 2023a).

All MSs, EEA and EFTA countries reported *Salmonella* data from food and/or animal sources. Poultry remains one of the primary food sources associated with high levels of *Salmonella* contamination. This was evident from prevalence data collected under Commission Regulation (EC) No 2073/2005, which includes food safety criteria for fresh poultry meat, minced meat, meat preparations and products, as well as process hygiene criteria for poultry carcasses. Additional prevalence data from other food sampling contexts further support these findings. The importance of poultry, in particular chicken meat, as a source of human infections has also been demonstrated by the multiple rapid outbreak assessments (ROAs) jointly published by EFSA and ECDC in recent years. One persistent cross-border outbreak of *S. Virchow* ST16 involved five EU/EEA countries, the United Kingdom and the United States. Epidemiological and analytical investigations identified kebab meat products containing contaminated chicken meat as the likely vehicles of infection (ECDC and EFSA, 2023b). Similarly, the multi-country outbreak due to *S. Enteritidis* ST11, already mentioned, was primarily linked to chicken meat consumption, with chicken kebabs identified as the most plausible vehicle of the human infections (ECDC and EFSA, 2023e). More recently, EFSA and ECDC published an ROA describing an ongoing multi-country outbreak linked to *S. Mbandaka* ST413, which has persisted in the EU/EEA and the UK for over 2 years. Initially, ready-to-eat chicken products and fresh chicken meat were identified as probable vehicles of infection. However, subsequent investigations pointed to frozen steam-cooked chicken breast as the likely vehicle of infection. Despite control measures being implemented, new cases have continued to emerge, suggesting that other undetected routes of exposure remain, which require further investigation (ECDC and EFSA, 2024a).

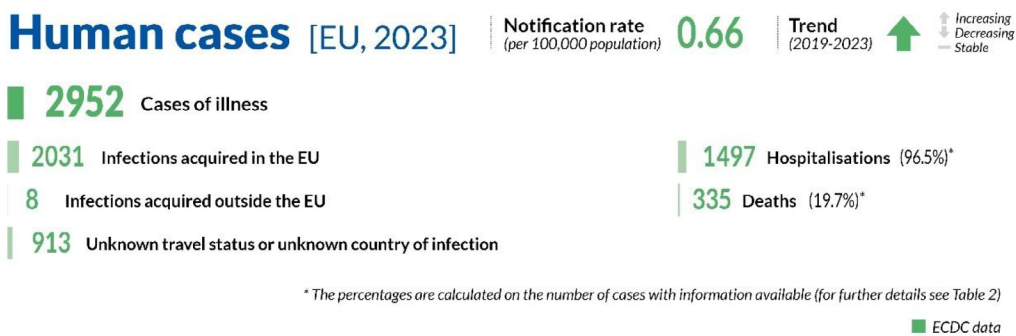
For *Salmonella*, surveillance approaches beginning at the primary production level and extending throughout the entire food chain are synergistic. They represent a unique collaboration between FBOp and CAs in control and surveillance efforts, unlike for any other zoonotic agents listed in Directive 2003/99/EC (Cota et al., 2024). The key distinction between *Salmonella* and other zoonoses lies in the implementation of NCPs at primary production level; these programmes are mandatory and harmonised across MSs and have been in place in poultry populations for more than a decade. While EU legislation sets a framework for NCPs, MSs have some flexibility to adapt their implementation according to their specific epidemiological situation. As part of corrective measures, NCPs typically include a range of actions, such as enhanced surveillance through targeted sampling protocols, vaccination of breeders and laying hens against target serovars (although this is not mandatory in all MSs), rigorous biosecurity measures, restrictions on animal movement and the destruction or heat treatment of infected birds and eggs. In the event of detecting targeted *Salmonella* serotypes in a poultry flock, additional actions such as testing derived meat may also be enforced. Lastly, effective cleaning and disinfection protocols at farm level are implemented (Tzani et al., 2021).

In the context of NCPs, an assessment of *Salmonella* flock prevalence trends revealed a significant decrease in target *Salmonella* serovars for *G. gallus* (all populations) from the NCP implementation period (2010–2013) to the present. However, over the last 5 years, no significant variations in target serovar prevalence were identified in any poultry population. A further descriptive analysis of NCP data was carried out to evaluate the successful achievement of final *Salmonella* targets by MSs across different poultry populations throughout the entire NCP implementation period, ranging from 11 years for turkeys to 14 years for breeding *G. gallus*. This assessment revealed that, in recent years, a notable number of MSs did not reach the

target in some poultry populations compared to the early years of NCP implementation. This trend was more evident in laying hens. Focusing on 2023 data, the number of MSs meeting the targets for all poultry populations was 15, whereas in 2022 this number was 19. In laying hens, in 2023, seven MSs (about one in four) did not meet the target. These findings suggest that, despite many years of NCP implementation, weaknesses remain in controlling *Salmonella* at the primary production level, including in the management of target *Salmonella* serovar-positive flocks. One possible factor that might have contributed to the increase in positive flocks is the practice of confirmatory sampling, which involves re-sampling and re-testing flocks identified as positive for target *Salmonella* before taking corrective action. While this practice is not routinely permitted, it is frequently applied in some MSs (personal communication, EURL-*Salmonella* Workshop 2024, available online [here](#)), and can lead to positive flocks remaining in production, increasing the risk of *Salmonella* spread (EFSA BIOHAZ Panel, 2019).

Nonetheless, from a One Health perspective, it is important to acknowledge that some studies conducted in different MSs using various scientific methodologies have demonstrated the positive impact of NCP implementation on reducing human salmonellosis. This was particularly evident during the early years of NCP application (Poirier et al., 2008; Wegener et al., 2003), but positive effects have also been observed more recently (Tzani et al., 2021).

### 3 | LISTERIA MONOCYTOGENES



## Foodborne outbreaks & related cases [EU, 2023]



\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

N of outbreaks	N of outbreaks per 100,000 population **	N of outbreak cases per 100,000 population	Implicated food vehicles (Strong-evidence outbreaks)
Austria	1	AT 0.011	Pig meat and products thereof <b>3</b> Outbreaks
Belgium	3	BE 0.026	
Bulgaria	0	BG 0	
Croatia	0	HR 0	Fish and fish products <b>2</b> Outbreaks
Cyprus	0	CY 0	
Czechia	0	CZ 0	Vegetables and juices and other products thereof <b>1</b> Outbreak
Denmark	4	DK 0.067	
Estonia	0	EE 0	Milk <b>1</b> Outbreak
Finland	0	FI 0	
France	1	FR 0.001	Cheese <b>1</b> Outbreak
Germany	4	DE 0.005	
Greece	0	EL 0	
Hungary	1	HU 0.010	
Ireland	0	IE 0	
Italy	3	IT 0.005	
Latvia	0	LV 0	
Lithuania	0	LT 0	
Luxembourg	0	LU 0	
Malta	0	MT 0	
Netherlands	0	NL 0	
Poland	0	PL 0	
Portugal	0	PT 0	
Romania	0	RO 0	
Slovakia	0	SK 0	
Slovenia	0	SI 0	
Spain	0	ES 0	
Sweden	2	SE 0.019	
UK (N. Ireland)	0	XI 0	

\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Listeria monocytogenes* and for the consultation of data collected, the following interactive tools are available:



### 3.1 | Key facts

- In 2023, 27 Member States reported 2952 confirmed invasive human cases of *Listeria monocytogenes*, corresponding to a European Union notification rate of 0.66 cases per 100,000 population. This was an increase of 5.8% compared with the rate in 2022 (0.63 cases per 100,000 population) and the highest rate and number of cases reported since 2007.
- The overall trend for *L. monocytogenes* infections showed a statistically significant increase over the 2019–2023 period.
- A total of 186,997 sampling units from different ‘ready-to-eat’ food categories, collected at the distribution or manufacturing stages, were reported by 25 Member States. In 2023, a major decrease in sample submissions was noted, primarily due to the absence of data from Poland, which had previously been a major contributor.
- At distribution, the proportions of single samples testing positive for *L. monocytogenes*, based on enumeration tests conducted by competent authorities as part of verification of the food safety criteria listed in Commission Regulation (EC) No 2073/2005 on microbiological criteria, were either zero or remained rare (<0.1%) to very low (0.1%–1.0%) in 6 out of 10 targeted ‘ready-to-eat’ food categories. The highest proportion of positive samples (14.8%) was found in ‘products of meat origin, fermented sausage’. For ‘hard cheeses’, ‘products of meat origin other than fermented sausages’ and ‘fish’, the proportions of positive samples were relatively low (1.8%, 1.4% and 1.1%, respectively). Statistics on positive samples indicated further that the proportion of samples exceeding 100 CFU/g was either zero or consistently rare to very low across all ‘ready-to-eat’ food categories. The highest proportion, 0.78%, was reported for ‘products of meat origin, fermented sausages’.
- At manufacturing, in the context of Commission Regulation (EC) No 2073/2005, the proportions of single samples testing positive for *L. monocytogenes*, based on detection tests conducted by competent authorities, were either zero or remained rare (<0.1%) to very low (0.1%–1.0%) in 4 out of 8 targeted ‘ready-to-eat’ food categories. The highest proportion of positive samples (2.8%) was found in ‘other products’. For ‘fishery products’, ‘fish’ and ‘soft and semi-soft cheeses’, the proportions of positive samples were low (1.8%, 1.4% and 1.3%, respectively). These proportions were higher at the manufacturing stage than at the distribution level across all targeted ‘ready-to-eat’ food categories, except for ‘products of meat origin other than fermented sausages’, where the proportion was lower (0.9%) compared to the distribution stage (1.4%). No *L. monocytogenes* was detected in ‘milk’, at any stage.
- In the context of other monitoring activities, the occurrence of *L. monocytogenes* gives an indication of the reasonably foreseeable contamination rate in these ‘ready-to-eat’ food categories. Results varied according to the ‘ready-to-eat’ food category, the sampling stage, the number of tested samples and the number of reporting countries. In the framework of objective sampling, all samplers and sampling units included, overall occurrences remained generally rare (<0.1%) to low (1%–10%) in these categories. The overall highest values (from 2% to 10%) were observed for ‘fish and fishery products’, ‘meat products from bovines or pigs’, ‘fruits and vegetables’ and ‘cheeses from raw or low heat-treated milk’.
- At primary production, the percentage of positive units was very low in pigs (0.26%) and low in small ruminants (sheep and goats) and cattle (4.2% and 1.5%, respectively). The low number of Member States reporting data reflects the absence of minimum legal requirements for harmonised sampling and reporting at primary production.

### 3.2 | Surveillance and monitoring of *Listeria monocytogenes* in the EU

#### 3.2.1 | Humans

Surveillance of listeriosis in humans in the EU focuses on invasive forms of *L. monocytogenes* infection, mostly manifesting as septicæmia, influenza-like symptoms, meningitis or spontaneous abortion.

Surveillance of listeriosis is mandatory in all MSs, except in one country (Belgium). The EU case definition was used by 25 countries. One country (Germany) reported using other case definitions, and another (France) did not specify which case definition was used.

All countries have comprehensive surveillance systems. The surveillance systems for listeriosis cover the whole population in all MSs, except in two (Belgium and Spain). The estimated coverage of the surveillance system was 80% in Belgium and 97% in Spain for 2021–2023. These estimated proportions of population coverage were used in the calculation of notification rates for these two countries. No estimated population coverage was provided for Spain prior to 2021, so notification rates were not calculated. In 2020, Spain did not receive data from all regions that usually report, so the case numbers may therefore not be complete. Bulgaria and Croatia reported aggregated data, while the other 25 countries reported case-based data.

### 3.2.2 | Food, animals and feed

Monitoring of *L. monocytogenes* is carried out along the food chain, at primary production, manufacturing and distribution.

The public health risk associated with RTE foods depends mainly on the effectiveness of control measures implemented by food business operators (FBOs), including:

- Good Agricultural Practices (GAP) at primary production
- Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP) programmes at manufacturing and distribution
- Microbiological criteria for RTE foods, as defined in Commission Regulation (EC) No 2073/2005.

#### **Listeria monocytogenes data in the context of Commission Regulation (EC) No 2073/2005**

Official sampling is scheduled by national CAs to verify whether FBOs correctly implement the legal framework of their own-check programmes. Official control samples are thus part of the verification of *L. monocytogenes* food safety criteria (FSC). Data provided to EFSA within this context enable a descriptive summary of contamination levels, especially of RTE foods, at the EU level.

#### **Listeria monocytogenes monitoring data for food, animals and feed**

All the food testing data was provided through Member State reporting obligations under Directive 2003/99/EC. The rationale for surveillance and monitoring of *L. monocytogenes* in animals, feed and food at the different stages along the food chain and the number of samples provided to EFSA are shown in Figure 8. Most of the reported data in animals and feed are generated by non-harmonised monitoring schemes across MSs, and for which mandatory reporting requirements are not in place. Data on the occurrence of *L. monocytogenes* in feed are only collected as part of clinical investigations in farm animals. Hence, monitoring data on *L. monocytogenes* in animal feed are rarely available.

## 3.3 | Data analyses

### 3.3.1 | Data on RTE foods in the context of Commission Regulation (EC) No 2073/2005

These data are based on single samples collected by CAs as part of verification of *L. monocytogenes* FSC listed in Commission Regulation (EC) No 2073/2005, which are to be complied by FBOs. These FSC are specified by RTE food category, and by sampling stage, and are underpinned by the results of either detection or enumeration analytical methods (Table 29). These data were extracted from the database using the criteria 'official sampling' for the sampler, 'single units' for the sampling unit and 'objective sampling' for the sampling strategy (Table 32).

**TABLE 29** *Listeria monocytogenes* FSC as described in Commission Regulation (EC) No 2073/2005 for the different RTE categories across the food chain, 2023.

Sampling stage	RTE foods intended for infants and RTE foods for special medical purposes	Other RTE foods	
		Able to support growth of <i>L. monocytogenes</i>	Unable to support growth of <i>L. monocytogenes</i>
Manufacturing <sup>a</sup>	NA	Based on detection method: <i>L. monocytogenes</i> not detected in 25 g of sample ( $n=5, c=0$ ) <sup>b</sup>	NA
Distribution <sup>c</sup>	Based on detection method: <i>L. monocytogenes</i> not detected in 25 g of sample ( $n=10, c=0$ )	Based on enumeration method: limit of 100 CFU/g ( $n=5, c=0$ ) <sup>d</sup>	Based on enumeration method: limit of 100 CFU/g ( $n=5, c=0$ )



**TABLE 29** (Continued)

Abbreviations: NA, not applicable; RTE, ready-to-eat.

<sup>a</sup>Before the food has left the immediate control of the food business operator that has produced it.

<sup>b</sup> $n$  = number of units comprising the sample (number of sample units per food batch that are required for testing);  $c$  = maximum allowable number of sample units yielding unsatisfactory test results. In a two-class attributes sampling plan defined by  $n=10$ ,  $c=0$  and a microbiological limit of 'not detected in 25 g', in order for the food batch to be considered acceptable, *L. monocytogenes* must not be detected in qualitative (detection) analyses of 25 g food test portions obtained from each one of 10 sample units taken from the batch. If even one of the sample units from the batch is found to contain *L. monocytogenes* (detected in 25 g), then the entire batch is deemed unacceptable. This criterion applies to products before they have left the immediate control of the producing food business operator, when the operator is not able to demonstrate, to the satisfaction of the CA, that the product will not exceed the limit of 100 CFU/g throughout the shelf-life.

<sup>c</sup>Products placed on the market during their shelf-life.

<sup>d</sup>This criterion applies if the manufacturer is able to demonstrate, to the satisfaction of the CA, that the product will not exceed the limit of 100 CFU/g throughout the shelf-life. The operator may fix intermediate limits during the process that should be low enough to guarantee that the limit of 100 CFU/g is not exceeded at the end of the shelf-life.

Data reported by MSs were classified into the different categories of RTE food/sampling stages based on the assumptions described in the EU Summary zoonoses and food-borne outbreaks report of 2016 (EFSA and ECDC, 2017). Briefly, these assumptions are: all sampling units that were collected from 'cutting plants' and 'processing plants' were considered units collected at the manufacturing stage, while sampling units that were obtained from 'catering', 'hospital or medical care facility', 'retail', 'wholesale', 'restaurant or cafe or pub or bar or hotel or catering service', 'border inspection activities', 'packing centre' and 'automatic distribution system for raw milk' were considered units collected at distribution. When the stage was 'not available' or 'unspecified', data were also considered part of the distribution stage. Other assumptions concerning the RTE categories are presented in the footnotes of Table 32.

### 3.3.2 | Monitoring data assessing *Listeria monocytogenes* occurrence in RTE foods

The overall occurrence of *L. monocytogenes* in different RTE food categories, regardless of the stage, was assessed from detection results reported by MSs. All levels of sampling unit (single and batches), sampling stages, sampler and sampling contexts ('surveillance', 'monitoring' and 'surveillance based on Regulation (EC) No 2073/2005') were considered. Only data obtained from the sampling strategies 'objective sampling' and 'census sampling' were used, excluding data reported from 'convenient sampling', 'suspect sampling', 'selective sampling' and 'other' contexts.

Since data were mostly reported by a limited number of MSs and are of a heterogeneous nature, results may not be representative of the EU level nor directly comparable across years.

### 3.3.3 | Monitoring data for *Listeria monocytogenes* in animals and feed

For animals and feed, all sampling strategies were included, even data reported for 'suspect sampling' and 'selective sampling'.

## 3.4 | Results

### 3.4.1 | Overview of key statistics, EU, 2019–2023

Table 30 summarises EU-level statistics on human listeriosis and on sampling units from RTE foods tested for *L. monocytogenes* during the period 2019–2023. Food data of interest reported were classified into the major categories and aggregated by year to obtain an annual overview of the volume of data submitted. More detailed descriptions of these statistics are provided in the below subsections and in the chapter on food-borne outbreaks.

Compared to 2022, there was a general decrease in the number of reported sampling units across all major RTE food categories – 'meat and meat products', 'milk and milk products', and 'fish and fishery products' – except for 'food intended for infants or special medical purposes'. This decrease can be attributed, on the one hand, to the absence of data from some Member States, particularly Poland, which in 2022 accounted for over 30% of the reported data in each category. On the other hand, notable reductions in reported sampling units were observed for Italy in the 'fish and fishery products' category (2244 units in 2022 vs. 921 in 2023), and for Czechia in the 'meat and meat products' category (5132 units in 2022 vs. 4145 in 2023).

**TABLE 30** Summary of *Listeria monocytogenes* statistics relating to invasive human infections and major RTE food categories, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	2952	2778	2365	1887	2621	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.66	0.63	0.53	0.43	0.46	ECDC
Number of reporting MSs	27	27	27	27	28	ECDC
Infection acquired in the EU	2031	1777	1546	1286	1816	ECDC
Infection acquired outside the EU	8	12	5	5	14	ECDC
Unknown travel status or unknown country of infection	913	989	814	596	791	ECDC
Number of outbreak-related cases	133	296	106	123	349	EFSA
Total number of outbreaks	19	35	24	17	21	EFSA
<b>Sampled major RTE food categories<sup>a</sup></b>						
<b>Meat and meat products</b>						
Number of sampling units	63,013	135,143	107,198	40,291	65,034	EFSA
Number of reporting MSs	23	24	23	22	22	EFSA
<b>Fish and fishery products</b>						
Number of sampling units	13,876	25,009	29,783	11,212	13,366	EFSA
Number of reporting MSs	22	24	24	23	22	EFSA
<b>Milk and milk products</b>						
Number of sampling units	60,199	97,157	66,633	49,132	62,016	EFSA
Number of reporting MSs	24	24	23	23	23	EFSA
<b>Products intended for infants or special medical purposes</b>						
Number of sampling units	4079	2672	2764	2394	2346	EFSA
Number of reporting MSs	19	19	19	19	19	EFSA
<b>Other products</b>						
Number of sampling units	104,743	120,432	94,693	81,487	80,149	EFSA
Number of reporting MSs	25	25	23	24	24	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States; RTE, ready-to-eat.

<sup>a</sup>Number of sampling units tested by detection or enumeration method.

Figure 8 shows that in 2023, 25 MSs reported a total of 186,997 sampling units tested for *L. monocytogenes* across various RTE food categories at the manufacturing and distribution stages. Compared with 2022, there was a slight decrease in the number of reporting MSs (26 in 2022) and a 40% reduction in the number of sampling units tested at these stages (312,849 samples in 2022). As mentioned above, this decrease was primarily due to the absence of data from Poland, which contributed 36% ( $N=113,766$ ) of the samples in 2022. At the primary production level, the volume of reported data was also lower compared with previous years. In 2023, 12 MSs reported 15,422 samples, down from 22,370 samples in 2020 (reported by 11 MSs) and 23,564 samples in 2021 (reported by 12 MSs).

	PRIMARY PRODUCTION	MANUFACTURING	DISTRIBUTION
Sampler & context	Clinical investigations in animals by CA and veterinarians Monitoring & surveys by CA, veterinarians and academia	Official sampling by CA Industry sampling by FBOp HACCP & own checks CA investigations, border inspection & surveys	Official sampling by CA Surveys by CA and academia Monitoring & surveys by CA, and academia
Objective & methods	Isolation of <i>Listeria</i> spp. in animals Microbiological <i>L. monocytogenes</i> isolation protocols	Detection and/or enumeration of <i>L. monocytogenes</i> in raw materials, intermediate, final products, environmental samples (surfaces, equipment) EN ISO 11290-1&2 or validated equivalent methods according to EN ISO 16140-2	Detection and/or enumeration of <i>L. monocytogenes</i> in 'batches or single samples' of RTE foods EN ISO 11290-1&2 or validated equivalent methods according to EN ISO 16140-2
Usefulness of data collected	Diagnosis of listeriosis in animals Occurrence of <i>Listeria</i> spp./ <i>L. monocytogenes</i> in livestock/feed	Compliance verification by CA with the Reg (EU) No 2073/2005 Corrective actions by FBOp and decisions by FBOp & CA Occurrence of <i>L. monocytogenes</i> in RTE foods	Compliance verification by CA with the Reg (EU) No 2073/2005 Corrective actions by FBOp and decisions by FBOp & CA Occurrence of <i>L. monocytogenes</i> in RTE foods
2023 data	15,422 sampling units; 12 MSs	186,997 sampling units; 25 MSs	

**FIGURE 8** Overview of *Listeria monocytogenes* testing of 'ready-to-eat' food along the food chain according to the sampling stage, the sampler and the objective of the sampling, EU, 2023.

### 3.4.2 | Human listeriosis

In 2023, 27 MSs reported 2952 confirmed cases of invasive listeriosis in humans (Table 30, Table 31). The EU notification rate was 0.66 cases per 100,000 population, 5.8% higher than in 2022 (0.63 per 100,000 population). The highest notification rates were observed for Finland, Sweden, Portugal, Spain, Denmark and Belgium, with 1.7, 1.2, 0.95, 0.92, 0.89 and 0.89 cases per 100,000 population, respectively. The lowest notification rates were reported by Romania and Croatia ( $\leq 0.20$  per 100,000). Cyprus reported no cases of listeriosis.

Overall, 21 MSs reported data on the travel status of cases. Most cases of listeriosis with information on the travel status ( $N=2042$ ) were acquired in the EU in 2023 (99.5%;  $N=2031$ ) (Table 30), including both domestic infections ( $N=2012$ ) and infections associated with travel within the EU ( $N=19$ ). Travel-associated cases of listeriosis were reported by 10 MSs (Austria, Belgium, Czechia, Finland, Germany, Greece, Lithuania, the Netherlands, Spain and Sweden). The most frequently reported countries as probable origin of infection in the EU were France, Germany, Greece and the Netherlands.

**TABLE 31** Reported confirmed human cases of invasive listeriosis and notification rates per 100,000 population in EU MS and non-MS countries, by country and year, 2019–2023.

Country	2023				2022		2021		2020		2019	
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate	
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Austria	Y	C	37	0.41	47	0.52	38	0.43	41	0.46	38	0.43
Belgium <sup>b</sup>	N	C	84	0.89	87	0.94	68	0.74	54	0.59	66	0.72
Bulgaria	Y	A	15	0.23	5	0.07	3	0.04	4	0.06	13	0.19
Croatia	Y	A	6	0.16	5	0.13	8	0.20	5	0.12	6	0.15
Cyprus	Y	C	0	0	1	0.11	1	0.11	2	0.23	1	0.11
Czechia	Y	C	45	0.42	48	0.46	24	0.23	16	0.15	27	0.25
Denmark	Y	C	53	0.89	86	1.5	62	1.1	43	0.74	61	1.1
Estonia	Y	C	5	0.37	11	0.83	5	0.38	3	0.23	21	1.6
Finland	Y	C	92	1.7	70	1.3	70	1.3	94	1.7	50	0.91
France	Y	C	538	0.79	451	0.66	435	0.64	334	0.50	373	0.56
Germany	Y	C	663	0.79	548	0.66	562	0.68	546	0.66	571	0.69

(Continues)

TABLE 31 (Continued)

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Greece	Y	C	31	0.30	7	0.07	21	0.20	20	0.19	10	0.09
Hungary	Y	C	46	0.48	64	0.66	35	0.36	32	0.33	39	0.40
Ireland	Y	C	18	0.34	17	0.34	14	0.28	6	0.12	17	0.35
Italy	Y	C	231	0.39	385	0.65	230	0.39	155	0.26	202	0.34
Latvia	Y	C	11	0.58	8	0.43	10	0.53	8	0.42	6	0.31
Lithuania	Y	C	20	0.70	13	0.46	7	0.25	7	0.25	6	0.21
Luxembourg	Y	C	4	0.61	4	0.62	4	0.63	4	0.64	3	0.49
Malta	Y	C	2	0.37	1	0.19	0	0	5	0.97	5	1.0
Netherlands	Y	C	95	0.53	94	0.53	86	0.49	90	0.52	103	0.60
Poland	Y	C	240	0.65	142	0.38	120	0.32	57	0.15	121	0.32
Portugal	Y	C	99	0.95	63	0.61	57	0.55	47	0.46	56	0.54
Romania	Y	C	21	0.11	14	0.07	11	0.06	2	0.01	17	0.09
Slovakia	Y	C	21	0.39	25	0.46	13	0.24	7	0.13	18	0.33
Slovenia	Y	C	16	0.76	20	0.95	19	0.90	26	1.2	20	0.96
Spain <sup>c</sup>	N	C	428	0.92	437	0.95	355	0.77	191	–	504	–
Sweden	Y	C	131	1.2	125	1.2	107	1.0	88	0.85	113	1.1
<b>EU Total 27</b>	–	–	<b>2952</b>	<b>0.66</b>	<b>2778</b>	<b>0.63</b>	<b>2365</b>	<b>0.53</b>	<b>1887</b>	<b>0.43</b>	<b>2467</b>	<b>0.49</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	154	0.23
<b>EU Total</b>	–	–	<b>2952</b>	<b>0.66</b>	<b>2778</b>	<b>0.63</b>	<b>2365</b>	<b>0.53</b>	<b>1887</b>	<b>0.43</b>	<b>2621</b>	<b>0.46</b>
Iceland	Y	C	3	0.77	2	0.53	5	1.4	4	1.1	4	1.1
Norway	Y	C	39	0.71	30	0.55	20	0.37	37	0.69	27	0.51
Liechtenstein	Y	C	0	0	0	0	0	0	–	–	–	–
Switzerland <sup>d</sup>	Y	C	74	0.84	78	0.89	33	0.38	58	0.67	36	0.42

Abbreviation: –, Data not reported.

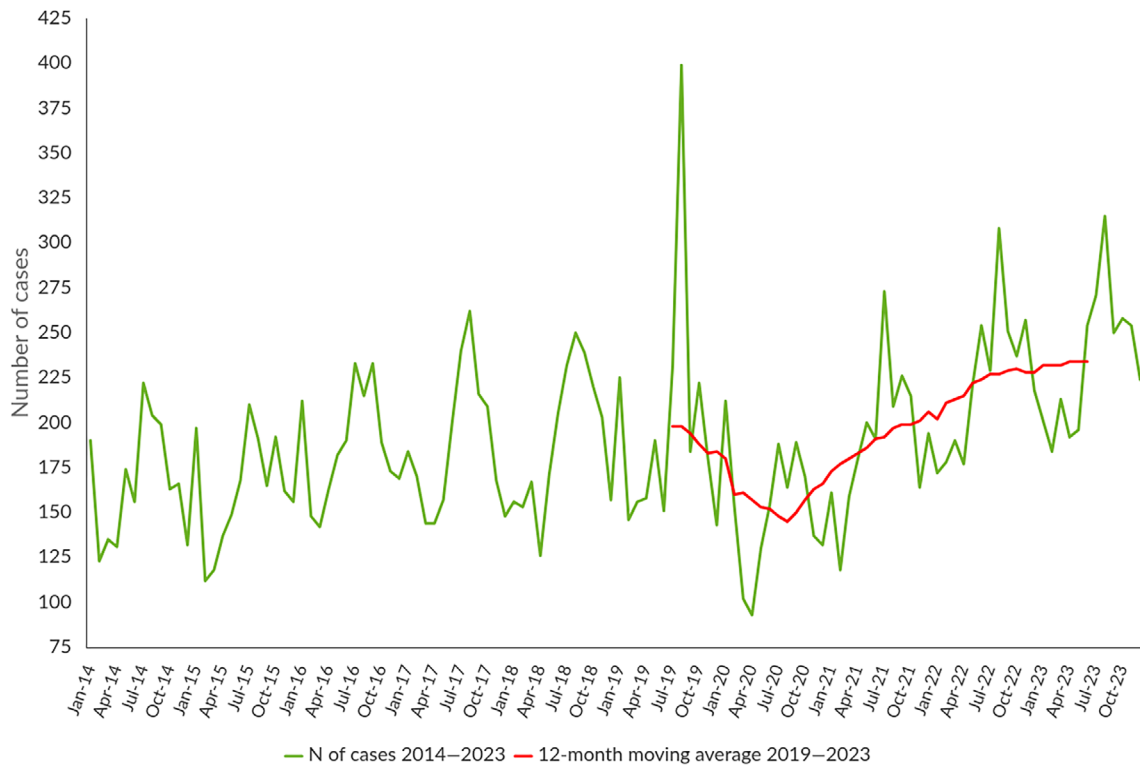
<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

<sup>b</sup>Sentinel system: notification rates calculated with an estimated population coverage of 80%.

<sup>c</sup>Sentinel system: notification rates calculated with an estimated population coverage of 97% in 2021–2023. No information on estimated coverage in 2019–2020, so notification rate cannot be estimated.

<sup>d</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

The distribution of cases by month in the last 5 years (2019–2023) shows a rise in case reports in the second half of the year, with a peak in the summer (Figure 9). The overall EU trend for listeriosis cases in the period 2019–2023 showed a significant increase. At the country level, a statistically significant increasing trend ( $p < 0.05$ ) was reported for Belgium, Czechia, Denmark, France, Hungary, Italy, Poland, Portugal, Slovakia, Spain and Sweden. No country exhibited a significant decreasing trend.



**FIGURE 9** Trend in reported confirmed human cases of listeriosis in the EU by month, 2019–2023. Source: Austria, Belgium, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain and Sweden.

### 3.4.3 | *Listeria monocytogenes* in RTE food

#### Data collected in the context of Commission Regulation (EC) No 2073/2005

In total, 20 MSs reported data in the context of the FSC according to the specifications mentioned above (Section 3.3.1) for 11 RTE food categories (Table 32).

Overall, *L. monocytogenes* occurrences reported from official sampling were rare to low, both at manufacturing and distribution (from 0% to 2.8%), except for ‘products of meat origin, fermented sausages’ for which a moderate positive proportion (14.8%) was observed at distribution. Occurrences were lower at distribution compared with manufacturing, except for ‘products of meat origin, other than fermented sausages’.

At distribution, the highest occurrences were reported for ‘products of meat origin, fermented sausages’ (14.8%), ‘hard cheeses’ (1.8%), ‘products of meat origin, other than fermented sausages’ (1.4%) and ‘fish’ (1.1%). Statistics on positive samples indicated further that the proportion of samples exceeding 100 CFU/g was either zero or consistently rare to very low across all RTE food categories. The highest proportion, 0.78%, was reported for ‘products of meat origin, fermented sausages’.

At manufacturing, the highest occurrences were reported for ‘fish and fishery products’ (1.8%), ‘fish’ (1.4%) and ‘soft and semi-soft cheeses’ (1.3%).

**TABLE 32** Proportions (%) of *Listeria monocytogenes* positive single samples at the manufacturing and distribution stages from official sampling by CAs in the context of verification of implementation by FBOs of the *L. monocytogenes* FSC in accordance with Commission Regulation (EC) No 2073/2005, EU, 2023.

RTE food category <sup>a</sup>	Manufacturing <sup>b</sup>		Distribution <sup>c</sup>					
	Analytical method <sup>d</sup>							
	Detection (EN ISO 11290-1)		Detection (EN ISO 11290-1)		Enumeration (EN ISO 11290-2)			
	% positive samples (N samples tested, N reporting MSs) <sup>d</sup>		% positive samples (N samples tested, N reporting MSs) <sup>d</sup>		% positive samples (N samples tested, N reporting MSs) <sup>d</sup>		% of samples exceeding 100 CFU/g <sup>e</sup>	
<b>Foods intended for infants and for medical purposes:</b> data reported from BE, CY, CZ, ES, GR, HU, IT, LU, SI, SK			0 (N = 1667; 10 MSs)					
<b>Fish:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, GR, HR, HU, IT, PT, SI, SK	1.4 (N = 640; 8 MSs)				1.1 (N = 873; 13 MSs)		0.11	
<b>Fishery products:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, GR, HR, IT, LU, RO, SI, SK	1.8 (N = 558; 10 MSs)				0.74 (N = 1887; 11 MSs)		0.11	
<b>Cheeses, soft and semi-soft:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, GR, HR, HU, IT, LT, PT, RO, SK	1.3 (N = 2970; 13 MSs)				0.23 (N = 2611; 14 MSs)		0.19	
<b>Cheeses, hard:</b> data reported from BG, ES, GR, HR, HU, IT, LU, PT, RO, SK					1.8 (N = 492; 10 MSs)		0.20	
<b>Cheeses, unspecified:</b> data reported from AT, BE, ES, GR, HR, HU, IT, RO, SI	0.55 (N = 2362; 6 MSs)				0 (N = 303; 7 MSs)		0	
<b>Other dairy products (excluding cheeses) – entire category:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, GR, HU, IT, LT, LU, RO, SI, SK	0.18 (N = 1689; 12 MSs)				0 (N = 1571; 13 MSs)		0	
<b>Milk:</b> data reported from AT, BG, CZ, EE, ES, GR, HR, HU, IT, RO	0 (N = 248; 7 MSs)				0 (N = 84; 7 MSs)		0	
<b>Products of meat origin, fermented sausages:</b> data reported from BE, BG, CY, CZ, ES, GR, HR, LT, PT, SK					14.8 (N = 386; 10 MSs)		0.78	
<b>Products of meat origin, other than fermented sausages:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, FR, GR, HR, IT, LU, RO, SI, SK	0.90 (N = 8289; 11 MSs)				1.4 (N = 4728; 14 MSs)		0.23	
<b>Other products:</b> data reported from AT, BE, BG, CY, CZ, DK, EE, ES, GR, HR, HU, IT, LT, LU, MT, PT, RO, SI, SK	2.8 (N = 878; 15 MSs)				0.37 (N = 6463; 17 MSs)		0.12	

Note: Grey boxes are not applicable in relation to the analytical method for the specific food category and sampling stage in the context of Commission Regulation (EC) No 2073/2005.

Abbreviations: CFU, colony forming units; MSs, Member States; N, number of single samples tested; RTE, ready-to-eat.

<sup>a</sup>In the absence of relevant physicochemical data (pH, aw), EFSA assumes that foods listed under 'fish and fishery products', 'soft and semi-soft cheeses', 'unspecified cheeses', 'milk', 'products of meat origin other than fermented sausages', 'other dairy products' and 'other products' belong to the category of foods that are able to support the growth of *L. monocytogenes*. EFSA assumes that 'fermented sausages' and 'hard cheeses' belong to the category of foods that are unable to support the growth of *L. monocytogenes*, because foods classified under these two categories of RTE products undergo ripening/fermentation and are expected to have low pH and moderate aw values. For 'other dairy products', EFSA presents the results in a conservative way, by considering all foods included in this category as capable of supporting the growth of *L. monocytogenes*.

<sup>b</sup>Includes samples collected from 'cutting plants' and 'processing plants'.

<sup>c</sup>Includes samples collected from 'catering', 'hospital or medical care facility', 'retail', 'wholesale', 'not available', 'unspecified', 'restaurant or cafe or pub or bar or hotel or catering service', 'automatic distribution system for raw milk', 'border inspection' and 'packing centre'.

<sup>d</sup>Proportion (%) of positive samples (detection of *L. monocytogenes* in 25 g of sample for qualitative analyses, or number of *L. monocytogenes* > or ≤ 100 CFU/g for enumeration analyses); in parentheses, the number of tested samples and the number of reporting MSs.

<sup>e</sup>Proportion (%) of samples exceeding 100 CFU/g for enumeration analyses.

The below text summarises results for the major food categories according to the criteria described in section 3.3.2.

## Monitoring data assessing *L. monocytogenes* occurrence in RTE foods

### Fish and fishery products, RTE

In 2023, 17 MSs and four non-MSs (Albania, Iceland, Montenegro and Serbia) reported detection data for fish or fishery products.

In the EU, as in previous years, the overall occurrence of *L. monocytogenes* in fish or fishery products remained among the highest across all RTE food categories, with an overall mean occurrence of 3.6% ( $N=4132$ ), ranging from 0% to 10.0% depending on the MS. Seven MSs (Bulgaria, Denmark, Germany, Italy, the Netherlands, Romania and Spain) accounted for 82.5% of the reported data for these categories.

### **Meat and meat products, RTE**

In 2023, 17 MSs and 4 non-MSs (Albania, Iceland, Republic of North Macedonia and Serbia) reported detection data for meat and meat products.

In the EU, the overall occurrence of *L. monocytogenes* in meat and meat products was 3.1% ( $N=16,445$  units tested for detection), ranging from 0% to 16.7% depending on the MS. Three MSs accounted for 67% of the reported data (Czechia, Romania and Spain). A total of 79.7% of tested units were associated with the four main animal species (pigs, cattle, broilers and turkeys), while the remaining 20.3% came from other or unspecified animals. RTE meat and meat products from pigs were the most frequently tested (72.8%). RTE meat and meat products from cattle, broilers and turkeys represented 4.1%, 2.3% and 0.49% of the tested sampling units, respectively.

#### *Pork products*

Fifteen MSs and four non-MSs (Albania, Iceland, Republic of North Macedonia and Serbia) reported data for RTE pork meat products.

In the EU, the overall occurrence was low and comparable to previous years: 3.1% in 2023 ( $N=11,976$ ), 1.9% in 2022 ( $N=32,068$ ) and 2.6% in 2021 ( $N=24,688$ ). As in previous years, four MSs accounted for 80.4% of the reported data on pork meat products (Czechia, Germany, Romania and Spain).

#### *Poultry meat products (broilers and turkeys)*

Eleven MSs reported data for RTE poultry meat products.

In the EU, the overall occurrence of *L. monocytogenes* in RTE poultry meat products was 0.44% ( $N=455$ ). This very low occurrence was comparable with previous years: 0.64% ( $N=1248$ ) in 2022, 1.3% ( $N=895$ ) in 2021 and 0.65% ( $N=464$ ) in 2020. In 2023, only one positive sampling unit was detected in RTE meats from each category: broilers ( $N=374$ ) or turkeys ( $N=81$ ). In 2023, five MSs accounted for 82.2% of the reported data on poultry meat products (Austria, Bulgaria, Czechia, Romania and Spain).

#### *Bovine meat products*

Twelve MSs and two non-MSs (Albania and Serbia) reported data for RTE bovine meat products.

In the EU, the overall occurrence of *L. monocytogenes* reported in RTE bovine meat products was 9.9% ( $N=679$ ). Four MSs accounted for 84.7% of the accounted data on bovine meat products (Bulgaria, Czechia, Italy and the Netherlands). For comparison, occurrences were 4.9% in 2022 ( $N=2712$ ), 3.9% in 2021 ( $N=2217$ ) and 7.4% in 2020 ( $N=856$ ).

### **Milk and milk products, RTE**

In 2023, 19 MSs and four non-MSs (Albania, Montenegro, Republic of North Macedonia and Serbia) reported detection data for RTE milk and milk products. Six MSs provided 79% of the reported data (Bulgaria, Czechia, Italy, the Netherlands, Romania and Spain).

In the EU, the overall occurrence of *L. monocytogenes* in RTE milk products was 0.47% ( $N=22,112$  tested units). The occurrence was 0.26% in cheeses made from pasteurised milk ( $N=7371$ ), 1.4% in cheeses made from raw milk or low heat-treated milk ( $N=1704$ ) and 0% in milk ( $N=727$ ). The highest occurrences were observed in cheeses made from raw or low heat-treated milk (including fresh cheese), with occurrences reaching up to 6.7%. In this category, five MSs (Austria, the Netherlands, Romania, Slovakia and Spain) accounted for 85.3% of the reported data. Of the tested sampling units, 76.3% of cheese and 92.4% of milk sampling units were of bovine origin.

### **Fruits, vegetables and juices, RTE**

Fifteen MSs reported detection data for RTE fruits, vegetables and juices.

The overall occurrence in the EU was 1.6% ( $N=1075$ ). A total of 80.1% of the data were reported by six MSs (Austria, Bulgaria, Hungary, Italy, Slovenia and Spain).

### 3.4.4 | *Listeria* spp. in animals

In 2023, 11 MSs, the United Kingdom (Northern Ireland) and two non-MSs (Republic of North Macedonia and Switzerland) reported 15,422 samples across various animal categories, including food-producing, wild, zoo and pet animals, as well as birds, from different species.

In the EU, the majority of the data (Table 33) were derived from individual animals (92.0%,  $N=14,181$ ) compared to other samples such as herd/flock or holdings. Cattle accounted for the largest proportion of animals tested for *Listeria* (46.2% of the total units tested), followed by small ruminants (30.9%) and pigs (17.3%). The percentages of positive units for *Listeria* spp. were 1.5% in cattle, 4.2% in small ruminants and 0.26% in pigs. The sample size, sampling strategies and proportion of positive findings varied considerably among the reporting countries and animal species. Notably, 76.2% of the EU data were reported by two MSs: the Netherlands (38.0%) and Ireland (38.2%).

Among the 320 positive samples for *Listeria*, 56.6% were reported as *L. monocytogenes*. Limited positive findings were attributed to *L. ivanovii* (6.3%) and *L. innocua* (3.1%). As in previous years, a large proportion of positive findings (34.1%) were classified as other or unspecified *Listeria* species.

**TABLE 33** Summary of *Listeria* species statistics relating to major animal species, MSs, 2023.

Animal species	N reporting MSs	N tested units	% positive units	N positive units for <i>L. monocytogenes</i>	N positive units for <i>L. ivanovii</i>	N positive units for <i>L. innocua</i>	N positive units for other <i>Listeria</i> species
Cattle	10	7127	1.5	67	0	10	29
Sheep and goats	12	4762	4.2	103	20	0	79
Pigs	6	2672	0.26	7	0	0	0
Others	6	861	0.58	4	0	0	1
<b>Total EU</b>	<b>12</b>	<b>15,422</b>	<b>2.1</b>	<b>181</b>	<b>20</b>	<b>10</b>	<b>109</b>

## 3.5 | Discussion

In 2023, the number of confirmed cases of human listeriosis was 2952, corresponding to an EU notification rate of 0.66 per 100,000 population and resulting in an increase of 5.8% in the notification rate compared with 2022. This was the highest notification rate and number of cases reported in the EU since the beginning of EU level surveillance in 2007. Listeriosis was the fifth most commonly reported zoonosis in humans in the EU in 2023, and one of the most serious food-borne diseases under EU surveillance due to the high rate of hospitalisations, and elevated morbidity and mortality, particularly among elderly people (Quereda et al., 2021).

Findings from the 2023 analysis of data reported to ECDC through TESSy indicate that listeriosis in Europe is increasing. It is noteworthy that for all MSs with statistically significant trends in cases of listeriosis reported in the period 2019–2023, the trend was towards a gradual increase, while no country reported a decreasing trend. This explains the statistically significant increasing trend at the EU level. Italy was the only country reporting far fewer cases in 2023, but this was due to a larger than expected number of cases observed in 2022 because of the occurrence of large community food-borne outbreaks of listeriosis (EFSA and ECDC, 2023).

In 2023, listeriosis caused 1497 hospitalisations and 335 deaths. In all, 80% of fatal cases were in the age group over 65 years and 89.3% when considering the age group over 60 years. Outbreaks were fewer than in previous years (19 in 2023 vs. 35 in 2022) with 133 related cases (296 in 2022). However, it is important to note that most human listeriosis cases are sporadic and until now sporadic cases of listeriosis were rarely traced to a food source (EFSA BIOHAZ et al., 2020a). Estimates of under-reporting and under-detection are lower than for other zoonotic agents due to the severity of invasive listeriosis (Haagsma et al., 2013).

Invasive listeriosis (fever, meningitis and septicæmia) affects mainly susceptible populations (elderly people over 65, pregnant women, newborns and immunocompromised people) (Quereda et al., 2021; Radoshevich & Cossart, 2018; Vázquez et al., 2024). With the ageing of the European population (21.3% of the European population is over 65) (Eurostat, 2024) and the increase in chronic age-related diseases (EFSA BIOHAZ Panel, 2020), more people are at risk of severe symptoms. Human cases of listeriosis are primarily caused by consuming RTE foods (such as cold smoked salmon, meat and meat products, and dairy products) (ECDC and EFSA, 2024b; Fernández-Martínez et al., 2022; Halbedel et al., 2023); frozen vegetables should also be considered as risky food, when consumed in raw state or improperly cooked under foreseeable conditions of use (EFSA BIOHAZ et al., 2020a). These listeriosis cases are not necessarily linked to social and community events, but to consumption of these foods in households (ECDC and EFSA, 2018a, 2018b, 2019).

The molecular characterisation of clinical isolates of *Listeria* has moved from pulsed-field gel electrophoresis (PFGE) (ECDC, 2021) to whole genome sequencing (WGS), combined with core genome multi-locus sequence typing (cgMLST) for strain typing, yielding greater accuracy (ECDC, 2019; Moura et al., 2016; Nielsen et al., 2017; Ruppitsch et al., 2015). Prior to the use of WGS, a system for rapid and accurate identification of clusters was lacking in sensitivity and, at the European



level, many outbreaks were not detected early (Van Walle et al., 2018); nowadays, WGS is a typing method for *Listeria* spp. that is in widespread use internationally (Fagerlund et al., 2022; Lee et al., 2023; Pietzka et al., 2019).

In the food sector, we observed an overall decrease of the number of tested units in RTE products (–40% in 2023 compared with 2022) mainly explained by the absence of data from Poland. Finland and Norway also did not provide data. Iceland and Northern Ireland provided very few monitoring results. The sampling effort at manufacturing and distribution remained focused on RTE products of animal origin. The occurrence of *L. monocytogenes* as assessed from detection results reported by MSs (covering objective sampling of single samples and batches) varied according to the food category and sample stage. Occurrences remained generally rare to low in RTE foods. The highest values were observed for ‘meat products from bovine animals’ (9.9%), ‘hard cheeses from raw or low heat-treated milk’ (6.7%), ‘fish and fishery products’ (3.6%), and ‘fruits and vegetables’ (1.6%). As in previous years, the highest proportions of positive official control samples, as part of verification of *L. monocytogenes* FSC, were observed at manufacturing compared with distribution, except for ‘products of meat origin other than fermented sausages’. No *L. monocytogenes* was detected in ‘milk’, at any stage. Contamination of the food processing environment is known to be a risk factor for food safety, particularly where persistent strains are concerned. For this reason, advances in next-generation sequencing (NGS) technologies, strategic hygiene measures and environmental monitoring have recently been reviewed (EFSA, 2018; EFSA BIOHAZ Panel, 2024), in order to provide recommendations to FBOs and risk assessors.

The results from official sampling at distribution showed that the proportion of samples exceeding 100 CFU/g was either zero or consistently rare to very low across all RTE food categories, with a maximum of 0.78% observed for ‘Products of meat origin, fermented sausage’.

In primary production, cattle were the most frequently sampled animal species and presented a low proportion of positive units (1.5%).

National data and trends for the occurrence of *L. monocytogenes* in food or animals over time must be interpreted with caution. Currently, surveillance data come from systems that are not fully harmonised and that vary in nature and effectiveness depending on the MS. Moreover, data may be reported by a limited number of MSs depending on each food/animal category.

Combining human, animal and food epidemiological data with molecular and genotyping data provides an efficient methodology to better understand the ecology of this pathogen at different stages of the food chain and will improve the investigation of listeriosis outbreaks affecting one or more MSs. In this framework, EFSA and ECDC have developed the One Health WGS System that interoperates to exchange cgMLST profiles and minimum metadata (EFSA, 2022). The system has been open to MSs since 2022. The aim is to collect typing information to detect clusters of food-borne disease and to generate hypotheses on the possible food vehicles involved, supporting risk managers. In 2023, one Rapid Outbreak Assessment was prepared, which also included an MS consultation on the genomic data of their isolates, after a genomic cluster of *L. monocytogenes* sequence type 155 infections was identified in the European Union/European Economic Area (EU/EEA) and the United Kingdom (UK) (ECDC and EFSA, 2023c). At the international level, the joint FAO/WHO expert meetings on microbial risk assessment (JEMRA) recommended expanding risk assessments on *L. monocytogenes* in RTE foods, incorporating a primary production-to-consumption perspective and reviewing groupings of susceptible populations (FAO and WHO, 2022). Models for the risk assessment of *L. monocytogenes* for lettuce, cantaloupe, frozen vegetables and RTE fish were developed, and recommendations were made in November 2022 and June 2023 by the Joint FAO/WHO Expert<sup>25</sup> to possibly revise the Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Foods (CXG 61–2007). FAO and WHO also established a roster of experts in 2022 to obtain more representative data on *L. monocytogenes* in food and to develop a new, full farm-to-table risk assessment.

<sup>25</sup>Summary and conclusions on [https://www.fao.org/food-safety/resources/publications/en/?page=6&ipp=10&tx\\_dynalist\\_pi1%5Bpar%5D=YToxOntzOjE6IkwiO3M6MToiMCI7fQ%3D%3D](https://www.fao.org/food-safety/resources/publications/en/?page=6&ipp=10&tx_dynalist_pi1%5Bpar%5D=YToxOntzOjE6IkwiO3M6MToiMCI7fQ%3D%3D) (The issuance of these documents do not constitute formal publication).

## 4 | SHIGA TOXIN-PRODUCING *ESCHERICHIA COLI* (STEC)

### Human cases [EU, 2023]

Notification rate  
(per 100,000 population) **3.1**

Trend  
(2019-2023)



Increasing  
Decreasing  
Stable

**10,217** Cases of illness

**7192** Infections acquired in the EU

**895** Infections acquired outside the EU

**2130** Unknown travel status or unknown country of infection

**1234** Hospitalisations (37.6%)\*

**31** Deaths (0.40%)\*

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

■ ECDC data

### Foodborne outbreaks & related cases [EU, 2023]

**66** Foodborne outbreaks

**6** Strong-evidence outbreaks ■

**60** Weak-evidence outbreaks ■

**270** Cases of illness

**48** Hospitalisations (17.8%)\*

**1** Death (0.37%)\*

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

#### N of outbreaks

Austria	5
Belgium	14
Bulgaria	0
Croatia	0
Cyprus	0
Czechia	0
Denmark	3
Estonia	0
Finland	0
France	18
Germany	8
Greece	0
Hungary	0
Ireland	9
Italy	0
Latvia	0
Lithuania	0
Luxembourg	0
Malta	2
Netherlands	1
Poland	2
Portugal	0
Romania	0
Slovakia	0
Slovenia	0
Spain	0
Sweden	2
UK (N. Ireland)	2

#### N of outbreaks per 100,000 population \*\*

AT	0.055
BE	0.119
BG	0
HR	0
CY	0
CZ	0
DK	0.051
EE	0
FI	0
FR	0.026
DE	0.009
EL	0
HU	0
IE	0.171
IT	0
LV	0
LT	0
LU	0
MT	0.369
NL	0.006
PL	0.005
PT	0
RO	0
SK	0
SI	0
ES	0
SE	0.019
XI	0.105

#### N of outbreak cases per 100,000 population

AT	0.132
BE	0.358
BG	0
HR	0
CY	0
CZ	0
DK	0.202
EE	0
FI	0
FR	0.166
DE	0.026
EL	0
HU	0
IE	0.379
IT	0
LV	0
LT	0
LU	0
MT	1.107
NL	0.084
PL	0.016
PT	0
RO	0
SK	0
SI	0
ES	0
SE	0.133
XI	0.419

#### Implicated food vehicles (Strong-evidence outbreaks)

##### Top food vehicles



Dairy products (other than cheeses)  
**3** Outbreaks



Cheese  
**2** Outbreaks



Bovine meat and products thereof  
**1** Outbreak

\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

■ EFSA data

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#), Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about Shiga toxin-producing *Escherichia coli* (STEC) and for the consultation of data collected, the following interactive tools are available:



## 4.1 | Key facts

- STEC infection was the third most commonly reported gastrointestinal food-borne illness in humans in the European Union.
- In 2023, there were 10,217 confirmed cases of human STEC infections, corresponding to a European Union notification rate of 3.1 cases per 100,000 population. This was an increase of 30.0% compared with 2022 (2.4 cases per 100,000 population).
- The overall trend for STEC infections showed an increase in the 2019–2023 period.
- In 2023, a total of 505 HUS cases were reported from 20 Member States.
- In 2023, STEC were isolated from 354 food sampling units of the 16,117 units sampled with 'objective sampling' as sampling strategy and tested with methods detecting any STEC.<sup>26</sup> The 'ready-to-eat' food category included 6863 sampling units reported by 19 Member States and 1.0% were positive for STEC, with positive sampling units originating mainly from the 'milk and milk products' (2.0% positives) and 'meat and meat products' (1.3%) food categories. However, 6.7% of the 45 sampling units belonging to the 'bakery products' food category were also positive for the presence of STEC. Out of the 9254 'non-ready-to-eat' samples reported by 21 Member States, 3.1% were positive, with the highest level of contamination in 'meat and meat products' (3.8%).
- Nine Member States tested 536 official control samples of 'sprouted seeds' in the context of Commission Regulation (EC) No 2073/2005 taken at retail and processing plants, with no positive results.
- In 2023, STEC testing was carried out by five Member States on animal samples belonging to different categories. Most of the units tested in the European Union ( $N=2129$ ) were from 'cattle' ( $N=937$ ), with 16.8% positives. The highest proportions of positive samples were obtained from the following animal categories: 'pigs' with 46.9%, 'goats and sheep' with 34.6%, based on 408 and 405 animal samples tested, respectively.

## 4.2 | Surveillance and monitoring of STEC infections in the EU

### 4.2.1 | Humans

In 2023, all 27 MSs reported information on STEC infections in humans. STEC surveillance is mandatory in 24 MSs, voluntary in 2 MSs (Belgium, France) and based on another system in Italy.

The EU case definition was used by 24 MSs. Three countries reported using a different case definition (France, Germany and the Netherlands).

All MSs, except Italy, indicated that the surveillance system is comprehensive. The surveillance systems for STEC infections cover the whole population in all EU MSs except for three MSs (France, Italy and Spain). The notification rates were not calculated in France and Italy, countries for which STEC surveillance is sentinel and primarily based on HUS cases. For Spain, as in 2022, population coverage of STEC cases was estimated at 97%.

All MSs reported case-based data, except Croatia which reported aggregated data.

### 4.2.2 | Food and animals

#### **STEC data in the context of Commission Regulation (EC) No 2073/2005, STEC food safety criterion for sprouts and seeds at the distribution level**

A food safety criterion has been in place for STEC in sprouts since 2013 (Commission Regulation (EC) No 2073/2005). The regulation specifies that sprouts placed on the market during their shelf-life shall not contain detectable STEC O157, O26, O111, O103, O145 or O104:H4 in 25 g of product. The legal basis indicates that the ISO TS 13136:2012 method (ISO, 2012) with the adaptation developed by the EURL for *E. coli* for detecting O104:H4 is the reference testing methodology. However, FBOps are allowed to use alternative methods validated according to the requirements of ISO 16140-4 (ISO, 2020).

As the sampling objectives and frequency are not indicated, these activities vary or are interpreted differently among MSs, resulting in non-harmonised data.

#### **Other STEC monitoring data from food and animals**

All the food and animal testing data, except for those on sprouts and seeds, originate from the reporting obligations of MSs under Directive 2003/99/EC. Due to the absence of explicitly indicated sampling strategies in this directive, the data generated by MSs are based on investigations with non-harmonised sampling programmes. Therefore, STEC monitoring data in accordance with Directive 2003/99/EC are not comparable between MSs and preclude assessing temporal and spatial

<sup>26</sup>The methods considered here are those not restricted to the detection of specific STEC serogroups e.g. ISO 16654 for O157.

trends at the EU level. Different sampling designs and inaccuracies due to limited numbers of samples tested also preclude an accurate estimation of prevalence.

Nevertheless, descriptive summaries of sample statistics at the EU level can be used to indicate the circulation of certain STEC types in food and animals. This information may be used to design sampling strategies within the MSs, provided that the above-mentioned relevant limitations of the data set are taken into consideration.

The analysis of the data available suggests that the isolated STEC strains should be characterised. Indeed, typing and subtyping data (e.g. virulotyping and *stx* gene subtyping) are considered to be the most valuable information for inferring the circulation of the various STEC types and on their possible association with the severity of human disease (EFSA BIOHAZ Panel, 2020; FAO and WHO, 2019; NACMCF, 2019).

## 4.3 | Data analyses

### 4.3.1 | Occurrence in food and animals

The monitoring data on sprouts as part of Commission Regulation (EC) No 2073/2005 were aggregated and summarised for trend watching according to the following 'filters': Sampling context: 'surveillance, based on Regulation No 2073/2005'; Sampling unit type: 'single'; Sampling stage: 'distribution'; Sampling strategy: 'objective sampling' and Sampler: 'official sampling'.

For the description of the occurrence of STEC-positive samples in the different food categories, the subset of the monitoring data with 'objective sampling' specified as sampling strategy was used ( $N=16,117$ ), meaning that the reporting MSs collected the samples according to a planned strategy based on the selection of random samples statistically representative of the population to be analysed.

### 4.3.2 | Serogroups and virulence features in food and animals

In 2023, the methods targeting any STEC were based on *stx* gene PCR and included the ISO TS 13136:2012 method (ISO, 2012), other PCR-based methods and commercial kits using the same principle. The methods designed to detect only *E. coli* O157 were the ISO 16654:2001 method (ISO, 2001), the NMKL 164:2005 method (NMKL, 2005), the DIN 10167:2004–03 (DIN, 2004) method and the AFNOR BIO 12/25–05/09 ELFA method for *E. coli* O157. The method indicated as the OIE method for *E. coli* O157 is an adaptation of the ISO 16654:2001 method used for animal samples (WOAH, 2023).

For the descriptive analyses of STEC strains from food and animals (primarily those on virulence gene types and on their frequency distribution), the full data set, regardless of the sampling strategy but excluding the samples assayed with methods detecting *E. coli* O157 only, was used ( $N=17,495$  for food and  $N=2107$  for animals).

## 4.4 | Results

### 4.4.1 | Overview of key statistics, EU, 2019–2023

**Table 34:** summarises EU-level statistics on human STEC infections and on samples tested for STEC from food and animals during 2019–2023. Food and animal data were classified into major categories and aggregated by year to obtain an annual overview of the volume of data submitted. The number of food-borne outbreaks caused by STEC in 2023 ( $N=66$ ) was slightly lower than that reported in 2022 ( $N=71$ ). More detailed descriptions of these statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

**TABLE 34** Summary of STEC statistics relating to humans, major food categories and the main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	10,217	8031	6406	4489	7801	ECDC
Total number of confirmed cases/100,000 population (notification rates)	3.1	2.4	1.9	1.5	2.1	ECDC
Number of reporting MSs	27	26	27	27	28	ECDC
Infection acquired in the EU	7192	5272	4365	3370	4836	ECDC
Infection acquired outside the EU	895	564	117	148	751	ECDC
Unknown travel status or unknown country of infection	2130	2195	1924	971	2214	ECDC

TABLE 34 (Continued)

	2023	2022	2021	2020	2019	Data source
Number of food-borne outbreak-related cases	270	408	275	208	208	EFSA
Total number of food-borne outbreaks	66	71	31	34	36	EFSA
<b>Food<sup>a</sup></b>						
<b>Meat and meat products</b>						
Number of sampling units	10,108	9932	12,160	10,866	14,110	EFSA
Number of reporting MSs	21	21	19	17	20	EFSA
<b>Milk and milk products</b>						
Number of sampling units	3582	5957	4094	4665	5479	EFSA
Number of reporting MSs	15	14	11	10	13	EFSA
<b>Fruits and vegetables (and juices)</b>						
Number of sampling units	2600	3075	4046	3398	2696	EFSA
Number of reporting MSs	15	16	16	15	13	EFSA
<b>Animals<sup>a</sup></b>						
<b>Cattle (bovine animals)</b>						
Number of sampling units	937	282	2077	868	1615	EFSA
Number of reporting MSs	3	3	5	3	7	EFSA
<b>Small ruminants (sheep, goats) and deer</b>						
Number of sampling units	421	822	151	227	320	EFSA
Number of reporting MSs	4	3	2	2	6	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States; STEC, Shiga toxin-producing *Escherichia coli*.

<sup>a</sup>The total number of sampling units was calculated by summing all reported sub-level entries for sampling units, stages, strategies and samplers, as listed in the EFSA Catalogue (EFSA and Ioannidou, 2019).

#### 4.4.2 | STEC infections in humans

In 2023, 10,217 confirmed cases of STEC infections were reported in the EU (Table 35). Twenty-six MSs reported at least one confirmed STEC case, only Cyprus reported zero cases. In 2023, the EU notification rate was 3.1 per 100,000 population with an increase of 30.0% compared with year 2022 (2.4 cases per 100,000 population).

The highest country-specific notification rates among the EU MSs were observed in Denmark, Ireland, Malta and Sweden (24.1, 15.8, 12.2 and 8.9 cases per 100,000 population, respectively) (Table 35). Three countries (Bulgaria, Lithuania and Slovakia) reported  $\leq 0.07$  cases per 100,000 population.

Most STEC cases reported with the information on the travel status were infected in the EU (88.0%), including both domestically acquired infections ( $N=6877$ ) and 315 cases of infections associated with travel in the EU (Table 35).

Germany, Sweden, Denmark and the Netherlands reported the highest number of travel-associated cases (421, 309, 157 and 128, respectively), together representing 78.1% of all imported cases (EU and non-EU). The most frequently reported countries as probable origin of infection within the EU were Spain, Italy, Croatia and Greece, with 21.3%, 13.3%, 9.5% and 8.6% cases, respectively.

TABLE 35 Reported confirmed human cases of STEC and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	Y	C	584	6.4	469	5.2	383	4.3	288	3.2	284	3.2
Belgium	Y	C	337	2.9	187	1.6	124	1.1	84	0.73	131	1.1
Bulgaria	Y	C	1	0.02	0	0	0	0	0	0	0	0
Croatia	Y	A	23	0.60	16	0.41	12	0.30	8	0.20	22	0.54
Cyprus	Y	C	0	0	0	0	0	0	0	0	0	0
Czechia	Y	C	52	0.48	58	0.55	36	0.34	32	0.30	33	0.31
Denmark	Y	C	1431	24.1	1329	22.6	928	15.9	445	7.6	623	10.7

(Continues)

TABLE 35 (Continued)

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Estonia	Y	C	21	1.5	11	0.83	7	0.53	10	0.75	6	0.45
Finland	Y	C	306	5.5	283	5.1	288	5.2	175	3.2	311	5.6
France <sup>b</sup>	N	C	342	–	473	–	298	–	262	–	335	–
Germany	Y	C	3485	4.1	1873	2.3	1635	2.0	1409	1.7	1907	2.3
Greece	Y	C	22	0.21	14	0.13	10	0.09	3	0.03	5	0.05
Hungary	Y	C	41	0.43	26	0.27	24	0.25	8	0.08	23	0.24
Ireland	Y	C	833	15.8	892	17.6	878	17.5	734	14.8	798	16.3
Italy <sup>b</sup>	N	C	96	–	118	–	65	–	45	–	62	–
Latvia	Y	C	31	1.6	–	–	13	0.69	2	0.10	48	2.5
Lithuania	Y	C	2	0.07	0	0	0	0	0	0	0	0
Luxembourg	Y	C	16	2.4	9	1.4	10	1.6	0	0	4	0.65
Malta	Y	C	66	12.2	78	15.0	68	13.2	43	8.4	53	10.7
Netherlands	Y	C	576	3.2	585	3.3	484	2.8	323	1.9	459	2.7
Poland	Y	C	75	0.20	34	0.09	7	0.02	3	0.01	14	0.04
Portugal	Y	C	11	0.11	6	0.06	2	0.02	5	0.05	1	0.01
Romania	Y	C	41	0.22	28	0.15	6	0.03	14	0.07	36	0.19
Slovakia	Y	C	4	0.07	4	0.07	5	0.09	1	0.02	3	0.06
Slovenia	Y	C	58	2.7	58	2.8	48	2.3	30	1.4	31	1.5
Spain <sup>c,d</sup>	N	C	824	1.8	623	1.4	422	0.92	74	–	269	–
Sweden	Y	C	939	8.9	857	8.2	653	6.3	491	4.8	756	7.4
<b>EU Total 27</b>			<b>10,217</b>	<b>3.1</b>	<b>8031</b>	<b>2.4</b>	<b>6406</b>	<b>1.9</b>	<b>4489</b>	<b>1.5</b>	<b>6214</b>	<b>2.0</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	1587	2.4
<b>EU Total</b>			<b>10,217</b>	<b>3.1</b>	<b>8031</b>	<b>2.4</b>	<b>6406</b>	<b>1.9</b>	<b>4489</b>	<b>1.5</b>	<b>7801</b>	<b>2.1</b>
Iceland	Y	C	14	3.6	4	1.1	7	1.9	4	1.1	27	7.6
Norway	Y	C	662	12.1	518	9.5	437	8.1	331	6.2	511	9.6
Liechtenstein	Y	C	8	20.2	4	10.2	7	17.9				
Switzerland <sup>e</sup>	Y	C	1224	13.9	1203	13.8	928	10.7	710	8.2	962	11.2

Abbreviations: –, Data not reported.

<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

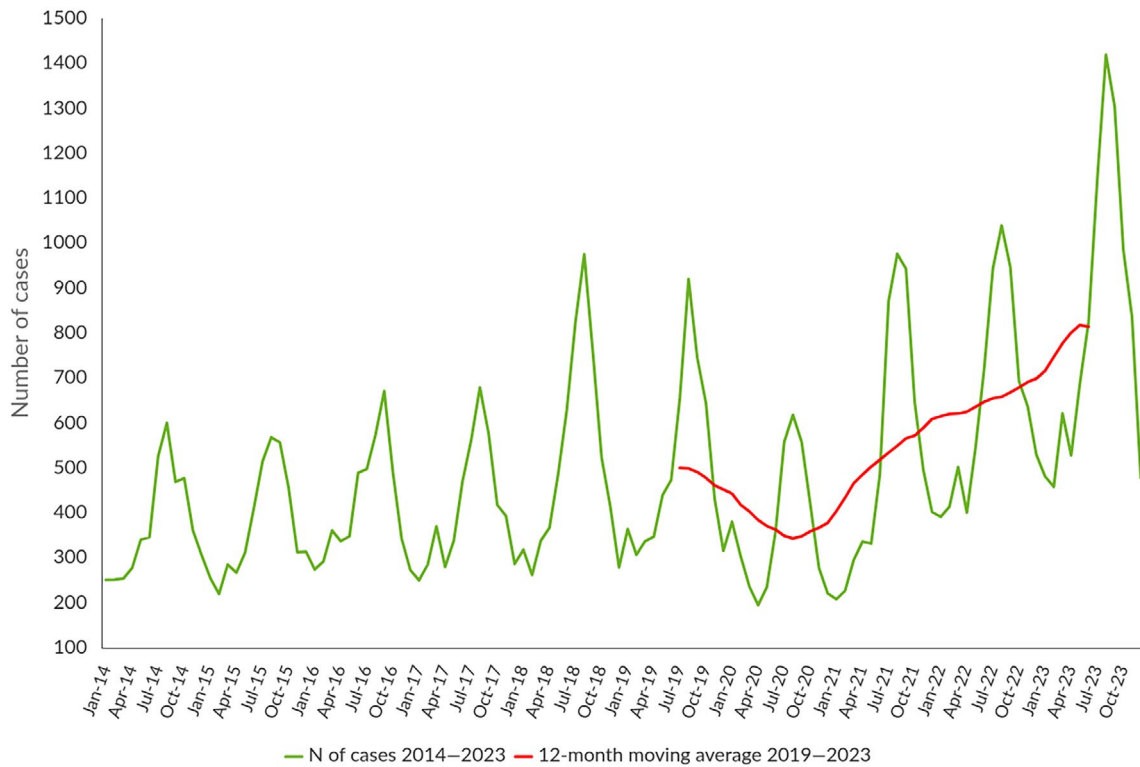
<sup>b</sup>Sentinel surveillance; mainly haemolytic-uraemic syndrome (HUS) cases are notified. Notification rate not calculated.

<sup>c</sup>Sentinel surveillance; notification rates calculated with an estimated population coverage of 97% in 2021–2022–2023.

<sup>d</sup>No information on estimated coverage in 2019–2020, so notification rate cannot be estimated.

<sup>e</sup>Switzerland provided the data directly to EFSA. The human data for Switzerland includes data from Liechtenstein for years 2019–2020.

The confirmed STEC cases maintained a stable marked seasonal trend, with most cases being reported during the summer months (Figure 10). The observed STEC infection seasonality is in line with that reported in the literature (Sapountzis et al., 2020). The overall trend for STEC in 2019–2023 showed a significant increasing trend ( $p < 0.05$ ) (Figure 10). At the MS level, the significant increasing trend ( $p < 0.05$ ) was observed over the same time period in 15 MSs: Austria, Belgium, Denmark, Germany, Greece, Finland, France, Hungary, Luxembourg, Malta, the Netherlands, Poland, Spain, Slovenia and Sweden. No countries reported decreasing trends from 2019 to 2023.



**FIGURE 10** Trend in reported confirmed human cases of STEC infection in the EU by month, 2014–2023. *Source:* Austria, Belgium, Bulgaria, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

In 2023, 505 HUS cases were reported by 20 MSs, with 15 fatalities. As observed in 2022, the most common serogroups among STEC isolated from HUS cases in 2023 were O26, with 37.8% of all HUS cases with serogroup reported ( $N=357$ ), followed by O157 (19.6%), O145 (7.6%) and O80 (5.3%).

#### 4.4.3 | STEC in food

In 2023, 24 MSs provided results from analyses of 17,495 food units (batches or single samples) regardless of the sampling strategy adopted, all assayed with methods detecting any STEC.<sup>27</sup> In 2023, 56.0% of the total number of food sampling units tested in the EU were collected from the food categories ‘bovine meat and products thereof’, ‘milk and milk products’ and ‘fruits, vegetables and products thereof’, which are known to be the vehicles most frequently implicated in STEC infections (EFSA BIOHAZ Panel, 2020; FAO and WHO, 2019).

#### Data collected in the context of Commission Regulation (EC) No 2073/2005

Regulation (EU) 2017/625 specifies that the CAs must only use methods complying with relevant internationally recognised rules or protocols (e.g. those accepted by the CEN) for food testing. Therefore, CAs are not allowed to use the alternative methods mentioned in Commission Regulation (EC) No 2073/2005 when they carry out official controls aiming to verify the correct implementation by FBOps of provisions of this regulation. Year 2023 is the second one of reporting food data in compliance with Regulation (EU) 2017/625; therefore, the implementation of this change should not affect the comparison of the official food control samples taken in the context of Commission Regulation (EC) No 2073/2005 results with those of 2022. Differences may still be present when the comparison is made with 2021 and earlier data and, for this reason, comparisons with previous years should be made with caution.

Regarding 2023 data for STEC on sprouted seeds in the context of Commission Regulation (EC) No 2073/2005, 447 samples taken at the distribution level and 89 at processing plants were tested by nine MSs with no positive batches (see the dashboard referenced at the start of the chapter). As noted in previous years, sprouted seeds are still not widely tested at the EU level. This may be due to the technical difficulties in testing this food commodity or to a poor perception of the risks associated with sprouts despite the German outbreak of STEC O104:H4 infections and the existence of a microbiological criterion for this food commodity in Commission Regulation (EC) No 2073/2005 since 2013.

<sup>27</sup>The methods considered here are those not restricted to the detection of specific STEC serogroups e.g. ISO 16654 for O157.

## Other STEC monitoring data from food

Overall, 2.2% ( $N=354$ ) of the 16,117 food sampling units collected using an objective sampling strategy and tested by 23 MSs were positive for STEC. For years 2022, 2021, 2020 and 2019, the figures for the reported STEC-positive food sampling units were 1.8%, 2.9%, 2.4% and 2.8%, respectively (EFSA and ECDC, 2023).

### RTE food

As regards 'ready-to-eat' (RTE) food, the testing of 6863 sampling units was reported by 19 MSs, with 1.0% found positive. The food category with the highest number of sample units tested was 'milk and milk products' with 2405 sampling units assayed, of which 92.6% were cheese sampling units, followed by 'meat and meat products' ( $N=1376$ ) and 'fruits, vegetables and juices' ( $N=1195$ ). In total, 71 RTE food sampling units were positive for STEC: 1.3% in 'meat and meat products', 2.0% in 'milk and milk products' (particularly cheese), but no positive sampling units were identified among the 'fruits, vegetables and juices'. Interestingly, 'bakery products' was the most contaminated RTE food category, although a low number of sampling units were reported by only two MSs: 6.7% ( $N=3$ ) of the 45 sampling units assayed were found to be positive for the presence of STEC. One of the positive sampling units was taken at the distribution level, with the remaining two taken at the manufacturing level.

### RTE and non-RTE food

To provide overall statistics, the following descriptive analyses are based on merged data from RTE food and non-RTE food.

#### *Meat and meat products*

##### Bovine meat

In 2023, 4128 units of fresh and unprocessed bovine meat were tested by 17 MSs. At the distribution level, 1560 units were sampled by 12 MSs with 0.83% of positives. Sampling units taken at the manufacturing level ( $N=2568$ ) were the most contaminated (5.3%, 13 MSs). Most specimens sampled at the manufacturing level were taken at the slaughterhouse (72.4%,  $N=1860$ ) and 6.5% tested positive for STEC.

##### Sheep and goat meat

In 2023, four MSs reported the results of an investigation on 416 sampling units of fresh sheep meat with 8.2% of these being STEC-positive, confirming the importance of these animals as reservoirs of STEC (Persad & LeJeune, 2014). No fresh goat meat sampling units were taken or assayed for the presence of STEC in 2023.

The sampling stage that yielded the highest proportion of positive fresh sheep meat sampling units was the distribution level, with 9.3% of units producing a STEC isolate, while the units taken at the slaughterhouse, accounting for 98.5% of the manufacturing level samples, showed a lower STEC contamination rate (7.6%).

##### Meat from other ruminants

In 2023, only two MSs provided information on the presence of STEC in 104 fresh deer meat samples with 21 (20.2%) positive sampling units. The sampling units taken at the distribution and manufacturing levels displayed STEC contamination rates of 19.1% and 30.0%, respectively. Only 10 sampling units were taken at the manufacturing level, of which 6 were from processing plants and four from game handling establishments.

##### Meat from other animal species

Eight MSs tested fresh pig meat in 2023 and reported data on 1358 sampling units, with 27 (2.0%) of these being positive for STEC. The proportion of pig meat positive sampling units was similar to that detected in 2022.

Fresh meat from animal species other than bovine, ovine, goat, pig and deer species was tested in 2023 by five MSs that reported on analyses carried out on 330 sampling units. This category included samples of meat from broilers, ducks, land mammals, horses, rabbits, turkeys, wild boar, wild game and meat sampling units of unspecified origin. Thirty-three (10%) sampling units were reported as STEC-positive.

##### Meat products and *meat preparations*

Meat products and meat preparations other than fresh meat were sampled in 2023 by 13 MSs, which tested 2122 sampling units, resulting in 32 (1.5%) isolated STEC strains.



### Milk and milk products

Overall, STEC were found in 49 (2.0%) out of 2405 sampling units of RTE milk and milk products reported by eight MSs and in 10 (1.5%) out of 675 sampling units of non-RTE milk and milk products reported by eight MSs.

In 2023, seven MSs reported on the testing of 567 sampling units of raw cows' milk with 10 positive units (1.8%). One MS reported monitoring results on one sampling unit of raw goats' milk, and two MS reported only six sampling units of raw sheep milk. Neither category included positive sampling units.

The presence of STEC in RTE milk products other than milk and cheeses was reported by four MSs, which tested 190 sampling units of butter, cream, ice cream, yoghurt, whey and fermented dairy products. No positive sampling units were detected in this food category.

For the cheese samples, 2226 sampling units were tested for the presence of STEC, with 49 (2.2%) positive units from eight MSs in 2023.

### Fruits, vegetables and juices

STEC were found in one (0.04%) out of 2328 sampling units of fruits, vegetables and juices.

In total, 1408 sampling units of spice and herbs, salads and sprouted seeds were tested and one STEC-positive unit was reported (0.07%).

### Other foodstuffs

This category contains miscellaneous food commodities not comprised in the previously mentioned categories, and included 'cereals and meals', 'bakery products', 'fish and fishery products', 'infant formula' and other. For the whole category, 875 sampling units were analysed by nine MSs with 11 (1.3%) positive sampling units reported from the 'cereals and meals', including wheat (7), 'bakery products' (3) and 'other food of non-animal origin' (1) food categories (see the dashboard referenced at the start of the chapter).

## 4.4.4 | STEC in animals

In 2023, 2129 samples ('animal' or 'herds/flocks') from animals, regardless of the sampling strategy adopted, were assayed and reported by five MSs with 23.0% positive samples. The number of tested animals was very similar to that reported in 2022 ( $N=1916$ ), which, however, produced only 7.6% of positive samples.

The most tested animal category in 2023 was cattle, followed by goats and sheep, and pigs, with 937, 408 and 405 sample units tested, respectively, that yielded 16.8%, 34.6% and 46.9% positive units, respectively.

## 4.4.5 | Focus on STEC strain features: Virulence genes and serogroups

### Humans

In 2023, the information on the serogroups of STEC was reported for 31.9% of the reported cases ( $N=3259$  cases of 10,217 total confirmed STEC cases). Seventy-eight more strains were reported as belonging to non-O157 serogroups and 1389 were reported as non-typable ('NT') (13.6% of the total number of human cases) and were not included in the isolates reported with serogroup information. The most common human STEC serogroups reported in the EU were O157 (22.7%) and O26 (18.9%), together representing 41.6% of the total number of confirmed human cases with known serogroups in 2023, excluding the NT isolates and those categorised as non-O157. Overall, the six most frequent serogroups of STEC from human infections were O157, O26, O146, O103, O145 and O63, representing 62.6% of the human isolates with serogroup information (3259 strains in total).

Data on virulotypes (based on the Shiga toxin genes *stx1*, *stx2* and the intimin-coding gene *eae*) were reported for 29.4% ( $N=3001$ ) of confirmed STEC infections in 2023, including 892 STEC strains from cases of severe infection (Table 36). Subtyping of the *stx* gene was carried out for 713 (79.9%) of the latter isolates. The most frequently reported virulence gene combination in strains from severe STEC disease (HUS, bloody diarrhoea and hospitalised cases) was *stx2/eae+*, accounting for 45.1% of these cases (Table 36). The proportion of the second most common virulotype *stx1/stx2/eae+* was 16.5% (Table 36). The most common *stx* gene subtypes in strains from severe human infections were *stx2a* (38.8% of 713 isolates with reported *stx* gene subtyping data), *stx1a* (24.1%), *stx2c* (10.5%) and *stx2b* (7.4%) (See dashboard referenced at the start of the chapter).

**TABLE 36** Virulotypes (*stx* type and presence of *eae*) identified in food, animal and human STEC isolates causing severe infection (haemolytic-uraemic syndrome (HUS), hospitalisation and bloody diarrhoea) in 2023.

Virulence gene profile	N of animal isolates in 2023 <sup>a</sup>	N of food isolates in 2023 <sup>a</sup>	N of human isolates in 2023 (%)	Relative frequency of the virulotype in <sup>b</sup>		
				HUS	Hospitalisation	Bloody diarrhoea
<i>stx2; eae+</i>	48	28	402 (45.1)	17.7	42.0	40.2
<i>stx1; stx2; eae+</i>	25	25	147 (16.5)	5.9	35.7	64.8
<i>stx2; eae-</i>	112	153	124 (13.9)	2.7	24.3	14.8
<i>stx1; eae+</i>	17	48	96 (10.8)	1.2	27.4	27.3
<i>stx1; eae-</i>	52	56	69 (7.7)	0.30	20.3	14.1
<i>stx1; stx2; eae-</i>	87	72	54 (6.1)	1.4	15.3	19.4
<b>Total</b>	<b>341</b>	<b>382</b>	<b>892 (100)</b>			

Abbreviations: STEC, Shiga toxin-producing *Escherichia coli*. The *stx* genes were characterised at the type level (*stx1* and *stx2*).

<sup>a</sup>Due to the low number of isolates virulotyped in food and animals, the percentages are not shown.

<sup>b</sup>Relative frequencies (%) of the different combinations of *stx* gene types with or without the *eae* gene in STEC isolated from severe disease (TESSy data, 2012–2017) (EFSA BIOHAZ Panel, 2020).

## Food

The information on the serogroups of STEC strains from food was reported for 63.9% of the isolates (260 strains out of the total 407 strains). The six serogroups most reported in food isolates were O26, O113, O157, O91, O103 and O146, together accounting for 42.7% of the strains with serogroup information.

Information on the presence of *stx1* and/or *stx2* and *eae* genes was provided for 382 (93.9%) of the 407 isolated STEC strains (Table 36), while only 127 (31.2%) of these were subtyped for the *stx* genes. As observed for human strains from severe disease, the most frequent *stx* gene subtype identified in STEC food isolates was *stx2a*, which was detected alone or in combination with *stx1a* in 19.7% and 18.9% of the STEC strains with the information on the toxin gene subtypes, respectively (see dashboard referenced at the start of the chapter).

## Animals

This section includes the analysis of the data relating to the 2107 animal samples tested with methods detecting any STEC,<sup>28</sup> of which 23.2% (*N*=489) were positive for the presence of STEC.

For the analysis of the distribution of STEC serogroups and virulotypes, 510 STEC strains isolated from the 489 animal positive samples were considered. Of these, 207 strains (40.6%) were provided with serogroup information. The isolates with a known serogroup belonged to 43 different O-groups, with O146, O100, O157 and O8 being the most frequent, accounting for 54.1% of the total number of strains with a known serogroup.

For the analysis of the virulence genes, 341 STEC animal isolates (66.9%) were provided with their virulotype based on the identification of the *stx1*, *stx2* and *eae* genes (Table 36). None of the isolates from animal samples were provided with information on *stx* gene subtyping.

## 4.5 | Discussion

In 2023, all 27 MSs provided information on STEC infections in humans. The overall trend of STEC infections during the 2019–2023 5-year period showed a significant increase, and in 2023 the annual notification rate was 30.0% higher than in 2022.

The determination of the strains' serogroup, although ascertained as not being associated with virulence, is still a useful marker for understanding the epidemiology of human infections. In 2023, less than half of the confirmed human cases reported by EU MSs had information on the serogroup with the most frequently reported being O157, followed by O26. However, for HUS cases, the figures of these two serogroups were reversed, with O26 accounting for 37.8% of the HUS cases and O157 representing only 19.6%. This observation seems to indicate that infections caused by STEC O26 are more prone to become HUS cases. In 2023 the non-typable STEC isolates made up 13.6% of the total number of strains reported. This high proportion of uncharacterised isolates is possibly due to either the application of pheno/genotyping methods targeting only a reduced panel of serogroups or to the absence of serotyping, thereby hindering any analysis of this category. Similarly, a low proportion of STEC isolates was reported with information on the presence of virulence genes (*stx1* or *stx2* and the *eae* genes). However, *stx* gene subtyping was carried out for 79.9% isolates from severe cases of infection.

Data on serotypes and virulotypes of strains from confirmed STEC infections in 2023 decreased compared to 2022. Taken together, these decreases represent a challenge for the surveillance of trends over time and the association with

<sup>28</sup>The methods considered here are those not restricted to the detection of specific STEC serogroups e.g. ISO 16654 for O157.

both clinical presentation (HUS, bloody diarrhoea and hospitalisation) and for observing differences in serotypes and virulotypes between EU-acquired cases and those from non-EU countries.

In 2023, 24 EU MSs provided information on STEC either in food, feed or animals, while no data were reported to EFSA by Denmark, Greece, Malta, Norway, Iceland, Switzerland or the United Kingdom (Northern Ireland). Twenty-four MSs reported monitoring results of STEC in 17,495 food sampling units. The food categories most tested were 'bovine meat and products thereof', 'milk and milk products' and 'fruits, vegetables and products thereof', representing the majority of all food sampling units assayed. As in previous years, the selection of the tested matrices reflected the last available source attribution exercise (EFSA BIOHAZ Panel, 2020).

In 2023, 2.2% of the total food sampling units tested positive for STEC. This figure falls in the range of the fluctuations observed in the last 5-year period 2018–2022 (1.8%, 2.9%, 2.4%, 2.8% and 2.8%).

Overall, STEC were isolated in 1.0% of the RTE products; within this food group 'milk and milk products', particularly cheese, was the most tested and contaminated matrix (2.0%), excluding the 'bakery products' category, which accounted for 6.7% of positive sampling units, but with only 45 sampling units tested. These data confirm the importance of testing RTE food commodities for the presence of STEC, as these foods are consumed without any treatment to reduce or eliminate the possible presence of the pathogen, posing a direct risk to the consumer.

Fresh meat from small ruminants, with only sheep meat tested in 2023, was confirmed to be among the most contaminated meat categories, together with fresh deer meat, underlining the importance of these animal reservoirs. Fresh bovine meat sampling units taken at the manufacturing level (slaughterhouse) were more contaminated (6.5%) than those collected at the distribution level (0.83%). This finding suggests that the procedures in place in the EU to transform bovine meat ensure a significant reduction of the contamination originating from this animal reservoir. This does not appear to be the pattern for fresh sheep meat, which showed 7.6% contamination of sampling units taken at the slaughterhouse and 9.3% of the specimens collected at the distribution level.

The low testing rate of sprouts and seeds appears to be entrenched. In 2023, only nine MS tested 536 official control samples taken in the context of Commission Regulation (EC) No 2073/2005, with no positive results.

Similarly, in 2023, the number of animal samples assayed continued to be low. The total number of these specimens was 2129, with 23.0% positives. The highest proportion of positive STEC samples was detected in pigs (46.9%), followed by goats and sheep (34.6%) and cattle (16.8%). Although the total number of samples tested was similar to that sampled in 2022, the number of positive units was much higher in 2023. This discrepancy might be due to the differences in the animal species sampled and in the non-harmonised sampling strategies. In any case, the low sample numbers hinder any robust inference. Pigs are known to be colonised by STEC and are a recognised reservoir of strains producing the Stx2e subtype (Cornick et al., 1999), which is of lower importance in terms of public health, compared with the other Stx subtypes. Unfortunately, the subtyping of animal STEC strains was not carried out in 2023, precluding any inference on the high STEC proportion of positive samples in this animal category.

Strain characterisation is pivotal to understanding the epidemiology of human STEC disease and the dynamics of STEC circulation in the vehicles of infection. In 2023, 63.9% of food isolates were provided with information on the O-group. The four most reported serogroups in strains from human infections, namely O157, O26, O146 and O103, also ranked highest in the food isolates' serogroups, in accordance with their zoonotic and food-borne origin.

Regarding STEC isolate characterisation, the determination of the presence of the *stx* and *eae* virulence genes (virulotyping) and of the *stx* gene subtypes, are the most informative features for assessing the association of certain STEC with the most severe forms of human infection (EFSA BIOHAZ Panel, 2020). In 2023, 93.9% of the food isolates were typed for *stx* and *eae* genes, but data on virulotypes was available for only 66.9% of the animal isolates and only 29.4% of human strains. Certain *stx* gene subtypes, such as *stx2a* and *stx2d* are recognised as being the most frequently associated with the severe forms of human infections (EFSA BIOHAZ Panel, 2020). Accordingly, the *stx2a* subtype was the most frequently identified in STEC from severe human cases of disease and in food isolates again in 2023. However, *stx* gene subtyping was provided for only 31.2% of the food isolates and was not carried out at all for animal strains.

Although the number of samples tested for the different food commodities has been relatively stable over the years, the typing and subtyping of the STEC isolates seems to fluctuate and fails to find a broad application. This lack of typing and subtyping persists despite the wide adoption of next-generation sequencing (NGS) in the food sector and the reference made to this technology in Regulation (EU) 2017/625. Encouraging NGS use in all sectors would be fundamental to promote a One Health approach in the assessment of the cases of disease in humans, the causative agents and the vehicles of infection and, more importantly, it has proven crucial in managing STEC outbreaks.

## 5 | INFECTION WITH *MYCOBACTERIUM TUBERCULOSIS* COMPLEX (FOCUSING ON *MYCOBACTERIUM BOVIS* AND *MYCOBACTERIUM CAPRAE*)

### Human cases [EU, 2023]

Notification rate  
(per 100,000 population) **0.04**

**138** Cases of illness

**67** Infections acquired in the EU

**NA** Hospitalisations

**62** Infection acquired outside the EU

**19** Deaths\*

**9** Unknown travel status or unknown country of infection

\* Data refers to 2022

■ ECDC data

### Foodborne outbreaks & related cases [EU, 2023]

**1** Foodborne outbreak\*\*

**3** Cases of illness

**1** Weak-evidence outbreak ■

\*\* No information on the *Mycobacterium* species was provided

■ EFSA data

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about zoonotic tuberculosis focusing on *Mycobacterium bovis* and *M. caprae* and for the consultation of data collected, the following interactive tools are available:



### 5.1 | Key facts

- In 2023, the percentage of zoonotic tuberculosis cases among the total number of tuberculosis cases in humans in European Union countries was 0.35%. There were 138 confirmed cases of human tuberculosis due to *M. bovis* or *M. caprae*, corresponding to a European Union notification rate of 0.04 cases per 100,000 population. This resulted in 6.1% decrease in notification in the European Union compared with 2022.
- In 2023 and 2022, the number of cases of human tuberculosis due to *M. bovis* or *M. caprae* in the European Union remained higher than during the pandemic years 2020 and 2021. In 2023, the number of human cases among the 25 Member States exceeded the number of cases reported in 2019.
- In 2023, the *M. bovis* and *M. caprae* case notification rate was 0.03 cases per 100,000 among European Union Member States with disease-free status and 0.05 cases per 100,000 in European Union Member States with non-disease-free status for the bovine population.
- The majority of *M. bovis* and *M. caprae* cases in humans (48.6%) were of European Union origin (native cases and/or cases originating from other Member States).
- In bovine animals, in 2023, the overall prevalence of tuberculosis (0.57%) due to *M. bovis* or *M. caprae* decreased slightly compared with the previous year (0.61%), and the number of infected cattle herds in the European Union decreased from 9845 to 8821 herds.
- Similar to previous years, the distribution of infected herds was heterogeneous and spatially clustered, with national herd-level prevalence ranging from <0.01% (Austria, Germany, Poland, Romania) to 7.2% (the United Kingdom (Northern Ireland)).

- Seventeen Member States had disease-free status in 2023. Ten Member States, along with the United Kingdom (Northern Ireland), were under an eradication programme, of which three Member States (Italy, Portugal and Spain) had disease-free status zones.
- In the disease-free status zones, a total of 162 cattle herds (0.02%) were reported to be infected with the *M. tuberculosis* complex, 13 more than in 2022, confirming that infection occurs rarely in these areas.
- In the zones under an eradication programme 8659 cattle herds (1.5% of the total) tested positive for *M. tuberculosis* complex in 2023, a 10.7% decrease from the 9696 herds reported in 2022. The United Kingdom (Northern Ireland) (7.2%), Ireland (4.8%) and Spain (3.2%) were the only countries with prevalence higher than 1%. No positive herds were reported by Bulgaria, Cyprus or Malta. Over the last decade (2014–2023), the total number of positive cattle herds in eradication programme zones decreased by 49.4%, largely due to the withdrawal of the United Kingdom from the European Union in 2020.

## 5.2 | Surveillance and monitoring of tuberculosis due to *Mycobacterium bovis* or *Mycobacterium caprae* in the EU

### 5.2.1 | Humans

The notification of tuberculosis in humans is mandatory in all MSs and covers the whole population. Countries can update their data retroactively; reported numbers are therefore subject to change in the future or may vary from numbers reported in previous reports. The *M. bovis* and *M. caprae* EU notification rate is calculated using the combined population of the EU MSs that reported data in 2023. The proportion of tuberculosis cases caused by *M. bovis* or *M. caprae* was calculated using the preliminary estimate of the total number of confirmed tuberculosis cases in 2023 among reporting EU MSs' species-specific data. In 2023, no human data on *M. bovis* or *M. caprae* cases were available for France because this MS did not report species-specific data within the *M. tuberculosis* complex (MTBC) for human tuberculosis cases. France has not reported species-specific data in any previous years. In addition, Latvia did not report any MTBC data for 2019, 2020 or 2023.

Because tuberculosis is a chronic disease with a long incubation period, it is not possible to assess travel-associated cases in the same way as for diseases with acute onset. Instead, a distinction is made between individuals with the disease originating from an EU MS (cases of EU origin) and those originating from outside the EU (case originating outside of the EU). In the analysis, origin is mainly based on the reported birthplace, except for cases from Austria, Belgium, Greece, Hungary and Poland, whose origin is based on reported nationality.

### 5.2.2 | Animals

#### Bovine tuberculosis surveillance data

Article 2 of Regulation (EU) 2016/429<sup>29</sup> states that its scope applies to transmissible diseases, including zoonoses, without prejudice to the provisions laid down in Directive 2003/99/EC. Therefore, the annual zoonoses data reporting requirements for MSs, as stipulated in Directive 2003/99/EC and implemented by EFSA through specific tools, manuals and guidance, remain unaffected by the entry into force of Commission Implementing Regulation (CIR) (EU) 2020/2002.<sup>30</sup> This latter CIR outlines the compulsory notification and annual reporting obligations that MSs must fulfil with respect to ADIS<sup>31</sup>: EU MSs need to report to ADIS outbreaks of infection with MTBC in bovine species (cattle, buffalo and bison), even-toed ungulates (Artiodactyla) and other terrestrial mammals. Summaries of these reports are regularly made available online.

In accordance with Directive 2003/99/EC, MSs must report annual surveillance data for bovine tuberculosis. These data are derived from compulsory national eradication and surveillance programmes implemented in compliance with EU legislation, including the AHL. The reports submitted by MSs are harmonised and enable the assessment of the epidemiological situation and trends analysis across MSs and their zones.

Article 36 of Regulation (EU) 2016/429 provides for the EC's approval of the disease-free status (DFS) of MSs or specific zones within them, with respect to MTBC infections. Due to the differing levels of infection risk between DFS zones and zones under an eradication programme (UEP), these zones have been treated separately in this chapter.

All cases of bovine tuberculosis caused by MTBC members (*M. bovis*, *M. caprae* or *M. tuberculosis*) were considered in summarising the EU situation on the disease in cattle. Whenever possible, reporting MSs provided detailed distinctions between these MTBC species.

<sup>29</sup>Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law').

<sup>30</sup>Commission Implementing Regulation (EU) 2020/2002 of 7 December 2020 laying down rules for the application of Regulation (EU) 2016/429 of the European Parliament and of the Council with regard to Union notification and Union reporting of listed diseases, to formats and procedures for submission and reporting of Union surveillance programmes and of eradication programmes and for application for recognition of disease-free status, and to the computerised information system, OJ L 412, 8.12.2020, p. 1–28.

<sup>31</sup>EU Animal Diseases Information System (ADIS). More information is available at: [https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis\\_en](https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis_en).

## Mycobacterium surveillance data from food and from animals other than bovine animals

*Mycobacterium* spp. monitoring data from food and from animals other than bovine animals are submitted to EFSA in accordance with Directive 2003/99/EC. Data collected allow for descriptive summaries to be compiled at the EU level, but do not allow trend watching or trend analyses (Table 1).

In accordance with CIR (EU) 2020/2002, notification to ADIS and surveillance rules apply to artiodactyla mammals other than bovine animals (such as camelids, cervids, suids, ovine and caprine animals) and other terrestrial mammals susceptible to infection with MTBC.

### 5.3 | Results

#### 5.3.1 | Overview of key statistics, EU, 2019–2023

**Table 37:** summarises the EU-level statistics on human tuberculosis due to *M. bovis* or *M. caprae* and on bovine tuberculosis during 2019–2023. More detailed descriptions of these statistics are provided in the subsections below.

**TABLE 37** Summary of tuberculosis due to *Mycobacterium bovis* and *Mycobacterium caprae* statistics relating to humans and bovine animals (stratified by disease status of MSs/ MS zones), EU, 2019–2023.

	2023 <sup>a</sup>	2022 <sup>a</sup>	2021 <sup>a</sup>	2020	2019 <sup>b</sup>	Data source
<b>Humans</b>						
Number of confirmed <i>M. bovis</i> cases	129	140	108	95	141	ECDC
Number of confirmed <i>M. caprae</i> cases	9	7	10	4	11	ECDC
Total number of confirmed cases	138	147	118	99	152	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.04	0.04	0.03	0.03	0.03	ECDC
Number of EU MSs that reported data on <i>M. bovis</i> or <i>M. caprae</i> cases	25	26	26	25	26	ECDC
<i>M. bovis</i> or <i>M. caprae</i> cases in individuals of EU origin	67	93	63	60	107	ECDC
<i>M. bovis</i> or <i>M. caprae</i> cases in individuals originating from outside the EU	62	47	49	35	40	ECDC
<i>M. bovis</i> or <i>M. caprae</i> cases in individuals of unknown origin	9	7	6	4	5	ECDC
Total number of food-borne outbreaks <sup>c</sup>	1	0	0	0	0	EFSA
Number of outbreak-related cases	3	0	0	0	0	EFSA
<b>Bovine animals</b>						
Number of infected herds in disease-free status zones <sup>d</sup>	162	149	139	139	143	EFSA
Number of reporting disease-free status MSs <sup>d</sup>	17	17	17	17	17	EFSA
Number of infected herds in zones under an eradication programme <sup>e</sup>	8659	9696	9255	7233	16,277	EFSA
Number of reporting MSs with zones under an eradication programme <sup>e</sup>	11	11	11	9 <sup>f</sup>	11	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>Data from the United Kingdom (Northern Ireland) were taken into account for 2021–2023. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to Member States include the United Kingdom in respect of Northern Ireland.

<sup>b</sup>Data from the United Kingdom were taken into account for the 2018–2019 period, since the United Kingdom was still an EU MS at that time. However, on 1 February 2020 it became a third country.

<sup>c</sup>No information on the species was available for the *Mycobacterium* outbreak reported in 2023.

<sup>d</sup>Member States, or zones thereof, with disease-free status regarding infection with the *Mycobacterium tuberculosis* complex *M. bovis*, *M. caprae*, *M. tuberculosis* (MTBC) in their bovine animal population.

<sup>e</sup>The Member States or zones thereof with an approved eradication programme (UEP) for infection with MTBC. In addition, the United Kingdom (Northern Ireland) has an approved eradication programme for infection with MTBC.

<sup>f</sup>No data reported from Bulgaria.

### 5.3.2 | Tuberculosis due to *Mycobacterium bovis* or *Mycobacterium caprae* in humans

In 2023, 138 confirmed human cases of tuberculosis due to *M. bovis* or *M. caprae* were reported from 13 MSs (Austria, Belgium, Denmark, Finland, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Romania, Spain and Sweden) (Table 38). Tuberculosis cases due to *M. bovis* (129 cases) were reported from all the above-mentioned MSs except Hungary, which only reported cases caused by *M. caprae*. Austria, Germany and Spain also reported cases due to *M. caprae*, which accounted altogether for nine cases in the EU.

In 2023, tuberculosis cases due to *M. bovis* or *M. caprae* accounted for a small proportion (0.35%) of total tuberculosis cases reported in the EU, Iceland, Norway, Liechtenstein and Switzerland. Overall, 25 MSs reported species-specific data on MTBC and 12 MSs did not report any cases. Reported cases of human tuberculosis due to *M. bovis* or *M. caprae* in the EU decreased slightly in 2023 relative to 2022 but remained high compared to the 2020–2021 COVID-19 pandemic years.

The EU notification rate in 2023 was 0.036 cases per 100,000 population, which is a decrease of 6.1% compared with 2022, when the notification rate was 0.039 per 100,000 population. In 2023, the highest notification rate was reported by Ireland (0.15 per 100,000), followed by Spain (0.11 per 100,000).

Among the 17 DFS MSs in 2023, 15 MSs reported on MTBC species. *M. bovis* and *M. caprae* human cases were reported in eight MSs. The notification rate in these MSs reporting on MTBC species was 0.03 cases per 100,000 population. The notification rate for *M. bovis* and *M. caprae* human cases reported in the 10 non-DFS MSs in 2023 was 0.05 cases per 100,000 population.

The majority of the *M. bovis* and *M. caprae* human cases reported in 2023 (67/138; 48.6%) were of EU origin (native cases and/or cases originating from other MSs). The other cases originated from outside the EU ( $N=62$ ; 44.9%) or had unknown origin ( $N=9$ ; 6.5%) (Table 37). Notification rates of *M. bovis* and *M. caprae* human cases of EU origin were lower in disease-free MSs ( $N=26$ ; 38.8%) than in non-disease-free MSs ( $N=41$ ; 61.2%).

**TABLE 38** Reported confirmed human cases of tuberculosis due to *Mycobacterium bovis* or *Mycobacterium caprae* and notification rates per 100,000 population in EU MS and non-MS countries, by country and year, 2019–2023.

Country	2023				2022		2021		2020		2019		
	Status	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates	
				Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Austria	DFS	Y	C	3	0.03	5	0.06	4	0.04	0	0	3	0.03
Belgium	DFS	Y	C	3	0.03	9	0.08	10	0.09	6	0.05	0	0
Bulgaria		Y	C	0	0	0	0	0	0	0	0	0	0
Croatia		Y	C	0	0	0	0	0	0	0	0	0	0
Cyprus		Y	C	0	0	0	0	0	0	0	0	0	0
Czechia	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Denmark	DFS	Y	C	1	0.02	0	0	0	0	0	0	0	0
Estonia	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Finland	DFS	Y	C	1	0.02	0	0	0	0	1	0.02	0	0
France <sup>b</sup>	DFS	–	–	–	–	–	–	–	–	–	–	–	–
Germany	DFS	Y	C	48	0.06	38	0.05	44	0.05	37	0.04	51	0.06
Greece		Y	C	1	0.01	1	0.01	0	0	2	0.02	1	0.01
Hungary	DFS	Y	C	1	0.01	0	0	0	0	0	0	0	0
Ireland		Y	C	8	0.15	7	0.14	2	0.04	4	0.08	7	0.14
Italy		Y	C	8	0.01	15	0.03	12	0.02	6	0.01	11	0.02
Latvia <sup>c</sup>	DFS	Y	C	–	–	0	0	0	0	–	–	–	–
Lithuania	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Luxembourg	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Malta		Y	C	0	0	0	0	0	0	0	0	0	0
Netherlands	DFS	Y	C	6	0.03	5	0.03	5	0.03	6	0.03	5	0.03
Poland	DFS	Y	C	0	0	1	<0.01	0	0	0	0	0	0
Portugal		Y	C	0	0	0	0	0	0	0	0	0	0
Romania		Y	C	3	0.02	1	0.01	0	0	1	0.01	1	0.01
Slovakia	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Slovenia	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Spain		Y	C	54	0.11	59	0.12	37	0.08	30	0.06	35	0.07
Sweden	DFS	Y	C	1	0.01	6	0.06	4	0.04	6	0.06	3	0.03
<b>EU Total 27</b>				<b>138</b>	<b>0.04</b>	<b>147</b>	<b>0.04</b>	<b>118</b>	<b>0.03</b>	<b>99</b>	<b>0.03</b>	<b>117</b>	<b>0.03</b>
United Kingdom		–	–	–	–	–	–	–	–	–	–	35	0.05
<b>EU Total</b>				<b>138</b>	<b>0.04</b>	<b>147</b>	<b>0.04</b>	<b>118</b>	<b>0.03</b>	<b>99</b>	<b>0.03</b>	<b>152</b>	<b>0.03</b>
Iceland <sup>d</sup>		Y	C	0	0	0	0	0	0	0	0	0	0
Norway	DFS	Y	C	1	0.02	0	0	0	0	0	0	1	0.02

(Continues)

TABLE 38 (Continued)

Country	2023				2022		2021		2020		2019		
	Status	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates		Confirmed cases and rates	
				Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Liechtenstein	DFS	Y	C	0	0	0	0	0	0	3	0.03	4	0.05
Switzerland <sup>e</sup>	DFS	Y	C	10	0.11	1	0.01	4	0.05				

Abbreviations: –, Data not reported; DFS, Disease-free status, i.e. free of infection with *M. bovis*, *M. caprae* or *M. tuberculosis* in the bovine animal population.

<sup>a</sup>Y: yes; N: no; A: aggregated data; C: case-based data.

<sup>b</sup>No surveillance system.

<sup>c</sup>Latvia did not report any MTBC data during 2019–2020 or 2023.

<sup>d</sup>In Iceland, which has no special agreement concerning animal health (status) with the EU, the last outbreak of bovine tuberculosis was in 1959.

<sup>e</sup>Switzerland provided data directly to EFSA.

- DFS All zones of the MS have disease-free status.
- Not all zones of the MS have disease-free status.
- No zones of the MS have disease-free status.

Figure 11: shows, for year 2023, the number of confirmed tuberculosis cases due to *M. bovis* or *M. caprae* in individuals of EU origin overlaid with the national aggregated herd prevalence of bovine tuberculosis.

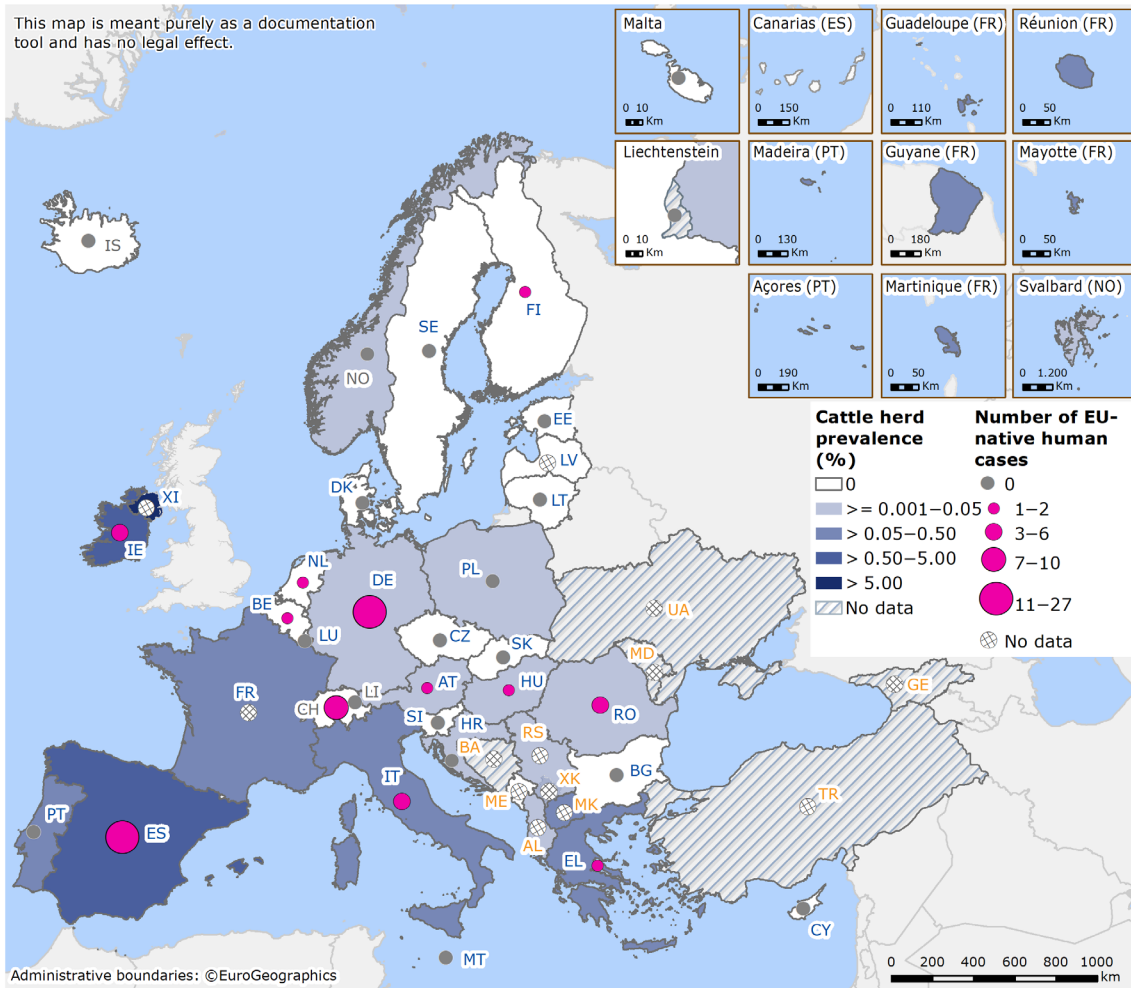


FIGURE 11 Map of the number of confirmed tuberculosis cases due to *Mycobacterium bovis* or *Mycobacterium caprae* in individuals of EU origin, and national herd prevalence of tuberculosis in the bovine animal population in EU MS and non-MS countries, 2023. Member States that reported data at the national level without specifying the specific zones or overseas territories where the bovine tuberculosis-positive cattle herds were detected, were assigned the same colour for all their zones, including overseas territories. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. For Albania, Kosovo and Serbia, prevalence data are at the animal level. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.



### 5.3.3 | *Mycobacterium* in food

No *Mycobacterium* species monitoring data from food were submitted for the year 2023.

### 5.3.4 | Tuberculosis in bovine animals

Seventeen MSs had DFS regarding MTBC during 2023 (Table 38). Of the remaining 10 MSs and the United Kingdom (Northern Ireland), three MSs had DFS zones or provinces:

- Italy: 12 regions and 23 provinces;
- Portugal: two regions (Algarve and Azores, except the island of São Miguel);
- Spain: seven autonomous communities and three provinces.

Seven MSs had no zones with DFS regarding MTBC. The United Kingdom (Northern Ireland) had no DFS zones either.

Norway, Switzerland and Liechtenstein had DFS, in accordance with the EU legislation. In Iceland, which has no special agreement with the EU on animal health status, the last outbreak of bovine tuberculosis was reported in 1959. A map of EU MSs' disease status is available [here](#).

In 2023, the overall proportion of cattle herds in the EU infected with MTBC was very low, 0.57%, a slight decrease from 0.61% in 2022. The total number of infected bovine herds in the EU also decreased, from 9845 in 2022 to 8821 in 2023.

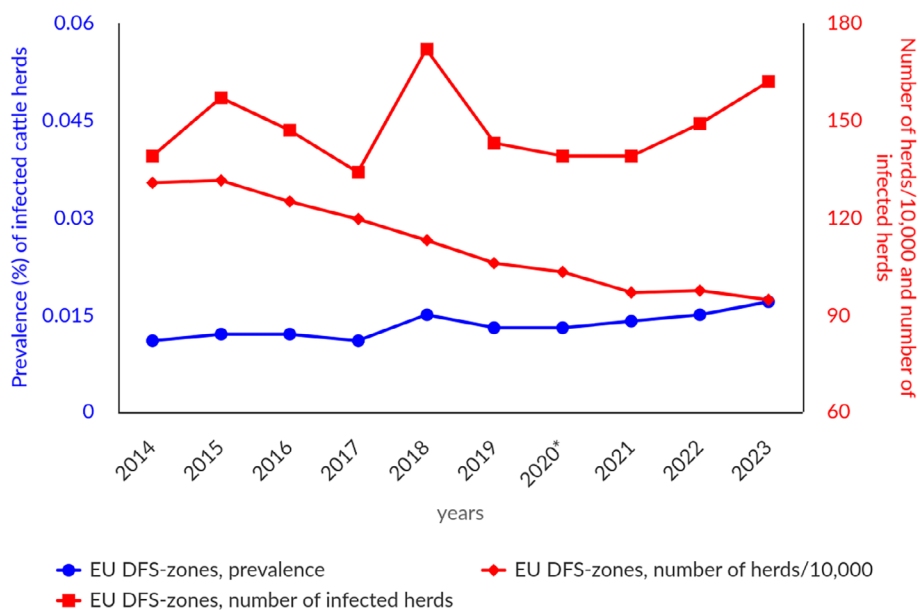
Fifteen MSs (12 DFS and three UEP countries) reported no cases of bovine tuberculosis. The remaining 12 MSs and the United Kingdom (Northern Ireland) reported cases of bovine tuberculosis. The distribution of infected herds was heterogeneous and spatially clustered, with national herd-level prevalence ranging from <0.01% (Austria, Germany, Poland, Romania) to 7.2% (the United Kingdom (Northern Ireland)). MTBC infections were primarily concentrated in UEP zones, where the overall prevalence of infected herds (1.5%) was 85 times higher than in DFS zones (0.02%).

Five MSs reported MTBC infections in cattle without specifying the *Mycobacterium* species. *M. bovis* was specifically detected in France, Germany, Ireland, Italy, Poland, Romania and the United Kingdom (Northern Ireland), while *M. caprae* was specifically reported in Austria, Germany and Romania. No cases of *M. tuberculosis* infection in cattle herds were reported.

#### MSs and MS zones with disease-free status regarding *Mycobacterium tuberculosis* complex infection

The majority of the EU's cattle population (61.4%) is located in the DFS zones across 20 MSs. However, the number of cattle herds in these zones has steadily declined, with a 27.6% decrease over the last decade (2014–2023). Over this 10-year period there was a slight increase in both the number of infected herds and the prevalence of MTBC-infected herds (Figure 12).

The total number of DFS zones in the EU increased during 2023 and in these zones seven MSs reported a total of 162 MTBC-infected bovine herds, confirming that the detection of bovine tuberculosis in DFS zones is rare. When comparing 2023 to 2022, the number of infected cattle herds increased by 13, while prevalence remained unchanged at 0.02%. The total number of cattle herds decreased by 2.9%.



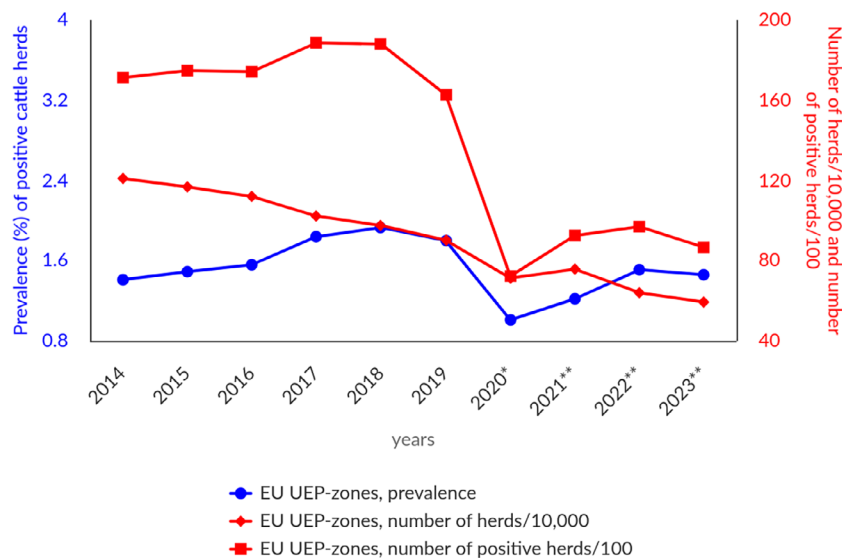
**FIGURE 12** Prevalence of cattle herds infected with the *Mycobacterium tuberculosis* complex in disease-free status (DFS) zones, EU, 2014–2023.

\*In contrast to years 2014–2019, year 2020 does not include the United Kingdom (Scotland) data. Since 1 February 2020, the United Kingdom has withdrawn from the EU and has become a third country.

## MSs and MS zones with an approved eradication programme for infection with *Mycobacterium tuberculosis* complex

In 2023, cattle herds from UEP zones across 10 MSs and the United Kingdom (Northern Ireland) represented 38.6% of the total EU cattle herd population. This population has been steadily declining, with a 51.0% decrease compared to 2014 (Figure 13). Over the last decade (2014–2023), the prevalence of bovine tuberculosis in UEP zones has shown varying trends. From 2014 to 2019, data included the EU-28 MSs. However, the sharp decrease in 2020 can be attributed to the withdrawal of the United Kingdom from the EU and to the absence of data from Bulgaria in that year. Starting from 2021, the increase in the number of reported cattle herds can be mainly explained by the resumption of data from Bulgaria after its 2020 hiatus and by the inclusion of data from the United Kingdom (Northern Ireland). Over the last decade (2014–2023), the total number of positive cattle herds in UEP zones decreased by 49.4%, whereas prevalence increased by 3.1%.

Seven MSs and the United Kingdom (Northern Ireland) reported a total of 8659 herds positive for bovine tuberculosis in 2023, a 10.7% decrease from the 9696 positive herds in 2022. This reduction was primarily driven by the United Kingdom (Northern Ireland), which had reported 2785 (12.2%) MTBC-positive herds in 2022, compared to 1628 (7.2%) in 2023. The United Kingdom (Northern Ireland) (7.2%), Ireland (4.8%) and Spain (3.2%) were the only countries with a prevalence higher than 1%. No positive herds were reported by Bulgaria, Cyprus or Malta. Compared with 2022, the overall prevalence in UEP zones remained stable at around 1.5%.



**FIGURE 13** Prevalence of cattle herds positive for bovine tuberculosis in zones under an eradication programme (UEP), EU, 2014–2023. \*In contrast to years 2014–2019, year 2020 does not include the United Kingdom data. Since 1 February 2020, the United Kingdom has withdrawn from the EU and has become a third country. No 2020 data were reported from Bulgaria. \*\*Data from the United Kingdom (Northern Ireland) were taken into account for 2021–2023. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with Section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to MSs include the United Kingdom in respect of Northern Ireland.

### Non-MSs and pre-accession countries

Bovine tuberculosis was not detected in 2023 in Iceland, Liechtenstein or Switzerland, whereas Norway reported one infected cattle herd and a herd prevalence of 0.01%. Among the pre-accession countries, Montenegro, as in the previous 3 years, reported no infected herds; the Republic of North Macedonia reported a herd prevalence of 0.08% (10/12,621), whereas Albania reported a prevalence of 0.01% (7/94,252). Kosovo<sup>32</sup> reported a prevalence of 0.07% intradermal tuberculin skin test-positive bovines (17/25,000).<sup>33</sup>

### 5.3.5 | *Mycobacterium tuberculosis* complex surveillance data from animals other than bovine animals

In 2023, two MSs (Finland, Sweden), the United Kingdom (Northern Ireland) and one non-MS (Norway) reported surveillance data on infection in farmed deer. In particular, Sweden reported data from a control programme in farmed deer. One case of MTBC infection in farmed deer was reported by the United Kingdom (Northern Ireland).

<sup>32</sup>This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

<sup>33</sup>The prevalence reported by Kosovo in 2022 was 3.1% (78/2500).

MSs also reported cases of MTBC infection in other mammal species. In particular, *M. bovis* was detected in farmed alpacas (Ireland), goats (France, Ireland), pigs (France, Ireland, Italy, the United Kingdom (Northern Ireland)), cats (France, Switzerland, the United Kingdom (Northern Ireland)), wild deer (Italy, Ireland), wild boar (Spain, France, Italy) and badgers (France, Ireland, the United Kingdom (Northern Ireland)). *M. caprae* was detected in laboratory monkeys (France). Finally, *M. tuberculosis* was detected in an African elephant (zoo animal) in Switzerland.

## 5.4 | Discussion

In 2023, the reporting of human tuberculosis due to *M. bovis* and *M. caprae* resulted in a total of 138 cases, a decrease compared with year 2022. This corresponds to a relative decrease in disease notification of 6.1% in 2023 (0.036 cases per 100,000) compared with 2022 (0.039 per 100,000 population). In particular, the decrease was due to *M. bovis* cases, by far the most frequent infection compared to *M. caprae* cases. The total number of *M. caprae* cases appears to be relatively constant over the years. It is important to highlight that, when analysing the trend over the last 5 years, notification rates were still higher in 2022–2023 than in the previous 3 years, but this upward trend is mainly due to the increased number of cases in Spain. Taken all together, the other countries observe a relatively stable epidemiological situation over the long term, suggesting the normalisation of the effect of the COVID-19 pandemic on human cases.

The specific analysis by country showed that 12 MSs reported no cases. In addition, notification of total cases noticeably decreased in Austria, Belgium, Italy, Spain and Sweden. In contrast, some countries showed an increase in total cases, particularly Germany. As expected, the total number of cases were highest in Germany and Spain, but when the data were examined on a per capita basis, the highest notification rates were observed in Ireland and Spain, i.e. both countries lack DFS at national level for tuberculosis in their bovine populations, demonstrating the importance of reaching full DFS. The number of notifications clearly depends on efficient surveillance standards and rapid diagnostic intervention. Finally, France and Latvia did not report any MTBC data in 2023. With regard to where the disease was acquired, the ratio of native to foreign origin approached 1 for the first time, with total native-origin disease notification being constant over recent years, whereas foreign acquired cases tended to increase, likely due to the resumption of population movement after the COVID-19 pandemic restrictions.

Tuberculosis cases of zoonotic origin (due to *M. bovis* or *M. caprae*) and notification rates are highly likely to have been underestimated. Bias is introduced by EU MSs that do not regularly perform routine tests to distinguish *M. bovis* and *M. caprae* from *M. tuberculosis*. This bias results in under-notification at the EU level, because all cases in these MSs are reported as *M. tuberculosis*, thereby undermining the possibility of tracing the origin of infections (Fujiwara & Olea-Popelka, 2016). Furthermore, a lower notification rate was observed in EU MSs with DFS compared with non-DFS MSs, supporting the effectiveness of the surveillance programmes.

In conclusion, despite the general warning that occupational exposure to zoonotic tuberculosis is an underestimated threat, particularly in developing countries (Devi et al., 2021), EU 2023 human data show positive short-term trends and, more generally, a relatively stable epidemiological situation, despite exceptions, over the long term, suggesting that disease control and surveillance in EU MSs are constant and efficient. Furthermore, for the future, the steady decline of the livestock population in the EU over recent years may help to better control zoonotic tuberculosis.

The regulatory framework for bovine tuberculosis changed substantially in the EU during 2021. Tuberculosis caused by MTBC infection is currently considered a disease to be controlled in all MSs with the goal of eradicating the disease in bovine animals throughout the EU, while being kept under surveillance in other mammals. All MSs are to have a surveillance programme, or a control and eradication programme approved by EC. This should lead, in the coming years, to progressive improvement in the already satisfactory epidemiological situation. In 2023, bovine tuberculosis was reported by 12 MSs and by the United Kingdom (Northern Ireland). Its distribution was heterogeneous and spatially clustered in the EU, with a national herd prevalence ranging from <0.01% (Austria, Germany, Poland, Romania) to 7.2% (the United Kingdom (Northern Ireland)).

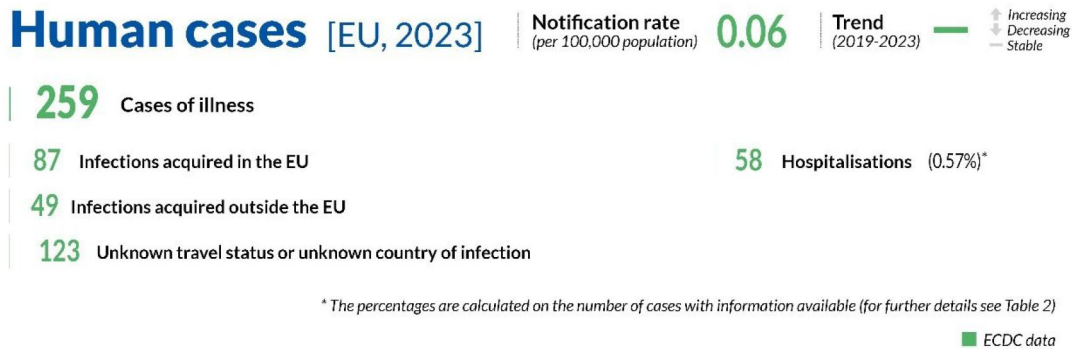
In 2023, 17 MSs had DFS. Of the remaining 10 MSs and the United Kingdom (Northern Ireland) three had DFS zones or provinces. The total number of DFS zones in the EU increased during 2023 and in these zones seven MSs detected bovine tuberculosis, which remained a rare event in these zones, as during the last decade (2014–2023). Seven of the 10 MSs with UEP zones, along with the United Kingdom (Northern Ireland), detected cases of bovine tuberculosis, resulting in an overall herd prevalence of 1.5%, similar to 2022. A 10.7% decrease in MTBC-positive herds was observed compared to 2022, primarily driven by a 41.5% reduction in MTBC-positive herds reported by the United Kingdom (Northern Ireland). Over the last decade (2014–2023), the total number of positive cattle herds in UEP zones decreased by 49.4%, whereas prevalence increased by 3.1%. These varying trends can be attributed for the most part to the decrease in the number of herds (–51.0%), the gradual progression of DFS in MSs with UEP and unfavourable environmental conditions hindering the eradication process in several UEP zones (Byrne et al., 2022; de la Cruz et al., 2019).

In 2023, *M. bovis* was reported to be isolated from a wide range of domestic and wild mammal species (other than bovine animals), which reflects the broad host range that this pathogen has. *M. caprae*, acknowledged to cause bovine tuberculosis, was reported only in cattle and in laboratory monkeys.

There is a major obstacle to eradication of bovine tuberculosis in areas where infection is endemic in wildlife. Successfully tackling bovine tuberculosis also involves addressing the wildlife reservoir of the disease. In 2018, Ireland introduced a vaccination policy in the Eurasian badger (*Meles meles*), a species known to be a maintenance host of *M. bovis*. Among other control measures, Ireland is actively reducing its badger population (Gormley et al., 2017). In contrast, no active badger

intervention or vaccination has been carried out in recent years in the United Kingdom (Northern Ireland), which may contribute to the persistently higher prevalence levels there. Stagnating or increasing trends in the prevalence of bovine tuberculosis demonstrate that eradication of this disease is a challenge, owing to the complex interactions between the pathogen, hosts and local environmental factors (EFSA AHAW Panel, 2014). MS-specific evaluations of status, trends and the relevance of bovine tuberculosis as a source of disease for humans can be found in the 2023 Annual National Zoonoses Country Reports available online [here](#).

## 6 | BRUCELLA



### Foodborne outbreaks & related cases [EU, 2023]



The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Brucella* and for the consultation of data collected, the following interactive tools are available:



### 6.1 | Key facts

- In 2023, there were 259 confirmed cases of human brucellosis, corresponding to a European Union notification rate of 0.06 cases per 100,000 population. This was a relative increase of 14.1% compared with 2022 (0.05 cases per 100,000 population).
- The overall trend for *Brucella* infections showed no significant increase or decrease in 2019–2023.
- Most of the infections reported in humans were due to *Brucella melitensis*, with the aetiological agent for 68 of 74 (91.9%) cases characterised to the *Brucella* species level.
- No brucellosis food-borne outbreaks were reported for the year 2023.
- Twenty-two Member States and the United Kingdom (Northern Ireland) had the disease-free status for brucellosis in cattle in 2023. Five Member States (Bulgaria, Greece, Hungary, Italy and Portugal) were not disease-free (under an eradication programme), of which two Member States (Italy and Portugal) had disease-free status zones.

- In the disease-free status zones for brucellosis in cattle, a total of five infected herds were reported in 2023, in Italy only, indicating rare occurrence of the disease (prevalence < 0.001%). In the zones under an eradication programme the prevalence of *Brucella*-positive cattle herds continued to decrease, reaching 284 herds (0.25%). Compared to 2014, the number of positive cattle herds in these zones notably decreased by 68%.
- Twenty-one Member States and the United Kingdom (Northern Ireland) had the disease-free status for brucellosis in sheep and goats in 2023. Five Member States (Bulgaria, Croatia, Greece, Italy and Portugal) were under an eradication programme, of which two Member States (Italy and Portugal) had disease-free status zones. Malta had no disease status with regard to brucellosis in sheep and goats in 2023.
- In the disease-free status zones for brucellosis in sheep and goats, a total of four infected flocks were reported in 2023, in Italy only, indicating rare occurrence of the disease (prevalence < 0.001%). In zones under an eradication programme, the prevalence of *Brucella*-positive sheep and goat flocks continued to decrease, reaching 141 flocks (0.15%). Compared to 2014, the number of positive flocks in these zones notably decreased by 88%.
- Brucellosis is still an animal health concern with public health relevance in southern European and Balkan countries that are not disease-free for brucellosis.

## 6.2 | Surveillance and monitoring of *Brucella* in the EU

### 6.2.1 | Humans

For 2023, 26 MSs reported information on brucellosis in humans. Surveillance is mandatory in 25 MSs. Belgium has another (unspecified) system. Denmark has no surveillance system in place for brucellosis, and the disease is not notifiable or reported at the EU level. The EU case definition was used by 23 countries, while three countries (France, Germany and Italy) reported using another case definition. All countries had a comprehensive surveillance system, with full national coverage in all MSs reporting brucellosis data. All countries reported case-based data with the exception of Bulgaria, which reported aggregated data.

### 6.2.2 | Food and animals

#### Surveillance data for bovine brucellosis, and ovine and caprine brucellosis

Article 2 of Regulation (EU) 2016/429 states that its scope applies to transmissible diseases, including zoonoses, without prejudice to the provisions laid down in Directive 2003/99/EC. Therefore, the annual zoonosis data reporting requirements for MSs, as stipulated in Directive 2003/99/EC and implemented by EFSA through specific tools, manuals and guidance, remain unaffected by the entry into force of CIR (EU) 2020/2002. This latter CIR outlines the compulsory notification and annual reporting obligations that MSs must fulfil with respect to ADIS<sup>34</sup>: EU MSs are required to report to the EU ADIS outbreaks of infection with *Brucella abortus*, *B. melitensis* and *B. suis* in cattle, sheep and goat populations, in other even-toed ungulates (*Artiodactyla*) and in other terrestrial animals. Summaries of these reports are regularly made available online.

In accordance with Directive 2003/99/EC, MSs must report annual surveillance data for bovine brucellosis. These data are derived from compulsory national eradication and surveillance programmes implemented in compliance with EU legislation, including the AHL. The reports submitted by MSs are harmonised and enable the assessment of the epidemiological situation and trends analysis across MSs and their zones.

Regulation (EU) 2016/429 provides for the EC's approval of the disease-free status (DFS) of MSs or specific zones within them, with respect to infection with *B. abortus*, *B. melitensis* and *B. suis* in cattle and in sheep and goat populations, and of the non-vaccination status of MSs or zones or compartments. Due to the differing levels of infection risk between DFS zones and zones under an eradication programme (UEP), these zones have been treated separately in this chapter. Commission Implementing Regulation CIR (EU) 2018/1882<sup>35</sup> includes *Bos ssp.*, *Bubalus ssp.*, *Bison ssp.*, *Ovis ssp.* and *Capra ssp.* as species for notification, surveillance, prevention, certification and compulsory eradication. Commission Delegated Regulation<sup>36</sup> (CDR) (EU) 2020/689 (Annex IV) describes the conditions required to grant, maintain or suspend the status of free from infection with *B. abortus*, *B. melitensis* and *B. suis* for an establishment keeping cattle or sheep and goats.

Annual surveillance programmes are carried out in DFS zones to confirm the absence of infection with *B. abortus*, *B. melitensis* and *B. suis* in cattle, and in sheep and goats. In UEP zones, control and eradication programmes are in place for brucellosis in cattle and in sheep and goats. These data are comparable across MSs because the monitoring schemes are harmonised, and the data collected and reported to EFSA originate from the census-as-sampling framework or a randomised design. These data can be used to carry out trend analyses both at the EU and MS levels, to perform trend watching and produce descriptive summaries, and to assess the impact of control and eradication programmes (Table 1).

<sup>34</sup>EU Animal Diseases Information System (ADIS). More information is available at: [https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis\\_en](https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis_en).

<sup>35</sup>Commission Implementing Regulation (EU) 2018/1882 of 3 December 2018 on the application of certain disease prevention and control rules to categories of listed diseases and establishing a list of species and groups of species posing a considerable risk for the spread of those listed diseases.

<sup>36</sup>Commission Delegated Regulation (EU) 2020/689 of 17 December 2019 supplementing Regulation (EU) 2016/429 of the European Parliament and of the Council as regards rules for surveillance, eradication programmes and disease-free status for certain listed and emerging diseases.

## Surveillance data for *Brucella* from food and from animals other than cattle, sheep and goats

Monitoring data for *Brucella* from food and from animals other than cattle, sheep and goats are submitted to EFSA in accordance with Directive 2003/99/EC. Data collected allow for descriptive summaries to be compiled at the EU level, but do not enable trend watching or trend analyses (Table 1).

In accordance with CIR (EU) 2020/2002, notification to ADIS and surveillance rules apply to other *Artiodactyla* species (such as camelids or cervids) as susceptible species for brucellosis.

### 6.3 | Results

#### 6.3.1 | Overview of key statistics, EU, 2019–2023

Table 39 displays statistics at the EU level on human and animal brucellosis, along with data on detection of *Brucella* in food, between 2019 and 2023. More detailed descriptions of these statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

**TABLE 39** Summary of *Brucella* statistics relating to humans, major food categories and animal species (stratified by status of disease of MSs/MS zones), EU, 2019–2023.

	2023 <sup>a</sup>	2022 <sup>a</sup>	2021 <sup>a</sup>	2020	2019 <sup>b</sup>	Data source
<b>Humans</b>						
Total number of confirmed cases	259	226	162	132	309	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.06	0.05	0.03	0.03	0.06	ECDC
Number of reporting MSs	26	26	26	26	27	ECDC
Infection acquired in the EU	87	66	75	68	126	ECDC
Infection acquired outside the EU	49	40	22	14	50	ECDC
Unknown travel status or unknown country of infection	123	120	65	50	133	ECDC
Total number of food-borne outbreaks	0	0	2	2	2	EFSA
Number of outbreak-related cases	0	0	1	1	1	EFSA
<b>Food</b>						
<b>Milk and milk products</b>						
Number of sampling units	200	182	320	275	586	EFSA
Number of reporting MSs	3	3	3	3	2	EFSA
<b>Animals</b>						
<b>Cattle (bovine animals)</b>						
Number of infected herds in disease-free status zones <sup>c</sup>	5	13	8	6	4	EFSA
Number of reporting disease-free status MSs <sup>c</sup>	23	23	22	20	20	EFSA
Number of positive herds in zones under an eradication programme	284	428	546	603	485	EFSA
Number of reporting MSs with zones under an eradication programme	5	5	6	6 <sup>d</sup>	8	EFSA
<b>Sheep and goats</b>						
Number of infected flocks in disease-free status zones <sup>e</sup>	4	2	15	3	1	EFSA
Number of reporting disease-free status MSs <sup>e</sup>	22	21	21	19	20	EFSA
Number of positive herds in zones under an eradication programme	141	234	331	349	451	EFSA
Number of reporting MSs with zones under an eradication programme	5 <sup>d,f</sup>	7 <sup>g</sup>	7	7 <sup>d</sup>	8	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>Data from the United Kingdom (Northern Ireland) were taken into account for 2021–2023. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with Section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to MSs include the United Kingdom in respect of Northern Ireland.

<sup>b</sup>Data from the United Kingdom were taken into account for the 2018–2019 period, since the United Kingdom was still an EU MS at that time. However, on 1 February 2020, it became a third country.

<sup>c</sup>Member States, or zones thereof, with DFS regarding infection with *B. abortus*, *B. melitensis* and *B. suis* in their bovine animal populations. In addition, the United Kingdom (Northern Ireland) has DFS with regard to infection with *B. abortus*, *B. melitensis* and *B. suis* in bovine animal populations.

<sup>d</sup>No data were reported by Bulgaria.

<sup>e</sup>Member States, or zones thereof, with DFS regarding infection with *B. abortus*, *B. melitensis* and *B. suis* in their sheep and goat populations. In 2023, Malta had no disease status. In addition, the United Kingdom (Northern Ireland) has DFS with regard to *B. abortus*, *B. melitensis* and *B. suis* in sheep and goat populations.

<sup>f</sup>Including Malta, which had no official status as regards infection with *B. abortus*, *B. melitensis* and *B. suis* in ovine and caprine animal populations, in 2023.

<sup>g</sup>Including France, in which the whole of metropolitan France obtained DFS in 2022 whereas overseas French regions did not have this status.

### 6.3.2 | Human brucellosis

In 2023, 259 confirmed cases were reported in the EU, which was a slight increase compared with 2022. The notification rate was 0.06 cases per 100,000 population, which was an increase of 14.1% compared with 2022 (0.05 cases per 100,000 population). In 2023, 26 MSs provided data and information on brucellosis in humans (Table 39). Greece and Slovakia reported the highest notification rates (0.28 and 0.18 per 100,000 population, respectively) (Table 40). Seven MSs (Cyprus, Estonia, Finland, Hungary, Latvia, Luxembourg and Malta) reported zero cases (Table 40).

In 2023, the proportion of human infections acquired in the EU was 64.0% (87 out of 136 cases with known travel status), which was an increase compared with 62.3% (66 out of 106) in 2022 and a decrease in contrast with 75.8% (269 out of 355) on average in 2019–2021 (Table 39). The proportion of cases with unknown travel status or travel destination was 47.5% (123 out of 259 cases), which was a decrease compared with 53.1% (120 out of 226) in 2022 and an increase compared to 41.1% (248 out of 603) in 2019–2021 (Table 39).

The number of confirmed, domestically acquired brucellosis cases in humans (patients not having been outside the country of notification during the disease incubation period) is overlaid with the national prevalence data on *Brucella*-positive cattle herds and sheep and goat flocks in the European Union in 2023 in Figure 15. Germany, Greece, Portugal, Slovakia and Spain had the highest number of confirmed domestic cases in humans. Italy, which reported a high number of human brucellosis cases over the years, did not provide information on the origin of infection for 2023. Greece, Portugal and Italy also had the highest prevalence of *Brucella*-positive ruminant herds.

**TABLE 40** Reported confirmed human cases of brucellosis and notification rates per 100,000 population in EU MSs and non-MSs, by country and year, 2019–2023.

Country	2023				2022		2021		2020		2019			
	Status				Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
	Bv <sup>a</sup>	Ov, Cp <sup>b</sup>	National coverage <sup>c</sup>	Data format <sup>c</sup>	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	DFS	DFS	Y	C	8	0.09	7	0.08	6	0.07	8	0.09	6	0.07
Belgium	DFS	DFS	Y	C	5	0.04	3	0.03	7	0.06	4	0.03	3	0.03
Bulgaria			Y	A	1	0.02	2	0.03	0	0	1	0.01	0	0
Croatia	DFS		Y	C	2	0.05	2	0.05	2	0.05	1	0.02	3	0.07
Cyprus	DFS	DFS	Y	C	0	0	0	0	1	0.11	0	0	0	0
Czechia	DFS	DFS	Y	C	1	0.01	0	0	1	0.01	0	0	4	0.04
Denmark <sup>d</sup>	DFS	DFS	–	–	–	–	–	–	–	–	–	–	–	–
Estonia	DFS	DFS	Y	C	0	0	0	0	0	0	0	0	1	0.08
Finland	DFS	DFS	Y	C	0	0	0	0	0	0	0	0	0	0
France	DFS	DFS	Y	C	22	0.03	37	0.05	21	0.03	19	0.03	34	0.05
Germany	DFS	DFS	Y	C	36	0.04	35	0.04	13	0.02	19	0.02	36	0.04
Greece			Y	C	29	0.28	35	0.33	24	0.22	30	0.28	65	0.61
Hungary		DFS	Y	C	0	0	0	0	0	0	0	0	0	0
Ireland	DFS	DFS	Y	C	5	0.09	1	0.02	0	0	0	0	0	0
Italy			Y	C	74	0.13	48	0.08	32	0.05	18	0.03	49	0.08
Latvia	DFS	DFS	Y	C	0	0	0	0	0	0	1	0.05	0	0
Lithuania	DFS	DFS	Y	C	2	0.07	0	0	0	0	0	0	0	0
Luxembourg	DFS	DFS	Y	C	0	0	1	0.15	1	0.16	0	0	0	0
Malta <sup>e</sup>	DF		Y	C	0	0	0	0	0	0	0	0	0	0
Netherlands	DFS	DFS	Y	C	4	0.02	5	0.03	2	0.01	2	0.01	7	0.04
Poland	DFS	DFS	Y	C	4	0.01	1	0	1	<0.01	0	0	2	0.01
Portugal			Y	C	14	0.13	13	0.13	10	0.10	9	0.09	33	0.32
Romania	DFS	DFS	Y	C	1	0.01	0	0	0	0	0	0	1	0.01
Slovakia	DFS	DFS	Y	C	10	0.18	3	0.06	6	0.11	2	0.04	1	0.02
Slovenia	DFS	DFS	Y	C	3	0.14	1	0.05	0	0	1	0.05	6	0.29
Spain <sup>f</sup>	DFS	DFS	Y	C	28	0.06	22	0.05	25	–	10	–	20	0.04
Sweden	DFS	DFS	Y	C	10	0.10	10	0.10	10	0.10	7	0.07	14	0.14
<b>EU Total 27</b>			–	–	<b>259</b>	<b>0.06</b>	<b>226</b>	<b>0.05</b>	<b>162</b>	<b>0.03</b>	<b>132</b>	<b>0.03</b>	<b>285</b>	<b>0.06</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	–	–	24	0.04

(Continues)

TABLE 40 (Continued)

Country	2023				Confirmed cases and rate		2022		2021		2020		2019	
	Status				Cases	Rate	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate	
	Bv <sup>a</sup>	Ov, Cp <sup>b</sup>	National coverage <sup>c</sup>	Data format <sup>c</sup>			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
<b>EU Total</b>			–	–	<b>259</b>	<b>0.06</b>	<b>226</b>	<b>0.05</b>	<b>162</b>	<b>0.03</b>	<b>132</b>	<b>0.03</b>	<b>309</b>	<b>0.06</b>
Iceland			Y	C	0	0	0	0	0	0	0	0	0	0
Norway	DFS	DFS	Y	C	1	0.02	1	0.02	3	0.06	2	0.04	4	0.08
Liechtenstein	DFS	DFS	Y	C	0	0	0	0	0	0	3	0.03	7	0.08
Switzerland <sup>g</sup>	DFS	DFS	Y	C	9	0.10	6	0.07	6	0.07				

Abbreviations: –, data not reported; DFS, disease-free status with regards to infection with *B. abortus*, *B. melitensis* and *B. suis* in cattle populations and/or in sheep and goat populations.

<sup>a</sup>Cattle populations.

<sup>b</sup>Sheep and goat populations.

<sup>c</sup>Y: yes; N: no; A: aggregated data; C: case-based data.

<sup>d</sup>No surveillance system.

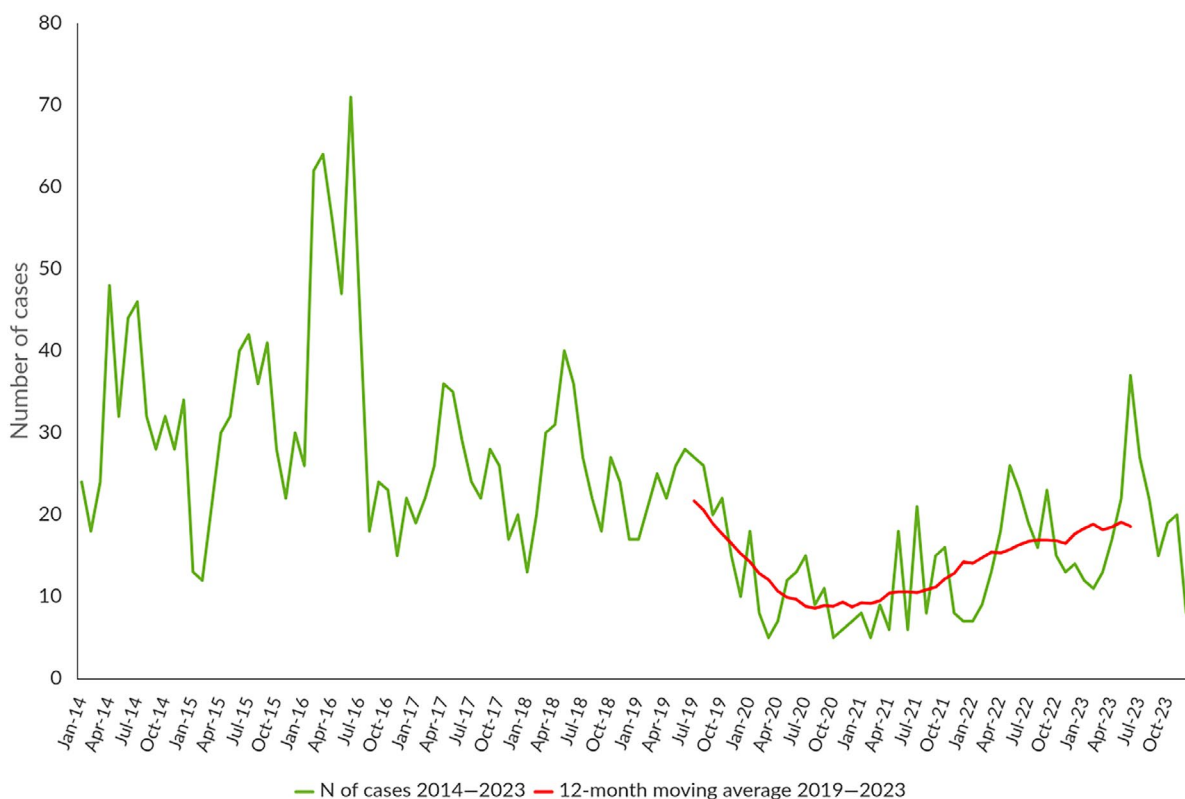
<sup>e</sup>Malta had no official status as regards infection with *B. abortus*, *B. melitensis* and *B. suis* in ovine and caprine animal populations, in 2023.

<sup>f</sup>Data incomplete for 2020–2021, rate not estimated.

<sup>g</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

DFS	All zones of the MS have disease-free status.
■	Not all zones of the MS have disease-free status.
■	No zone of the MS has disease-free status.
■	No status.

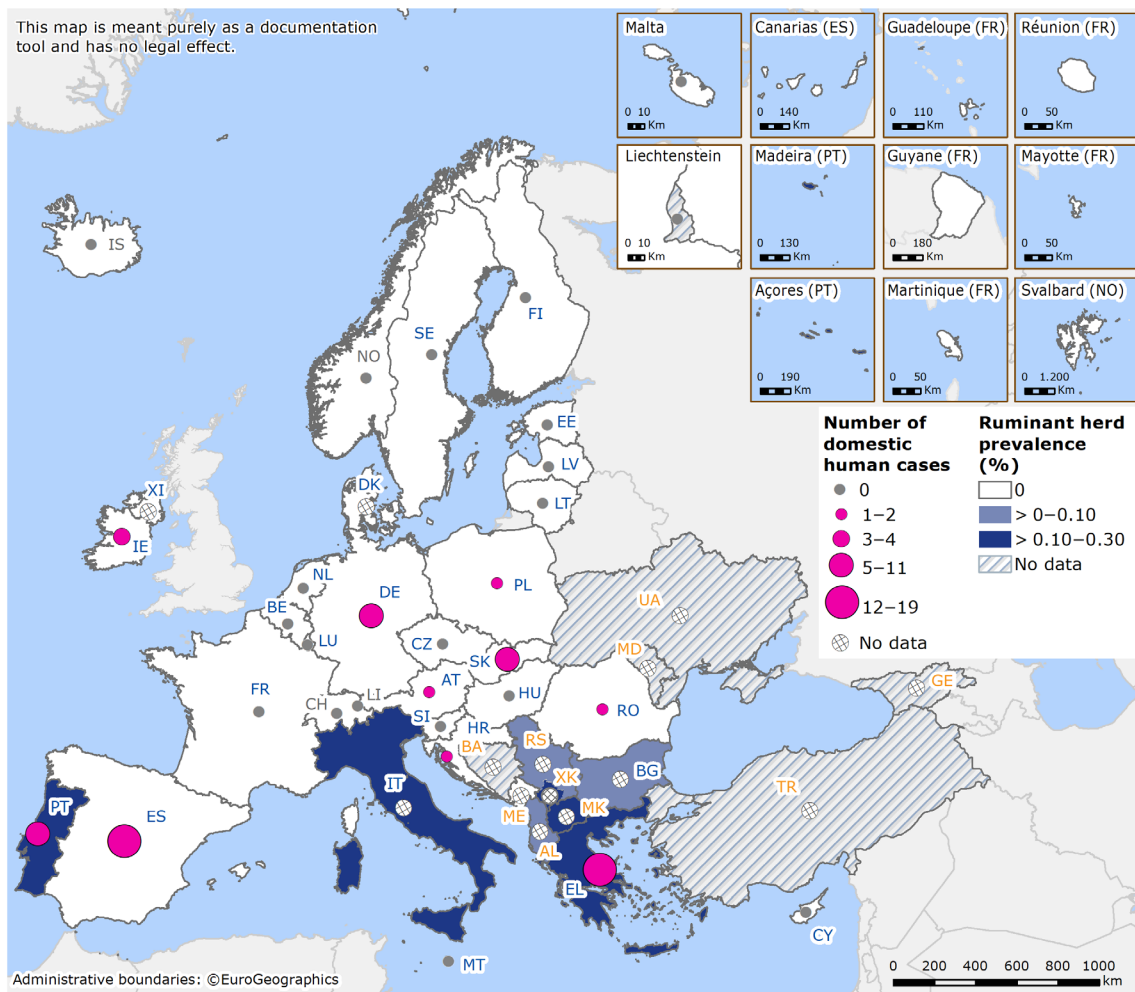
In 2023, clear seasonality was observed in the number of confirmed brucellosis cases in the EU, with more cases reported from March to August (Figure 14). Over the 2019–2023 period, there was no statistically significant increase or decrease in the overall trend in the EU. The trend for one MS (Slovakia) was a significant increase over 5 years, from 2019 to 2023. None of the MSs reported a decreasing trend.



**FIGURE 14** Trend in reported confirmed human cases of brucellosis in the EU, by month, 2019–2023. Source: Austria, Belgium, Cyprus, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia and Sweden.



Out of 259 human cases, 74 (28.6%) were reported with information on *Brucella* species by 14 MSs. *Brucella melitensis* was reported as the aetiological agent in 68 cases (91.9%); *B. abortus* was reported in three cases (4.0%); *B. suis* in one case (1.3%); and other (unspecified) *Brucella* species in two cases (2.7%). The proportion of *B. melitensis* infections was slightly lower than in 2022 (94.4%). Italy did not provide any information regarding the typing of *Brucella* isolates. Conversely, Greece provided data for seven cases, all of which were identified as *B. melitensis*. Portugal also provided data for three cases, which were identified as *B. melitensis* ( $N=1$ ), *B. abortus* ( $N=1$ ) and other *Brucella* species ( $N=1$ ).



**FIGURE 15** Number of confirmed, domestically acquired brucellosis cases in humans and national prevalence of *Brucella*-positive cattle herds and sheep and goat flocks, in EU MSs and non-MSs, 2023. Member States that reported data at the national level without specifying the specific zones or overseas territories where the *Brucella*-positive animal herds were detected, were assigned the same colour for all their zones, including overseas territories. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. For Kosovo and Serbia, prevalence data are at the animal level. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

### 6.3.3 | *Brucella* in food

Very few monitoring data for *Brucella* were submitted in 2023, as was the case in previous years. In total, 200 single samples of milk and cheeses were collected from primary production, and from the manufacturing and distribution stages, by three MSs (Italy, Portugal and Spain). No positive sample was reported.

### 6.3.4 | *Brucella* in animals

#### Surveillance data for bovine brucellosis, and ovine and caprine brucellosis

##### Cattle

The status of countries for brucellosis in cattle was stable in 2023 compared with 2022, with 22 MSs and the United Kingdom (Northern Ireland) having DFS in 2023. Out of the five MSs with UEP zones (Bulgaria, Greece, Hungary, Italy and Portugal), only Italy reported an increasing number of DFS zones. Two countries had DFS zones or provinces in cattle:

- Italy: 13 regions and 12 provinces; and
- Portugal: one region (the autonomous region of the Azores) and nine districts (from the Central region and from the Azores islands).

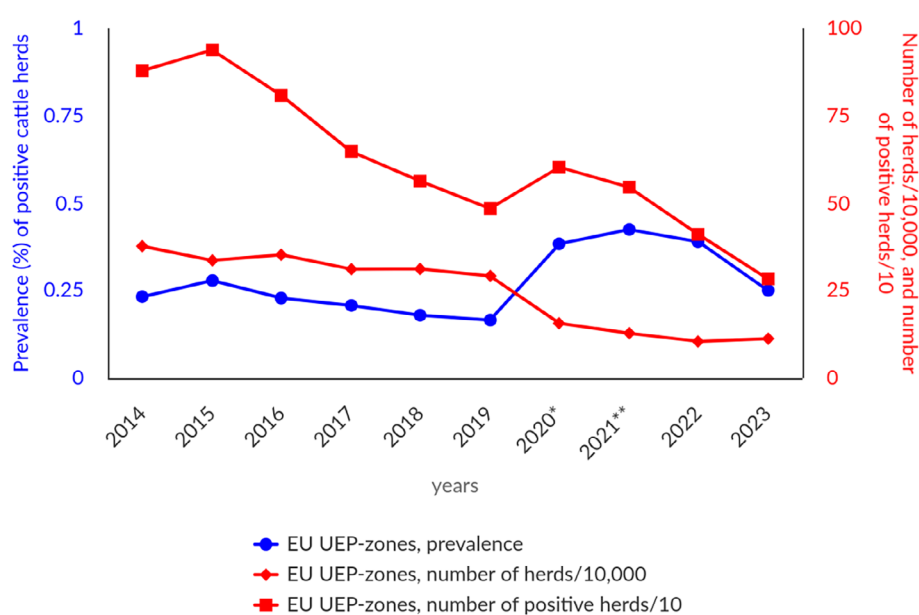
Bulgaria, Greece and Hungary did not have any DFS zones.

Liechtenstein, Norway and Switzerland have DFS in accordance with EU legislation. Iceland, which does not have any special agreement on animal health (status) with the European Union, has never reported any brucellosis cases caused by *B. abortus*, *B. melitensis* or *B. suis*.

In 2023, infection of cattle herds with brucellosis in the EU remained a rare event (<0.01%; 289 out of 1,528,397 herds), with 23 MSs reporting no cases. Greece and Italy had the highest numbers of infected herds.

Among the DFS zones, no infected cattle herds were reported in 2023, except in Italy, where five herds tested positive. The overall prevalence in DFS zones remained below 0.001%.

In 2023, within the UEP zones of the five non-DFS MSs, the prevalence of *Brucella*-positive cattle herds continued to decrease, reaching 284 herds (0.25%), down from 411 herds (0.39%) in 2022. Compared to 2020, the number of positive cattle herds notably decreased by 53%, from 603 to 284 in 2023. Italy reported 217 positive herds in its UEP zones (down from 346 in 2022), while Portugal reported 21 herds (the same as in 2022). Greece reported 35 positive herds (down from 42 in 2022) and Bulgaria reported 11 (up from two in 2022). Over the last decade (2014–2023), the total number of positive cattle herds in UEP zones decreased by 68% from 879 in 2014 to 284 in 2023, whereas the prevalence fluctuated around 0.25% (Figure 16).



**FIGURE 16** Prevalence of *Brucella*-positive cattle herds, in zones under an eradication programme, EU, 2014–2023. UEP, under an eradication programme. \*In contrast to years 2014–2019, the year 2020 does not include the United Kingdom data. Since 1 February 2020, the United Kingdom has withdrawn from the EU and has become a third country. \*\*Data from the United Kingdom (Northern Ireland) were considered for 2021–2023. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with Section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to MSs include the United Kingdom in respect of Northern Ireland.

In 2024, no cases of bovine brucellosis were detected in the four non-MS countries of Iceland, Liechtenstein, Norway and Switzerland, which have DFS. In the Balkans, *Brucella* remains present in cattle. EU candidate countries reported seropositive results from national monitoring data, with Albania identifying five positive herds (0.005%) and the Republic of North Macedonia detecting 15 positive herds (0.12%). Additionally, Albania reported 1875 seropositive results (5.2%) from a total of 35,796 blood samples. The Republic of North Macedonia identified 422 seropositive animals (0.41%) out of 102,400 tested, while Serbia reported nine positives (0.002%) from 433,415 animals. Kosovo<sup>37</sup> reported 0.35% positives, with 21 positive animals out of 6000 tested.

### Sheep and goats

In 2023, 21 MSs and the United Kingdom (Northern Ireland) had DFS with regard to ovine and caprine brucellosis, while 5 MSs had UEP zones (Bulgaria, Croatia, Greece, Italy and Portugal). Malta had no official status as regards infection with *B. abortus*, *B. melitensis* and *B. suis* in sheep and goats. Italy and Portugal had DFS zones:

<sup>37</sup>This designation is subject to positions on status and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

- Italy: 15 regions and 10 provinces,
- Portugal: one region (the autonomous region of the Azores).

Italy reported an increasing number of DFS zones.

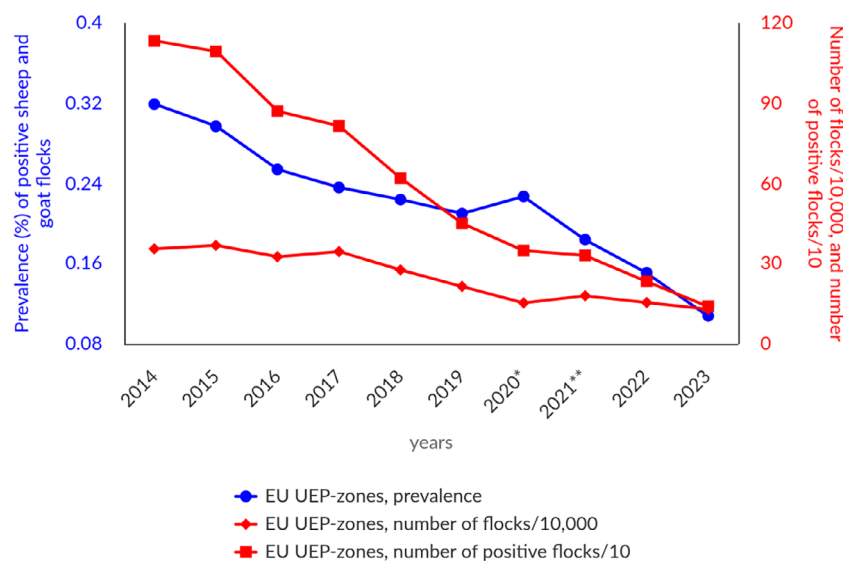
Bulgaria, Croatia and Greece no DFS zones.

Bulgaria did not report any data for sheep and goat brucellosis.

In 2023, the overall proportion of sheep and goat flocks infected with *B. abortus*, *B. melitensis* and *B. suis* in the EU remained very low (0.015%; 145 out of 974,714 flocks).

Among the DFS zones, no infected sheep and goat flocks were reported in 2023, except in Italy, where four flocks tested positive. The overall prevalence in DFS zones remained below 0.001%.

In 2023, within the UEP zones of the five non-DFS MSs and Malta, the prevalence of *Brucella*-positive sheep and goat flocks continued to decrease, reaching 141 flocks (0.15%), down from 234 flocks (0.11%) in 2022 (Figure 17). The number of positive flocks reported by these MSs was 34 in Italy (down from 66 in 2022), 3 in Greece (down from 13 in 2022) and 104 in Portugal (down from 154 in 2022). No positive flocks were reported by Croatia, Malta or Portugal. For the past 4 years, Croatia has reported zero infected herds, indicating that eradication of sheep and goat brucellosis is almost achieved. Over the last decade (2014–2023), the total number of positive sheep and goat flocks in UEP zones decreased by 88% from 1133 in 2014 to 141 in 2023, whereas the prevalence decreased by 66% from 0.32% in 2014 to 0.11% in 2023 (Figure 17).



**FIGURE 17** Prevalence of *Brucella*-positive sheep and goat flocks, in zones under an eradication programme, EU, 2014–2023. UEP, under an eradication programme. \*In contrast to years 2014–2019, the year 2020 does not include the United Kingdom data. Since 1 February 2020, the United Kingdom has withdrawn from the EU and has become a third country. \*\*Data from the United Kingdom (Northern Ireland) were considered for 2021–2023. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with Section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to MSs include the United Kingdom in respect of Northern Ireland.

In 2023, no cases of brucellosis were detected in sheep and goat flocks in the following non-MS countries: Albania, Iceland, Montenegro, Norway and Switzerland. The Republic of North Macedonia reported 23 positive flocks and 966 (0.19%) seropositive small ruminants out of 500,949 tested. Serbia reported only seven infected animals out of 1,220,364 (0.0006%) based on national monitoring data for ovine and caprine brucellosis. Kosovo<sup>38</sup> reported 0.1% positive sheep and goats, with 2 positives out of 2000 tested.

### Surveillance data for *Brucella* from animals other than cattle, sheep and goats

In contrast to 2022 reports on *Brucella* in animals other than cattle, sheep and goats, the detection of the *Brucella* genus (without species identification) was reported in a smaller range of animal species. Several strains of *B. canis* ( $N=21$ ) were reported in dogs from five countries (in France, Greece, Italy, Romania and the Netherlands). Moreover, *B. suis* biovar 2 was also isolated in three dogs (France and Italy). *Brucella* was detected in pigs in France, while seropositive animals were reported by two MSs (Germany and Romania) as well as by Switzerland. A total of 1249 negative microbiological or PCR analyses were reported for pigs and wild boars across seven MSs: Finland (17), France (2), Germany (938), Ireland (3), Italy (18), Romania (249) and Sweden (22). Additionally, 70,819 seronegative results were recorded in nine MSs: Bulgaria (4726),

<sup>38</sup>This designation is subject to positions on status and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

Croatia (15), Finland (1536), Germany (20,631), Italy (6), Latvia (3267), Romania (35,812), Sweden (821) and Slovakia (786), along with the United Kingdom (Northern Ireland) with 648 and Norway with 2571 seronegative results. Moreover, one seropositive alpaca was detected in Switzerland, while no seropositive animals were reported by Finland, Italy, Sweden or the United Kingdom (Northern Ireland). Finally, serological tests for *Brucella* were carried out on llamas (in Italy), domestic solipeds (in Romania and Switzerland), deer (in Slovakia) and bison (in Slovakia), all yielding results.

## 6.4 | Discussion

The 5-year trend of confirmed cases of human brucellosis in the EU remained unchanged from 2019 to 2023. However, the EU notification rate was higher in 2023 (0.06 per 100,000 population) than in 2022, with Greece, Slovakia, Slovenia, Portugal, Italy and Sweden contributing most to this increase. All EU countries reported brucellosis data. Human brucellosis remains a persistent public health problem in some MSs, particularly in Greece, Portugal and Italy where the infection in cattle and small ruminants is present. Several different *Brucella* spp. genotypes, mostly of endemic origin and persisting in different foci, were detected in Greece in 1999–2009 (Brangsch et al., 2023). In Europe, 24.3% (0.18/0.74 billion) of people were at risk of contracting brucellosis in 2014–2018 (Laine et al., 2023). The consumption of unpasteurised milk products and the handling of contaminated tissues, such as aborted livestock placentas, are considered the primary sources of infection (Corbel et al., 2006). The overall regional risk assessment identified a major hotspot in the eastern Mediterranean and an increased risk in the central sub-region of Europe (Laine et al., 2023), as reported in the Balkan EU candidate countries.

In 2023, infections acquired in the EU increased slightly, which was mainly due to the rise of cases in Slovakia and Ireland, most of which were of domestic origin.

Like in 2022, a number of domestic human cases were reported in MSs that did not yet eradicate brucellosis in their cattle sheep and goat populations. This was the case of Greece and Portugal. Italy, as well, documented persistent *Brucella* infection in ruminant herds; however, no information on the origin of infection was provided and no link to the disease in ruminants was possible. Conversely, high numbers of domestic human cases were also recorded in DFS countries, such as in Germany, Ireland, Slovakia and Spain. Persons working with farm animals are known to be at increased risk of brucellosis, which remains the predominant occupational disease (Alzuheir et al., 2021; Pereira et al., 2020). Food-borne exposure is normally limited to the consumption of unpasteurised milk and dairy products or undercooked contaminated meat from countries where brucellosis is endemic in animals. The uncontrolled importation of dairy products from endemic regions may be a contributing factor to the acquisition of human *Brucella* infections in non-endemic EU countries (Jansen et al., 2019). Most domestic human cases in DFS countries were linked to travel outside the EU, with the greatest number of cases occurring in Germany, fewer cases in Spain and none in Slovakia. Interestingly, neither Hungary (non-DFS for cattle) nor Malta (non-DFS for sheep and goats) reported any cases of human brucellosis.

In 2023, data on *Brucella* species was available for 28.6% of reported human cases, with the vast majority attributed to infections caused by *B. melitensis*. This information is very important when optimising risk management to further reduce the disease in humans, considering that *B. melitensis* is mainly, if not completely, associated with brucellosis in sheep and goats. In contrast to 2022, *B. suis* caused infection in humans, albeit in only one case. This pathogen should be monitored over the coming years to detect any trend for a potentially emerging condition.

A recent retrospective study described the genetic diversity of sequenced isolates of *B. melitensis* circulating in Greece between 1999 and 2009 in humans ( $n=15$ ) and small ruminants ( $n=28$ ). In-silico genotyping revealed that the isolates belonged primarily to the eastern Mediterranean genotype and clustered with strains from the western Balkans or Turkey (Brangsch et al., 2023).

A new *Brucella* species has been described in French Guiana, isolated from two Brazilian gold miners working in the Amazon rainforest who were hospitalised with symptoms of brucellosis. Genetic and phenotypic analyses of the bacterial isolates from these patients revealed that they represented a new species, which was named *Brucella amazoniensis* (About et al., 2023). Until now, this species had not been detected in animals. The phylogenetic analysis classifies this species as being close to the classical *Brucella* core clade, especially *B. neotomae* and *B. nosferati*, another recent *Brucella* species discovered in bats from Costa Rica (Hernández-Mora et al., 2023). This new species highlights the importance of monitoring and studying zoonotic diseases, especially in regions with rich biodiversity like the Amazon.

Bovine brucellosis and ovine and caprine brucellosis have been eradicated by most EU MSs. In 2023, France was declared DFS for brucellosis in sheep and goats. In DFS MSs or DFS MSs' zones, very few infected herds or flocks were reported for 2023: five infected cattle herds, and four infected sheep and goat flocks, by Italy.

Some MSs were not yet officially free from bovine brucellosis or from brucellosis in sheep and goats, and both infections were mostly reported in Greece, Italy and Portugal. In Greece, the proportion of tested herds and flocks remained small, which may affect surveillance precision. The overall numbers of positive herds and flocks should be interpreted differently between countries, as the proportion of those tested was highly variable between MSs. Notably, Bulgaria reported an increase in *Brucella*-positive cattle herds but did not submit any surveillance data for brucellosis in sheep and goats.

Nevertheless, from 2014 to 2023, as well as from 2022 to 2023, the overall number of reported positive ruminants in the UEP zones decreased notably, with a decrease in prevalence. In Italy, remaining problems were concentrated in the southern part of the country. Moreover, the infection was present in water buffaloes from the provinces of Caserta, where the prevalence and incidence of infection have remained high in recent years. In UEP zones, non-food-borne transmission of brucellosis to humans may still occur through direct contact with infected animals. People working with farm animals,

including farmers, livestock breeders, butchers, slaughterhouse workers and veterinarians, are known to be at increased risk of brucellosis in endemic countries.

In the Balkans, in EU candidate countries, Albania reported positive results for bovine brucellosis, and Kosovo,<sup>39</sup> the Republic of North Macedonia and Serbia reported positive results for brucellosis in cattle, sheep and goats.

Attention should also be paid to canine brucellosis cases, which are also considered zoonotic, even though this infection is not included in Directive 2003/99/EC. After 2020, an increased number of cases caused by *B. canis* was described in Western Europe (Djokic et al., 2023) and was associated with an updated risk assessment and new importation rules in the United Kingdom (UKHSA, 2023). Moreover, cases of *B. suis* infections in domestic dogs have been reported in France and Germany, with identification of *B. suis* biovar 2 (Girault et al., 2023) and biovar 1 (Aurich et al., 2023) respectively. The Netherlands already reported a case of *B. suis* biovar 1 in a dog in 2018 related to importation of hare meat (van Dijk et al., 2018). These new cases highlight the importance of diagnosing smooth *Brucella* strains in dogs, including *B. abortus*, *B. melitensis* and *B. suis*.

In conclusion, although cases of brucellosis in humans and ruminants are declining in the European Union, brucellosis is still an animal health concern with public health relevance, especially in southern European and Balkan countries that are not free from the disease.

## 7 | TRICHINELLA

### Human cases [EU, 2023] Notification rate (per 100,000 population) **0.02**

**76** Cases of illness

**68** Infections acquired in the EU

**14** Hospitalisations (25.0%)\*

**6** Infection acquired outside the EU

**2** Unknown travel status or unknown country of infection

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

■ ECDC data

### Foodborne outbreaks & related cases [EU, 2023]

**3** Foodborne outbreaks

**31** Cases of illness

**2** Strong-evidence outbreaks ■

**5** Hospitalisations (16.1%)\*

**1** Weak-evidence outbreaks ■


\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

N of outbreaks	N of outbreaks per 100,000 population **	N of outbreak cases per 100,000 population
Austria	0	AT 0
Belgium	0	BE 0
Bulgaria	1	BG 0.016
Croatia	0	HR 0
Cyprus	0	CY 0
Czechia	0	CZ 0
Denmark	0	DK 0
Estonia	0	EE 0
Finland	0	FI 0
France	0	FR 0
Germany	0	DE 0
Greece	0	EL 0
Hungary	0	HU 0
Ireland	0	IE 0
Italy	0	IT 0
Latvia	0	LV 0
Lithuania	0	LT 0
Luxembourg	0	LU 0
Malta	0	MT 0
Netherlands	0	NL 0
Poland	0	PL 0
Portugal	0	PT 0
Romania	1	RO 0.005
Slovakia	0	SK 0
Slovenia	0	SI 0
Spain	1	ES 0.002
Sweden	0	SE 0
UK (N. Ireland)	0	XI 0

#### Implicated food vehicles (Strong-evidence outbreaks)

##### Top food vehicles

 **Pig meat and products thereof**  
**1** Outbreak

 **Other or mixed red meat and products thereof**  
**1** Outbreak

■ EFSA data

\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

<sup>39</sup>This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Trichinella* and for the consultation of data collected, the following interactive tools are available:



## 7.1 | Key facts

- In 2023, there were 76 confirmed cases of human trichinellosis, corresponding to a European Union notification rate of 0.02 cases per 100,000 population with an increase of 94.0% compared with 2022 (0.01 cases per 100,000 population).
- The overall notification rate for trichinellosis did not exceed 0.03 cases per 100,000 population in 2019–2023.
- In 2023, no *Trichinella* infections were reported in tested fattening pigs (30 million) or breeding pigs (0.6 million) raised under controlled housing conditions recognised by the competent authorities, in the European Union. This confirms that farming conditions play a crucial role in preventing infection with this zoonosis.
- Among other domestic pigs in the European Union, 46 (0.00003%) out of more than 168 million tested positive for *Trichinella*. Positive domestic pigs were reported by Romania (43), Spain (two) and Croatia<sup>40</sup> (one).
- As in previous years (2019–2022), no *Trichinella* infections were detected in domestic solipeds within the European Union in 2023.
- In 2023, the proportions of *Trichinella*-positive hunted wild boar and foxes (used as indicator animals) were 0.07% and 1.8%, respectively, compared to 0.08% and 0.95% in 2022.

## 7.2 | Surveillance and monitoring of *Trichinella* in the EU

### 7.2.1 | Humans

For 2023, 26 EU MSs reported information on trichinellosis in humans. The surveillance of *Trichinella* infections is mandatory in all reporting MSs, except in Belgium and France, where the surveillance systems are voluntary. Denmark has no surveillance system for trichinellosis, and the disease is not notifiable or reported at the EU level. Twenty-three MSs used the EU case definition, while other case definitions were used by three MSs. The surveillance systems cover the whole population in all MSs reporting trichinellosis data. All countries reported case-based data except Belgium, Bulgaria, Croatia and the Netherlands, which reported aggregated data.

### 7.2.2 | Animals

#### ***Trichinella* monitoring data for domestic pigs, farmed wild boar and solipeds**

In accordance with Commission Implementing Regulation (EU) 2015/1375,<sup>41</sup> all *Trichinella*-susceptible animals intended for human consumption in the EU, i.e. domestic pigs (both fattening and breeding animals), farmed wild boar and solipeds, should be tested for the presence of *Trichinella* larvae in the muscles unless carcasses have undergone a freezing treatment (freezing inactivates the parasite). ISO 18743/2015/Amd 1:2023 (ISO, 2015a) or an equivalent method should be used (Commission Implementing Regulation (EU) 2015/1375). Therefore, data on *Trichinella* infections in these animals are comparable across MSs because the monitoring schemes are harmonised and the data collected and reported to EFSA originate from census sampling (EFSA BIOHAZ Panel, 2013a, 2013b) (Table 1).

Domestic pigs, farmed and hunted wild boar, and other wild animals (e.g. bears) that are not processed to be placed on the EU market (e.g. those intended for own consumption) are exempted from CIR (EU) 2015/1375, and their control falls under national legislation. CIR (EU) 2015/1375 states that the reporting of data for domestic pigs shall, at least, provide specific information related both to the number of animals tested that were raised under controlled housing conditions and

<sup>40</sup>Croatia reported only positive results.

<sup>41</sup>Commission Implementing Regulation (EU) 2015/1375 of 10 August 2015 laying down specific rules on official controls for *Trichinella* in meat (text with EEA relevance). OJ L 212, 11.8.2015, pp. 7–34.

to the number of breeding sows, boar and fattening pigs tested. Furthermore, the regulation states that a negligible risk status for a country or region is no longer recognised.

From 2022, for reporting *Trichinella* monitoring results for domestic pigs, MSs have the possibility of specifying whether the pigs were raised under controlled housing conditions officially recognised by the CA or not (Pigs – others). Further voluntary reporting could specify whether these pigs were raised under controlled housing conditions not recognised by the CA or whether they were not raised under controlled housing conditions. When *Trichinella*-positive results are reported, it is mandatory to indicate whether the pigs were raised indoors or outdoors.

### **Trichinella monitoring data for animals other than domestic pigs, farmed wild boar and solipeds**

MSs should monitor the circulation of *Trichinella* in the main natural reservoir hosts (carnivorous and omnivorous animals) to acquire information on the risk of transmission to domestic animals (and from these to humans) and on the introduction of new *Trichinella* species from non-EU countries. However, monitoring data provided by the MSs to EFSA are generated by non-harmonised monitoring schemes across MSs without mandatory reporting requirements. Wild animals are the main reservoir hosts of *Trichinella*, and their biology and ecology vary from one MS to another and from one region or habitat in the same MS to another due to the human and environmental impact on ecosystems, resulting in different transmission patterns and prevalence rates of infection. Therefore, data on *Trichinella* in wild animals are not fully comparable among MSs, as neither harmonised monitoring schemes nor mandatory reporting requirements are in place and the reported findings must be interpreted with caution. These data allow descriptive summaries to be produced at the EU level but preclude any subsequent data analysis, such as assessing temporal and spatial trends (Table 1).

## **7.3 | Results**

### **7.3.1 | Overview of key statistics, EU, 2019–2023**

Table 41 summarises EU-level statistics on human trichinellosis and *Trichinella* in animals for 2019–2023. More detailed descriptions of these statistics are provided in the subsections below and in the chapter on food-borne outbreaks.

**TABLE 41** Summary of *Trichinella* statistics relating to humans (2019–2023), domestic pigs (2022–2023) and other main animal species (2019–2023), EU.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	76	39	77	117	97	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.02	0.01	0.02	0.03	0.02	ECDC
Number of reporting MSs	26	26	26	26	27	ECDC
Infections acquired in the EU	68	25	29	99	26	ECDC
Infections acquired outside the EU	6	1	2	2	2	ECDC
Unknown travel status or unknown country of infection	2	13	46	16	69	ECDC
Number of outbreak-related cases	31	68	2	119	44	EFSA
Total number of outbreaks	3	7	1	6	5	EFSA
<b>Animals</b>						
<b>Domestic pigs raised under controlled housing conditions, recognised by the competent authorities</b>						
Number of animals tested	30,653,165	34,183,655	–	–	–	EFSA
% of positive animals	0	0	–	–	–	EFSA
Number of reporting MSs	10	7	–	–	–	EFSA
<b>Domestic pigs (other)</b>						
<i>Controlled housing conditions not recognised by the competent authorities</i>						
Number of animals tested	17,806,783	15,644,310	–	–	–	EFSA
% of positive animals	0	0	–	–	–	EFSA
Number of reporting MSs	7	8	–	–	–	EFSA
<i>Not controlled housing conditions</i>						
Number of animals tested	133,449,395	96,748,782	–	–	–	EFSA
% of positive animals	0.00003	0.00007	–	–	–	EFSA
Number of reporting MSs	20	20	–	–	–	EFSA
<i>Other, unspecified</i>						
Number of animals tested	17,365,718	63,084,065	–	–	–	EFSA

(Continues)

TABLE 41 (Continued)

	2023	2022	2021	2020	2019	Data source
% of positive animals	0	0	–	–	–	EFSA
Number of reporting MSs	4	5	–	–	–	EFSA
<b>Farmed wild boar</b>						
Number of animals tested	4726	5372	5755	3922	7570	EFSA
% of positive animals	0	0	0	0	0	EFSA
Number of reporting MSs	8	8	8	6	7	EFSA
<b>Hunted wild boar<sup>a</sup></b>						
Number of animals tested	1,692,182	1,514,255	1,786,892	1,470,830	1,757,383	EFSA
% of positive animals	0.07	0.08	0.07	0.05	0.08	EFSA
Number of reporting MSs	21	21	20	21	23	EFSA
<b>Foxes</b>						
Number of animals tested	3731	6652	6776	5764	6696	EFSA
% of positive animals	1.8	0.95	1.6	0.85	1.3	EFSA
Number of reporting MSs	10	11	11	9	10	EFSA

Abbreviations: –, Data not reported; ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>Including wild boar without information whether hunted or not.

### 7.3.2 | Human trichinellosis

In 2023, 76 confirmed cases of trichinellosis were reported by 11 MSs, which was an increase of 37 cases compared with 2022 (Table 42). The EU notification rate increased by 94.0% from 0.01 per 100,000 in 2022 to 0.02 per 100,000 in 2023. This increase was due to the increment in the number of confirmed human cases reported in 2023 by Romania (+19), Spain (+18), Italy (+8), Austria and Poland (+4 each), Germany (+3) and Croatia, Latvia and Lithuania (+1 each). The number of MSs reporting zero cases in 2023 decreased by 16.7% ( $N=15$ ) (Table 42).

In 2023, Latvia and Romania had the highest notification rates in the EU (0.21 and 0.12 cases per 100,000, respectively), followed by Austria (0.07 cases per 100,000) (Table 42).

In 2023, 68 cases (89.5%) of trichinellosis with known travel status and known country of infection were reported as having been acquired in the EU. Three MSs (Austria, Germany and Lithuania) reported seven travel-associated trichinellosis cases, one acquired in Italy and six outside the EU. Travel status was not reported for two cases (2.6%) (Table 41).

TABLE 42 Reported confirmed human cases of trichinellosis and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	Y	C	6	0.07	2	0.02	10	0.11	6	0.07	1	0.01
Belgium <sup>b</sup>	Y	A	0	–	0	–	0	–	0	–	0	–
Bulgaria	Y	A	1	0.02	9	0.13	29	0.42	13	0.19	55	0.79
Croatia	Y	A	1	0.03	0	0	17	0.42	0	0.00	3	0.07
Cyprus	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Czechia	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Denmark <sup>c</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Estonia	Y	C	0	0	1	0.08	0	0.00	0	0.00	0	0.00
Finland	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
France	Y	C	2	<0.01	15	0.02	2	0.00	1	0.00	2	0.00
Germany	Y	C	3	<0.01	0	0	2	0.00	1	0.00	3	0.00
Greece	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Hungary	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Ireland	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Italy	Y	C	12	0.02	4	0.01	0	0.00	79	0.13	10	0.02
Latvia	Y	C	4	0.21	3	0.16	7	0.37	1	0.05	1	0.05
Lithuania	Y	C	1	0.03	0	0	1	0.04	0	0.00	0	0.00



**TABLE 42** (Continued)

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Luxembourg	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Malta	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Netherlands	Y	A	0	0	0	0	0	0.00	0	0.00	1	0.01
Poland	Y	C	5	0.01	1	<0.01	2	0.01	11	0.03	2	0.01
Portugal	Y	C	0	0	0	0	0	0.00	0	0.00	1	0.01
Romania	Y	C	23	0.12	4	0.02	6	0.03	4	0.02	6	0.03
Slovakia	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Slovenia	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Spain <sup>d</sup>	Y	C	18	0.04	0	0	1	–	1	–	12	0.03
Sweden	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
<b>EU Total 27</b>			<b>76</b>	<b>0.02</b>	<b>39</b>	<b>0.01</b>	<b>77</b>	<b>0.02</b>	<b>117</b>	<b>0.03</b>	<b>97</b>	<b>0.02</b>
United Kingdom	Y	C	–	–	–	–	–	–	–	–	0	0.00
<b>EU Total</b>			<b>76</b>	<b>0.02</b>	<b>39</b>	<b>0.01</b>	<b>77</b>	<b>0.02</b>	<b>117</b>	<b>0.03</b>	<b>97</b>	<b>0.02</b>
Iceland	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Norway	Y	C	0	0	0	0	0	0.00	0	0.00	0	0.00
Liechtenstein	Y	C	0	0	0	0	0	0.00	4	0.05	3	0.03
Switzerland <sup>e</sup>	Y	C	2	0.02	4	0.05	0	0.00				

Abbreviation: –, Data not reported.

<sup>a</sup>Y: yes; A: aggregated data; C: case-based data.

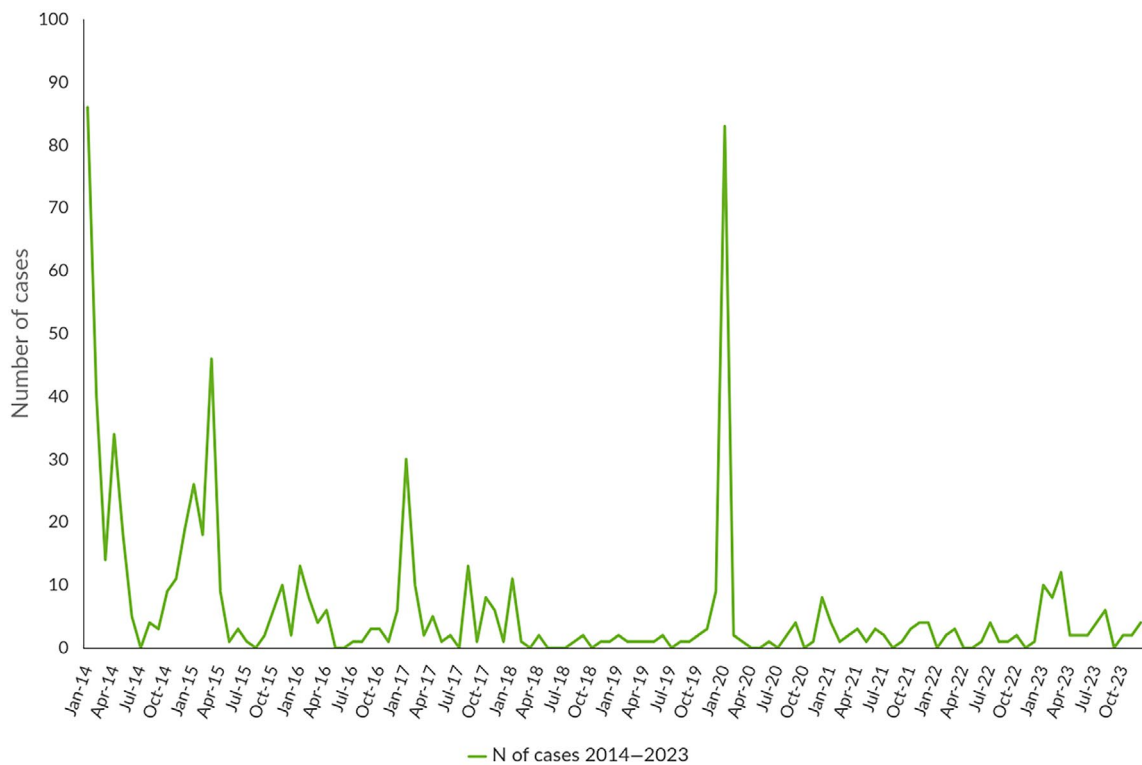
<sup>b</sup>Sentinel surveillance changed to comprehensive for trichinellosis for 2023; no rate could be calculated for the country. Before 2023 sentinel surveillance, the disease was not under formal surveillance; notification rates could not be calculated.

<sup>c</sup>No surveillance system.

<sup>d</sup>Data not complete for 2020–2021. Notification rate could not be calculated.

<sup>e</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

The number of EU confirmed cases of trichinellosis showed an increase in winter over the period 2019–2023 (Figure 18).



**FIGURE 18** Number of confirmed human cases of trichinellosis in the EU by month and year, 2014–2023. Source: Austria, Cyprus, Czechia, Estonia, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Sweden.

*Trichinella spiralis* was identified as the causative agent of 34 (44.7%) confirmed human cases reported by five MSs.

In 2023, 31 food-borne outbreak (FBO)-related human trichinellosis cases were reported to EFSA. *Trichinella* was identified in three FBOs reported by three MSs: Bulgaria, Romania and Spain. Two out of three FBOs were reported as strong-evidence FBOs and affected 13 people. One FBO was reported by Spain as a weak-evidence FBO and involved 18 people. The FBO reported as a strong-evidence FBO by Romania was caused by *T. spiralis* whereas the causative agent of the FBO reported by Bulgaria was unknown. One non-MS (Serbia) reported two strong-evidence FBOs, with 12 human cases in which *T. spiralis* was the causative agent identified. More detailed descriptions of these FBOs are provided in the chapter on food-borne outbreaks.

### 7.3.3 | *Trichinella* in food and animals

No MSs reported monitoring data for food for 2023.

In 2023, 31 countries (27 MSs, the United Kingdom (Northern Ireland) and three non-MSs) provided information on *Trichinella* in domestic animals (pigs and/or farmed wild boar). Nine MSs and the United Kingdom (Northern Ireland) reported data on breeding ( $N=652,504$ ) and/or fattening pigs ( $N=30,000,661$ ) raised under controlled housing conditions officially recognised by the CA; no positive findings were reported. Seven MSs and one non-MS (Iceland) reported data on breeding and/or fattening pigs raised under controlled housing conditions not recognised by the CA; no positive findings were reported. Nineteen MSs, the United Kingdom (Northern Ireland) and two non-MSs reported data on breeding and/or fattening pigs not raised under controlled housing conditions (Table 41) 46 positive findings were reported (Table 43). Moreover, eight MSs reported monitoring data in farmed wild boar with no positive results reported (Table 41).

**TABLE 43** Positive *Trichinella* monitoring results for domestic pigs not raised under controlled housing conditions, in reporting EU MSs and non-MS countries, 2023.

Country	N positive/tested (% positive)	
	Fattening pigs	Breeding pigs
Croatia <sup>a</sup>	–	1/1 (100) <sup>b</sup>
Romania <sup>c</sup>	43/196,620 (0.02)	–
Spain <sup>a</sup>	2/6293 (0.03)	–
<b>EU Total (27 + XI)</b>	45/127,455,407 <sup>d</sup> (0.00004)	1/5,993,988 <sup>d</sup> (0.0002)
<b>Total non-EU countries</b>	0/3,910,961 <sup>d</sup> (0)	0/0 (0)
<b>Total EU (27+ XI) + non-EU countries</b>	45/131,366,368 <sup>d</sup> (0.00004)	1/5,993,988 <sup>d,e</sup> (0.0002)

<sup>a</sup>Outdoor pigs.

<sup>b</sup>Sow from a mixed herd. Croatia reported only positive results.

<sup>c</sup>Indoor pigs.

<sup>d</sup>Total  $N$  tested includes samples from additional countries not listed in the table, as no positive *Trichinella* monitoring results ( $N$  positive) were reported for those countries. However, their data contribute to the overall total number of animals sampled and tested ( $N$  tested).

<sup>e</sup>Portugal informed during the last phase of the production of this report of a reporting error and that 2,664 fattening pigs not raised under controlled housing conditions were mistakenly reported as outdoor breeding pigs.

Three MSs (Croatia, Romania and Spain) reported positive findings for domestic pigs not raised under controlled housing conditions with a total of 46 (0.000034%) positive out of 133 million animals tested in 27 MSs and the United Kingdom (Northern Ireland). Croatia reported one positive outdoor breeding pig, Romania reported 43 positive indoor fattening pigs and Spain reported two positive outdoor fattening pigs (Table 43). Species identification was reported for 41 (89.1%) of 46 pigs. *T. spiralis* was detected in 32 (78.0%) and *T. britovi* in nine (21.9%) of the 41 pigs for which species identification was reported. As in previous years, these *Trichinella* infections were found in pigs not raised under controlled housing conditions (Romania) or in free-range and backyard pigs reared in rural EU regions (Spain and Croatia).

In 2023, as in the previous 5-year period (2018–2022), positive findings were not reported either in 91,597 domestic solipeds tested in 20 MSs or in 9730 domestic solipeds tested in two non-MSs (Iceland and Switzerland).

**TABLE 44** Trichinella monitoring results for hunted wild boar and wild boar with unspecified habitat and foxes, in reporting EU MSs and non-MS countries, 2023.

Country	N positive/tested (% positive)	
	Hunted or unspecified wild boar	Foxes
Austria	–	2/159 (1.3)
Bulgaria	128/31,298 (0.41)	–
Croatia	65/49,985 (0.13)	–
Czechia	1/255,657 (<0.01)	–
Estonia	11/3386 (0.32)	–
Finland	1/595 (0.17)	53/176 (30.1)
France	4/55,035 (<0.01)	–
Germany	20/416,930 (<0.01)	–
Hungary	4/33,863 (0.01)	–
Italy	15/213,445 (<0.01)	5/2060 (0.24)
Latvia	19/8768 (0.22)	–
Poland	242/219,218 (0.11)	–
Romania	29/7245 (0.4)	–
Slovakia	2/9764 (0.02)	–
Slovenia	4/2953 (0.14)	5/276 (1.8)
Spain	556/210,873 (0.26)	–
Sweden	3/98,365 (<0.01)	1/88 (1.1)
<b>EU Total (27 + XI)</b>	1104/1,692,182 <sup>a</sup> (0.07)	66/3731 <sup>a</sup> (1.8)
Republic of North Macedonia	17/4850 (0.35)	–
<b>Total non-EU countries</b>	17/13,817 <sup>a</sup> (0.12)	–
<b>Total EU (27+ XI) + non-EU countries</b>	1121/1,705,999 <sup>a</sup> (0.07)	66/3731 <sup>a</sup> (1.8)

<sup>a</sup>Total N tested includes samples from additional countries not listed in the table, as no positive *Trichinella* monitoring results (N positive) were reported for those countries. However, their data contribute to the overall total number of animals sampled and tested (N tested).

Sixteen MSs reported positive findings for hunted or unspecified wild boar (1104 positive results out of 1,692,182 animals tested (0.07%) (Table 44)). Species identification was provided for 351 wild boar (31.8%), of which 279 (79.5%) were infected with *T. spiralis*, 69 (19.7%) with *T. britovi* and three (<0.85%) with *T. pseudospiralis*. For 754 (68.3%) animals, species identification was not reported.

Five MSs (Austria, Finland, Italy, Slovenia and Sweden) reported positive findings for *Trichinella* in foxes (*Vulpes vulpes*) with, in total, 66 (1.8%) positive out of 3731 tested animals in 10 MSs and the United Kingdom (Northern Ireland) (Table 44). *T. britovi* was identified in 12 (92.3%) animals and *T. nativa* in one (7.7%) out of 13 positive foxes with species identification provided.

In 2023, the proportion of positive samples from wildlife was higher in raccoon dogs (32.3%), wolves (10.8%) and lynxes (8.6%) than in other animals sampled but their population sizes and distributions in Europe are generally limited to a few countries.

## 7.4 | Discussion

Trichinellosis is a severe but rare human disease reported by 11 EU MSs in 2023. Seventy-six human cases were reported, with an increased EU notification rate (0.02 cases per 100,000 population) compared to 2022 (0.01 cases per 100,000 population). Fifteen of twenty-six MSs reported zero cases, including four MSs (Cyprus, Finland, Luxembourg and Malta) that have never reported any trichinellosis cases to TESSy.

In general, *Trichinella* infections in humans are often linked to FBOs; therefore, the number and size of FBOs have affected the EU trend for trichinellosis. The EU notification rate was not higher than 0.03 per 100,000 population in the last 5 years, from 2019 to 2023, with the highest rate (0.03) reported in 2020. The lowest rate (0.01) was reported in 2022. In 2023, Romania and Spain together accounted for over half (53.9%) of all confirmed trichinellosis cases in the EU. Three FBOs involving 31 human cases were reported by Bulgaria, Romania and Spain. As in previous years, discrepancies between the number of FBO-related human cases (31) reported to EFSA and the confirmed human cases of trichinellosis (76) reported to TESSy arose from differences in case classification between the two reporting databases.

Pigs are the largest livestock category in the EU for which not all MSs or EEA and EFTA countries report data (i.e. Croatia). In 2023, nearly 200 million pigs were tested for *Trichinella* across MSs, out of over 220 million pigs slaughtered (based on pig-meat production data by the EU Directorate-General for Agriculture and Rural Development) (European Commission, 2024). Of those, only 46 animals tested positive, corresponding to approximately 0.21 cases per million slaughtered pigs, and an overall prevalence of just 0.00002%. Only three of 27 MSs – Croatia, Romania and Spain – reported positive findings for *Trichinella* in pigs. Positive cases were exclusively found in pigs not raised under controlled housing conditions. Croatia and Spain reported one and two positive outdoor pigs, respectively, while Romania documented 43 positive indoor pigs from backyard farms. Ten MSs provided data for pigs raised under controlled housing conditions officially recognised by the CA, and seven MSs reported on pigs raised under controlled housing conditions not recognised by the CA, with no positive cases detected in either group. This confirms that controlled housing conditions play a crucial role for preventing infection with this zoonosis. Pigs most at risk are backyard or free-range pigs, typically slaughtered at home where veterinary controls may be circumvented. *Trichinella*-infected pigs are primarily concentrated in five MSs: Bulgaria, Croatia, Poland, Romania and Spain, though sporadic infections have been reported in other MSs (Pozio, 2014). In 2023, species-level identification of *Trichinella* larvae confirmed that *T. spiralis* was more prevalent in pigs than *T. britovi* (78.0% vs. 21.9%) (Pozio et al., 2009), though *T. spiralis* was unevenly distributed. No cases of *T. pseudospiralis* were reported in 2023, in accordance with the low prevalence of this species in Europe, especially in pigs (Pozio, 2016).

Hunted wild boar meat has been a major source of trichinellosis infections in humans since 2015 according to the data reported to TESSy, whereas earlier, pig meat was the main source. Human behaviour can strongly influence sylvatic cycles, both favouring and reducing the transmission of *Trichinella* spp. For example, carcasses of *Trichinella*-infected animals left by hunters, or animals that have died in road accidents, may be scavenged by other wild animals, thereby contributing to transmission.

No positive findings were reported for solipeds in 2023. Over the last 15 years, only four horses tested positive, out of more than two million tested (EFSA and ECDC, 2010, 2011, 2012, 2014, 2015a, 2015b, 2016, 2017, 2018, 2019, 2021a, 2021b, 2022). This extremely low (0.000002%) prevalence may have been related to effective control which, according to the EFSA BIOHAZ Panel (EFSA BIOHAZ Panel, 2013b), should be maintained if there is no reliable traceability system in place, especially since meat from solipeds can be eaten raw in some EU countries.

*Trichinella* spp. circulate widely among wild animals across much of Europe; however, the prevalence of infection in these animals can vary among the sampling areas. Negative findings reported by MSs may result from limited surveys, inadequate sample sizes or investigations in areas where environmental conditions do not support the transmission of these zoonotic nematodes among wildlife. In 2023, some MSs – such as Germany, Italy and Slovakia – tested non-susceptible wild animals (e.g. deer) for *Trichinella* infection, which may have further contributed to the absence of positive results in those cases. Apart from horses, some other herbivores, such as beavers, moose, etc., can be considered accidental hosts of *Trichinella* spp. (Kärssin et al., 2021). High endemicity for *Trichinella* in the sylvatic cycles of these countries and/or convenience sampling might justify surveillance in these animals. The large and widespread population of foxes (indicator animals) can be considered as the main natural reservoir of *Trichinella* in Europe. In 2023, the percentage of positive specimens was 1.8%, which was almost double that observed in 2022 (0.95%). In 2023, the number of MSs reporting data from pigs raised under controlled housing conditions officially recognised by the CA increased to 10, vs. seven in 2022. In most MSs, there has been increased control at slaughter of pigs not raised under controlled housing conditions during the last few years. These measures, combined with trichinellosis awareness-raising and farmers' education activities, may have contributed to a reduction in the parasite biomass in domestic habitats and the probability of acquiring an infection for humans.

Farming practices at risk of transmitting *Trichinella* spp. (rearing outdoor, backyard or free-range pigs (Pozio et al., 2021) occur), in general, in disadvantaged and poor areas where veterinary services do not exist or are unable to control many small pig units, or where veterinary supervision can be circumvented (Pozio, 2014). There are examples from the past where countries had suitable controls in place for parasite management in domestic pigs but where changes in pork production affected by socioeconomic conflicts resulted in the re-emergence of trichinellosis as a severe public health problem (Cuperlovic et al., 2005; Djordjevic et al., 2003). The increasing number of wild boar and foxes and the spread of the raccoon dog population from eastern to western Europe and of the jackal population from southeastern to northwestern Europe may increase the prevalence of *Trichinella* circulating among wild animals (Alban et al., 2011; Széll et al., 2013).

## 8 | ECHINOCOCCUS

### Human cases [EU, 2023] Notification rate (per 100,000 population) **0.21**

**929** Cases of illness

**427** Infections acquired in the EU

**103** Infections acquired outside the EU

**399** Unknown travel status or unknown country of infection

**153** Hospitalisations (37.7%)\*

**3** Deaths (0.53%)\*

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

■ ECDC data

The summary data which make up this chapter, and additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases [here](#).

For additional information about *Echinococcus* and for the consultation of data collected, the following interactive tools are available:



### 8.1 | Key facts

- In 2023, there were 929 confirmed cases of human echinococcosis, corresponding to a European Union notification rate of 0.21 per 100,000 population and an increase of 8.4% compared with 2022 (0.19 per 100,000 population).
- In 2023, *Echinococcus granulosus sensu lato* causing cystic echinococcosis accounted for 67.3% of human cases reported with species information, while *E. multilocularis* causing alveolar echinococcosis accounted for 32.7% of cases.
- In 2023, *E. multilocularis* was detected by nine Member States and one non-Member State in four different animal categories. Most samples that tested positive in the European Union were from foxes (6399), and the proportion of positives was 15.2%. Czechia, France, Germany, Poland and Slovenia reported the largest proportions of infected foxes among those tested, accounting for 22.0%, 15.2%, 19.7%, 31.2% and 17.6% of positive individuals, respectively.
- In 2023, *E. granulosus sensu lato* was detected by 12 Member States and one non-Member State in nine different animal categories. The majority of the samples tested in the European Union were from sheep and goats (11,543,410), cattle (6,794,791) and pigs (55,162,890), and the proportion of positives was 0.66%, 0.28% and <0.01%, respectively. Italy and Spain accounted for the largest proportions of sheep and goats (49.0% and 43.4%), cattle (27.3% and 65.2%) and pigs (17.3% and 75.8%) that tested positive, respectively.
- Data from Finland, Ireland, Malta, the United Kingdom (Northern Ireland) and mainland Norway confirmed the free status of these countries for *E. multilocularis* in 2023 in accordance with Commission Delegated Regulation (EU) 2018/772.

### 8.2 | Surveillance and monitoring of cystic and alveolar echinococcosis in humans and animals in the EU

#### 8.2.1 | Humans

For 2023, 26 Member States (MSs) reported information on echinococcosis infections in humans. Surveillance is mandatory in 23 MSs and voluntary in 3 (Belgium, France and the Netherlands). Denmark does not have a surveillance system for echinococcosis. The EU case definition was used by 23 countries; Germany and Italy reported cases using a different case definition, and France did not specify which case definition was used. All MSs except Belgium have comprehensive surveillance systems. The surveillance systems for echinococcosis cover the whole population in all MSs where surveillance systems are in place. All countries reported case-based data except Bulgaria, Croatia and the Netherlands, which reported aggregated data.

Alveolar echinococcosis (AE) caused by the tapeworm *E. multilocularis* and cystic echinococcosis (CE) caused by *E. granulosus sensu lato (s.l.)* are listed under the common disease name 'echinococcosis' in the EU case definition, thus making no distinction between these two diseases. Alveolar echinococcosis and CE can be reported by species and, as of 2019 (2018 data), by clinical presentation of the disease in the ECDC TESSy database.

## 8.2.2 | Animals

Surveillance of *E. multilocularis* in Europe is usually carried out voluntarily, except in the reporting countries claiming to be free of this parasite per Commission Delegated Regulation (CDR) (EU) 2018/772.<sup>42</sup> Surveillance is mainly carried out in red foxes, Europe's main definitive host. In 2023, Finland, Ireland, mainland Norway (Svalbard archipelago excluded) and the United Kingdom (Northern Ireland) demonstrated the absence of *E. multilocularis* through the implementation of an annual surveillance programme in compliance with CDR (EU) 2018/772 (EFSA, 2024c). In accordance with this regulation, Malta is not required to implement a surveillance programme due to the absence of the definitive host (red fox) on its territory. In all other MSs, data on *E. multilocularis* depend on whether findings are notifiable, monitoring is in place or studies on *E. multilocularis* are performed. Data on *E. multilocularis* in animals vary geographically across and within countries and over time, depending on the sampling effort and it is therefore challenging to compare reported cases of *E. multilocularis* within and between countries. According to a meta-analysis based on studies published between 1900 and 2015, *E. multilocularis* has been documented in red foxes from 21 countries (Oksanen et al., 2016). Since 2018, this parasite has also been found in golden jackals and foxes from Bosnia and Herzegovina, Croatia, Hungary, Serbia and Slovenia (Balog et al., 2021; Dušek et al., 2020; Omeragić et al., 2022; Sindičić et al., 2018). Human AE cases have also been detected recently in Croatia, Italy and Serbia (Dušek et al., 2020; Lalošević et al., 2023; Tamarozzi et al., 2024). In accordance with CIR (EU) 2020/2002, disease-free EU MSs must notify outbreaks of infection with *E. multilocularis* in Canidae to the EU ADIS.<sup>43</sup>

Surveillance of *E. granulosus s.l.* is carried out in livestock intermediate hosts during slaughterhouse inspections. Necropsies on sheep livers and lungs are performed to detect the presence of parasitic cysts. In contrast, methods based on polymerase chain reaction (PCR) methods are used to confirm and identify genotype/species belonging to the *Echinococcus* genus (Siles-Lucas et al., 2017). Although CDR (EU) 2018/772 is in force for *E. multilocularis*, no specific EU regulation is in place for detecting *E. granulosus s.l.* in animals or humans. Surveillance of the latter parasite, therefore, depends on national regulations. Approximate geographical distribution of *E. granulosus s.l.* species causing human CE as well as country-based incidences in Europe were reported recently (Casulli et al., 2022; Casulli et al., 2023).

## 8.3 | Results

### 8.3.1 | Overview of key statistics, EU, 2019–2023

Table 45 summarises EU-level statistics aggregated by year for echinococcosis (AE and CE) in humans and *E. granulosus s.l.* and *E. multilocularis* in their most relevant definitive and intermediate animal hosts in 2019–2023. More detailed descriptions of these statistics are provided in the subsections below.

**TABLE 45** Summary statistics on echinococcosis caused by *Echinococcus multilocularis* and *Echinococcus granulosus s.l.* in humans and the most relevant definitive and intermediate animal hosts, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	929	739	592	547	779	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.21	0.19	0.17	0.16	0.17	ECDC
Number of reporting MSs	26	25	25	25	26	ECDC
Infection acquired in the EU	427	294	173	132	176	ECDC
Infection acquired outside the EU	103	105	85	77	96	ECDC
Unknown travel status or unknown country of infection	399	340	334	338	507	ECDC

<sup>42</sup>Commission Delegated Regulation (EU) 2018/772 of 21 November 2017 supplementing Regulation (EU) 576/2013 of the European Parliament and of the Council with regard to preventive health measures for the control of *Echinococcus multilocularis* infection in dogs and repealing Delegated Regulation (EU) 1152/2011 C/2017/7619 OJ L 130, 28.5.2018, pp. 1–10.

<sup>43</sup>EU Animal Disease Information System (ADIS). More information is available at: [https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis\\_en](https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis_en).

TABLE 45 (Continued)

	2023	2022	2021	2020	2019	Data source
<b>Animals</b>						
<b><i>Echinococcus multilocularis</i> in foxes</b>						
Number of animals tested	6399	6331	6318	5506	6326	EFSA
positive animals	15.2	13.2	17.0	16.1	13.7	EFSA
Number of reporting MSs	14	14	14	10	13	EFSA
<b><i>Echinococcus</i> spp. in dogs</b>						
Number of animals tested	2619	2502	2942	2515	2113	EFSA
positive animals	0.73	0.08	0.07	0.08	0.24	EFSA
Number of reporting MSs	6	7	5	5	6	EFSA
<b><i>Echinococcus granulosus</i> s.l. in cattle (bovine animals)</b>						
Number of animals tested	6,794,791	7,185,526	7,065,934	7,035,066	10,956,688	EFSA
positive animals	0.28	0.32	0.21	0.21	0.17	EFSA
Number of reporting MSs	17	16	16	15	16	EFSA
<b><i>Echinococcus granulosus</i> s.l. in sheep and goats</b>						
Number of animals tested	11,543,410	12,337,176	10,806,419	11,089,043	36,890,847	EFSA
positive animals	0.66	0.81	0.38	0.96	0.38	EFSA
Number of reporting MSs	14	13	14	12	15	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

### 8.3.2 | Human echinococcosis

In 2023, 929 confirmed echinococcosis cases were recorded by 26 MSs, corresponding to an EU notification rate of 0.21 cases per 100,000 population (Table 46) and an increase of 8.4% compared with 2022 (0.19 per 100,000 population). A mean notification rate of 0.18 per 100,000 population was reported over 2019–2022. In 2023, 22 MSs reported at least one confirmed case; four MSs reported zero cases (Estonia, Finland, Ireland and Malta); and Denmark did not report any data. In 2023, the highest notification rates were observed in Lithuania and Bulgaria, with 3.1 and 1.8 cases per 100,000 population, respectively, followed by Slovenia and Austria with 0.76 and 0.59 cases per 100,000 population, respectively.

In 2023, more than half of the EU echinococcosis cases (59.3%; 551/929) were reported with data on importation and probable country of infection; 71.3% (393/551) of cases reported with such information were domestic, while 28.7% (158/551) were imported.

TABLE 46 Reported confirmed human cases of cystic and alveolar echinococcosis and notification rates per 100,000 population in EU MSs and non-MSs, by country and year, 2019–2023.

Country	2023				2022		2021		2020		2019	
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate	
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Austria	Y	C	54	0.59	54	0.60	42	0.47	34	0.38	36	0.41
Belgium	Y	C	25	0.21	23	0.20	17	0.15	19	0.16	22	0.19
Bulgaria	Y	A	117	1.8	89	1.3	89	1.3	95	1.4	193	2.8
Croatia	Y	A	8	0.21	5	0.13	3	0.07	3	0.07	3	0.07
Cyprus	Y	C	2	0.22	0	0	0	0	1	0.11	0	0
Czechia	Y	C	13	0.12	10	0.10	1	0.01	4	0.04	1	0.01
Denmark <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Estonia	Y	C	0	0	1	0.08	4	0.30	1	0.08	2	0.15
Finland <sup>c</sup>	Y	C	0	0	2	0.04	6	0.11	4	0.07	8	0.14
France	Y	C	94	0.14	79	0.12	75	0.11	55	0.08	55	0.08
Germany	Y	C	186	0.22	180	0.22	163	0.20	171	0.21	150	0.18
Greece	Y	C	10	0.10	5	0.05	4	0.04	7	0.07	7	0.07
Hungary	Y	C	19	0.20	9	0.09	7	0.07	4	0.04	10	0.10
Ireland <sup>c</sup>	Y	C	0	0	1	0.02	1	0.02	0	0	0	0
Italy <sup>d</sup>	Y	C	15	0.03	–	–	–	–	–	–	–	–

(Continues)





TABLE 47 (Continued)

Country	2023			2022			2021			2020			2019		
	Total cases	Eg	Em	Total cases	Eg	Em	Total cases	Eg	Em	Total cases	Eg	Em	Total cases	Eg	Em
Estonia	0	0	0	1	0	1	4	–	–	1	1	0	2	–	–
Finland <sup>b</sup>	0	0	0	2	2	0	6	5	–	4	3	–	8	8	0
France	94	31	63	79	25	54	75	22	53	55	13	42	55	20	35
Germany	186	113	36	180	103	50	163	97	43	171	81	54	150	87	41
Greece	10	–	–	5	–	–	4	–	–	7	7	0	7	–	–
Hungary	19	9	6	9	7	1	7	–	–	4	1	–	10	–	–
Ireland <sup>b</sup>	0	0	0	1	–	–	1	1	0	0	0	0	0	0	0
Italy <sup>c</sup>	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Latvia	7	4	–	4	–	–	6	6	0	5	5	0	6	4	–
Lithuania	89	24	26	74	5	28	20	2	14	37	0	0	81	30	21
Luxembourg	3	3	0	1	1	0	1	–	–	3	3	0	1	1	0
Malta <sup>b</sup>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	46	–	–	45	–	–	53	–	–	48	–	–	48	–	–
Poland	66	21	27	46	11	26	26	12	11	18	8	6	70	21	25
Portugal	2	2	0	2	1	–	2	2	0	1	1	0	5	5	0
Romania	38	26	–	4	–	–	1	–	–	0	0	0	1	–	–
Slovakia	10	1	6	6	1	4	2	0	2	3	1	2	11	3	8
Slovenia	16	4	5	5	1	–	11	2	2	3	1	–	6	1	–
Spain <sup>d</sup>	90	19	1	72	11	–	33	1	–	8	1	–	34	6	–
Sweden	19	8	1	22	11	2	25	12	–	23	8	3	26	17	2
<b>EU-27 total</b>	<b>929</b>	<b>420</b>	<b>204</b>	<b>739</b>	<b>306</b>	<b>193</b>	<b>592</b>	<b>286</b>	<b>139</b>	<b>547</b>	<b>258</b>	<b>121</b>	<b>776</b>	<b>424</b>	<b>155</b>
United Kingdom <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–	3	3	0
<b>EU total</b>	<b>929</b>	<b>420</b>	<b>204</b>	<b>739</b>	<b>306</b>	<b>193</b>	<b>592</b>	<b>286</b>	<b>139</b>	<b>547</b>	<b>258</b>	<b>121</b>	<b>779</b>	<b>427</b>	<b>155</b>
Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norway <sup>b</sup>	12	1	2	9	–	1	11	5	–	6	1	1	7	2	–
Liechtenstein <sup>a</sup>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Switzerland <sup>a</sup>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Abbreviations: –, data not reported; Eg, *Echinococcus granulosus sensu lato*; Em, *Echinococcus multilocularis*.

<sup>a</sup>No surveillance system.

<sup>b</sup>Finland, Ireland, Malta, the United Kingdom (Northern Ireland) and mainland Norway have been declared free of *E. multilocularis*.

<sup>c</sup>No surveillance system before 2023.

<sup>d</sup>Data not complete for 2020 and 2021.

### 8.3.3 | *Echinococcus* spp. in animals and food

#### Monitoring data for *Echinococcus multilocularis*

Table 48 shows *Echinococcus multilocularis* positive monitoring results in wild and domestic animals in reporting EU MSs and non-MSs in 2023. In 2023, a total of 13 MSs, the United Kingdom (Northern Ireland) and 2 non-MSs (Norway and Switzerland) reported monitoring data from 6399 and 513 foxes examined for *E. multilocularis*, respectively. Nine MSs (Austria, Czechia, Denmark, France, Germany, Luxembourg, Poland, Slovenia and Sweden) and one non-MS (Switzerland) reported 14.1% positive samples. Czechia, France, Germany, Poland and Slovenia reported the largest numbers of infected foxes in Europe, accounting for 22.0%, 15.2%, 19.7%, 31.2% and 17.6% of positive individuals, respectively.

In addition to its presence in foxes, *E. multilocularis* was reported in 15 other wild species (three wolves in France and three wild boars, two beavers and seven coypus in Germany), 10 pigs (Poland and Switzerland) and 16 dogs (Switzerland). Moreover, 26 pigs tested positive for *Echinococcus* spp. (unspecified) in Slovakia, where circulation of both *E. multilocularis* and *E. granulosus s.l.* is known, meaning that the positive samples could potentially be from animals infected with *E. multilocularis*.

**TABLE 48** *Echinococcus multilocularis* positive monitoring results in wild and domestic animals in reporting EU MSs and non-MSs, 2023.

Country	Presence of <i>Em/Eg</i> <sup>a</sup>	N positive/N tested (% positive)		
		Dogs	Foxes	Other wild species <sup>b</sup>
Austria	<i>Em</i>		18/144 (12.5)	
Czechia	<i>Em/Eg</i>		552/2511 (22.0)	
Denmark	<i>Em</i>		6/157 (3.8)	
France	<i>Em/Eg</i>		25/165 (15.2)	3/218 (1.4)
Germany	<i>Em</i>		119/604 (19.7)	12/69 <sup>c</sup> (5.0)
Luxembourg	<i>Em</i>		4/41 (9.8)	
Poland	<i>Em/Eg</i>		212/680 (31.2)	
Slovenia	<i>Em/Eg</i>		33/188 (17.6)	
Sweden	<i>Em/Eg</i>		3/393 (0.76)	
<b>EU total (27+ XI)</b>		<b>0/2619 (0)<sup>d</sup></b>	<b>972/6399 (15.2)<sup>d</sup></b>	<b>15/14,058 (0.11)<sup>d,e</sup></b>
Switzerland	<i>Em</i>	16/38 (42.1)	1/1 (100)	2/7 (28.6)
<b>Total non-EU countries</b>		<b>16/38 (42.1)</b>	<b>1/513 (0.19)<sup>d</sup></b>	<b>2/7 (28.6)</b>
<b>Total EU (27+ XI) + non-EU countries</b>		<b>16/2657 (0.60)<sup>d</sup></b>	<b>973/6912 (14.1)<sup>d</sup></b>	<b>17/14,065 (0.06)<sup>d,e</sup></b>

Abbreviations: *Em*, *Echinococcus multilocularis*; *Eg*, *Echinococcus granulosus sensu lato*.

<sup>a</sup>Presence in the country of *Echinococcus multilocularis* (*Em*) and/or *Echinococcus granulosus sensu lato* (*Eg*).

<sup>b</sup>Includes beavers, coypus, jackals, raccoons, raccoon dogs, wolves and wild boars, with positive observed only among wolves and wild boars, and farmed and zoo animals excluded from the total number of animals tested (i.e. *N* tested).

<sup>c</sup>One positive sample from wild boar, reported without *Echinococcus* species information, was mentioned in the table given the known circulation of *E. multilocularis* in the reporting country.

<sup>d</sup>Total *N* tested includes samples from additional countries not listed in the table, as no positive monitoring results (*N* positive) were reported for those countries. However, their data contribute to the overall total number of animals sampled and tested (*N* tested).

<sup>e</sup>The percentage of positive cases was calculated based on the total number of samples (i.e. *N* tested) from suitable hosts in countries where *E. multilocularis* is known to circulate.

### Monitoring data for *Echinococcus granulosus sensu lato*

Table 49 shows *Echinococcus granulosus s.l.* positive monitoring results in relevant definitive and intermediate hosts in reporting EU MSs and non-MSs in 2023. In 2023, 20 MSs and two non-MSs (Norway and Switzerland) reported monitoring data for *E. granulosus s.l.* The data reported were from approximately 74 million domestic and wild animals tested for *E. granulosus s.l.*, more than 99% of which were domestic animals (sheep, cattle, goats, pigs, horses, water buffalos and dogs). Most of these data were obtained from livestock during meat inspections at the slaughterhouse. Wild animals tested included deer, moose, mouflons, mountain goats, reindeers, wolves and wild boars. A total of 97,327 (0.13%) positive samples were reported by 12 MSs and one non-MS, mainly from domestic animals. These positive samples came primarily from small ruminants (sheep and goats; *N*=76,163), accounting for 78.3% of positive results. Positive tests in small ruminants were mainly reported by Italy and Spain, accounting for 49.0% and 43.4% of positive animals, respectively, followed by Bulgaria, Greece and Slovakia. A total of 18,750 cattle tested positive (19.3% of animals positive for *E. granulosus s.l.*), mainly reported by Spain (65.2%) and Italy (27.3%), followed by Bulgaria and Greece. A total of 2314 pigs tested positive (2.4% of animals positive for *E. granulosus s.l.*), of which Spain reported 75.8%.

During the last 5 years (2019–2023), small ruminants accounted for 77.8% of all positive samples for *E. granulosus s.l.* and were mainly reported by a small number of countries (Italy, Spain, Greece and Bulgaria) with large animal populations. During the same period, cattle and pigs accounted for 15.0% and 7.1% of all positive samples for *E. granulosus s.l.*, respectively, and were mainly reported by a small number of countries (Italy and Spain for cattle; Poland and Spain for pigs).

**TABLE 49** *Echinococcus granulosus sensu lato* positive monitoring results in wild and domestic animals in reporting EU MSs and non-MSs, 2023.

Country	Presence of <i>Em/Eg</i> <sup>a</sup>	<i>N</i> positive / <i>N</i> tested (% positive)								Wild species <sup>b</sup>
		Buffalos	Cattle (bovine animals)	Dogs	Pigs	Goats	Sheep	Sheep and goats	Solipeds, domestic	
Belgium	<i>Em</i>						3/75,479 (<0.01)			
Bulgaria	<i>Eg</i>		1268/36,177 (3.5)		130/1,200,664 (0.01)			4366/157,113 (2.8)		
Cyprus	<i>Eg</i>									2/58 (3.4)
Finland	<i>Eg</i>									5/63,412 (0.01)
France	<i>Em/Eg</i>									3/218 (1.4)
Greece	<i>Eg</i>	8/594 (1.3)	113/39,924 (0.28)		2/219,449 (<0.01)	18/150,646 (0.01)	800/758,781 (0.11)			
Hungary	<i>Eg</i>		2/2 (100)							
Italy	<i>Em/Eg</i>	3/6082 (0.05)	5122/1,882,256 (0.27)	19/238 (8.0)	400/4,202,000 (0.01)	496/62,614 (0.79)	36,817/1,034,031 (3.6)			53/41,508 (0.13)
Portugal	<i>Eg</i>		7/403,247 (<0.01)		2/5,282,049 (<0.01)		8/598,976 (<0.01)			
Romania	<i>Em/Eg</i>		13/26 (50.0)				3/30 (10.0)			
Slovakia	<i>Em/Eg</i>		2/30,620 (0.01)		26/517,310 (0.01) <sup>c</sup>		564/374,039 (0.15)			
Spain	<i>Eg</i>		12,223/2,275,285 (0.54)		1754/38,284,434 (<0.01)	3581/1,130,562 (0.32)	29,507/6,789,618 (0.43)		1/10,391 (0.01)	6/408,650 (<0.01)
<b>EU total (27 + XI)</b>		<b>11/6676 (0.16)</b>	<b>18,750/6,794,791 (0.28)<sup>d</sup></b>	<b>19/2612 (0.73)<sup>d,e</sup></b>	<b>2314/55,162,890 (&lt;0.01)<sup>d,e</sup></b>	<b>4095/1,441,844 (0.28)<sup>d</sup></b>	<b>67,702/9,944,453 (0.68)<sup>d</sup></b>	<b>4366/157,113 (2.8)</b>	<b>1/14,171 (0.01)<sup>d</sup></b>	<b>69/577,605 (0.01)<sup>d,e</sup></b>
Norway	<i>Eg</i>									4/9 (44.4)
<b>Total non-EU countries</b>		<b>0/0 (0)</b>	<b>0/302,000 (0)<sup>d</sup></b>	<b>0/0 (0)</b>	<b>0/1,600,000 (0)<sup>d,e</sup></b>	<b>0/26,000 (0)<sup>d</sup></b>	<b>0/1,100,000 (0)<sup>d</sup></b>	<b>0/0 (0)</b>	<b>0/0 (0)</b>	<b>4/9 (44.4)<sup>e</sup></b>
<b>Total EU (27+ XI) + non-EU countries</b>		<b>11/6676 (0.16)</b>	<b>18,750/7,096,791 (0.26)<sup>d</sup></b>	<b>19/2612 (0.73)<sup>d,e</sup></b>	<b>2314/56,762,890 (&lt;0.01)<sup>d,e</sup></b>	<b>4095/1,467,844 (0.28)<sup>d</sup></b>	<b>67,702/11,044,453 (0.61)<sup>d</sup></b>	<b>4366/157,113 (2.8)</b>	<b>1/14,171 (0.01)<sup>d</sup></b>	<b>73/577,614 (0.01)<sup>d,e</sup></b>

Abbreviations: *Em*, *Echinococcus multilocularis*; *Eg*, *Echinococcus granulosus sensu lato*.

<sup>a</sup>Presence in the country of *E. multilocularis* (*Em*) and/or *E. granulosus sensu lato* (*Eg*).

<sup>b</sup>Includes deer, moose, mouflons, mountain goats, reindeers, wolves and wild boars, with farmed and zoo animals excluded from the total number of animals tested (i.e. *N* tested).

<sup>c</sup>Positive samples with unspecified *Echinococcus* species.

<sup>d</sup>Total *N* tested includes samples from additional countries not listed in the table, as no positive monitoring results (*N* positive) were reported for those countries. However, their data contribute to the overall total number of animals sampled and tested (*N* tested).

<sup>e</sup>The percentage of positive cases was calculated based on the total number of samples (i.e. *N* tested) from suitable hosts in countries where *E. granulosus sensu lato* is known to circulate.

## 8.4 | Discussion

In 2023, the EU notification rate of confirmed human echinococcosis cases increased when compared with previous data reported from 2019 to 2022. This peak, corresponding to the highest number of confirmed human cases ( $N=929$ ) in the last 15 years, may be explained by increased human surveillance activities and improved notification systems for these diseases. For instance, Italy notified cases for the first time in 2023, reporting 15 cases of echinococcosis to the ECDC TESSy database. Increased awareness about the diseases among clinicians, as well as immigration from endemic countries, may also have influenced the numbers of CE and AE diagnosed cases in some non-endemic countries in Northern Europe (Scandinavia) and Western Europe (Casulli et al., 2022; Casulli et al., 2023; Richter et al., 2019). The recent discovery of AE in other countries such as Croatia, Italy and Serbia points to a geographical spread of the parasite (Balen et al., 2023; Lalošević et al., 2023; Tamarozzi et al., 2024). It should be emphasised that the true proportion of positive samples of these diseases is extremely difficult to estimate due to the long incubation period (years), high proportion of asymptomatic or paucisymptomatic carriers who never seek medical attention, non-specific symptoms and under-reported or misdiagnosed CE and AE cases. The factors mentioned above contribute to underestimation of the burden of these diseases (Casulli, 2020). For these reasons, the patchy data reported by MSs on the number of people with echinococcosis currently represent the 'tip of the iceberg' for infections, with asymptomatic carriers and misdiagnosed cases of CE and AE making up the invisible portion. For instance, it has been estimated that the official figures from hospital records should be far higher, with true values 10 and 700 times greater for Bulgaria and Romania in 2015–2016, respectively (Tamarozzi et al., 2018). More recently, a multicentred retrospective study to lower uncertainty limits on the impact of human CE identified around 65,000 human cases in Europe in 1997–2021 (Casulli et al., 2023). Using different data sources, this study also identified a total number of CE cases fourfold greater than ECDC data in 2017–2019 (Casulli et al., 2023).

In 2023, 25 MSs, the United Kingdom (Northern Ireland) and two non-MSs (Norway and Switzerland) reported monitoring data on *E. granulosus s.l.* and *E. multilocularis* in animals. No data were reported by Croatia, Iceland or Lithuania. As for 2022, in 2023 the highest numbers of animals infected with *E. granulosus s.l.* were reported in Italy and Spain, followed by Bulgaria and Greece. Infections were mainly observed in sheep intermediate hosts and, to a lesser extent, in cattle and goats. Regarding *E. multilocularis*, similarly to data reported in 2022, in 2023 most of the infected animals (primarily red foxes) were reported by Czechia, followed by Poland and Germany. The surveillance of *E. multilocularis* in foxes is important for assessing the proportion of positive samples of AE in Europe, given that its geographical distribution seems to have widened in recent decades. It is difficult to establish whether the increased geographical distribution of *E. multilocularis* is due to a growing fox population in Europe (Deplazes et al., 2004) or whether it reflects greater surveillance efforts, as there is a general lack of baseline data and standardised detection methods. One growing concern is the detection in recent years of *E. multilocularis* in golden jackals, which are extending their geographical range from southeastern to northwestern Europe, and therefore contributing to the dispersion of this parasite over long distances (Balog et al., 2021; Dušek et al., 2020). In this context, *E. multilocularis* was detected for the first time in Serbia (in golden jackals and foxes) and in Bosnia and Herzegovina (in foxes) (Marinković et al., 2022; Miljević et al., 2021; Omeragić et al., 2022).

Moreover, in animals, notification is necessary to obtain reliable data, and information on parasite speciation is essential to risk management efforts, since *E. granulosus s.l.* and *E. multilocularis* have different epidemiologies and pose different health risks for humans (Conraths et al., 2017; Possenti et al., 2016). For *E. granulosus s.l.*, requiring notification would ensure that comparable data between MSs are obtained from meat inspections of food-producing animals. For *E. multilocularis*, while the need for general notification by all MSs may raise questions, it is nevertheless required in countries free from this parasite, per CDR (EU) 2018/772.

## FOOD-BORNE OUTBREAKS (IN ACCORDANCE WITH DIRECTIVE 2003/99/EC)

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#).

For additional information about food-borne outbreaks and for the consultation of data collected, the following interactive tools are available:



### 1 | KEY FACTS

- In 2023, 27 European Union Member States and the United Kingdom (Northern Ireland) reported 5691 food-borne outbreaks, 52,127 human cases, 2894 hospitalisations and 65 deaths. The number of deaths in 2023 was similar to that reported in 2022 (one more death in 2023) and was the highest value reported in the last 10 years. A total of 100 food-borne outbreaks, 1158 cases of illness, 125 hospitalisations and eight deaths were reported by seven non-Member States.
- Food-borne outbreaks in the European Union decreased slightly by 1.2% in 2023 compared with the previous year (5763 in 2022). Conversely, the number of human cases and hospitalisations increased, by 7.2% (48,605 cases in 2022) and 4.0% (2783 hospitalisations in 2022), respectively. The number of deaths also increased in 2023, by 1.6% (64 deaths in 2022).
- The food-borne outbreak reporting rate was 1.3 per 100,000 population, an increase of 26.2% compared with the mean annual rate for the period 2019–2022 (1.0 per 100,000 population). The case reporting rate rose to 11.6 cases per 100,000 population, an increase of 41.8% compared with the mean annual rate for the 2019–2022 period (8.2 per 100,000 population).
- *Salmonella* was identified in the most food-borne outbreaks with known causative agents ( $N=1115$ ) and it was associated with the highest number of human cases ( $N=9210$ ), hospitalisations ( $N=1726$ ) and deaths ( $N=16$ ). *S. Enteritidis* was the most frequently reported serovar (542 food-borne outbreaks; 81.5% of *Salmonella* outbreaks with serovar information available). *Salmonella* was also the causative agent associated with the most multi-country food-borne outbreaks reported in the European Union in 2023 (17 food-borne outbreaks; 81.0% of the total for multi-country food-borne outbreaks).
- *Listeria monocytogenes* caused 11 deaths, which is a high number since this agent caused only a small number of food-borne outbreaks ( $N=19$ ), confirming its high health impact in terms of case fatality rate (8.3% of cases) and proportion of hospitalisations (63.2% of cases).
- The proportion of food-borne outbreaks of unknown aetiology accounted for 48.4% of total reported food-borne outbreaks and was the highest value reported since 2014. The Netherlands, France and Belgium contributed most to this reporting.
- A total of 51 very large food-borne outbreaks ( $\geq 100$  cases each) were reported. They were mainly caused by *Salmonella*, norovirus and other calicivirus, and bacterial toxins (i.e. *Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus* toxins), followed by *Cryptosporidium*, enteroinvasive *E. coli* (EIEC), *Campylobacter*, enterotoxigenic *E. coli* (ETEC), atropine and histamine.
- A total of 578 strong-evidence outbreaks were reported in 2023 (10.2% of all food-borne outbreaks), causing 11,160 human cases, 944 hospitalisations and 18 deaths.
- Foodstuffs belonging to the group 'composite foods, multi-ingredient foods and other foods' were implicated in most of these food-borne outbreaks (179 strong-evidence food-borne outbreaks; 31.0% of strong-evidence food-borne outbreaks) with an increase of 26.1% over 2022 (142 strong-evidence outbreaks in 2022), causing most cases (30.5% of cases in strong-evidence outbreaks) and hospitalisations (35.8% of hospitalisations in strong-evidence food-borne outbreaks). Foods of animal origin had a major impact. 'Eggs and egg products' was the second most frequently reported food vehicle group in strong-evidence food-borne outbreaks. The numbers of strong-evidence food-borne outbreaks ( $N=95$ ) and hospitalisations ( $N=125$ ) associated with the consumption of these products were rather stable in 2023, but cases ( $N=1223$ ) increased by 33.1% (304 more cases than in 2022). 'Broiler meat (*G. gallus*) and products thereof' and 'fish and fish products' caused 52 and 43 strong-evidence outbreaks, respectively, and ranked third and fourth as implicated foods in strong-evidence food-borne outbreaks. Consumption of 'fish and fish products' was associated with the highest number of deaths among cases in strong-evidence outbreaks (seven deaths).
- Most strong-evidence food-borne outbreaks took place on domestic premises (196 outbreaks; 33.9% of all strong-evidence outbreaks). However, approximately one in four cases and one in four hospitalisations were associated with consumption of food in a 'restaurant or cafe or pub or bar or hotel or catering service' (2608 cases; 23.4% of all strong-evidence outbreak-related cases and 270 hospitalisations; 28.6% of all hospitalisations in strong-evidence outbreaks). In the latter setting, strong-evidence outbreaks increased by 35.1% (134 strong-evidence outbreaks in 2022), with cases

increasing by 47.8% (1764 cases in strong-evidence outbreaks in 2022) and hospitalisations by 101.5% (134 hospitalisations in strong-evidence outbreaks in 2022).

- ‘Infected food handler’ ranked first among the contributory factors for outbreaks taking place in a ‘restaurant, pub, street vendors, take away, etc.’ (24 outbreaks, 28.6% of all strong-evidence outbreaks with information on risk factors available). The most frequent factor contributing to strong-evidence outbreaks occurring in ‘domestic premises’ was ‘inadequate heat treatment’ (24 outbreaks, 61.5% of all strong-evidence outbreaks with information on risk factors available).

## 2 | SURVEILLANCE AND MONITORING OF FOOD-BORNE OUTBREAKS IN THE EU

Every year, EU Member States (MSs) and non-MSs report to EFSA concerning the food-borne outbreaks (FBOs) occurring in their country, in compliance with Directive 2003/99/EC. The reporting of FBO data is mandatory for EU MSs and based on the standard set out in the guidance document, published annually by EFSA (EFSA, 2024a, 2024b). The key findings are summarised in this report.

EFSA is assigned the task of describing the causative agents and foodstuffs implicated in FBOs, the place of exposure and contributing factors, along with their time trends. The aim is to assess the health impact of FBOs in Europe and to characterise the food vehicles most frequently implicated. Outbreaks are categorised as ‘strong evidence’ or ‘weak evidence’ based on the strength of evidence implicating a suspected food vehicle as the cause of the outbreak (EFSA, 2014). The analysis takes account of uncertainty around the evidence implicating a given food as the vehicle of the outbreak, by limiting the description of certain findings (i.e. implicated food vehicles, place of exposure and contributory factors) to strong-evidence outbreaks.

The current data reporting system is known as the European Union Foodborne Outbreak Reporting System (EU-FORS) (EFSA, 2014). It applies to FBOs caused by bacteria, viruses, parasites, fungi and their products, such as toxins and biological amines (e.g. histamine), whether typical food-borne agents or agents for which food-borne transmission is usually accidental. Outbreaks caused by the ingestion of drinking water are also considered in FBO reporting, since drinking water is defined as a food in Regulation (EC) No 178/2002.<sup>44</sup>

A description of the national systems in place for FBO surveillance and reporting can be found in the national zoonoses reports submitted in accordance with Directive 2003/99/EC and published on the EFSA website, together with the EU One Health Zoonoses Report, both available online [here](#).

Information on the surveillance and monitoring of food-borne outbreaks in the EU is also summarised in the EFSA story map ([here](#) see story map sections on ‘What food-borne outbreaks are and how they are classified’, ‘Who investigates food-borne outbreaks’ and ‘EU regulatory framework and the role of EFSA’).

## 3 | DATA ANALYSES

Key statistics on FBOs described in this chapter refer to the EU level for 2023, unless specified otherwise. Basic indicators used to describe the impact of FBOs on human health include the total number of outbreaks, cases, the number and proportion of cases (%) leading to hospitalisations or deaths, the mean outbreak size ( $N$  cases per outbreak) and its range (minimum and maximum). Outbreak size was categorised as very small ( $< 10$  cases), small ( $\geq 10$  and  $< 25$  cases), medium ( $\geq 25$  and  $< 50$  cases), large ( $\geq 50$  and  $< 100$  cases) and very large ( $100 \geq$  cases). Outbreak and case reporting rates (per 100,000 population) are used as relative measures of occurrence in the population, allowing a direct comparison among MSs, independently of the size of the population and its variation over time. However, due to the lack of full harmonisation of FBO surveillance among MSs, any direct comparison of findings between countries should be interpreted with caution. Counts of hospitalisations and deaths and the proportion (%) of hospitalisations and deaths among outbreak cases are used as indicators for outbreak severity. However, since the total number of hospitalisations and deaths can be reported as ‘unknown’ by MSs, these values might be underestimated and should be interpreted with caution.

The causative agents in FBOs in 2023 have been grouped in accordance with the following criteria (see also Section 1 of the FBO addendum for further details on the EFSA Knowledge Junction at Zenodo [here](#)):

- ‘*E. coli* other than STEC’ includes any pathogenic *Escherichia coli* other than ‘Shiga Toxin-producing *E. coli* (STEC)’. In 2023, this group included ‘enteroaggregative *E. coli* (EAEC)’, ‘enteroinvasive *E. coli* (EIEC)’, ‘enteropathogenic *E. coli* (EPEC)’, ‘enterotoxigenic *E. coli* (ETEC)’ and ‘*E. coli*, unspecified’.
- ‘*Bacillus cereus* toxins’ includes ‘*B. cereus*’ and ‘*B. cereus* enterotoxins’.
- ‘*Staphylococcus aureus* toxins’ includes ‘*S. aureus*’, ‘*Staphylococcus*, unspecified’ and ‘staphylococcal enterotoxins’.
- ‘Norovirus (and other calicivirus)’ includes ‘calicivirus, unspecified’, ‘norovirus’ (Norwalk-like virus) and ‘sapovirus’ (Sapporo-like virus).

<sup>44</sup>Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.

Food vehicles have been grouped according to the general criteria (see section 2 of the FBO addendum for further details on the EFSA Knowledge Junction at Zenodo [here](#)) set out in the EFSA data catalogues (EFSA, 2024d). Places of exposure have been grouped according to the general characteristics and level of risk associated with the setting, as well as the process behind food preparation (see section 3 of the FBO addendum for further details on the EFSA Knowledge Junction at Zenodo [here](#)).

Eurostat data on the resident population (on 1 January 2024) were used to calculate reporting rates at national and EU level. Data from the NISRA<sup>45</sup> from 2021 were used for the United Kingdom (Northern Ireland).

Short-term variations over time were described using the same metrics (annual mean) by comparison with 2022 and 2019–2022. Long-term variations were also described, taking 2014–2023 as the reference time period. Frequency distributions are shown at EU level. Trends were analysed only at MS level, according to the rationale described in Boelaert et al. (2016) for data quality. Time trends were tested for statistical significance over the period 2014–2023 using the Cox-Stuart sign test, a non-parametric test appropriate for limited numbers of observations. A *p*-value of < 0.05 was considered to identify a statistically significant trend, beyond chance. Significant long-term trends 2014–2023 may not fully reflect short-term trend fluctuations. The detection of significant trends at national level should be interpreted with caution, following changes in the reporting specifications for FBOs, introduced in 2014 (EFSA, 2014).

Key statistics on FBOs for 2022 and previous years may differ from those published in the European Union One Health 2022 Zoonoses Report, as MSs may have updated their historical data.

## 4 | RESULTS AND DISCUSSION

### 4.1 | Overview of countries reporting food-borne outbreak data, in 2023

In 2023, 27 MSs and the United Kingdom (Northern Ireland) reported a total of 5691 food-borne outbreaks (FBOs), with 52,127 human cases, 2894 hospitalisations and 65 deaths. Luxembourg reported no FBOs occurring in 2023.<sup>46</sup> In addition, seven non-MSs reported 100 FBOs, 1158 cases, 125 hospitalisations and 8 deaths (Table 50).

The number of FBOs and cases reported by each MS varied considerably across countries. Most outbreaks (4694 outbreaks; 82.5%) and cases (39,185 cases; 75.2%) were limited to a few countries (Belgium, France, Netherlands, Poland and Spain). France was the main contributor, accounting for 35.8% of all FBOs and 38% of all cases reported in 2023, which is consistent with observations from previous years. Most hospitalisations (2140 hospitalisations; 73.9%) and deaths (55 deaths; 84.6%) were also reported by five MSs (France, Germany, Italy, Poland and Spain) only. The outbreak reporting rates and case reporting rates (Table 50), show how frequently FBOs and cases were reported, regardless of the country population size. In 2023, there was an increase of 26.2% in the outbreak reporting rate and of 41.8% in the case reporting rate compared with the respective mean annual rates for the 2019–2022 period. There was enormous variation in these values among MSs. The 'outbreak reporting rate' ranged from 0.03 (Bulgaria) to 6.1 (Belgium), while the 'case reporting rate' ranged from 0.06 (Bulgaria) to 29.7 (Denmark). Considerable variations among MSs were also observed in the 'mean outbreak size' (Table 50). All these indicators provide evidence on the considerable variability in the sensitivity of the surveillance and the types of FBOs monitored across MSs.

Although the number of FBOs reported by MSs and the United Kingdom (Northern Ireland) decreased slightly in 2023 (72 fewer FBOs 1.2% decrease, compared with 2022), a 7.2% increase in the number of human cases was observed (3522 more cases than in 2022), while the overall health impact of FBOs in the EU did not change substantially. A total of 111 more hospitalisations (4.0% increase) and one more death were reported than in 2022. The number of deaths was the highest reported to EFSA since 2014.

At the country level, the relative variation in the number of FBOs and the outbreak-related cases reported in 2023 compared with 2022, are shown in Figure 19 (left panel and right panel, respectively). An increase in the number of FBOs was observed for 16 MSs and the United Kingdom (Northern Ireland), while for nine MSs (Belgium, Czechia, Finland, Germany, Italy, Luxembourg, Netherlands, Slovenia and Sweden) the number of FBOs decreased. For Cyprus and Malta, the number of FBOs reported in 2023 was stable. A similar pattern was observed for outbreak-related cases, with 15 MSs reporting more cases in 2023 and 11 MSs fewer cases.

Information on the type of outbreak was reported for 3866 FBOs (67.9%). All MSs except Bulgaria and the United Kingdom (Northern Ireland), reported 'general' outbreaks (2560 FBOs). For five MSs (Cyprus, Finland, Hungary, Portugal and Slovenia) and the United Kingdom (Northern Ireland), this was the only type of outbreak reported. 'General' outbreaks involve human cases from more than one household, while 'household' outbreaks, which are usually smaller, are outbreaks where all cases live in a single household. Eighteen MSs provided information on household outbreaks (1283 FBOs), and this was the most frequently reported type of outbreak for nine MSs (Austria, Croatia, Estonia, Greece, Ireland, Italy, Lithuania, Malta and Poland). No 'household' outbreaks were reported by Bulgaria, Cyprus, Denmark, Finland, Germany, Hungary, Portugal, Slovenia and the United Kingdom (Northern Ireland). In general, MSs with the highest 'mean outbreak size' were those that reported predominantly or exclusively 'general' outbreaks. A similar pattern on the type of outbreak

<sup>45</sup>Northern Ireland Statistics and Research Agency (NISRA) <https://www.nisra.gov.uk/>.

<sup>46</sup>Since Luxembourg reported no outbreaks in 2023, it will not be mentioned again in this chapter.

was observed in non-MSs, with most outbreaks (57 FBOs) reported as 'general outbreaks' by all non-MSs reporting data to EFSA in 2023, followed by 'household outbreaks' (22 FBOs).

Five MSs (Austria, Belgium, Denmark, France, Italy and Sweden) reported 21 general FBOs as part of multi-country outbreaks in 2023, resulting in 275 cases, 39 hospitalisations and 2 deaths. Three FBOs were reported by Norway as part of a multi-country outbreak. Among MSs, the number of reported FBOs, cases and hospitalisations linked to multi-country outbreaks decreased by 32.3% (10 fewer FBOs than 2022), 66.0% (533 fewer human cases than 2022) and 68.8% (86 fewer hospitalisations than 2022), respectively, compared with 2022. Most multi-country FBOs were caused by *Salmonella* (17 FBOs), followed by *Listeria monocytogenes* (two FBOs), *Bacillus cereus* toxins and *Cryptosporidium* (one FBO each). Rapid information exchange systems, such as the Early Warning Response System (EWRS), EpiPulse and the Rapid Alert System for Food and Feed (RASFF), play a crucial role in real-time alert dissemination across European countries, significantly supporting the investigation of multi-country FBOs.

In 2023, MSs and non-MSs reported a total of 51 and two very large FBOs ( $\geq 100$  cases each), respectively. Overall, the numbers of cases included in these outbreaks were 9898 and 330, respectively.

For a more interactive look at FBO data by reporting countries, visit the dedicated page in the EFSA's dashboard on FBO ([here](#)).



**TABLE 50** Number of food-borne outbreaks, human cases, hospitalisations and deaths, in reporting EU MSs and non-MS countries, 2023.

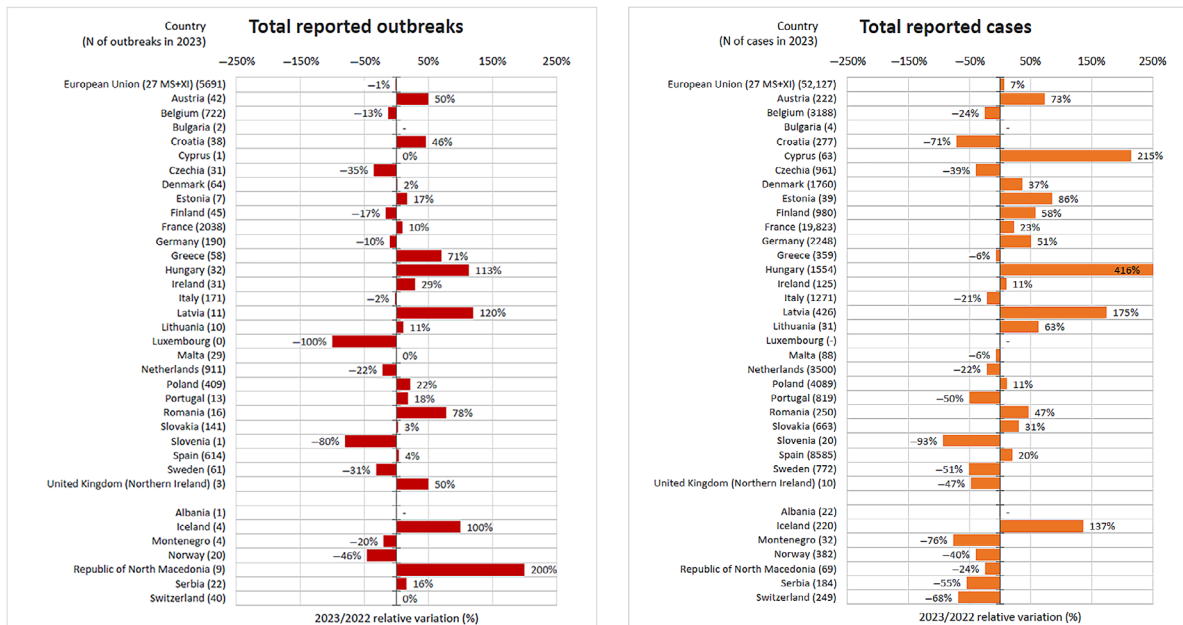
Country	Outbreaks				Cases					Hospitalised		Deaths	
	Total (strong-evidence) N	% of total	Outbreaks per 100,000		N	% of total	Mean outbreak size (N) and range (min-max)	Cases per 100,000		N	% of total	N	% of total
			2023	2019–2022				2023	2019–2022				
Austria	42 (12)	0.74	0.46	0.33	222	0.43	5.3 (1–32)	2.4	3.1	38	1.3	1	1.5
Belgium	722 (6)	12.7	6.1	4.9	3188	6.1	4.4 (2–124)	27.1	21.7	76	2.6	1	1.5
Bulgaria	2 (2)	0.04	0.03	0.08	4	0.01	2.0 (1–3)	0.06	1.1	3	0.10	0	0
Croatia	38 (3)	0.67	0.99	0.59	277	0.53	7.3 (2–41)	7.2	10.3	19	0.66	1	1.5
Cyprus	1 (0)	0.02	0.11	0.11	63	0.12	63.0 (–)	6.8	1.6	5	0.17	0	0
Czechia	31 (9)	0.54	0.29	0.32	961	1.8	31.0 (5–141)	8.9	12.5	52	1.80	2	3.1
Denmark	64 (18)	1.1	1.1	0.91	1760	3.4	27.5 (2–323)	29.7	25.5	47	1.62	0	0
Estonia	7 (2)	0.12	0.51	0.77	39	0.07	5.6 (2–15)	2.9	2.3	11	0.38	0	0
Finland	45 (20)	0.79	0.81	0.87	980	1.9	21.8 (2–150)	17.6	16.1	3	0.10	0	0
France	2038 (74)	35.8	3.0	2.2	19,823	38.0	9.7 (2–740)	29.1	18.3	528	18.2	23	35.4
Germany	190 (18)	3.3	0.23	0.29	2248	4.3	11.8 (2–538)	2.7	1.7	283	9.8	13	20.0
Greece	58 (2)	1.0	0.56	0.12	359	0.69	6.2 (2–69)	3.4	3.4	81	2.8	1	1.5
Hungary	32 (12)	0.56	0.33	0.21	1554	3.0	48.6 (2–300)	16.2	8.1	88	3.0	0	0
Ireland	31 (0)	0.54	0.59	0.39	125	0.24	4.0 (2–13)	2.4	2.1	8	0.28	0	0
Italy	171 (41)	3.0	0.29	0.20	1271	2.4	7.4 (2–107)	2.2	2.0	349	12.1	3	4.6
Latvia	11 (0)	0.19	0.58	0.88	426	0.82	38.7 (5–61.2)	22.6	16.9	15	0.52	0	0
Lithuania	10 (10)	0.18	0.35	0.68	31	0.06	3.1 (2–8)	1.1	4.1	25	0.86	0	0
Luxembourg	0 (0)	0	0	0.16	–	–	–	0	2.6	–	–	–	–
Malta	29 (1)	0.51	5.4	6.1	88	0.17	3.0 (2–156)	16.2	25.2	8	0.28	0	0
Netherlands	911 (3)	16.0	5.1	4.7	3500	6.7	3.8 (2–184)	19.7	18.5	13	0.45	1	1.5
Poland	409 (89)	7.2	1.1	0.81	4089	7.8	10.0 (8–209)	11.1	9.2	669	23.1	7	10.8
Portugal	13 (6)	0.23	0.12	0.11	819	1.6	63.0 (3–40)	7.8	6.3	0	0	0	0
Romania	16 (14)	0.28	0.08	0.03	250	0.48	15.6 (2–69)	1.3	0.66	97	3.4	3	4.6
Slovakia	141 (21)	2.5	2.6	6.0	663	1.3	4.7 (20–20)	12.2	19.7	157	5.4	0	0
Slovenia	1 (1)	0.02	0.05	0.08	20	0.04	20.0 (2–580)	0.94	4.5	2	0.07	0	0
Spain	614 (201)	10.8	1.3	0.78	8585	16.5	14.0 (2–154)	17.9	8.8	311	10.7	9	13.8
Sweden	61 (12)	1.1	0.58	0.61	772	1.5	12.7 (2–5)	7.3	11.5	3	0.10	0	0
United Kingdom (Northern Ireland)	3 (1)	0.05	0.16	0.10	10	0.02	3.3 (–)	0.52	0.94	3	0.10	0	0
<b>EU Total (27 + XI)</b>	<b>5691 (578)</b>	<b>100</b>	<b>1.3</b>	<b>1.0</b>	<b>52,127</b>	<b>100</b>	<b>9.2 (1–740)</b>	<b>11.6</b>	<b>8.2</b>	<b>2894</b>	<b>100</b>	<b>65</b>	<b>100</b>

(Continues)

**TABLE 50** (Continued)

Country	Outbreaks				Cases					Hospitalised		Deaths	
	Total (strong-evidence) N	% of total	Outbreaks per 100,000		N	% of total	Mean outbreak size (N) and range (min-max)	Cases per 100,000		N	% of total	N	% of total
			2023	2019–2022				2023	2019–2022				
Albania	1 (0)	–	0.04	0	22	–	–	0.80	0	3	–	0	–
Iceland	4 (0)	–	1.0	0.82	220	–	55.0 (3–19)	56.7	15.8	5	–	1	–
Montenegro	4 (0)	–	0.65	0.64	32	–	8.0 (2–140)	5.2	11.7	3	–	0	–
Norway	20 (13)	–	0.36	0.61	382	–	19.1 (3–15)	7.0	19.4	4	–	0	–
Republic of North Macedonia	9 (3)	–	0.49	0.15	69	–	7.7 (2–19)	3.8	4.6	16	–	0	–
Serbia	22 (18)	–	0.33	0.25	184	–	8.4 (2–26)	2.8	3.7	59	–	1	–
Switzerland <sup>a</sup>	40 (2)	–	0.45	0.33	249	–	6.6 (–)	2.8	5.3	35	–	6	–

<sup>a</sup>For two outbreaks, information on cases was not available. These outbreaks were excluded from the calculation of the mean outbreak size.

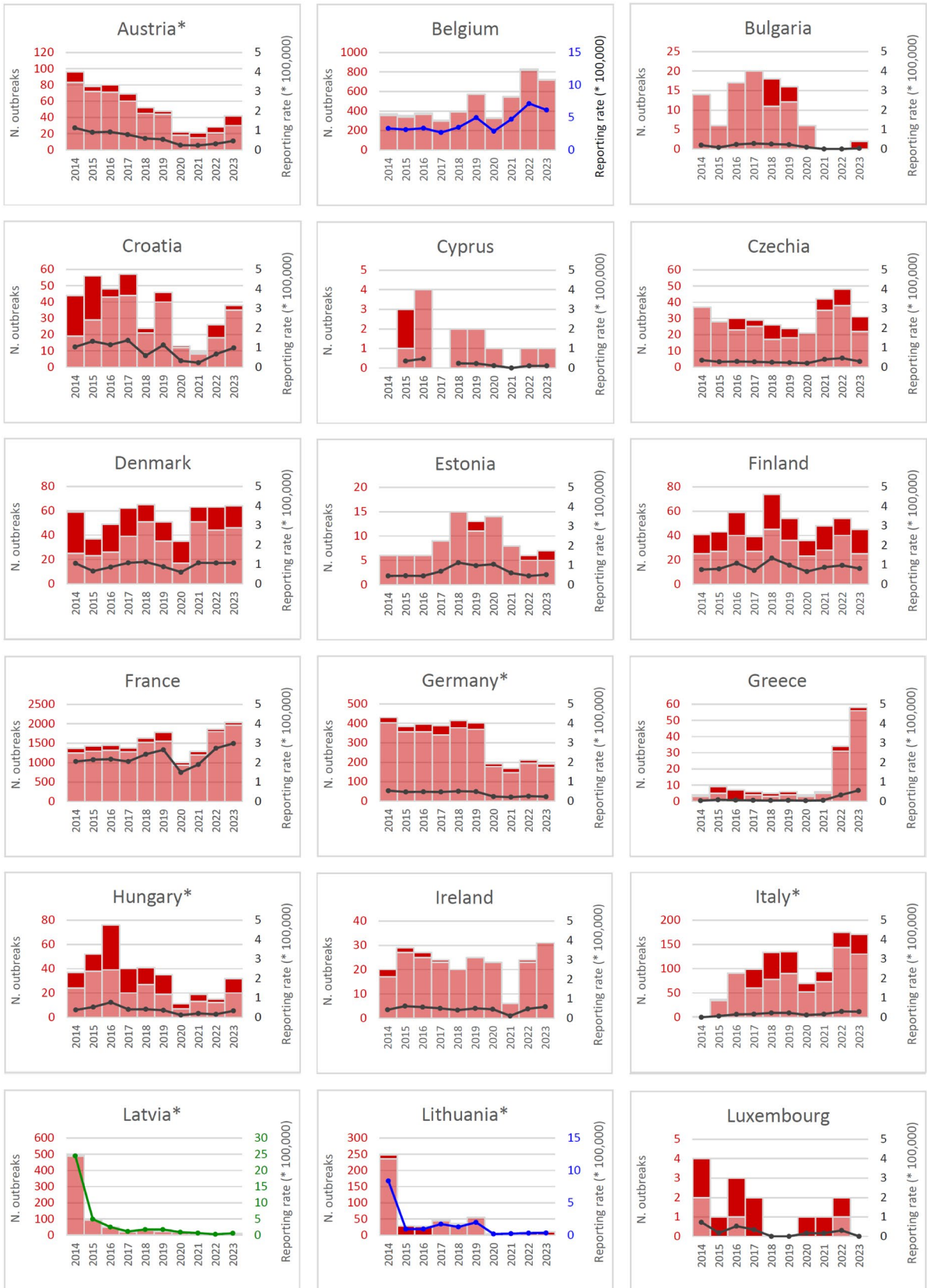


**FIGURE 19** Relative variation (%) in food-borne outbreaks and outbreak-related cases reported in 2023 compared with 2022, by reporting country.

A total of 578 strong-evidence FBOs were identified by 23 MSs (all MSs except Cyprus, Ireland and Latvia) and the United Kingdom (Northern Ireland). This reporting accounted for 10.2% of all FBOs. In 2022, strong-evidence outbreaks accounted for 8.4%. Most strong-evidence FBOs were reported by four MSs (France, Italy, Poland and Spain), which alone accounted for 70.1% of the reporting (405 strong-evidence FBOs).

For the period 2014–2023, the country-level distribution of FBOs by strength of evidence and the outbreak reporting rate (per 100,000 population) in the EU MSs and non-MSs is presented in [Figure 20](#). Overall, the number of FBOs observed over the last 10 years has decreased significantly for seven MSs (Austria, Germany, Hungary, Latvia, Lithuania, Romania and Sweden), and increased for two MSs (Italy and Netherlands) and Switzerland. These trends should be interpreted with caution since annual variations may be influenced by changes in the FBO surveillance of MSs, including changes in the procedures for outbreak detection and investigation.

In 2023, there were 20 FBOs involving travel-associated cases, which is the highest value ever reported to EFSA. These FBOs involved 96 cases, 19 hospitalisations but no deaths.





**FIGURE 20** Trends in the number of strong-evidence and weak-evidence outbreaks (left axis) and outbreak reporting rate (per 100,000 population) (right axis) in the EU and reporting EU MSs and non-MSs, 2014–2023. \*Indicates countries with a statistically significant trend ( $p < 0.05$ ) over the period. Dark red and light red show strong- and weak-evidence outbreaks, respectively. Black dots and lines show FBO reporting rates. The dots, lines and secondary Y-axis in blue or green showing the outbreak reporting rates have been used for Belgium, Latvia, Lithuania, Malta, Netherlands and Slovakia, in order to draw attention to a scale that is different to that of the other countries.

## 4.2 | Overview of causative agents in food-borne outbreaks in 2023

In 2023, a causative agent was identified in 2934 FBOs (51.6% of all FBOs reported in the EU). These outbreaks were responsible for 32,273 cases, 2491 hospitalisations and 43 deaths. [Table 51](#) provides a detailed overview of the causative agents responsible for FBOs in the EU in 2023.

The proportion of FBOs of unknown aetiology (48.4%) was the highest reported by MSs since 2014. The Netherlands (880 FBOs), France (759 FBOs) and Belgium (661 FBOs) contributed most to the reporting of FBOs of unknown aetiology (2300 FBOs; 83.4%).

Sixty-two FBOs with known causative agent (62.0%) and thirty-eight with unknown aetiology (38.0%) were also reported by seven and five non-MSs, respectively. FBOs with unknown causative agents were mostly reported by Switzerland (28 outbreaks).

Among outbreaks with known causative agents, bacteria were reported to have caused most FBOs, followed by bacterial toxins, viruses, 'other' causative agents and parasites. The same ranking was observed for number of cases, hospitalisations and deaths (no deaths were caused by parasites or 'other' causative agents). Among the causative agents, *Salmonella* was responsible for the highest number of FBOs, cases, hospitalisations and deaths. *Listeria monocytogenes* had the most severe health impact in relative terms, i.e. proportion of hospitalisations and case fatality rate, together with *Clostridium botulinum* toxins ([Table 51](#)).

The range of causative agents reported in FBOs by MSs and non-MSs was very variable in 2023. This finding likely reflects the differences in the monitoring of FBOs across European countries. A high number of causative agents (more than 10) was reported by six MSs (Belgium, France, Germany, Italy, Poland and Spain) while eight MSs (Bulgaria, Czechia, Estonia, Greece, Hungary, Latvia, Lithuania and Slovenia) and the United Kingdom (Northern Ireland) reported three or less causative agents.

Among travel-related outbreaks, *Salmonella* was the most frequently reported causative agent (11 FBOs), followed by *Campylobacter* (seven FBOs), hepatitis A virus and toxigenic *Vibrio cholerae* (one outbreak each).

In the very large outbreaks ( $\geq 100$  cases, each) reported by MSs in 2023, *Salmonella* and norovirus (and other calicivirus) (eight FBOs each) prevailed followed by bacterial toxins (i.e. *Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus* toxins) (nine FBOs), *Cryptosporidium* (two FBOs), enteroinvasive *E. coli* (EIEC) (two FBOs) and atropine, *Campylobacter*, enterotoxigenic *E. coli* (ETEC) and histamine (one FBO each). For 16 very large FBOs the causative agent was unknown. In non-MSs, one very large FBO was associated with norovirus and one with unknown aetiology.

For a more interactive look at FBO data by causative agents, visit the dedicated page in the EFSA's dashboard on FBO ([here](#)).

### 4.2.1 | Bacteria

All MSs, except Bulgaria, Cyprus and the United Kingdom (Northern Ireland), and all non-MSs reported FBOs caused by bacteria. Key statistics on FBOs associated with this agent group are available in [Table 51](#).

#### **Salmonella**

In 2023, FBOs caused by *Salmonella* (1115 FBOs) were reported by most MSs (all except Bulgaria, Cyprus and Portugal) and the United Kingdom (Northern Ireland) as well as by seven non-MSs (26 FBOs). Details on FBOs caused by *Salmonella* are shown in [Table 51](#).

Most FBOs associated with this causative agent were reported by four MSs, i.e. Poland (269 FBOs), Spain (252 FBOs), France (143 FBOs) and Slovakia (120 FBOs), accounting altogether for 70.3% of all *Salmonella* outbreaks in the EU. In 14 MSs (Austria, Croatia, Czechia, Denmark, Estonia, Germany, Greece, Italy, Latvia, Lithuania, Poland, Slovakia, Slovenia and Spain) and 3 non-MSs (Albania, Montenegro and Serbia), *Salmonella* was the leading cause of FBOs.

FBOs caused by *Salmonella* increased moderately, with 101 more FBOs than 2022 (a 10.0% relative increase). The number of *Salmonella* FBOs remained fairly consistent with what has been observed in the last 10 years, excluding the COVID-19 pandemic period (i.e. 2020–2021). Conversely, compared with 2022, cases, hospitalisations and deaths involved in *Salmonella* outbreaks increased sharply in 2023 with 2578 more cases (a 38.9% increase), 320 more hospitalisations (a 22.8% increase) and 8 more deaths (a 100% increase). This increasing pattern was mainly due to the reporting of more FBOs due to **S. Enteritidis**, as described below.

Information on the serovar was available for 59.6% of the FBOs caused by *Salmonella* in the EU (665 FBOs). *S. Enteritidis* was the most frequently reported serovar (542 FBOs; 81.5% of *Salmonella* FBOs with known serovar), followed by **S. Typhimurium** (50 FBOs) and **monophasic S. Typhimurium** (20 FBOs).

The number of FBOs caused by *S. Enteritidis* increased compared with 2022, by 37.2% (147 more FBOs than 2022). At country level, there was a similar increase in most MSs (see section 4 of the FBO addendum for further details on the EFSA Knowledge Junction at Zenodo [here](#)). The health impact of this serovar was high in the EU. *S. Enteritidis* caused 5323 cases (2877 more cases than in 2022; a 117.6% increase), 1040 hospitalisations (471 more hospitalisations; an 82.8% increase) and 9 deaths (six more deaths; a 200.0% increase). The increase was attributed to the reporting of more FBOs linked to 'broiler meat (*Gallus gallus*) and products thereof' and 'mixed foods' as the implicated or suspected food vehicle. *S. Enteritidis* was responsible for a multi-country outbreak in 2023, probably associated with the consumption of 'chicken meat' and 'chicken meat products'. Five MSs (Austria, Denmark, France, Italy and Sweden) reported data on this multi-country outbreak to EFSA as separate individual outbreaks.

Compared with 2022, the number of FBOs caused by *S. Typhimurium* and monophasic *S. Typhimurium* decreased in 2023, by 12.3% (seven fewer FBOs) and 4.8% (one fewer FBO), respectively. Fewer cases than in 2022 resulted also from FBOs caused by either *S. Typhimurium* (189 fewer cases; a 37.1% decrease) or monophasic *S. Typhimurium* (132 fewer cases; a 41.6% decrease). There was also a reduction in the number of hospitalisations (nine fewer hospitalisations for *S. Typhimurium*; an 8.7% decrease and 76 fewer hospitalisations for monophasic *S. Typhimurium*; a 64.4% decrease).

Among non-typhoidal *Salmonella*, the other serovars identified in FBOs in 2023 accounted overall for 7.8% (52 FBOs) of the total number of *Salmonella* outbreaks with known serovars. They included **S. Adelaide, S. Agama, S. Ajiobo, S. Anatum, S. Bareilly, S. Brandenburg, S. Bredeney, S. Chester, S. Coeln, S. Derby, S. Give, S. Infantis, S. Kentucky, S. London, S. Mbandaka, S. Mikawasima, S. Montevideo, S. Muenchen, S. Newport, S. Oranienburg, S. Panama, S. Rissen, S. Saintpaul, S. Senftenberg, S. Stanley, S. Stanleyville, S. Strathcona, S. Thompson** and **S. Virchow**. *S. Montevideo, S. Strathcona* and *S. Senftenberg* were reported by MSs as causative agents associated with four multi-country outbreaks.

Five weak-evidence outbreaks associated with paratyphoid *Salmonella* were reported by three MSs (Belgium, Slovakia and Croatia) in 2023, causing 23 cases and two hospitalisations. Four outbreaks were caused by **S. Paratyphi B** and in one FBO the variant Java was reported. For two FBOs, both weak-evidence FBOs, the suspected food vehicles were 'broiler meat and products thereof' and 'mixed foods'. For one outbreak only **S. Paratyphi** was reported, without specification of the serovar. The suspected food vehicle was 'Pig meat and products thereof'.

### **Campylobacter**

**Campylobacter** ranked second in 2023 among bacterial causative agents and fourth among all known causative agents in the EU. Compared with 2022, in 2023 the number of FBOs caused by *Campylobacter* (229 FBOs) decreased by 10.2% (26 fewer FBOs) while the number of cases and hospitalisations remained fairly stable, with 77 more cases and seven more hospitalisations than 2022.

Sixteen MSs (Austria, Belgium, Croatia, Denmark, Estonia, France, Germany, Greece, Italy, Lithuania, Malta, Netherlands, Poland, Slovakia, Spain and Sweden) and two non-MSs (Norway and Switzerland) reported FBOs caused by *Campylobacter*. France, Germany and Spain alone accounted for 58.5% of total reporting in the EU. In Malta, *Campylobacter* was the main causative agent of FBOs.

In most FBOs, the *Campylobacter* species involved was unknown (161 FBOs; 70.3% of FBOs caused by *Campylobacter*). Among the FBOs with known species, **C. jejuni** and **C. coli** were identified in 63 and five outbreaks, respectively. No hospitalisations and deaths were reported.

### **Shiga toxin-producing E. coli (STEC)**

In 2023, **Shiga toxin-producing E. coli (STEC)** was reported as the causative agent of 66 FBOs in the EU, a decrease of 7.0% compared with 2022 (five fewer outbreaks). The number of cases and hospitalisations decreased by 33.8% (138 fewer cases than 2022) and 23.8% (15 fewer hospitalisations). The number of deaths remained stable, with one death reported in 2023.

Ten MSs (Austria, Belgium, Denmark, France, Germany, Ireland, Malta, Netherlands, Poland and Sweden), the United Kingdom (Northern Ireland) and Norway reported FBOs caused by STEC. This agent ranked first in FBOs in Ireland and the United Kingdom (Northern Ireland).

Information on the STEC serogroup was available for 22 outbreaks (33.3% of FBOs caused by STEC in the EU). STEC **O157** was identified in nine FBOs. Among non-O157 STEC, serogroup **O26** (five FBOs) prevailed over **O145** (three FBOs), **O103** (two FBOs), **O146** (two FBOs) and **O63** (one FBO).

### **Listeria monocytogenes**

In 2023, **L. monocytogenes** was reported as the causative agent of 19 FBOs in the EU. The health impact of FBOs caused by *L. monocytogenes* remained high in 2023 although not comparable to that observed in 2022, which was particularly high due to large listeriosis outbreaks reported from Italy (EFSA and ECDC, 2023). In particular, in 2023 the number of hospitalisations and deaths decreased sharply by 65.3% and 60.7% (158 fewer hospitalisations and 17 fewer deaths), respectively. The number of FBOs and cases decreased by 45.7% and 55.1% (16 fewer FBOs and 163 fewer cases), respectively. *L. monocytogenes* was the causative agent associated with the highest case fatality rate among all causative agents detected in FBOs in 2023.

Overall, eight MSs (Austria, Belgium, Denmark, France, Germany, Hungary, Italy and Sweden) and two non-MSs (Norway and Switzerland) reported FBOs caused by *L. monocytogenes*.

Interestingly, one large strong-evidence outbreak caused by *L. monocytogenes* serotype 4b was reported by Italy. It was responsible for 38 cases, all hospitalised and two deaths. The implicated food vehicle was 'table olives'.

### **Other bacteria**

In total, 24 FBOs caused by **Shigella** were reported by seven MSs (Belgium, Croatia, France, Ireland, Poland, Slovakia and Spain) in similar numbers compared with 2022. **S. sonnei** and **S. flexneri** were identified in eight and four FBOs, respectively. For 12 outbreaks the species was not specified.

**Escherichia coli other than STEC** were identified in 20 FBOs (five more FBOs than 2022) from eight MSs (Denmark, Finland, France, Ireland, Italy, Romania, Spain and Sweden). Three FBOs were also reported by two non-MSs (Norway and Switzerland). **Enterotoxigenic E. coli (ETEC)** caused two FBOs while **enteropathogenic E. coli (EPEC)**, **enteroinvasive E. coli (EIEC)** and **enteroaggregative E. coli (EAEC)** caused one FBO each. For 10 FBOs the *E. coli* pathogroup was unknown. Denmark and Sweden reported two very large strong-evidence outbreaks. The first involved 197 cases and was associated with EIEC, with 'mixed foods' identified as the implicated food vehicle. The second outbreak, caused by ETEC, involved 154 cases and was linked to parsley as the implicated food. Denmark also reported another very large weak-evidence outbreak caused by EIEC with 114 cases involved.

A total of 17 FBOs caused by **Yersinia** (three more FBOs than in 2022) were reported from seven MSs (Austria, France, Germany, Poland, Slovakia, Spain and Sweden). **Yersinia enterocolitica** was identified in 16 FBOs while for one FBO the *Yersinia* species was unspecified. One FBO caused by *Yersinia* was also reported by one non-MS (Switzerland).

**Vibrio parahaemolyticus** was identified in seven FBOs reported from three MSs (France, Portugal and Spain).

In 2023, for the first time since EFSA began collecting data on FBOs, weak-evidence FBOs caused by **Mycobacterium spp.** and **toxigenic Vibrio cholerae** (one FBO each) were reported. The former outbreak occurred in Ireland and involved a total of three cases living in the same household. Consumption of raw cow's milk was the suspected source of infection. No information was available on the *Mycobacterium* species. The latter was a travel-associated outbreak caused by toxigenic *Vibrio cholerae* and involved three cases reported by Germany. Details on the suspect food vehicle, type of outbreak and place of exposure were not available.

#### 4.2.2 | Bacterial toxins

In 2023, FBOs caused by bacterial toxins were reported by 16 MSs (Belgium, Bulgaria, Croatia, Czechia, Denmark, Finland, France, Germany, Hungary, Italy, Poland, Portugal, Romania, Slovakia, Spain and Sweden) and 3 non-MSs (Norway, Republic of North Macedonia and Serbia). France was the main contributor, alone accounting for 86.1% of the reporting (769 FBOs). More information on the outbreaks caused by bacterial toxins in the EU is available in [Table 51](#).

*Bacillus cereus* toxins were the most reported agents in this group, followed by *Staphylococcus aureus* toxins and *Clostridium perfringens* toxins. Outbreaks caused by these pathogens increased by 54.9% (168 more FBOs than in 2022), 51.1% (70 more FBOs) and 154.5% (85 more FBOs), respectively. Conversely, the number of FBOs due to unspecified bacterial toxins decreased significantly, by 89.5% compared with 2022 (569 fewer FBOs).

**Bacillus cereus toxins** ranked second among known causative agents of FBOs in 2023, totalling 474 FBOs, behind only *Salmonella*. Eight MSs (Belgium, Finland, France, Germany, Italy, Portugal, Spain and Sweden) contributed to this reporting. One non-MS (Norway) reported one FBO caused by this agent in 2023. Four deaths were reported among cases involved in FBOs caused by *B. cereus* toxins and were all associated with outbreaks occurring in 'health care and residential facilities', namely in a 'residential institution (prison or boarding school)' (three deaths) and a 'nursing home' (one death).

**Staphylococcus aureus toxins**, reported in 207 FBOs, caused the highest number of hospitalisations among cases involved in FBOs caused by bacterial toxins. Thirteen MSs (Belgium, Croatia, Czechia, Finland, France, Germany, Hungary, Italy, Poland, Portugal, Romania, Slovakia and Spain) and two non-MSs (Republic of North Macedonia and Serbia) reported FBOs linked to *S. aureus* toxins. In Portugal and Romania, *S. aureus* toxins were the leading causative agents of FBOs.

**Clostridium perfringens toxins** were associated with the highest number of cases and deaths. In total, 140 FBOs caused by *C. perfringens* toxins were reported by nine MSs (Belgium, Croatia, Denmark, Finland, France, Germany, Italy, Portugal and Spain). Seven deaths associated with *C. perfringens* toxins were reported from FBOs occurring in a 'residential institution (prison or boarding school)'.

**Clostridium botulinum toxins** were responsible for five FBOs (two fewer outbreaks than in 2022) reported by four MSs (Bulgaria, Italy, Romania and Spain) and three FBOs in two non-MSs (Norway and Serbia). *C. botulinum* toxins were among the causative agents with the highest relative impact on health in 2023, in terms of proportion of hospitalisations and case fatality. All FBOs caused by this agent were very small in size and occurred mainly in 'domestic premises' (four FBOs). One death was reported from Italy, among the cases of botulism notified in 2023. The patient was involved in an outbreak caused by a food belonging to the 'fish and fishery products' vehicle group.



**TABLE 51** Number of food-borne outbreaks, human cases, hospitalisations and deaths, by causative agent, in reporting EU MSs, 2023.

Type of agent		Outbreaks				Cases of illness						
		Total (strong-evidence)		Reporting rate per 100,000		Human cases		Mean outbreak size (cases) and range (min-max)	Hospitalisations		Deaths	
		N	% of total <sup>a</sup>	2023	2019–2022	N	% of total <sup>a</sup>		N	% of cases <sup>b</sup>	N	% of cases <sup>b</sup>
<b>Bacteria</b>	<i>Campylobacter</i>	229 (27)	4.0	0.05	0.07	1174	2.3	5.1 (2–112)	90	7.7	0	0
	<i>Escherichia coli</i> other than STEC <sup>c</sup>	20 (6)	0.35	<0.01	<0.01	683	1.3	34.2 (2–197)	3	0.44	0	0
	<i>Listeria monocytogenes</i>	19 (8)	0.33	<0.01	0.01	133	0.26	7.0 (2–38)	84	63.2	11	8.3
	<i>Mycobacterium</i> spp.	1 (0)	0.02	<0.01	0	3	0.01	3.0 (–)	0	0	0	0
	<i>Salmonella</i>	1115 (258)	19.6	0.25	0.20	9210	17.7	8.3 (1–300)	1726	18.7	16	0.17
	Shiga toxin-producing <i>E. coli</i> (STEC)	66 (6)	1.2	0.01	0.01	270	0.52	4.1 (2–36)	48	17.8	1	0.37
	<i>Shigella</i>	24 (2)	0.42	0.01	<0.01	123	0.24	5.1 (2–24)	24	19.5	0	0
	<i>Vibrio cholerae</i> (toxigenic)	1 (0)	0.02	<0.01	0	3	0.01	3.0 (–)	0	0	0	0
	<i>Vibrio parahaemolyticus</i>	9 (1)	0.16	<0.01	<0.01	43	0.08	4.8 (2–14)	8	18.6	0	0
	<i>Yersinia</i>	17 (2)	0.3	<0.01	<0.01	73	0.14	4.3 (2–20)	9	12.3	0	0
	<b>Subtotal</b>	<b>1501 (310)</b>	<b>26.4</b>	<b>0.33</b>	<b>0.30</b>	<b>11,715</b>	<b>22.5</b>	<b>7.8 (1–300)</b>	<b>1992</b>	<b>17.0</b>	<b>28</b>	<b>0.24</b>
<b>Bacterial toxins</b>	<i>Bacillus cereus</i> toxins	474 (19)	8.3	0.11	0.03	4665	8.9	9.8 (2–251)	101	2.2	4	0.09
	<i>Clostridium botulinum</i> toxins	5 (3)	0.09	<0.01	<0.01	14	0.03	2.8 (2–4)	10	71.4	1	7.1
	<i>Clostridium perfringens</i> toxins	140 (30)	2.5	0.03	0.01	3342	6.4	23.9 (2–426)	20	0.60	8	0.24
	<i>Staphylococcus aureus</i> toxins	207 (32)	3.6	0.05	0.02	2268	4.4	11.0 (2–123)	113	5.0	1	0.04
	Bacterial toxins, unspecified	67 (4)	1.2	0.01	0.12	372	0.71	5.6 (2–43)	6	1.6	0	0
		<b>Subtotal</b>	<b>893 (88)</b>	<b>15.7</b>	<b>0.20</b>	<b>0.18</b>	<b>10,661</b>	<b>20.5</b>	<b>11.9 (2–426)</b>	<b>250</b>	<b>2.3</b>	<b>14</b>
<b>Viruses</b>	Adenovirus	3 (0)	0.05	<0.01	<0.01	13	0.02	4.3 (2–8)	2	15.4	0	0
	Flavivirus (incl. tick-borne encephalitis virus)	3 (3)	0.05	<0.01	<0.01	36	0.07	12.0 (2–28)	34	94.4	0	0
	Hepatitis A virus	11 (2)	0.19	<0.01	<0.01	46	0.09	4.2 (2–13)	36	78.3	0	0
	Hepatitis E virus	3 (0)	0.05	<0.01	<0.01	6	0.01	2.0 (–)	0	0	0	0
	Norovirus and other calicivirus <sup>d</sup>	359 (65)	6.3	0.08	0.06	8149	15.6	22.7 (2–580)	99	1.2	1	0.01
	Rotavirus	2 (0)	0.04	<0.01	<0.01	18	0.03	9 (5–13)	0	0	0	0
		<b>Subtotal</b>	<b>381 (70)</b>	<b>6.7</b>	<b>0.08</b>	<b>0.07</b>	<b>8268</b>	<b>15.9</b>	<b>21.7 (2–580)</b>	<b>171</b>	<b>2.1</b>	<b>1</b>
<b>Parasites</b>	<i>Anisakis</i>	5 (0)	0.09	<0.01	<0.01	31	0.06	6.2 (3–10)	0	0	0	0
	<i>Cryptosporidium</i>	18 (4)	0.32	<0.01	<0.01	684	1.3	38.0 (2–225)	4	0.58	0	0
	<i>Giardia</i>	9 (0)	0.16	<0.01	<0.01	31	0.06	3.4 (2–8)	1	3.2	0	0
	<i>Trichinella</i>	3 (2)	0.05	<0.01	<0.01	31	0.06	10.3 (1–18)	5	16.1	0	0
		<b>Subtotal</b>	<b>35 (6)</b>	<b>0.62</b>	<b>0.01</b>	<b>&lt;0.01</b>	<b>777</b>	<b>1.5</b>	<b>22.2 (1–225)</b>	<b>10</b>	<b>1.3</b>	<b>0</b>

(Continues)

TABLE 51 (Continued)

Type of agent		Outbreaks				Cases of illness						
		Total (strong-evidence)		Reporting rate per 100,000		Human cases		Mean outbreak size (cases) and range (min-max)	Hospitalisations		Deaths	
		N	% of total <sup>a</sup>	2023	2019–2022	N	% of total <sup>a</sup>		N	% of cases <sup>b</sup>	N	% of cases <sup>b</sup>
<b>Other causative agents</b>	Histamine and scombrototoxin	66 (15)	1.2	0.01	0.02	414	0.79	6.3 (2–154)	18	4.3	0	0
	Marine biotoxins <sup>e</sup>	38 (11)	0.67	0.01	0.01	162	0.31	4.3 (2–26)	4	2.5	0	0
	Mushroom toxins	18 (15)	0.32	<0.01	<0.01	57	0.11	3.2 (2–8)	46	80.7	0	0
	Other agents (incl. unspecified) <sup>f</sup>	2 (1)	0.04	<0.01	<0.01	219	0.42	109.5 (10–209)	0	0	0	0
	<b>Subtotal</b>	<b>124 (42)</b>	<b>2.2</b>	<b>0.03</b>	<b>0.02</b>	<b>852</b>	<b>1.6</b>	<b>6.9 (2–209)</b>	<b>68</b>	<b>8.0</b>	<b>0</b>	<b>0</b>
<b>Unknown</b>	Unknown / Unspecified	2757 (62)	48.4	0.61	0.42	19,854	38.1	7.2 (2–740)	403	2.0	22	0.11
<b>EU Total</b>		<b>5691 (578)</b>	<b>100</b>	<b>1.3</b>	<b>1.0</b>	<b>52,127</b>	<b>100</b>	<b>9.2 (1–740)</b>	<b>2894</b>	<b>5.6</b>	<b>65</b>	<b>0.12</b>

<sup>a</sup>Percentage of the total number of cases reported in the EU.

<sup>b</sup>Percentage of the total number of cases caused by the causative agent.

<sup>c</sup>*Escherichia coli* other than STEC' includes 'enteropathogenic *E. coli* (EPEC)' (8), 'enterotoxigenic *E. coli* (ETEC)' (6), 'enteroinvasive *E. coli* (EIEC)' (4), 'enteroaggregative *E. coli* (EAEC)' (1) and other unspecified *Escherichia coli* (1).

<sup>d</sup>Norovirus and other calicivirus' includes 'norovirus' (317), 'sapovirus' (1) and other unspecified 'calicivirus' (41).

<sup>e</sup>Marine biotoxins' includes 'ciguatoxin' (8) and other unspecified toxins (30).

<sup>f</sup>Other agents' includes 'atropine' (1) and 'lectins' (1).

### 4.2.3 | Viruses

During 2023, 17 MSs (Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Netherlands, Poland, Portugal, Slovakia, Spain and Sweden) reported 381 FBOs caused by viruses. Ten FBOs involving viruses were also reported by three non-MSs. Key statistics on FBOs associated with viruses are available in [Table 51](#).

#### Norovirus (and other calicivirus)

Outbreaks caused by **norovirus (and other calicivirus)** were reported by 16 MSs (Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Netherlands, Poland, Portugal, Spain and Sweden) and 3 non-MSs (Iceland, Norway and Switzerland).

Norovirus (and other calicivirus) was the third most frequently implicated agent in FBOs in 2023 (with 359 FBOs), ranking second for number of cases involved. In Finland, Iceland and Norway, norovirus (and other calicivirus) was the leading causative agent of FBOs. The number of FBOs due to this causative agent increased by 8.1% compared with 2022 (27 more FBOs). The mean size of outbreaks associated with this agent group was among the largest observed in 2023 and many outbreaks were large (27 outbreaks included  $\geq 50$  and  $< 100$  cases each) or very large in size (8 outbreaks included  $\geq 100$  cases each). The largest ones involved more than 500 cases each and were reported by Spain and Germany. The implicated food vehicles were 'tap water, including well water' and a dairy dessert, precisely a quark dessert with mixed berries. FBOs caused by norovirus (and other calicivirus) were mostly reported as 'general outbreaks' (66.9%) and most strong-evidence outbreaks occurred in a 'restaurant, pub, street vendors, take away, etc.' (44.4%) or 'domestic premises' (23.8%).

#### Hepatitis A

Outbreaks caused by **hepatitis A virus** were reported by three MSs (Germany, Italy and Poland), resulting in three more FBOs than 2022 in the EU (11 FBOs in total). In the two hepatitis A strong-evidence outbreaks, reported by Italy and Poland, the implicated food vehicles were 'fruit, berries and juices and other products thereof'. They occurred in a 'restaurant or cafe or pub or bar or hotel or catering service' and 'domestic premises', respectively.

#### Other viruses

Three strong-evidence outbreaks caused by **tick-borne encephalitis virus (TBE)** were reported by Slovakia. All outbreaks were associated with the consumption of 'fresh cheeses made from sheep's milk' and occurred mainly in 'domestic premises' (two FBOs). Other reported viruses causing FBOs in the EU in 2023 were **adenovirus**, **hepatitis E virus** and **rotavirus**. All were reported as weak-evidence outbreaks.

### 4.2.4 | Parasites

Outbreaks caused by parasites were reported by 12 MSs (Belgium, Bulgaria, Denmark, France, Germany, Ireland, Italy, Malta, Poland, Romania, Spain and Sweden) and by 3 non-MSs (Norway, Serbia and Switzerland). Details on the FBOs caused by parasites are available in [Table 51](#).

#### *Cryptosporidium*

Among parasites, ***Cryptosporidium*** was the leading causative agent of FBOs and cases in the EU in 2023, responsible for 18 FBOs. A total of seven MSs (Denmark, Germany, Ireland, Italy, Malta, Spain and Sweden) contributed to this reporting. Three more FBOs caused by *Cryptosporidium* were reported compared with 2022. Another two outbreaks were reported by one non-MS (Norway).

*Cryptosporidium* was associated with one of the highest mean outbreak sizes among all causative agents. ***Cryptosporidium parvum*** was involved in three FBOs. For the remaining FBOs (15 outbreaks) information on the *Cryptosporidium* species was not available. 'Tap water, including well water' was frequently implicated in three strong-evidence FBOs, while 'cheeses made from goats' milk' was identified in one strong-evidence FBO. Two very large strong-evidence outbreaks including 225 and 119 cases, reported by Spain, were caused by contaminated 'tap water, including well water', a source frequently documented in *Cryptosporidium* outbreaks.

#### *Trichinella*

Outbreaks caused by *Trichinella* (three FBOs) were reported by three MSs (Bulgaria, Romania and Spain) in smaller numbers compared with 2022 (four fewer FBOs). ***T. spiralis*** was involved in two of the three (for one FBO the information on the species was not reported). In all outbreaks, 'meat and meat products' was the implicated or suspected food vehicle. The two largest outbreaks were caused by *T. spiralis* and involved 18 and 12 human cases, with one and four hospitalisations, respectively. The first outbreak was reported as a weak-evidence FBO by Spain, with 'unspecified meat and meat products' as the suspected food vehicle. The second FBO occurred in Romania and was likely associated with the consumption of

'other or mixed red meat and products thereof', with strong evidence. Two strong-evidence FBOs due to *T. spiralis* were also reported by one non-MS (Serbia) and were linked with the consumption of 'pig meat and products thereof'.

### Other parasites

The other reported parasites causing FBOs were **Giardia** and **Anisakis**, both causing only weak-evidence outbreaks. FBOs caused by *Giardia* were reported by five MSs (Belgium, Germany, Ireland, Italy and Poland). **G. intestinalis** was implicated in two FBOs, while no information on the species was reported for seven other FBOs. All outbreaks were very small in size.

Five outbreaks (all weak evidence) caused by *Anisakis* were reported by France. Consumption of 'fish and fish products' was the suspected food vehicle implicated in these FBOs. The suspected place of exposure for four FBOs involving 28 cases was 'school and kindergarten', i.e. a public catering setting. No hospitalisations or deaths were reported.

### 4.2.5 | Other causative agents

Nine MSs (Belgium, Denmark, France, Italy, Malta, Poland, Portugal, Spain and Sweden) reported a total of 124 FBOs caused by causative agents other than the ones mentioned above. One FBO was reported by one non-MS (Switzerland). These causative agents are not routinely monitored by national surveillance programmes. As a result, the total number of FBOs reported in the EU may be underestimated and direct comparison among MSs, even when using population-based indicators (e.g. FBO reporting rate), is likely highly biased. Key statistics on FBOs associated with other causative agents are available in [Table 51](#).

'**Histamine and scombrototoxin**' were the most frequent agents reported in this group (53.2%) with six MSs (Belgium, France, Italy, Malta, Spain and Sweden) providing information on such outbreaks. In 2023, the number of FBOs (66 FBOs) decreased by 34.0% compared with the number of outbreaks of 'histamine and scombrototoxin' reported in 2022 (34 fewer FBOs). Almost all these FBOs were due to **histamine** (65 FBOs; 98.5%), while only one outbreak was caused by **scombrototoxin**. 'Histamine and scombrototoxin' poisoning outbreaks were mostly very small in size, involving fewer than 10 human cases and occurred mainly in a 'restaurant, pub, street vendors, take away, etc.' (seven strong-evidence FBOs), followed by 'domestic premises' (three strong-evidence FBOs). All but one of the reported strong-evidence FBOs caused by histamine were linked or suspected to be linked to the consumption of 'fish and fishery products' (14 FBOs). One strong-evidence FBO was associated with the consumption of a canned fish product (one FBO). For the first time since the start of FBO data collection, one very large weak-evidence outbreak involving 154 human cases, was reported by Spain. This weak-evidence outbreak was linked to a 'canteen or workplace catering' setting and was suspected to be associated with the consumption of 'fish and fish products'. No hospitalisations and deaths were reported.

**Marine biotoxins** were responsible for 38 FBOs reported by France and Spain, with seven more outbreaks than in 2022 (an increase of 22.6%). France accounted for most of these FBOs (28 FBOs; 73.7%). **Ciguatoxins** were implicated in eight FBOs while in the other FBOs the specific marine biotoxins were not specified.

Four MSs (France, Italy, Poland and Spain) reported 18 FBOs caused by **mushroom toxins** (11 more FBOs than 2022). Italy contributed the most to this reporting (14 FBOs; 77.8%). Overall, mushroom toxins were associated with very small outbreaks (mean outbreak size of 3.2 cases).

**Atropine** and **lectins** were associated with two FBOs in 2023, as reported by Portugal and Denmark, respectively. The first FBO was a very large strong-evidence outbreak, which involved a total of 209 cases. The food vehicle implicated was a 'bakery product', specifically a cornbread made from a mixture of cereal flours. Both atropine and scopolamine were identified as the causative agents, found in both the cornbread and the corn flour. No hospitalisations or deaths were reported.

### 4.2.6 | Outbreaks caused by unknown/unspecified agents

In 2023, the number of FBOs with unknown aetiology or unspecified causative agents increased slightly, by 3.7%, resulting in 98 more FBOs than in 2022, bringing the total to 2757. Key statistics on FBOs caused by unknown causative agents are available in [Table 51](#).

Eighteen MSs (Belgium, Croatia, Cyprus, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Spain and Sweden) contributed to reporting these data. Outbreaks with unknown causative agents were also reported by five non-MSs (Montenegro, Norway, Republic of North Macedonia, Serbia and Switzerland). Countries with the most reported outbreaks with an unknown or unspecified causative agent were Belgium, Cyprus, France, Hungary, the Netherlands and Sweden, and among non-MSs Montenegro, Republic of North Macedonia and Switzerland. In each of the following three MSs – Belgium, Cyprus and the Netherlands – the reporting of FBOs with unknown aetiology accounted for more than 90.0% of all reported FBOs.

Most outbreaks were very small (< 10 cases) in size (2436 FBOs; 88.4%). This finding suggests that in very small outbreaks, occurring in a confined environment, it is relatively easier to find a link among cases, although identification of the causative agent may be challenging. However, in 2023, various very large outbreaks with unknown causative agents were also reported. The largest one was a weak-evidence outbreak reported by France in a site categorised as a 'canteen or workplace catering' setting, which involved a total of 740 cases. Consumption of 'milk or milk products' was the suspected implicated food vehicle.

### 4.3 | Overview of food vehicles implicated in food-borne outbreaks in 2023

The following sections provide information on the food vehicles implicated in FBOs in 2023. Only strong-evidence outbreaks are considered for this purpose since the body of evidence (i.e. the proof) linking a food vehicle and the human cases means that the association is highly likely and the level of uncertainty around this association is low.

For a more interactive look at FBO data by food vehicles, visit the dedicated page in EFSA's dashboard on FBO ([here](#)).

#### 4.3.1 | Food vehicles in strong-evidence outbreaks

Twenty-three MSs (all except Cyprus, Ireland and Latvia) and the United Kingdom (Northern Ireland) provided information on 578 strong-evidence FBOs (10.2% of all FBOs reported in the EU in 2023), an increase of 18.9% over 2022 (92 more FBOs than in 2022). Spain was by far the main contributor of strong-evidence FBOs (34.8%), followed by Poland (15.4%) and France (12.8%). [Table 52](#) describes the food vehicles implicated in strong-evidence FBOs in 2023 in the EU. In addition, information on a total of 36 strong-evidence FBOs was also reported by four non-MSs (Norway, Republic of North Macedonia, Serbia and Switzerland).

#### Composite foods, multi-ingredient foods and other foods

In 2023 foodstuffs belonging to the group '**composite foods, multi-ingredient foods and other foods**' ranked first among the food vehicles implicated in strong-evidence FBOs, similarly to 2022 and 2021.

Nineteen MSs (all MSs reporting strong-evidence FBOs except for Greece, Lithuania, Malta and Netherlands) and three non-MSs (Republic of North Macedonia, Serbia and Switzerland) reported a total of 179 and nine strong-evidence FBOs linked to this food group, respectively ([Table 52](#)). At the EU level the increase over 2022 was 26.1% (37 more FBOs than 2022). A complete description of the food vehicles included in this category is available as a footnote in [Table 52](#).

Within this big group, the foodstuffs classified under the '**mixed foods**' category caused the highest number of strong-evidence FBOs, cases and hospitalisations among all foods implicated in strong-evidence FBOs in 2023. Approximately one in four strong-evidence FBOs, cases and hospitalisations were due to the consumption of 'mixed foods'. Seventeen MSs (Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Poland, Portugal, Romania, Slovakia, Spain and Sweden) and three non-MSs (Republic of North Macedonia, Serbia and Switzerland) reported strong-evidence FBOs caused by this type of food. Compared with 2022, strong-evidence FBOs, cases and hospitalisations caused by consumption of 'mixed foods' increased in the EU by 52.7%, 42.1% and 49.7%, respectively (49 more strong-evidence FBOs, 826 more cases and 81 more hospitalisations). One reason for this increase was the rise in the number of very large strong-evidence FBOs ( $\geq 100$  cases each), which accounted for seven FBOs in 2023 while there were only two in 2022. Two very large strong-evidence FBOs were caused by *Salmonella* (*S. Enteritidis* and *S. Thompson*), one was associated with *Staphylococcus aureus* toxins, one with enteroinvasive *E. coli* (EIEC), while for three FBOs the aetiology was unknown.

Almost half of strong-evidence FBOs due to consumption of 'mixed foods' were caused by *Salmonella* (65 outbreaks) and in particular by *S. Enteritidis* (28 outbreaks), *S. Virchow* (two outbreaks), *S. Infantis*, *S. London*, *S. Newport*, *S. Oranienburg*, *S. Thompson* and *S. Typhimurium* (one outbreak each). For 29 strong-evidence *Salmonella* FBOs the serovar was not specified. Overall, strong-evidence outbreaks caused by *Salmonella* associated with 'mixed foods' increased sharply in 2023 (41 more outbreaks than in 2022, corresponding to a 170.8% increase) making this pathogen/food combination the second most frequently reported combination in strong-evidence FBOs in the EU ([Table 53](#)). Among the other strong-evidence FBOs implicating this food group, 33 outbreaks were caused by bacterial toxins (i.e. *Bacillus cereus* toxins, *Clostridium botulinum* toxins, *Clostridium perfringens* toxins and *Staphylococcus aureus* toxins), 14 outbreaks were caused by mushroom toxins, 13 outbreaks were caused by norovirus (and other calicivirus) and 3 by bacteria (*Campylobacter*, EIEC and *Vibrio parahaemolyticus*). For 13 strong-evidence FBOs, the causative agent was not identified.

'**Bakery products**' were reported as the implicated food from nine MSs (Czechia, France, Germany, Italy, Poland, Portugal, Slovakia, Slovenia and Spain) and one non-MS (Serbia). Strong-evidence FBOs ( $N=25$ ), cases ( $N=479$ ) and hospitalisations ( $N=82$ ) caused by this food group ([Table 52](#)) also increased compared with 2022 (8 more strong-evidence outbreaks, 217 more cases and 22 more hospitalisations). *S. Enteritidis* was identified in 17 of all strong-evidence FBOs caused by this food group (68.0%), including one very large outbreak involving 109 cases, reported from Poland. Other causative agents associated with 'bakery products' included atropine, which was responsible for a single FBO involving 209 cases, *Bacillus cereus* toxins, norovirus and *Staphylococcus aureus* toxins (one strong-evidence FBO each). In four strong-evidence FBOs the causative agent was unknown.

*S. Enteritidis* was also responsible for two strong-evidence FBOs due to '**buffet meals**' and one single strong-evidence FBO associated with '**sweets and chocolate**'. No substantial variations compared with recent years were observed for 'buffet meals' and '**canned food products**' while strong-evidence FBOs and cases implicating '**other foods**' decreased sharply (nine fewer outbreaks and 510 fewer cases than in 2022).

**TABLE 52** Frequency distribution of strong-evidence food-borne outbreaks, by food vehicle, in reporting EU MSs, in 2023.

Type of vehicle	Strong-evidence outbreaks								Reporting rate per 100,000		Rank	
	Outbreaks		Cases		Hospitalisations		Deaths		2023	2019–2022	2023	2019–2022
	N	% of total	N	% of total	N	% of total	N	% of total				
<b>Composite foods, multi-ingredient foods and other foods</b>												
Mixed foods <sup>a</sup>	142	24.6	2786	25.0	244	25.8	2	11.1	0.032	0.015	1	2
Bakery products <sup>b</sup>	25	4.3	479	4.3	82	8.7	0	0	0.006	0.004	7	7
Buffet meals	8	1.4	125	1.1	7	0.74	0	0	0.002	0.002	13	15
Sweets and chocolate	2	0.35	15	0.13	4	0.42	0	0	<0.001	0.001	17	16
Canned food products <sup>c</sup>	1	0.17	2	0.02	1	0.11	0	0	<0.001	<0.001	18	22
Other foods	1	0.17	2	0.02	0	0	0	0	<0.001	0.002	18	12
<b>Subtotal</b>	<b>179</b>	<b>31.0</b>	<b>3409</b>	<b>30.5</b>	<b>338</b>	<b>35.8</b>	<b>2</b>	<b>11.1</b>	<b>0.040</b>	<b>0.025</b>	–	–
<b>Meat and meat products</b>												
Broiler meat ( <i>Gallus gallus</i> ) and products thereof <sup>d</sup>	52	9.0	658	5.9	86	9.1	2	11.1	0.012	0.004	3	9
Meat and meat products, unspecified	27	4.7	1098	9.8	24	2.5	1	5.6	0.006	0.004	6	8
Pig meat and products thereof <sup>e</sup>	23	4.0	454	4.1	118	12.5	3	16.7	0.005	0.006	8	5
Bovine meat and products thereof <sup>f</sup>	6	1.0	90	0.81	13	1.4	0	0	0.001	0.002	14	10
Turkey meat and products thereof <sup>g</sup>	2	0.35	6	0.05	4	0.42	0	0	<0.001	<0.001	17	21
Other or mixed red meat and products thereof <sup>h</sup>	13	2.2	132	1.2	9	0.95	1	5.6	0.003	0.002	11	14
Other, mixed or unspecified poultry meat and products thereof <sup>i</sup>	10	1.7	140	1.3	3	0.32	0	0	0.002	0.001	12	18
<b>Subtotal</b>	<b>133</b>	<b>23.0</b>	<b>2578</b>	<b>23.1</b>	<b>257</b>	<b>27.2</b>	<b>7</b>	<b>38.9</b>	<b>0.030</b>	<b>0.020</b>	–	–
<b>Eggs and egg products<sup>j</sup></b>	<b>95</b>	<b>16.4</b>	<b>1223</b>	<b>11.0</b>	<b>125</b>	<b>13.2</b>	<b>0</b>	<b>0</b>	<b>0.021</b>	<b>0.016</b>	<b>2</b>	<b>1</b>
<b>Fish and fishery products</b>												
Fish and fish products <sup>k</sup>	43	7.4	355	3.2	57	6.0	7	38.9	0.010	0.008	4	4
Crustaceans, shellfish, molluscs and products thereof <sup>l</sup>	40	6.9	472	4.2	1	0.11	0	0	0.009	0.012	5	3
<b>Subtotal</b>	<b>83</b>	<b>14.4</b>	<b>827</b>	<b>7.4</b>	<b>58</b>	<b>6.1</b>	<b>7</b>	<b>38.9</b>	<b>0.018</b>	<b>0.020</b>	–	–

TABLE 52 (Continued)

Type of vehicle	Strong-evidence outbreaks								Reporting rate per 100,000		Rank	
	Outbreaks		Cases		Hospitalisations		Deaths		2023	2019–2022	2023	2019–2022
	N	% of total	N	% of total	N	% of total	N	% of total				
<b>Foods of non-animal origin</b>												
Vegetables and juices and other products thereof <sup>m</sup>	25	4.3	435	3.9	60	6.4	2	11.1	0.006	0.005	7	6
Fruit, berries and juices and other products thereof	8	1.4	120	1.1	20	2.1	0	0	0.002	0.001	13	20
Cereal products including rice and seeds/pulses (nuts, almonds) <sup>n</sup>	5	0.87	101	0.91	2	0.21	0	0	0.001	0.001	15	19
Herbs and spices <sup>o</sup>	2	0.35	184	1.6	0	0	0	0	<0.001	<0.001	17	23
<b>Subtotal</b>	<b>40</b>	<b>6.9</b>	<b>840</b>	<b>7.5</b>	<b>82</b>	<b>8.7</b>	<b>2</b>	<b>11.1</b>	<b>0.009</b>	<b>0.008</b>	–	–
<b>Milk and milk products</b>												
Cheese <sup>p</sup>	20	3.5	183	1.6	57	6.0	0	0	0.004	0.002	9	11
Dairy products (other than cheeses) <sup>q</sup>	15	2.6	664	5.9	20	2.1	0	0	0.003	0.001	10	17
Milk <sup>r</sup>	3	0.52	11	0.10	5	0.53	0	0	0.001	0.002	16	14
<b>Subtotal</b>	<b>38</b>	<b>6.6</b>	<b>858</b>	<b>7.7</b>	<b>82</b>	<b>8.7</b>	<b>0</b>	<b>0</b>	<b>0.008</b>	<b>0.005</b>	–	–
<b>Water (and other beverages)<sup>s</sup></b>	<b>10</b>	<b>1.7</b>	<b>1425</b>	<b>12.8</b>	<b>2</b>	<b>0.21</b>	<b>0</b>	<b>0</b>	<b>0.002</b>	<b>0.002</b>	<b>12</b>	<b>13</b>
<b>EU Total</b>	<b>578</b>	<b>100</b>	<b>11,160</b>	<b>100</b>	<b>944</b>	<b>100</b>	<b>18</b>	<b>100</b>	<b>0.128</b>	<b>0.098</b>		

Notes: Single food items are consolidated into major groups according to their origin. The 'outbreak reporting rate' columns include the mean outbreak reporting rate per 100,000 for 2023 and for the previous years (2019–2022) for trend watching. The ranking of each food item provides a visual demonstration of the relative importance of the item, among all food vehicles implicated in food-borne outbreaks, for the same year and period.

<sup>a</sup>Mixed foods' includes 'mixed foods' (83), 'other processed food products and prepared dishes' (20), 'other processed food products and prepared dishes – mushroom based dishes' (14), 'other processed food products and prepared dishes – meat based dishes' (8), 'other processed food products and prepared dishes – pizza and pizza-like dishes' (2), 'other processed food products and prepared dishes – sushi' (2), 'other processed food products and prepared dishes – vegetable-based dishes' (2), 'sauce and dressings' (2), 'sauce and dressings – mayonnaise' (2), 'bean curd sauce' (1), 'other processed food products and prepared dishes – fish and seafood based dishes' (1), 'other processed food products and prepared dishes – pasta – simple pasta' (1), 'other processed food products and prepared dishes – pasta based dishes' (1), 'other processed food products and prepared dishes – rice based dishes' (1), 'soups – ready-to-eat' (1), 'vegetable-based cooked sauce' (1).

<sup>b</sup>Bakery products' includes 'bakery products' (15), 'bakery products – desserts – containing raw eggs' (4), 'bakery products – pastry – made with raw eggs' (2), 'bakery products – bread' (1), 'bakery products – cakes' (1), 'bakery products – cakes – containing heat-treated cream' (1), 'bakery products – desserts' (1).

<sup>c</sup>Canned food products' includes 'fish – canned' (1).

<sup>d</sup>Broiler meat (*Gallus gallus*) and products thereof' includes 'broiler meat (*Gallus gallus*) and products thereof' (49), 'meat from broilers (*Gallus gallus*)' (1), 'meat from broilers (*Gallus gallus*) – fresh – skinned' (1), 'meat from broilers (*Gallus gallus*) – meat products' (1).

<sup>e</sup>Pig meat and products thereof' includes 'pig meat and products thereof' (9), 'meat from pig – fresh' (4), 'meat from pig – meat products – meat specialities' (3), 'meat from pig – meat products – ready-to-eat' (2), 'meat from pig – meat preparation' (1), 'meat from pig – meat products – cooked ham' (1), 'meat from pig – meat products – raw and intended to be eaten raw' (1), 'meat from pig – minced meat' (1), 'meat from pig – minced meat – intended to be eaten raw' (1).

<sup>f</sup>Bovine meat and products thereof' includes 'bovine meat and products thereof' (3), 'meat from bovine animals – meat products' (2), 'meat from bovine animals – meat products – raw and intended to be eaten raw' (1).

<sup>g</sup>Turkey meat and products thereof' includes 'meat from turkey – fresh' (2).

<sup>h</sup>Other or mixed red meat and products thereof' includes 'other or mixed red meat and products thereof' (7), 'meat from farmed game – land mammals – meat products' (1), 'meat from rabbit – meat preparation' (1), 'meat from wild boar' (1), 'meat, mixed meat – meat preparation – intended to be eaten raw' (1), 'meat, mixed meat – meat products' (1), 'meat, mixed meat – meat products – ready-to-eat' (1).

<sup>i</sup>Other, mixed or unspecified poultry meat and products thereof' includes 'other mixed or unspecified poultry meat and products thereof' (8), 'meat from poultry, unspecified – meat preparation' (1), 'meat from poultry, unspecified – meat products' (1).

<sup>j</sup>Eggs and egg products' includes 'eggs and egg products' (88), 'eggs' (7).

(Continues)

**TABLE 52** (Continued)

<sup>k</sup>Fish and fish products' includes 'fish and fish products' (39), 'fish' (1), 'fish – cooked' (1), 'fish – fishery products from fish species associated with a high amount of histidine – not enzyme matured' (1), 'fish – gravad /slightly salted' (1).

<sup>l</sup>Crustaceans, shellfish, molluscs and products thereof' includes 'live bivalve molluscs – oysters' (25), 'crustaceans, shellfish, molluscs and products thereof' (9), 'live bivalve molluscs – mussels' (5), 'bivalve molluscs' (1).

<sup>m</sup>Vegetables and juices and other products thereof' includes 'vegetables and juices and other products thereof' (13), 'potatoes' (2), 'tomato' (2), 'cherry tomato' (1), 'lettuce' (1), 'lettuce, leaf' (1), 'sprouts' (1), 'sprouts - ready-to-eat' (1), 'table olives' (1), 'vegetables' (1), 'vegetables – products – cooked' (1).

<sup>n</sup>Cereal products including rice and seeds/pulses (nuts, almonds)' includes 'cereal products including rice and seeds/pulses (nuts, almonds)' (3), 'rice' (1), 'sesame paste (tahini) (*Sesamum indicum*)' (1).

<sup>o</sup>Herbs and spices' includes 'herbs and spices' (1), 'parsley' (1).

<sup>p</sup>Cheese' includes 'cheese' (10), 'cheeses made from cows' milk' (4), 'cheeses made from sheep's milk – fresh' (3), 'cheese made from raw or low heat-treated milk' (1), 'cheeses made from cows' milk – fresh' (1), 'cheeses made from goats' milk' (1).

<sup>q</sup>Dairy products (other than cheeses)' includes 'dairy products (other than cheeses)' (9), 'dairy products (excluding cheeses) – cream' (2), 'dairy products (excluding cheeses) – buttermilk' (1), 'dairy products (excluding cheeses) – dairy desserts' (1), 'dairy products (excluding cheeses) – milk powder and whey powder' (1), 'dairy products (excluding cheeses) – yoghurt' (1).

<sup>r</sup>Milk' includes 'milk' (1), 'milk, cows' (1), 'milk, cows' – raw milk' (1).

<sup>s</sup>Water (and other beverages)' includes 'tap water, including well water' (8), 'water – potable water' (2).



## Foods of animal origin

Foods of animal origin includes 'eggs and egg products', 'meat and meat products', 'fish and fishery products' and 'milk and milk products'. Altogether these vehicles caused 349 strong-evidence FBOs (60.4% of all strong-evidence FBOs), 5486 cases (49.2 of all cases in strong-evidence FBOs), 522 hospitalisations (55.3% of all hospitalisations in strong-evidence FBOs) and 14 deaths (77.8% of all deaths in strong-evidence FBOs). All MSs but two (Croatia and Slovenia) and the United Kingdom (Northern Ireland), as well as four non-MSs (Norway, Republic of North Macedonia, Serbia and Switzerland), provided information on FBOs associated with foods of animal origin.

'Meat and meat products' was the food vehicle group reported most frequently by MSs. However, despite the increase observed in 2023 in the number of strong-evidence FBOs (133 outbreaks in total, 33 more than in 2022; 33.0% increase), the number of cases, hospitalisations and deaths associated with this food group decreased by 17.9% (563 fewer cases), 20.7% (67 fewer hospitalisations) and 22.2% (two fewer deaths), respectively, compared with 2022.

The drop in the number of cases and hospitalisations was mainly attributable to fewer FBOs caused by 'bovine meat and products thereof' (251 fewer cases and 36 fewer hospitalisations), 'pig meat and products thereof' (276 fewer cases and 10 fewer hospitalisations) or 'other or mixed red meat and products thereof' (870 fewer cases and two fewer hospitalisations). Conversely, more FBOs and cases were reported in strong-evidence FBOs caused by 'broiler meat (*Gallus gallus*) and products thereof' (31 more FBOs and 272 more cases) and 'meat and meat products, unspecified' (11 more FBOs and 642 more cases).

*Salmonella* was the causative agent associated with the largest number of strong-evidence FBOs (59 outbreaks; 44.4%), hospitalisations ( $N=213$ ; 82.9%) and deaths ( $N=3$ ; 42.9%) caused by the consumption of 'meat and meat products', while *Clostridium perfringens* toxins caused the largest number of cases ( $N=957$ ; 37.1%). In Spain, consumption of 'meat and meat products' contaminated with *C. perfringens* toxins caused two very large strong-evidence FBOs (426 and 165 cases, respectively). The largest one involved cases in 'school or kindergarten'. In Poland, *S. Enteritidis* in 'meat and meat products' was responsible for 184 cases in a single strong-evidence FBO. *Salmonella* serovars associated with the 'meat and meat products' vehicle included *S. Enteritidis* (29 strong-evidence FBOs), monophasic *S. Typhimurium* (seven strong-evidence FBOs), *S. Infantis* (three strong-evidence FBOs) and *S. Brandenburg*, *S. Stanley* and *S. Typhimurium* (one FBO each).

'Eggs and egg products' was the second most frequently reported food vehicle group in strong-evidence FBOs (95 FBOs). The number of outbreaks and hospitalisations linked to this food remained rather stable in 2023 (eight fewer outbreaks and 17 fewer hospitalisations than 2022) despite an increase in the number of cases (304 more cases; 33.1% increase). There was also a decrease in deaths (four fewer deaths). Twelve MSs (Austria, Czechia, France, Hungary, Italy, Lithuania, Malta, Netherlands, Poland, Slovakia, Spain and Sweden) reported strong-evidence FBOs caused by 'eggs and egg products', with two of these countries (Poland and Spain) contributing the most to these FBOs (81 outbreaks; 85.3%). Five strong-evidence FBOs caused by 'eggs and egg products' were also reported by one non-MS (Serbia).

As with 2022, *Salmonella* was the main agent involved in strong-evidence FBOs associated with the consumption of 'eggs and egg products' (83 outbreaks; 87.4%), including *S. Enteritidis* (38 outbreaks), *S. Typhimurium* and *S. Kentucky* (1 outbreak each) and other unspecified *Salmonella* serovars (43 outbreaks). Two very large strong-evidence FBOs caused by the consumption of 'eggs and egg products' contaminated with *S. Enteritidis* were reported by Hungary (300 cases in a 'school or kindergarten') and the Netherlands (156 cases exposed in 'multiple places of exposure in one country').

A total of 83 strong-evidence FBOs caused by the consumption of food items belonging to the 'fish and fishery products' group were reported by 12 MSs (Belgium, Denmark, Estonia, Finland, France, Germany, Italy, Poland, Romania, Slovakia, Spain and Sweden). Two strong-evidence FBOs linked to these foodstuffs were reported by two non-MSs (Norway and Switzerland). In 2023, strong-evidence FBOs linked to consumption of 'fish and fishery products' increased by 20.3% (14 more outbreaks) compared to 2022. Moreover, the health impact associated with these outbreaks was much higher than in the previous year, with an increase of 39.2% in the number of cases (233 more cases), 56.8% in the number of hospitalisations (21 more hospitalisations) and, most critically, 250% in the number of deaths (five more deaths). In particular, the increase in hospitalisations and deaths was mostly due to strong-evidence FBOs caused by 'fish and fish products' (28 more hospitalisations and 5 more deaths than in 2022).

A wide range of causative agents was associated with 'fish and fish products' including in decreasing order histamine and scombrototoxin, *Salmonella*, marine biotoxins, *Bacillus cereus* toxins, norovirus (and other calicivirus), *Listeria monocytogenes*, *Staphylococcus aureus* toxins, *Campylobacter*, *Shigella*, *Clostridium perfringens* toxins and *Clostridium botulinum* toxins. In four strong-evidence FBOs causing 29 hospitalisations and three deaths, the implicated agent was unknown. In 'crustaceans, shellfish, molluscs and products thereof' the most frequently reported causative agent was by far norovirus, which was reported in 30 strong-evidence FBOs (75.0% of all strong-evidence FBOs caused by this vehicle group) totalling 414 cases (87.7% of cases). Among these strong-evidence FBOs, Finland reported a single strong-evidence FBO associated with oysters, causing 150 cases.

In the 'milk and milk products' group, strong-evidence FBOs associated with the consumption of either 'cheese', 'dairy products (other than cheeses)' or 'milk' were reported by 12 MSs (Belgium, Finland, France, Germany, Hungary, Italy, Lithuania, Poland, Romania, Slovakia, Spain and Sweden) and two non-MSs (Republic of North Macedonia and Serbia) totalling 38 FBOs. The health impact of strong-evidence FBOs linked to this food group was lower than in 2022 in terms of deaths (no deaths in 2023, there were seven in 2022) but not in terms of cases (392 more cases; 84.1% increase) and hospitalisations (30 more cases; 57.7% increase).

The causative agents linked to strong-evidence FBOs associated with 'milk and milk products' included bacteria (19 FBOs caused by *Campylobacter*, *Listeria monocytogenes*, *Salmonella*, Shiga toxin-producing *E. coli* (STEC)), bacterial toxins (eight outbreaks caused by *Staphylococcus aureus* toxins), viruses (five outbreaks caused by tick-borne encephalitis virus, norovirus) and parasites (one outbreak caused by *Cryptosporidium*). The second largest strong-evidence FBO in this group was reported by Germany and was associated with the consumption of a quark dessert with mixed berries contaminated with norovirus. The outbreak involved a total of 538 cases and was linked to a 'canteen or workplace catering' as the place of exposure.

### Foods of non-animal origin

Strong-evidence FBOs linked to foods of non-animal origin were reported by 10 MSs (Austria, Belgium, Croatia, Finland, France, Germany, Italy, Poland, Spain and Sweden) and 1 non-MS (Norway). In total 40 FBOs were reported in the EU. The health impact of foods of non-animal origin fell approximately within the same range observed in the last 5 years regarding the total number of outbreaks, cases and hospitalisations, although there were specific annual variations. The number of deaths linked to strong-evidence FBOs associated with the consumption of foods of non-animal origin decreased sharply over 2022 (four fewer deaths). The largest FBO linked to foods of non-animal origin was reported by Sweden and was caused by enterotoxigenic *E. coli* (ETEC) and involved a total of 154 cases. It was the second largest strong-evidence FBO caused by '**herbs and spices**' reported in the EU in the last 10 years. The implicated food was parsley imported from Italy.

A wide variety of causative agents were reported in strong-evidence FBOs associated with foods of non-animal origin. In the 25 strong-evidence FBOs caused by '**vegetables and juices and other products thereof**', *Salmonella* (7 FBOs, 132 cases and 19 hospitalisations) and norovirus (and other calicivirus) (5 FBOs and 138 cases) prevailed ahead of the other causative agents (*Bacillus cereus* toxins, *Clostridium perfringens* toxins, *Escherichia coli* other than STEC, *Listeria monocytogenes*, mushroom toxins, *Staphylococcus aureus* toxins, *Yersinia* and unknown agents), which altogether caused 13 FBOs, 165 cases, 41 hospitalisations and two deaths (both associated with *Listeria monocytogenes*). *S. Adelaide*, *S. Enteritidis*, *S. Senftenberg* and *S. Strathcona* were the *Salmonella* serovars associated with this foodstuff group. In the eight strong-evidence FBOs caused by '**fruit, berries and juices and other products thereof**', the causative agents included norovirus, hepatitis A virus, *Shigella*, *Salmonella* and unknown agents. *Bacillus cereus* toxins, unspecified bacterial toxins and *S. Senftenberg* were the causative agents reported in the five strong-evidence FBOs associated with '**cereal products including rice and seeds/pulses (nuts, almonds) products**'.

### 4.3.2 | Suspect foods in weak-evidence outbreaks

In 2023, 21 MSs (all MSs reporting weak-evidence FBOs except Cyprus, Germany) and 5 non-MSs (Iceland, Montenegro, Republic of North Macedonia, Serbia and Switzerland) described the suspect foods in weak-evidence FBOs. The information was available for a total of 3107 weak-evidence FBOs reported in the EU (60.8% of all weak-evidence FBOs).

The pattern of food vehicles implicated in weak-evidence FBOs with information available was generally consistent with that observed in strong-evidence outbreaks, with a few exceptions. Consistencies were observed for 'composite foods, multi-ingredient foods and other foods' and 'meat and meat products', which ranked first and second, respectively in both strong-evidence and weak-evidence outbreak groups as well as for 'foods of non-animal origin', 'milk and milk products' and 'water (and other beverages)', which ranked fifth, sixth and seventh. In contrast, 'eggs and egg products' ranked third in strong-evidence FBOs but fourth in weak-evidence FBOs since this food group was much more frequently reported in strong-evidence FBOs (Table 52) than in weak-evidence FBOs (235 outbreaks; 7.6% of total weak-evidence FBOs). The opposite ranking was observed for 'fish and fishery products'. This food group ranked fourth in strong-evidence FBOs (Table 52) and third in weak-evidence FBOs (559 outbreaks, 18.0% of total weak-evidence FBOs) mainly due to a more frequent reporting of 'crustaceans, shellfish, molluscs and products thereof' in weak-evidence FBOs (315 outbreaks; 10.1%) than in strong-evidence FBOs (Table 52). Other noteworthy differences concern 'cheese', which was suspected less frequently in weak-evidence FBOs (five outbreaks, 0.16% of total weak-evidence FBOs) as well as 'fruit, berries and juices and other products thereof' (four outbreaks, 0.13% of total weak-evidence FBOs).

### 4.3.3 | Top-10 agent/food pairs in strong-evidence outbreaks associated with the highest impact on health in the EU

The top-10 pairs of causative agents and food vehicles in strong-evidence FBOs with the highest health impact in 2023 in the EU, in terms of number of FBOs, cases, hospitalisations and deaths, are shown in Tables 53–56. These tables include details on the number of MSs reporting FBOs for the related food/agent pair in 2023, as well as for the period 2019–2022, for trend watching purposes. Regarding food vehicles, details were provided in the table footnotes, if available.

Overall, *Salmonella* paired with either 'mixed foods' or 'broiler meat (*Gallus gallus*) and products thereof' ranked among the top 10 in all the classifications. In combination with 'eggs and egg products' *Salmonella* was the most frequent pair for total number of outbreaks and cases and was second for total number of hospitalisations. *Salmonella*, in combination with other types of food (i.e. 'pig meat and products thereof', 'bakery products' and 'fish and fish products'), was also frequently

reported among the top-10 pairs for hospitalisations and deaths. These findings confirm the high health burden of this food-borne pathogen in the EU in 2023.

Interestingly, the reporting of single FBOs with an uncommonly very large number of either cases or hospitalisations, or even deaths, in 2023 is the main explanation for variations > 50% in the number of either cases, hospitalisations or deaths compared with previous years (Tables 53–55). Such fluctuations due to single sporadic events or even to the reporting of new agent/food combinations deserve attention since they potentially represent early signals of possible changes in the epidemiology of food-borne pathogens, in the EU horizon. An example is given by the top-two pairs causing the highest number of deaths in 2023. Aside from 'meat from pig – meat products – ready-to-eat', which is a well-known food vehicle implicated in the transmission of *Listeria monocytogenes* to humans, the food matrix 'table olives' has rarely been reported before in the literature as a source of *L. monocytogenes*. The reporting of this severe FBO shed light on the risk connected to this food of non-animal origin.

**TABLE 53** Top-10 pathogen/food vehicle pairs causing the highest number of strong-evidence outbreaks in reporting EU MSs, in 2023.

2023					2019–2022			Evaluation
Rank <sup>a</sup>	Causative agent	Food vehicle	Outbreaks (N)	Reporting MS (N outbreaks)	Rank <sup>a</sup>	Outbreaks (N/year) (range)	Reporting MS (N/year)	2023 vs 2019–2022 <sup>b</sup>
1	<i>Salmonella</i>	Eggs and egg products <sup>c</sup>	83	Spain (44), Poland (25), Slovakia (3), Austria (2), Hungary (2), Czechia (1), France (1), Italy (1), Lithuania (1), Malta (1), Netherlands (1), Sweden (1)	1	70.0 (37–118)	8.3	–
2	<i>Salmonella</i>	Mixed foods <sup>d</sup>	65	Spain (23), Poland (18), Slovakia (6), Hungary (4), Romania (4), Germany (3), Czechia (2), France (2), Italy (2), Estonia (1)	3	19.0 (3–25)	7.0	↑↑
3	Norovirus and other calicivirus	Crustaceans, shellfish, molluscs and products thereof <sup>e</sup>	30	France (19), Denmark (3), Sweden (3), Belgium (2), Spain (2), Finland (1)	2	50.3 (10–144)	5.5	↓
3	<i>Salmonella</i>	Broiler meat ( <i>Gallus gallus</i> ) and products thereof <sup>f</sup>	30	Lithuania (6), Spain (6), Austria (5), France (3), Hungary (3), Poland (3), Denmark (1), Greece (1), Romania (1), Slovakia (1)	8	8.5 (2–14)	5.3	↑↑
4	<i>Salmonella</i>	Bakery products <sup>g</sup>	17	Poland (10), Czechia (2), Italy (2), Slovakia (2), Slovenia (1)	6	16.8 (9–32)	4.3	–
5	<i>Campylobacter</i>	Broiler meat ( <i>Gallus gallus</i> ) and products thereof	15	Denmark (8), France (2), Lithuania (2), Spain (2), Poland (1)	11	7.5 (4–10)	4.3	↑↑
6	Histamine and scombrototoxin	Fish and fish products <sup>h</sup>	14	Spain (11), France (1), Italy (1), Sweden (1)	4	18.3 (14–24)	5.0	–
6	Mushroom toxins	Mixed foods <sup>i</sup>	14	Italy (14)	NA	0	0	NA
7	Norovirus and other calicivirus	Mixed foods	13	Finland (5), Spain (5), Denmark (2), Belgium (1)	7	10.8 (5–16)	5.5	–
7	<i>Staphylococcus aureus</i> toxins	Mixed foods <sup>j</sup>	13	Romania (3), France (2), Portugal (2), Spain (2), Czechia (1), Hungary (1), Poland (1), Slovakia (1)	13	6.0 (1–12)	3.5	↑↑

Abbreviation: NA, not applicable.

<sup>a</sup>Ranking of the food vehicle based on the number of strong-evidence FBOs in which the combination (causative agent/food vehicle) was implicated (rank 1 is the highest rank meaning the most commonly implicated). Strong-evidence outbreaks with unknown causative agents are not included.

<sup>b</sup>A single arrow indicates variations between –25% and –50% in the number of outbreaks; double arrows indicate variations  $\geq \pm 50\%$ ; a 'stable' value indicates variations of between –25% and +25%.

<sup>c</sup>In 2023, 'eggs and egg products' includes 'eggs and egg products' (76), 'eggs' (7).

<sup>d</sup>In 2023, 'mixed foods' includes 'mixed foods' (50), 'other processed food products and prepared dishes – meat based dishes' (6), 'other processed food products and prepared dishes' (3), 'sauce and dressings – mayonnaise' (2), 'other processed food products and prepared dishes – fish and seafood based dishes' (1), 'other processed food products and prepared dishes – pizza and pizza-like dishes' (1), 'other processed food products and prepared dishes – sushi' (1), 'sauce and dressings' (1).

<sup>e</sup>In 2023, 'crustaceans, shellfish, molluscs and products thereof' includes 'live bivalve molluscs – oysters' (25), 'crustaceans, shellfish, molluscs and products thereof' (4), 'bivalve molluscs' (1).

<sup>f</sup>In 2023, 'broiler meat (*Gallus gallus*) and products thereof' includes 'broiler meat (*Gallus gallus*) and products thereof' (27), 'meat from broilers (*Gallus gallus*)' (1), 'meat from broilers (*Gallus gallus*) – fresh – skinned' (1), 'meat from broilers (*Gallus gallus*) – meat products' (1).

<sup>g</sup>In 2023, 'bakery products' includes 'bakery products' (10), 'bakery products – desserts – containing raw eggs' (4), 'bakery products – pastry – made with raw eggs' (2), 'bakery products – cakes – containing heat-treated cream' (1).

<sup>h</sup>In 2023, 'fish and fish products' includes 'fish and fish products' (13), 'fish – fishery products from fish species associated with a high amount of histidine – not enzyme matured' (1).

<sup>i</sup>In 2023, 'mixed foods' includes 'other processed food products and prepared dishes – mushroom based dishes' (14).

<sup>j</sup>In 2023, 'mixed foods' includes 'mixed foods' (5), 'other processed food products and prepared dishes' (5), 'other processed food products and prepared dishes – meat based dishes' (1), 'other processed food products and prepared dishes – pasta based dishes' (1), 'other processed food products and prepared dishes – pizza and pizza-like dishes' (1).

**TABLE 54** Top-10 pathogen/food vehicle pairs causing the highest number of cases in strong-evidence outbreaks in reporting EU MSs, in 2023.

2023					2019–2022			Evaluation	
Rank <sup>a</sup>	Causative agent	Food vehicle	Cases (N)	Reporting MS (N cases)	Rank <sup>a</sup>	Cases (N/year) (range)	Reporting MS (N/year)	2023 vs 2019–2022 <sup>b</sup>	
1	<i>Salmonella</i>	Eggs and egg products <sup>c</sup>	1101	Spain (336), Hungary (312), Netherlands (156), Poland (154), Sweden (82), Slovakia (20), Austria (19), Czechia (12), France (4), Italy (2), Lithuania (2), Malta (2)	1	630.3 (303–1307)	8.3	↑↑	
2	<i>Salmonella</i>	Mixed foods <sup>d</sup>	839	Spain (211), Czechia (180), Poland (156), Slovakia (112), Hungary (52), Romania (50), Germany (42), Italy (16), Estonia (14), France (6)	2	604.5 (91–1595)	7.0	↑	
3	Norovirus and other calicivirus	Water <sup>e</sup>	751	Spain (650), Finland (62), Greece (39)	5	355.0 (8–984)	2.8	↑↑	
4	<i>Clostridium perfringens</i> toxins	Meat and meat products, unspecified	616	Spain (616)	16	148.0 (23–368)	2.0	↑↑	
5	Norovirus and other calicivirus	Dairy products (other than cheeses) <sup>f</sup>	603	Germany (603)	48	30.5 (0–122)	0.50	↑↑	
6	<i>Cryptosporidium</i>	Water <sup>g</sup>	569	Spain (569)	67	18.3 (0–73)	0.25	↑↑	
7	Norovirus and other calicivirus	Crustaceans, shellfish, molluscs and products thereof <sup>h</sup>	414	Finland (150), France (120), Denmark (100), Sweden (22), Belgium (14), Spain (8)	3	521.8 (147–1152)	5.5	–	
8	<i>Salmonella</i>	Broiler meat ( <i>Gallus gallus</i> ) and products thereof <sup>i</sup>	359	Greece (69), Hungary (56), Austria (54), Spain (49), France (46), Denmark (28), Lithuania (23), Romania (19), Slovakia (9), Poland (6)	19	100.8 (16–240)	5.3	↑↑	
9	<i>Staphylococcus aureus</i> toxins	Mixed foods <sup>j</sup>	358	Portugal (172), Slovakia (60), Romania (34), Spain (33), Czechia (30), France (12), Poland (11), Hungary (6)	13	189.8 (3–466)	3.5	↑↑	
10	Norovirus and other calicivirus	Mixed foods	335	Spain (148), Finland (130), Denmark (42), Belgium (15)	6	354.8 (223–487)	5.5	–	

<sup>a</sup>Ranking of the food vehicle based on the number of cases of illness in strong-evidence FBOs in which the combination (causative agent/food vehicle) was implicated (rank 1 is the highest rank meaning the most commonly implicated). Strong-evidence outbreaks with unknown causative agents are not included.

<sup>b</sup>A single arrow indicates variations between +25% and +50% in the number of outbreaks; double arrows indicate variations > +50%; a 'stable' value indicates variations of between –25% and +25%.

<sup>c</sup>In 2023, 'eggs and egg products' includes 'eggs and egg products' (837), 'eggs' (264).

<sup>d</sup>In 2023, 'mixed foods' includes 'mixed foods' (689), 'other processed food products and prepared dishes – meat based dishes' (73), 'other processed food products and prepared dishes – fish and seafood based dishes' (19), 'sauce and dressings – mayonnaise' (18), 'sauce and dressings' (14), 'other processed food products and prepared dishes – sushi' (12), 'other processed food products and prepared dishes' (10), 'other processed food products and prepared dishes – pizza and pizza-like dishes' (4).

<sup>e</sup>In 2023, 'water' includes 'tap water, including well water' (689), 'water – potable water' (62).

<sup>f</sup>In 2023, 'dairy products (other than cheeses)' includes 'dairy products (excluding cheeses) – dairy desserts' (538), 'dairy products (excluding cheeses) – yoghurt' (65).

<sup>g</sup>In 2023, 'water' includes 'tap water, including well water' (569).

<sup>h</sup>In 2023, 'crustaceans, shellfish, molluscs and products thereof' includes 'live bivalve molluscs – oysters' (379), 'crustaceans, shellfish, molluscs and products thereof' (22), 'bivalve molluscs' (13).

<sup>i</sup>In 2023, 'broiler meat (*Gallus gallus*) and products thereof' includes 'broiler meat (*Gallus gallus*) and products thereof' (262), 'meat from broilers (*Gallus gallus*) – meat products' (69), 'meat from broilers (*Gallus gallus*) – fresh – skinned' (19), 'meat from broilers (*Gallus gallus*)' (9).

<sup>j</sup>In 2023, 'mixed foods' includes 'other processed food products and prepared dishes' (190), 'mixed foods' (129), 'other processed food products and prepared dishes – meat based dishes' (23), 'other processed food products and prepared dishes – pasta based dishes' (11), 'other processed food products and prepared dishes – pizza and pizza-like dishes' (5).

**TABLE 55** Top-10 pathogen/food vehicle pairs causing the highest number of hospitalisations in strong-evidence outbreaks in reporting EU MSs, in 2023.

2023					2019–2022			Evaluation
Rank <sup>a</sup>	Causative agent	Food vehicle	Hospitalisations (N)	Reporting MS (N hospitalisations)	Rank <sup>a</sup>	Hospitalisations (N/year) (range)	Reporting MS (N/year)	2023 versus 2019–2022 <sup>b</sup>
1	<i>Salmonella</i>	Mixed foods <sup>c</sup>	149	Poland (32), Hungary (23), Spain (23), Slovakia (19), Romania (17), Germany (14), Czechia (13), Italy (6), Estonia (1), France (1)	2	88.0 (11–198)	6.0	↑↑
2	<i>Salmonella</i>	Eggs and egg products <sup>d</sup>	123	Spain (55), Poland (50), Austria (4), France (3), Slovakia (3), Czechia (2), Italy (2), Lithuania (2), Hungary (1), Malta (1)	1	157.8 (46–382)	6.5	–
3	<i>Salmonella</i>	Pig meat and products thereof <sup>e</sup>	94	Germany (40), Italy (50), France (4)	4	42.5 (22–57)	4.5	↑↑
4	<i>Salmonella</i>	Bakery products <sup>f</sup>	82	Poland (69), Slovakia (7), Czechia (3), Slovenia (2), Italy (1)	3	55.8 (21–94)	4.0	↑
5	<i>Salmonella</i>	Broiler meat ( <i>Gallus gallus</i> ) and products thereof <sup>g</sup>	79	Lithuania (18), Austria (16), Hungary (16), Greece (11), Denmark (8), Poland (5), France (3), Slovakia (1), Spain (1)	9	23.3 (3–73)	3.3	↑↑
6	<i>Staphylococcus aureus</i> toxins	Mixed foods <sup>h</sup>	41	Romania (28), Hungary (6), Slovakia (6), Czechia (1)	5	33.0 (0–58)	1.8	–
7	Mushroom toxins	Mixed foods <sup>i</sup>	39	Italy (39)	NA	0	0	NA
8	<i>Listeria monocytogenes</i>	Vegetables and juices and other products thereof <sup>f</sup>	38	Italy (38)	28	3.8 (0–13)	0.50	↑↑
9	Flavivirus (incl. tick-borne encephalitis virus)	Cheese <sup>k</sup>	34	Slovakia (34)	39	1.0 (0–4)	0.25	↑↑
10	<i>Salmonella</i>	Fish and fish products <sup>l</sup>	24	Poland (18), Estonia (3), France (2), Spain (1)	36	1.8 (0–5)	0.75	↑↑

Abbreviation: NA, not applicable.

<sup>a</sup>Ranking of the food vehicle based on the number of hospitalisations in strong-evidence FBOs in which the combination (causative agent/food vehicle) was implicated (rank 1 is the highest rank meaning the most commonly implicated). Strong-evidence outbreaks with unknown causative agents are not included.

<sup>b</sup>A single arrow indicates variations between +25% and +50% in the number of outbreaks; double arrows indicate variations > +50%; a 'stable' value indicates variations of between –25% and +25%.

<sup>c</sup>In 2023, 'mixed foods' includes 'mixed foods' (107), 'other processed food products and prepared dishes – meat based dishes' (28), 'other processed food products and prepared dishes – sushi' (4), 'sauce and dressings – mayonnaise' (3), 'other processed food products and prepared dishes' (3), 'other processed food products and prepared dishes – fish and seafood based dishes' (3), 'sauce and dressings' (1).

<sup>d</sup>In 2023, 'eggs and egg products' includes 'eggs and egg products' (115), 'eggs' (8).

<sup>e</sup>In 2023, 'pig meat and product thereof' includes 'pig meat and products thereof' (50), 'meat from pig – minced meat – intended to be eaten raw' (14), 'meat from pig – minced meat' (13), 'meat from pig – meat products – raw and intended to be eaten raw' (13), 'meat from pig – fresh' (4).

<sup>f</sup>In 2023, 'bakery products' includes 'bakery products' (69), 'bakery products – desserts – containing raw eggs' (10), 'bakery products – cakes – containing heat-treated cream' (2), 'bakery products – pastry – made with raw eggs' (1).

<sup>g</sup>In 2023, 'broiler meat (*Gallus gallus*) and products thereof' includes 'broiler meat (*Gallus gallus*) and products thereof' (67), 'meat from broilers (*Gallus gallus*) – meat products' (11), 'meat from broilers (*Gallus gallus*)' (1).

<sup>h</sup>In 2023, 'mixed foods' includes 'other processed food products and prepared dishes – meat based dishes' (23), 'mixed foods' (13), 'other processed food products and prepared dishes' (5).

<sup>i</sup>In 2023, 'mixed foods' includes 'other processed food products and prepared dishes – mushroom based dishes' (39).

<sup>j</sup>In 2023 'vegetables and juices and other products thereof' includes 'table olives' (38).

<sup>k</sup>In 2023, 'cheese' includes 'cheeses made from sheep's milk – fresh' (34).

<sup>l</sup>In 2023, 'fish and fish products' includes 'fish and fish products' (21), 'fish – gravad /slightly salted' (3).

**TABLE 56** Top-10 pathogen/food vehicle pairs causing the highest number of deaths in strong-evidence outbreaks in reporting EU MSs, in 2023.

2023					2019–2022			Evaluation
Rank <sup>a</sup>	Causative agent	Food vehicle	Deaths (N)	Reporting MS (N deaths)	Rank <sup>a</sup>	Deaths (N/year) (range)	Reporting MS (N/year)	2023 vs 2019–2022 <sup>b</sup>
1	<i>Listeria monocytogenes</i>	Pig meat and products thereof <sup>c</sup>	2	Germany (2)	5	1.3 (0–3)	1.0	↑↑
1	<i>Listeria monocytogenes</i>	Vegetables and juices and other products thereof <sup>d</sup>	2	Italy (2)	5	1.3 (0–5)	0.25	↑↑
1	<i>Salmonella</i>	Mixed foods	2	Spain (2)	9	0.25 (0–1)	0.25	↑↑
2	<i>Bacillus cereus</i> toxins	Fish and fish products	1	Spain (1)	NA	0	0	NA
2	<i>Clostridium botulinum</i> toxins	Fish and fish products	1	Italy (1)	NA	0	0	NA
2	<i>Clostridium perfringens</i> toxins	Broiler meat ( <i>Gallus gallus</i> ) and products thereof	1	France (1)	NA	0	0	NA
2	<i>Clostridium perfringens</i> toxins	Fish and fish products	1	Spain (1)	NA	0	0	NA
2	<i>Salmonella</i>	Broiler meat ( <i>Gallus gallus</i> ) and products thereof	1	Austria (1)	NA	0	0	NA
2	<i>Salmonella</i>	Fish and fish products	1	Spain (1)	NA	0	0	NA
2	<i>Salmonella</i>	Meat and meat products, unspecified	1	Poland (1)	9	0.25 (0–1)	0.25	↑↑
2	<i>Salmonella</i>	Pig meat and products thereof	1	Germany (1)	9	0.25 (0–1)	0.25	↑↑

Abbreviation: NA, Not Applicable.

<sup>a</sup>Ranking of the food vehicle based on the number of deaths in strong-evidence FBOs in which the combination (causative agent/food vehicle) was implicated (rank 1 is the highest rank meaning the most commonly implicated). Strong-evidence outbreaks with unknown causative agents are not included.

<sup>b</sup>Double arrows indicate variations > ±50%. footnote "b" in Table 56.

<sup>c</sup>In 2023, 'pig meat and products thereof' includes 'meat from pig – meat products – ready-to-eat' (2).

<sup>d</sup>In 2023, 'vegetables and juices and other products thereof' includes 'table olives' (2).

## 4.4 | Overview of the places of exposure in strong-evidence outbreaks in 2023

The places of exposure for strong-evidence FBOs were reported for 547 FBOs (94.6% of all strong-evidence FBOs) by 21 MSs (all MSs reporting strong-evidence FBOs except Bulgaria and Czechia) and the United Kingdom (Northern Ireland). Information on the place of exposure is described below for 503 FBOs only, since for 44 FBOs the place of exposure was reported as 'others' with no further details. Key statistics are shown in [Table 57](#).

Although the number of strong-evidence FBOs in '**domestic premises**' in 2023 exceeded that of any other place of exposure in the EU, other sites were more frequently identified by the cases as the places of consumption of the implicated food (i.e. place of exposure). In detail, '**restaurant or cafe or pub or bar or hotel or catering service**', '**multiple places of exposure in one country**' and '**school or kindergarten**' were places associated with a larger number of cases compared with FBOs occurring in '**domestic premises**'. Overall, 5632 cases were exposed to contaminated food in one of the three above-mentioned places (50.5% of total cases involved in strong-evidence FBOs).

The overall impact of strong-evidence FBOs in 'domestic premises' was higher compared with 2022, with 51 more strong-evidence FBOs (35.2% increase), 168 more cases (24.1% increase) and 75 more hospitalisations (35.4% increase). The health impact of FBOs in 'domestic premises' is likely even higher since only 13 MSs (Austria, Finland, France, Greece, Italy, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Spain) and one non-MS (Serbia) provided information to EFSA on strong-evidence FBOs in domestic premises. As described above (see Section 4.1 on the countries reporting food-borne outbreak data in 2023), not all MSs report information on 'household' outbreaks (i.e. FBOs where all the human cases live in one single household), which are mostly associated with the place of exposure 'domestic premises'. *Salmonella*, and in particular *S. Enteritidis*, was by far the most frequent food-borne pathogen identified in these strong-evidence FBOs, causing more than half of FBOs in this setting ( $N=115$ ).

Strong-evidence FBOs in a 'restaurant or cafe or pub or bar or hotel or catering service' were reported by 17 MSs (Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Poland, Romania, Slovakia, Spain and Sweden) and three non-MSs (Republic of North Macedonia, Serbia and Switzerland), i.e. a higher number of countries than in 2022 (14 MSs and one non-MS). Among MSs FBOs linked to this place of exposure also increased in 2023 compared with 2022 (47 more outbreaks, 35.1% increase) as did cases (844 more cases, 47.8% increase), hospitalisations (136 more hospitalisations, 101.5% increase) and deaths (no deaths had been communicated in 2022 for this place of exposure). The most frequently implicated causative agents in strong-evidence FBOs occurring in a 'restaurant or cafe or pub or bar or hotel or catering service' were *Salmonella* (73 outbreaks, 992 cases, 199 hospitalisations and 3 deaths), norovirus (and other calicivirus) (30 outbreaks, 720 cases, 2 hospitalisations), *Staphylococcus aureus* toxins (14 outbreaks, 211 cases, 47 hospitalisations) and *Clostridium perfringens* toxins (8 outbreaks, 173 cases, 1 hospitalisation).

Eleven MSs (Belgium, France, Germany, Hungary, Italy, Lithuania, Poland, Portugal, Romania, Slovakia and Spain) contributed to information on strong-evidence FBOs in a 'school or kindergarten'. Outbreaks occurring in these settings are frequently medium, large or very large in size. In 2023, there were 13 (44.8%) strong-evidence FBOs including 25 or more cases in these places of exposure and the four largest outbreaks totalled altogether 955 cases (63.5% of cases involving these places of exposure). The health impact of these FBOs was characterised by a limited number of hospitalisations and no deaths and was not substantially different from that observed in the four previous years.

A sharp increase in the number of cases was observed in the 10 strong-evidence FBOs occurring in a '**canteen or workplace catering**' setting. In 2023 cases increased by 134.8% compared to 2022 (407 more cases) mainly due to a very large outbreak caused by norovirus reported from Germany, which included more than 500 cases (see also Section 4.4 on the places of exposure in strong-evidence outbreaks in 2023 and [Table 54](#)).

The same number of strong-evidence FBOs in '**health care and residential facilities**' was reported as in 2022 (30 outbreaks), but with fewer cases (543 fewer cases) and hospitalisations (21 fewer hospitalisations). There was however a high death toll from the strong-evidence FBOs associated with these facilities (eight deaths), which is cause for concern because the people in these settings are more vulnerable compared with the general population, and frequently suffer from multiple conditions that contribute to make the impact of food-borne diseases more severe than in most other population subgroups. Causative agents associated with deaths in these strong-evidence FBOs included *Listeria monocytogenes* (two deaths), *Bacillus cereus* toxins and *Clostridium perfringens* toxins (one death each). For four deaths, the causative agent was not identified.

Strong-evidence FBOs with '**multiple places of exposure**' in one or multiple countries were reported by 11 MSs (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain and Sweden) and the United Kingdom (Northern Ireland). The causative agents most frequently reported in these strong-evidence FBOs were bacteria (*Salmonella*, *Campylobacter*, Shiga toxin-producing *E. coli* (STEC), *Escherichia coli* other than STEC) and norovirus.

For a more interactive look at FBO data by places of exposure, visit the dedicated page in EFSA's dashboard on FBO ([here](#)).



**TABLE 57** Frequency distribution of strong-evidence food-borne outbreaks by place of exposure (setting), in reporting EU MSs, 2023.

Place of exposure	Strong-evidence outbreaks								Outbreak reporting rate per 100,000	
	Outbreaks		Cases		Hospitalisations		Deaths		2023	2019–2022
	N	% of total	N	% of total	N	% of total	N	% of total		
<b>Domestic premises</b>	196	33.9	866	7.8	287	30.4	3	16.7	0.043	0.036
<b>Restaurant, pub, street vendors, take away, etc.</b>										
Restaurant or cafe or pub or bar or hotel or catering service	181	31.3	2608	23.4	270	28.6	3	16.7	0.040	0.025
Take-away or fast-food outlet	4	0.69	154	1.4	54	5.7	0	0	0.001	0.001
Mobile retailer or market/street vendor	3	0.52	15	0.13	8	0.85	0	0	0.001	0.001
<b>Canteen or catering at workplace, school, etc.</b>										
School or kindergarten	29	5.0	1504	13.5	32	3.4	0	0	0.006	0.006
Canteen or workplace catering	10	1.7	709	6.4	3	0.32	0	0	0.002	0.002
Catering on aircraft or ship or train	2	0.35	53	0.47	2	0.21	0	0	<0.001	<0.001
<b>Multiple places of exposure</b>										
Multiple places of exposure in one country	33	5.7	1520	13.6	156	16.5	3	16.7	0.007	0.005
Multiple places of exposure in more than one country	3	0.52	23	0.21	9	0.95	0	0	0.001	0.001
<b>Health care and residential facilities</b>										
Residential institution (prison or boarding school) <sup>a</sup>	12	2.1	263	2.4	2	0.21	1	5.6	0.003	–
Nursing home <sup>a</sup>	12	2.1	237	2.1	5	0.53	2	11.1	0.003	–
Hospital and medical care facility	6	1.0	221	2.0	32	3.4	5	27.8	0.001	0.002
<b>Other place of exposure</b>										
Others	44	7.6	1650	14.8	40	4.2	1	5.6	0.010	0.005
Camp or picnic	7	1.2	172	1.5	15	1.6	0	0	0.002	0.002
Temporary mass catering (fairs or festivals)	3	0.52	10	0.09	3	0.32	0	0	0.001	<0.001
Farm	1	0.17	2	0.02	1	0.11	0	0	<0.001	<0.001
Primary production	1	0.17	14	0.13	0	0	0	0	<0.001	<0.001
<b>Unknown</b>	31	5.4	1139	10.2	25	2.6	0	0	0.007	0.006
<b>EU Total</b>	<b>578</b>	<b>100</b>	<b>11,160</b>	<b>100</b>	<b>944</b>	<b>100</b>	<b>18</b>	<b>100</b>	<b>0.128</b>	<b>0.098</b>

<sup>a</sup>Since 2024, food-borne outbreaks occurring in nursing homes could be reported specifically within the 'nursing homesetting'. Previously, this setting was grouped under 'residential institution (nursing home, prison or boarding school)'. As no information on FBOs occurring specifically in nursing homes in 2019–2022 was available, the outbreak reporting rate could not be estimated in this period.

## 4.5 | Contributing factors in strong-evidence food-borne outbreaks in 2023

Information on factors contributing to strong-evidence FBOs was available for 196 FBOs (33.9% of all strong-evidence FBOs).

**'Inadequate heat treatment'** and **'inadequate chilling'** were reported to have contributed to 49 and 24 strong-evidence FBOs, respectively. In particular, **'inadequate heat treatment'** was the contributory factor reported most often in strong-evidence FBOs caused by *Salmonella* (29 out of 74 outbreaks corresponding to 39.2% of strong-evidence *Salmonella* FBOs with information on contributory factors available) and by *Campylobacter* (eight outbreaks, 40.0%). **'Unprocessed contaminated ingredient'**, which was reported for 41 strong-evidence FBOs overall, also made a major contribution to *Campylobacter* FBOs (eight outbreaks, 40.0%) and FBOs caused by norovirus and other calicivirus (10 outbreaks, 37.0%). **'Cross-contamination'** was reported in 41 strong-evidence FBOs. This factor was the most frequently reported in FBOs caused by *Listeria monocytogenes* (three outbreaks, 75.0%). **'Time storage/temperature abuse'** was reported in 36 strong-evidence FBOs and was the top contributory factor in FBOs caused by *Clostridium perfringens* (11 outbreaks, 73.3%), *Bacillus cereus* (three outbreaks, 75.0%), histamine and scombrototoxin (two outbreaks, 50.0%), and *Escherichia coli* other than STEC (two outbreaks, 50.0%). **'Infected food handler'** was identified in 31 strong-evidence FBOs and ranked first among factors contributing to FBOs caused by norovirus (and other calicivirus) (11 outbreaks, 40.7%) and *Staphylococcus aureus* toxins (eight outbreaks, 61.5%). **'Water treatment failure'** and **'untreated drinking water'** were reported in two and three strong-evidence water-borne outbreaks, respectively.

The distribution of contributory factors by either type of implicated food or place of exposure indicates that the use of an 'unprocessed contaminated ingredient' was the most important factor in strong-evidence FBOs implicating 'foods of non-animal origin' (six outbreaks, 46.2%), 'fish and fishery products' (eight outbreaks, 38.1%) and 'milk and milk products' (four outbreaks, 26.7%), as well as in strong-evidence FBOs involving cases exposed to contaminated food in 'multiple places of exposure' (15 outbreaks, 71.4%). Outbreaks occurring in 'domestic premises' were mostly associated with 'inadequate heat treatment' (24 outbreaks, 61.5%). This factor was of primary importance also in strong-evidence FBOs caused by 'eggs and egg products' (14 outbreaks, 46.7%), while in strong-evidence FBOs associated with the consumption of 'composite foods, multi-ingredient foods and other foods', this role was played by 'infected food handler' (23 outbreaks, 41.1%). 'Infected food handler' also ranked first among all contributory factors in strong-evidence FBOs associated with a 'restaurant, pub, street vendors, take away, etc.' (24 outbreaks, 28.6%), followed by 'cross-contamination' (20 outbreaks, 23.8%) and 'storage time/temperature abuse' (16 outbreaks, 19.0%). For strong-evidence FBOs caused by 'meat and meat products', 'cross-contamination' and 'storage time/temperature abuse' were the top contributory factors, while the use of 'untreated drinking water' was conceivably the most important contributor to strong-evidence FBOs implicating 'water (and other beverages)' (three outbreaks, 75.0%). 'Storage time/temperature abuse' contributed the most to strong-evidence FBOs connected to a 'canteen or catering at workplace, school, etc.' (eight outbreaks, 50.0%), while 'cross-contamination' was the most frequent factor reported in 'health care and residential facilities' (four outbreaks, 36.4%).

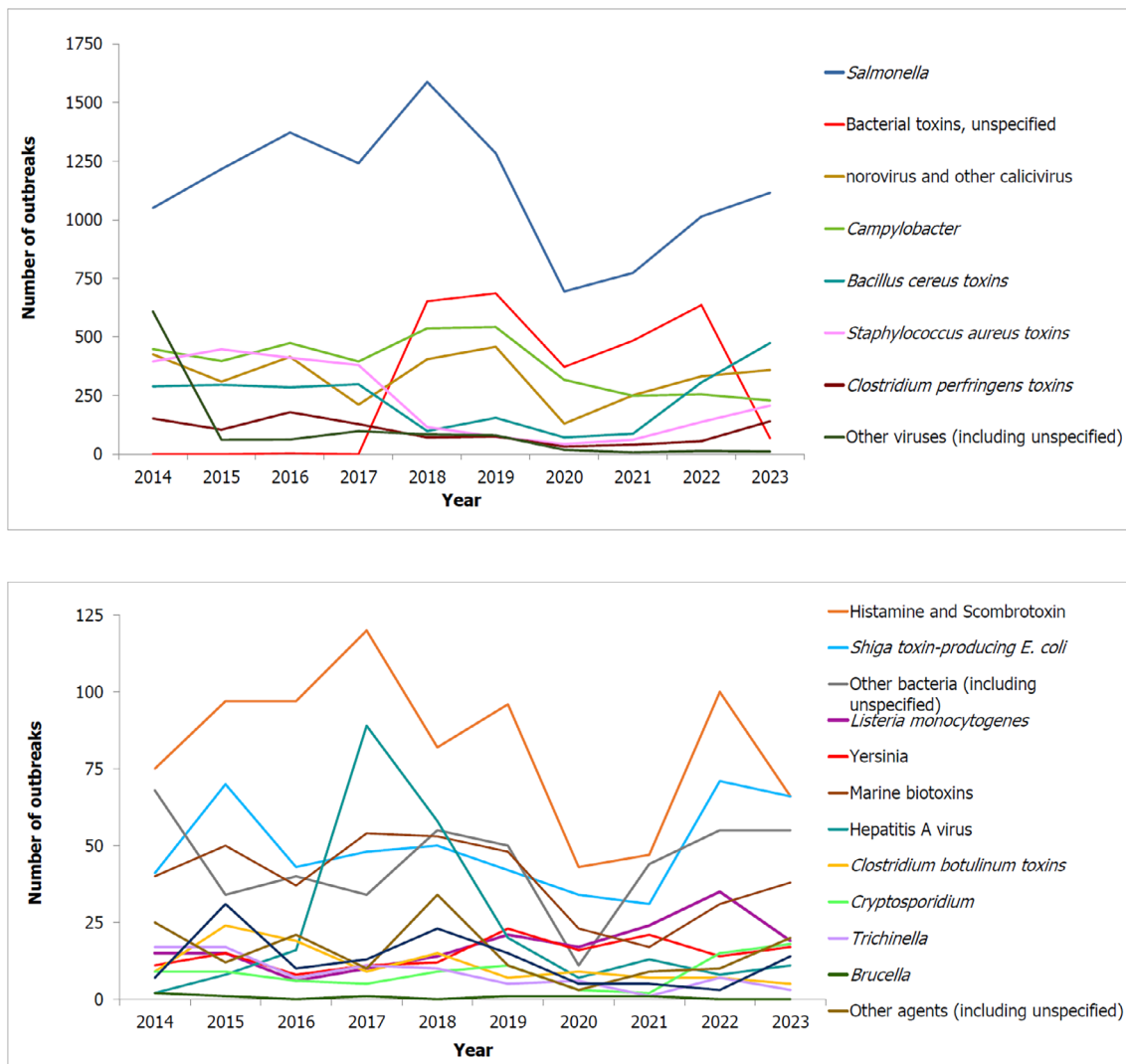
See the EFSA story map on FBOs ([here](#)), section on 'How, why and where food contamination may occur'.

## 4.6 | Temporal trends by causative agents, 2014–2023

### 4.6.1 | Temporal trends at EU level

The number of FBOs reported by MSs over 2014–2023, by causative agent, is illustrated in [Figure 21](#). Since the collection of FBO data is not fully harmonised across the EU, and changes in FBO surveillance might have occurred over the years in MSs, the annual fluctuations in the distribution of causative agents reported in [Figure 21](#) might not accurately represent the true epidemiological pattern at the EU level.

For a more interactive look at time trends in FBO data, visit the dedicated page in EFSA's dashboard on FBO ([here](#)).



**FIGURE 21** Number of food-borne outbreaks by causative agent, reported to the EU by MSs, 2014–2023. ‘Marine biotoxins’ includes ciguatoxin, muscle-paralysing toxin and unspecified marine biotoxins. ‘Norovirus (and other calicivirus)’ includes norovirus (Norwalk-like virus), sapovirus (Sapporo-like virus) and unspecified calicivirus. ‘Other bacteria (incl. unspecified)’ includes *Aeromonas*, *Arcobacter*, *Cronobacter sakazakii*, *E. coli* other than STEC, *Enterococcus*, *Francisella*, *Leptospira*, *Mycobacterium* spp., *Shigella*, *Streptococcus*, *Vibrio cholerae* (non-toxigenic), *Vibrio cholerae* (toxigenic), *Vibrio parahaemolyticus* and other unspecified bacteria. ‘Other parasites (incl. unspecified)’ includes *Anisakis*, *Cysticerci*, *Enterocytozoon bieneusi*, *Giardia* and other unspecified parasites. ‘Other viruses (incl. unspecified)’ includes adenovirus, enterovirus, flavivirus (incl. tick-borne encephalitis virus), hepatitis E virus, unspecified hepatitis virus, rotavirus and other unspecified virus. ‘Other agents (incl. unspecified)’ includes atropine, chemical agents, lectins, monosodium glutamate, mushroom toxins, mycotoxins, unspecified toxins, wax esters (from fish) and other unspecified agents.

#### 4.6.2 | Temporal country-specific trends by causative agent

Only statistically significant trends in the number of FBOs, by causative agent and country, are described in this section. More information on the methodology used for trend analyses is provided in the section on data analyses of this chapter (Section 3 on Data Analysis). Figures on statistically significant country-specific temporal trends by causative agent, over the 2014–2023 period, are available in the ‘Addendum on food-borne outbreaks, complementing the European Union One Health Zoonoses Report 2023’, Section 5, published on the EFSA Knowledge Junction at Zenodo ([here](#)).

Various statistically significant increasing or decreasing trends, by causative agent and reporting EU MS, were observed over the period 2014–2023.

The trend analysis for **Salmonella** highlighted a significant decreasing trend for four MSs (Germany, Latvia, Lithuania and Romania), two fewer countries with statistically significant decreasing trends than 2022. For Germany, Latvia and Lithuania this decrease was primarily due to a significant decrease in the number of outbreaks due to **S. Enteritidis**. In Austria, a significant decrease in the number of FBOs was observed for **S. Enteritidis** and **S. Typhimurium**.

The second bacterial agent with statistically significant trends was **Campylobacter**. A significant decreasing trend over 2014–2023 was observed in two MSs (Austria and Germany), while the trend increased significantly in France. A significant decrease was also detected for FBOs caused by **Shigella** in Germany.

Considering **norovirus**, a statistically significant decreasing trend was observed in the Netherlands. Other agents with a statistically significant reduction in the number of FBOs over the 2014–2023 period were **Trichinella** in Romania and **marine biotoxins** in France.

Lastly, in the EU, a statistically significant decrease in the number of FBOs with an unknown agent was observed in Finland and Sweden, while Czechia, Italy and the Netherlands experienced a significant increase. In non-MSs, a decreasing trend was observed in Norway and an increase in Switzerland. The differences in trends across these countries may be attributed to variations in outbreak surveillance sensitivity, as well as changes in laboratory testing and subtyping methods.

#### 4.6.3 | Temporal trends by implicated food vehicle

Only strong-evidence FBOs were considered for the trend analysis by implicated food vehicle at country level. Few statistically significant trends were detected for food vehicles over the 2014–2023 period.

Decreasing trends were identified for strong-evidence FBOs associated with the consumption of **'pig meat'** and **'buffet meals'** in Romania, **'cheese'** in France and **'sweets and chocolate'** in Poland. The decreasing trends observed for France and Poland were both driven by a significant decrease in FBOs caused by *Salmonella* in 'cheese' and 'sweets and chocolate', respectively ( $p < 0.05$ ). Only for Italy an increasing trend was observed in the number of FBOs associated with 'pig meat'.

Figures describing statistically significant temporal trends in the number of outbreaks, both by causative agent and MS and by food vehicle and MS, are available as downloadable files from the EFSA knowledge junction at Zenodo [here](#).

### 4.7 | Water-borne outbreaks

In 2023, 42 water-borne outbreaks were reported by 11 MSs (Belgium, Croatia, Czechia, Finland, France, Greece, Ireland, Italy, Slovakia, Spain and Sweden) and three by two non-MSs (Norway and Switzerland). In the EU, water-borne outbreaks involved a total of 1954 human cases with nine hospitalisations, corresponding to four fewer cases and 41 fewer hospitalisations than in 2022. No deaths were reported in water-borne outbreaks.

Among the FBOs observed in the EU, 10 outbreaks were considered strong-evidence and included outbreaks caused by **'tap water, including well water'** ( $N=8$ ) and **'potable water'** ( $N=2$ ).

The causative agents involved were norovirus and other calicivirus ( $N=10$ ), *Cryptosporidium* ( $N=7$ ), Shiga toxin-producing *E. coli* (STEC) ( $N=4$ ), *Campylobacter* ( $N=2$ ), *Shigella* ( $N=1$ ), *Clostridium perfringens* toxins ( $N=1$ ) and *Giardia* ( $N=1$ ). In 16 outbreaks the aetiology remained unknown.

Water-borne outbreaks often include a large or very large number of cases. In 2023 the mean size of water-borne outbreaks in the EU was 46.5 cases per outbreak (range 2–580 cases). Two very large outbreaks ( $\geq 100$  cases each) were reported to EFSA, both from Spain. The largest one involved 580 cases and was caused by norovirus, resulting from a failure in the water treatment system, while the other outbreak involved 119 cases and was caused by *Cryptosporidium*. Two other outbreaks were reported jointly to EFSA from Spain and were caused by *Cryptosporidium* involving altogether 450 cases.

Norway also reported a very large water-borne outbreak (140 cases) with unknown aetiology. In addition, Norway and Switzerland reported two other outbreaks linked to 'water' and 'potable water', which were caused by *E. coli* other than STEC and an unknown agent, respectively.

### 4.8 | ECDC and EFSA rapid outbreak assessment (ROA)

ECDC and EFSA jointly assessed the public risk of various FBOs occurring in 2023, publishing Rapid Outbreak Assessments (ROA).

The first ROA referred to a cross-border outbreak caused by *Salmonella* Virchow ST16, which involved 210 cases in five EU countries (Denmark, France, Germany, Ireland and Netherlands), the United Kingdom (UK) and the United States of America over the period 2017–2023. The proportion of hospitalisations varied across countries. No deaths were reported. Information from case interviews, food traceability investigations and whole genome sequencing (WGS) cluster analysis identified chicken meat products including chicken kebab as the likely vehicle of infection. However, the source(s) of contamination had not been established at the date of publication of this ROA (ECDC and EFSA, 2023b).

A second outbreak was caused by *S. Senftenberg* ST14 and occurred in the years 2022 and 2023. This outbreak caused 92 cases in 11 EU/EEA countries (Austria, Belgium, Czechia, Estonia, Finland, France, Germany, Ireland, Netherlands, Norway and Sweden), the UK and the US, involving predominantly women. Twelve cases were hospitalised while one patient died. Case interviews pointed to cherry tomatoes as the likely source of infection. The outbreak strain was detected in a mixed salad dish containing cherry tomatoes. However, following traceability investigations, no common epidemiological (trade) link between the traced back food business operators and the countries reporting cases was revealed. Since June 2023, the number of cases has declined as well as the risk of new infections (ECDC and EFSA, 2023a).

In 2023, *S. Enteritidis* ST11 was the causative agent responsible for an outbreak causing 335 cases, nine hospitalisations and one death in 14 EU/EEA countries, the UK and the US. Three different molecular clusters were identified based on WGS analysis. Food exposure information and microbiological investigations identified chicken meat and chicken meat products, including kebab, as the likely vehicle of human infections. Traceability information revealed that some kebab products shared common food business operators in Poland. However, at the time of publication of the ROA, further traceability and microbiological investigations were still needed to identify the source of contamination and infections (ECDC and EFSA, 2023e).

An update of the multi-country outbreak caused by *S. Mbandaka* ST413, described in 2022 (ECDC and EFSA, 2022), was published in March 2024 (ECDC and EFSA, 2024a). This outbreak involved 300 cases, with an increase of 53.1% (104 new cases in 2023) compared with 2022, in six EU countries (Estonia, Finland, France, Germany, Ireland and Netherlands) and the UK. Twenty-three cases were hospitalised and one patient died. Case interviews, microbiological analyses and traceability investigations indicated frozen steam-cooked chicken breast, produced by a Ukrainian factory, as the source of infection. Various control measures were adopted, and the contaminated batches were assumed to no longer be on the market. However, other undetected routes of exposures might still be present posing a risk of new infections (ECDC and EFSA, 2024a).

Two other assessments were published and concerned clusters of *Listeria monocytogenes* of two different sequence types (ST). The first ROA described a cluster of *L. monocytogenes* ST155, serogroup IIa. Three sub-clusters were identified through genomic similarity analysis; however, the assessment focused on sub-cluster 1, which occurred between 2016 and 2023. A total of 64 cases and 10 deaths were reported by five EU countries (Austria, Belgium, Italy, Germany and Netherlands). Case interviews identified ready-to-eat fish products as the likely vehicle of infection, and traceability and genomic investigations pointed to three Lithuanian processing plants (ECDC and EFSA, 2023c).

The second ROA focused on a cluster caused by *L. monocytogenes* ST1607, identified in three EU countries (Denmark, Germany and Italy) between 2019 and 2024. Twenty cases and five deaths were notified. Case interviews, and microbiological and food traceability investigations identified smoked salmon products as the probable source of infections. The outbreak strain was identified from products and from the environment of a Danish processing plant. Various control measures were soon adopted by the Danish factory, including withdrawal and recall of the contaminated batches (ECDC and EFSA, 2024b).

## 5 | CONCLUSIONS

### 5.1 | Health impact, causative agents and trends

In 2023, the reporting of FBOs in the EU did not substantially change compared with 2022 in terms of total outbreaks, cases, hospitalisations and deaths. Despite a slight reduction in the overall number of outbreaks, there was an increase in the number of cases, likely attributable to the identification of a higher proportion of larger FBOs compared with the previous year. Most of the reported FBOs were general outbreaks, involving cases belonging to more than one household. A total of 65 deaths were reported in 2023 in the EU, the highest value reported to EFSA in the last 10 years.

The outbreak and case reporting rate observed in 2023 showed an increase compared with the average annual rate for the 2019–2022 period, which was lower primarily because it included the years of the COVID-19 pandemic (2020–2021). The resurgence in the rates observed in 2023 indicated a return to pre-pandemic levels. At the national level, significant variability was observed in the epidemiological indicators used to describe FBOs, including reporting rates, mean outbreak size, type of outbreak and severity. This variability reflects both epidemiological differences and disparities in the approach and sensitivity of FBO surveillance across countries.

In the EU, various multi-country outbreaks were reported in 2023, with *Salmonella* being the most frequently reported causative agent. The widespread use of WGS across countries has revolutionised outbreak detection and investigation and has considerably improved the early detection of cases of food-borne infections, even among countries (Brown et al., 2019; Gilchrist et al., 2015). WGS has significant potential in the surveillance and monitoring of emerging health threats, also in the context of food-borne outbreaks, by enabling accurate characterisation of pathogens, and supporting cross-border food-borne outbreak investigation and management (EFSA, 2022).

The key results from the 2023 data indicate that the health impact of FBOs caused by *Salmonella*, and in particular by *S. Enteritidis*, continues to be very high in Europe. The high number of deaths is a major finding emerging from the 2023 data analysis, since non-typhoidal *Salmonella* infections typically cause mild, self-limiting enterocolitis in industrialised countries, usually characterised by abdominal pain, diarrhoea, nausea and vomiting, and resolving spontaneously (Coburn et al., 2007). The rise in deaths from *Salmonella* infections highlights the potential for severe and fatal infection from outbreaks of *Salmonella*, particularly in vulnerable population subgroups (i.e. young children, elderly, immunocompromised individuals), which may develop severe and invasive diseases (Acheson & Hohmann, 2001). These population subgroups are also at risk from the development of severe listeriosis (i.e. septicaemia, meningitis and meningoencephalitis). *Listeria monocytogenes* continues to be the causative agent associated with the highest case fatality rate. Many deaths caused by severe listeriosis were reported among epidemic cases in healthcare settings in 2023. These findings need to be carefully considered, with particular attention paid to the wide variety of food vehicles, even some that are not traditionally considered as likely sources of infections (e.g. table olives), which may support the growth of *L. monocytogenes* and cause FBOs (e.g. meat and meat products, fish and fish products, mixed and multi-ingredient foods, dairy products and vegetables) (Desai et al., 2019; Koopmans et al., 2023).

Interestingly, in the EU, more FBOs in 2023 than in 2022 involved travel-related cases, with *Salmonella* being the most frequent causative agent. This finding highlights the need to continue raising awareness among the public regarding food safety and the risk of developing food-borne illness while travelling, particularly in regions with less stringent food safety standards compared with the EU.

## 5.2 | Food vehicles and places of exposure

Directive 2003/99/EC focuses on the importance of collecting information on FBOs in Europe. This is the only data source that allows the simultaneous collection of information on food vehicles and human disease cases. The assessment of the level of uncertainty with respect to the evidence associating epidemic cases with the food vehicles and, in general, with the context in which the outbreak occurred is an important element contributing to the quality of EFSA's epidemic data collection. It enables an assessment of the accuracy of findings evaluated in the epidemic context.

The data collection carried out by EFSA in 2023 on food vehicles linked to epidemic outbreaks and the places where these foods were consumed reveals information that consolidates the results of previous years and related trends. Findings emerging from the analysis of 2023 data on food vehicles concur with those for the entire 2019–2022 period. 'Composite foods, multi-ingredient foods and other foods' followed by 'meat and meat products', 'eggs and egg products' and 'fish and fishery products' were the food groups most frequently identified in strong-evidence outbreaks and having the highest impact in terms of cases and hospitalisations.

The number of outbreaks associated with 'composite foods, multi-ingredient foods and other foods' and in particular 'mixed foods' has increased steadily since 2020. This finding is not surprising since this group includes a wide miscellanea of food of different natures obtained by mixing ingredients of either animal or non-animal origin. The contamination of mixed foods may arise from a single contaminated ingredient which remains unidentified during the outbreak investigation. Problems leading to contamination of single ingredients or contributing to boost the level of contamination in the final mixed food preparation may originate and propagate through different mechanisms and at various stages of the food production chain and meal preparation at the consumer level. Food handling increases the risk of contamination and even of microbial growth when food is prepared by an infected food handler or through mechanisms of cross-contamination, in particular when food is prepared under poor hygiene procedures or at temperatures allowing microbial growth. Findings from the 2023 EFSA data analysis on FBOs indicate that all these factors have made a major contribution to outbreaks linked to public catering, making it even more important to strengthen HACCP implementation.

Training, attitudes, knowledge awareness and practices of operators in the catering service sector and in particular in restaurants, pubs, cafés and hotel catering, etc. are crucial to keep the risk of exposure to contaminated food under control, since public catering (either for leisure or connected to daily activities such as school and the workplace) is very frequently implicated in food-borne outbreaks in the EU. The importance of restaurants, pubs, cafés and hotel catering, etc. increased sharply in 2023, with more MSs reporting outbreaks connected to these places (either more outbreaks, cases, hospitalisations or deaths) compared with 2022. These variations, however, do not necessarily indicate an increased risk of exposure to contaminated food for consumers as they may be the result of more meals and food consumed in these settings. Recent data from the EFSA/Eurobarometer study (EFSA, 2022) indicate that the total household expenditure on catering services is on the rise in most MSs, which suggests an increased tendency to eat out.

People's eating behaviours vary considerably among MSs and among population subgroups, with important socio-demographic and food environment factors influencing the patterns and the places of food consumption. As an example, young adults and people living in urban areas are more frequently exposed to food prepared in public catering than older adults and people living in rural area or suburbs who more frequently consume meals at home. Education at home on how to prepare and consume food safely, including the importance of following the instructions on food labels, is crucial to improve food safety in domestic kitchens. EFSA recommends once again the importance of promoting food-safety education programmes such as the WHO Five Keys campaign<sup>47</sup> in domestic kitchens and is directly committed to supporting MSs in the annual communication campaigns for consumers.

The 2023 annual FBO data collection revealed that that 'inadequate heat treatment' was the most frequent factor contributing to food-borne outbreaks in domestic premises. Not paying attention to information about food safety has a direct impact on the risk of exposure to contaminated food in this place of exposure. The recent Special Eurobarometer 97.2 study on Food safety in the EU (EFSA, 2022) shed light on the reasons underpinning the lack of consumer engagement with food safety. Conviction that food sold is safe, a perception by consumers that they know enough to avoid or mitigate food risks and difficulties in understanding food safety information due to highly technical and complex language were the main identified reasons. Such factors may hamper the adoption of correct food handling and consumption behaviours at home, in particular by the most vulnerable groups of the population. Consumers' self-awareness of their personal role and responsibility in keeping food safe at home is therefore critical. Unfortunately, older adults have been found in a recent study to perceive themselves as having lower levels of risk than other individuals, suggesting perceptions of optimistic bias and personal invulnerability (Evans & Redmond, 2019).

In conclusion, food-borne outbreaks remain a significant public health threat in the EU, with increasing cases and deaths in 2023, particularly affecting vulnerable groups. Advances in genome sequencing have probably improved outbreak detection in the EU, in particular detection of large general outbreaks disseminated in the community. On the other hand improper food handling and errors in food preparation, especially in public and domestic premises, continue to represent major risk factors in food contamination and consumer exposure to contaminated food. Globalisation, shifting consumption habits and population movements further heighten the risk of food-borne outbreaks, posing ongoing challenges to public health.

<sup>47</sup>The core messages of the WHO Five Keys campaign are: keep clean; separate raw and cooked; cook thoroughly; keep food at safe temperatures; and use safe water and raw materials.

# ZOOSES AND ZONOTIC AGENTS MONITORED ACCORDING TO THE EPIDEMIOLOGICAL SITUATION (DIRECTIVE 2003/99/EC LIST B)

## 1 | YERSINIA

### Human cases [EU, 2023]

Notification rate (per 100,000 population) **2.4**

Trend (2019-2023)    
↑ Increasing  
 ↓ Decreasing  
 — Stable

**8738** Cases of illness

**4929** Infections acquired in the EU

**152** Infections acquired outside the EU

**3657** Unknown travel status or unknown country of infection

**651** Hospitalisations (25.5%)\*

**1** Death (0.02%)\*

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

 ECDC data

### Foodborne outbreaks & related cases [EU, 2023]

**17** Foodborne outbreaks

**2** Strong-evidence outbreaks 

**15** Weak-evidence outbreaks 

**73** Cases of illness

**9** Hospitalisations (12.3%)\*

\* The percentages are calculated on the number of cases with information available (for further details see Table 2)

#### N of outbreaks

Austria	1
Belgium	0
Bulgaria	0
Croatia	0
Cyprus	0
Czechia	0
Denmark	0
Estonia	0
Finland	0
France	4
Germany	1
Greece	0
Hungary	0
Ireland	0
Italy	0
Latvia	0
Lithuania	0
Luxembourg	0
Malta	0
Netherlands	0
Poland	3
Portugal	0
Romania	0
Slovakia	2
Slovenia	0
Spain	5
Sweden	1
UK (N. Ireland)	0

#### N of outbreaks per 100,000 population \*\*

AT	0.011
BE	0
BG	0
HR	0
CY	0
CZ	0
DK	0
EE	0
FI	0
FR	0.006
DE	0.001
EL	0
HU	0
IE	0
IT	0
LV	0
LT	0
LU	0
MT	0
NL	0
PL	0.008
PT	0
RO	0
SK	0.037
SI	0
ES	0.010
SE	0.010
XI	0

#### N of outbreak cases per 100,000 population

AT	0.022
BE	0
BG	0
HR	0
CY	0
CZ	0
DK	0
EE	0
FI	0
FR	0.016
DE	0.002
EL	0
HU	0
IE	0
IT	0
LV	0
LT	0
LU	0
MT	0
NL	0
PL	0.057
PT	0
RO	0
SK	0.074
SI	0
ES	0.027
SE	0.190
XI	0

#### Implicated food vehicles (Strong-evidence outbreaks)

##### Top food vehicles



Vegetables and juices and other products thereof

**1** Outbreak



Meat and meat products, unspecified

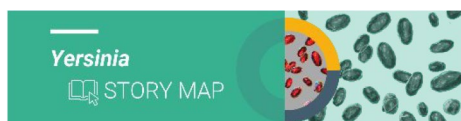
**1** Outbreak

\*\* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.

 EFSA data

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Yersinia*, the following interactive tool is available:



## 1.1 | Key facts

- In 2023, there were 8738 confirmed cases of human yersiniosis, corresponding to a European Union notification rate of 2.4 cases per 100,000 population. This was an increase of 13.5% compared with 2022 (2.2 per 100,000 population).
- The overall trend for *Yersinia* infection showed a statistically significant increase ( $p < 0.01$ ) in the 2019–2023 period.
- In 2023, *Yersinia enterocolitica* was the species reported in the majority (97.7%) of human cases, while *Yersinia pseudotuberculosis* was notified in 2.3% of human cases for which the information on *Yersinia* species was available.
- In 2023, none of 314 'ready-to-eat' (RTE) food sampling units reported by four Member States were positive for *Yersinia*. Of 1210 'non-RTE' sampling units reported by six Member States, 10.2% were positive. The only positive category was 'meat and meat products' with a rate of 10.2%. Of 953 'fresh meat' sampling units, only 'fresh meat from pigs' showed *Yersinia*-positive sampling units, with a rate of 12.6%.
- In 2023, *Yersinia* was detected by six Member States in more than eight different animal categories, which overall include more than 30 animal species. The majority of the units tested in the European Union ( $N=6901$ ) were from cattle, and the proportion of positives was 0.97% for *Yersinia enterocolitica* and 1.0% for *Yersinia pseudotuberculosis*. The proportions of positive sampling units from 'small ruminants', pigs and 'pet animals' were 0.60%, 1.5% and 1.4% for *Y. enterocolitica*, and 0.25%, 0% and 2.9% for *Y. pseudotuberculosis*, respectively.

## 1.2 | Surveillance and monitoring of *Yersinia* in the EU

### 1.2.1 | Humans

In 2023, 26 MSs reported information on yersiniosis in humans. Surveillance of yersiniosis is mandatory in 22 MSs. In four MSs (Belgium, France, Greece and Italy), notification is based on a voluntary system. No yersiniosis surveillance system is in place in the Netherlands. The EU case definition was used by 21 MSs, and five MSs used a different case definition for reporting (Denmark, France, Germany, Greece and Italy). All MSs, except two (Greece and Italy) had a comprehensive surveillance system. The yersiniosis surveillance system covers the whole population in all MSs, except France, Italy and Spain. No population coverage estimates were provided for France and Italy, so no notification rates were calculated for these two MSs in any year. The estimated coverage of the surveillance system was 92% in Spain. This estimated proportion of population coverage was used in the calculation of notification rates for this MS. For the period 2021–2022, the estimated coverage of surveillance systems was 91%, while for the years 2019–2020, the rate could not be calculated as no information on coverage was provided. All countries reported case-based data, except Bulgaria and Greece, which reported aggregated data.

### 1.2.2 | Food and animals

Although it is not mandatory to report the presence of *Yersinia* in food and animals, MSs can report monitoring data on *Yersinia* to EFSA, in accordance with Directive 2003/99/EC. The directive specifies that, in addition to the zoonoses and zoonotic agents for which monitoring is mandatory, zoonoses such as yersiniosis and agents thereof must also be monitored according to the epidemiological situation.

At present, no harmonised *Yersinia* monitoring plan is in place for food or animals in the EU. Therefore, data on *Yersinia* in food and animals submitted to EFSA by the MSs are not harmonised. Nevertheless, an EFSA Scientific Opinion recommends the most optimal monitoring methods for *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* in foodstuffs and animal populations from a public health perspective (EFSA, 2007), whereas harmonised monitoring and reporting criteria for *Y. enterocolitica* in slaughter pigs were recommended in an EFSA scientific report (EFSA, 2009b).

At the EU level, monitoring data submitted by MSs for *Yersinia* in food and animals allow for descriptive summary statistics only, and do not support trend analyses and trend watching (Table 1). Consequently, the reported occurrence of



*Yersinia* in major food categories for the year 2023 and for the 4-year period 2019–2022 was summarised descriptively, making a distinction between 'ready-to-eat' (RTE) and 'non-RTE' foods. Only results obtained from samples collected and tested for *Yersinia* under an 'objective sampling' strategy were considered, in order to limit selection bias. Objective sampling means that MSs collected and tested the samples according to a planned strategy based on a random sampling design representative of the population under study.

## 1.3 | Results

### 1.3.1 | Overview of key statistics, EU, 2019–2023

**Table 58** summarises EU-level statistics on human yersiniosis, and on the occurrence of *Yersinia* in food and animals, for the period 2019–2023. Although yersiniosis was the fourth most frequently reported food-borne gastrointestinal infection in humans in the EU in 2023, data on *Yersinia* in food and animals continue to be reported by few MSs, like in previous years. More detailed descriptions of these statistics are provided in the below subsections and in the chapter on food-borne outbreaks.

**TABLE 58** Summary of *Yersinia* statistics relating to humans, major food categories and main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	8738	7929	7009	5737	6967	ECDC
Total number of confirmed cases/100,000 population (notification rates)	2.4	2.2	1.9	1.7	1.7	ECDC
Number of reporting MSs	26	25	26	26	27	ECDC
Infection acquired in the EU	4929	3954	3548	2745	3468	ECDC
Infection acquired outside the EU	152	81	18	61	96	ECDC
Unknown travel status or unknown country of infection	3657	3894	3443	2931	3403	ECDC
Number of food-borne outbreak-related cases	73	96	125	236	160	EFSA
Total number of food-borne outbreaks	17	14	21	16	23	EFSA
<b>Food<sup>a</sup></b>						
<b>Meat and meat products</b>						
Number of sampling units	2245	1640	1789	1597	2304	EFSA
Number of reporting MSs	8	4	6	6	6	EFSA
<b>Fruits and vegetable products</b>						
Number of sampling units	212	83	142	256	17	EFSA
Number of reporting MSs	5	3	3	4	2	EFSA
<b>Animals<sup>a</sup></b>						
<b>Cattle (bovine animals)</b>						
Number of sampling units	6901	15,764	19,218	14,796	16,885	EFSA
Number of reporting MSs	4	4	5	5	4	EFSA
<b>Pigs</b>						
Number of sampling units	2718	2010	2164	2368	2591	EFSA
Number of reporting MSs	5	3	5	4	5	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>The total number of sampling units was calculated by summing all reported sub-level entries for sampling units, stages, strategies and samplers, as listed in the EFSA Catalogue (EFSA and Ioannidou, 2019).

### 1.3.2 | Human yersiniosis

In 2023, 8738 confirmed cases of yersiniosis were reported by 26 MSs. The notification rate of confirmed yersiniosis cases in the EU was 2.4 cases per 100,000 population. This was an increase of 13.5% compared with 2022 (2.2 per 100,000 population). As in recent years, Germany accounted for the highest number of cases, followed by France and Spain (**Table 59**). Cases reported by these three countries together accounted for 53.0% of all confirmed yersiniosis cases in the EU. As in the previous year, the highest notification rates in 2023 were reported by Denmark (20.2 cases per 100,000 population), followed by Czechia (5.7 cases per 100,000 population). The lowest rates in 2023 were observed in Bulgaria, Croatia, Greece, Hungary, Ireland, Poland, Portugal and Romania ( $\leq 0.83$  per 100,000) (**Table 59**).

For most (96.9%) of the reported yersiniosis cases of known origin, the infection was acquired in the EU (Table 58), as compared with 98.0% in 2022 and an average of 98.2% in the period 2019–2021. Thirteen countries reported data on imported cases. The proportion of domestic cases with known data was above 90.0% in all reporting countries, except for five MSs that reported the highest proportion of travel-associated cases: Finland (25.3%), Luxembourg (23.1%), Sweden (15.1%), Austria (14.6%) and Denmark (12.5%). The proportion of observed travel-associated cases among those with such information available in 2023 was 7.0%. The number of infections acquired outside the EU in 2023 was 152, which is almost double the number of cases compared with 2022 (i.e. a relative increase of 87.7%). Of the 334 travel-associated cases with a known country of origin, 182 cases (54.5%) were linked to travel within the EU, with most infections probably acquired in Spain, Greece, Italy and Croatia (21.4%, 12.1%, 9.9% and 8.2%, respectively).

**TABLE 59** Reported confirmed human cases of yersiniosis and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	Y	C	100	1.1	131	1.5	138	1.5	128	1.4	112	1.3
Belgium	Y	C	393	3.3	357	3.1	329	2.8	336	2.9	406	3.5
Bulgaria	Y	A	15	0.23	8	0.12	5	0.07	4	0.06	11	0.16
Croatia	Y	A	28	0.73	–	–	12	0.30	11	0.27	12	0.29
Cyprus	Y	C	0	0	1	0.11	0	0	0	0	0	0
Czechia	Y	C	614	5.7	525	5.0	456	4.3	437	4.1	618	5.8
Denmark	Y	C	1199	20.2	746	12.7	453	7.8	413	7.1	221	3.8
Estonia	Y	C	57	4.2	53	4.0	45	3.4	44	3.3	42	3.2
Finland	Y	C	279	5.0	408	7.4	331	6.0	386	7.0	406	7.4
France <sup>b</sup>	N	C	1384	–	1568	–	1451	–	988	–	1135	–
Germany	Y	C	1931	2.3	1814	2.2	1912	2.3	1860	2.2	2164	2.6
Greece	Y	A	12	0.12	9	0.09	7	0.07	3	0.03	13	0.12
Hungary	Y	C	54	0.56	60	0.62	50	0.51	25	0.26	38	0.39
Ireland	Y	C	29	0.55	17	0.34	19	0.38	13	0.26	9	0.18
Italy <sup>b</sup>	N	C	34	–	36	–	35	–	21	–	12	–
Latvia	Y	C	87	4.6	76	4.1	83	4.4	88	4.6	60	3.1
Lithuania	Y	C	146	5.1	114	4.1	153	5.5	123	4.4	181	6.5
Luxembourg	Y	C	34	5.1	35	5.4	12	1.9	26	4.2	18	2.9
Malta	Y	C	0	0	0	0	0	0	0	0	0	0
Netherlands <sup>c</sup>	Y	–	–	–	–	–	–	–	–	–	–	–
Poland	Y	C	305	0.83	180	0.48	142	0.38	90	0.24	196	0.52
Portugal	Y	C	25	0.24	36	0.35	34	0.33	25	0.24	29	0.28
Romania	Y	C	23	0.12	14	0.07	15	0.08	6	0.03	36	0.19
Slovakia	Y	C	288	5.3	287	5.3	213	3.9	168	3.1	255	4.7
Slovenia	Y	C	56	2.6	54	2.6	50	2.4	26	1.2	28	1.3
Spain <sup>d</sup>	N	C	1317	3.0	1162	2.7	754	1.7	296	–	409	–
Sweden	Y	C	328	3.1	238	2.3	310	3.0	220	2.1	393	3.8
<b>EU Total 27</b>	–	–	<b>8738</b>	<b>2.4</b>	<b>7929</b>	<b>2.2</b>	<b>7009</b>	<b>1.9</b>	<b>5737</b>	<b>1.7</b>	<b>6804</b>	<b>2.1</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	163	0.24
<b>EU Total</b>	–	–	<b>8738</b>	<b>2.4</b>	<b>7929</b>	<b>2.2</b>	<b>7009</b>	<b>1.9</b>	<b>5737</b>	<b>1.7</b>	<b>6967</b>	<b>1.7</b>
Iceland	Y	C	8	2.1	1	0.27	4	1.1	3	0.82	2	0.56
Norway	Y	C	86	1.6	117	2.2	85	1.6	83	1.5	85	1.6
Liechtenstein <sup>c</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Switzerland <sup>c</sup>	–	–	–	–	–	–	–	–	–	–	–	–

Abbreviations: MSs, Member States; –, Data not reported.

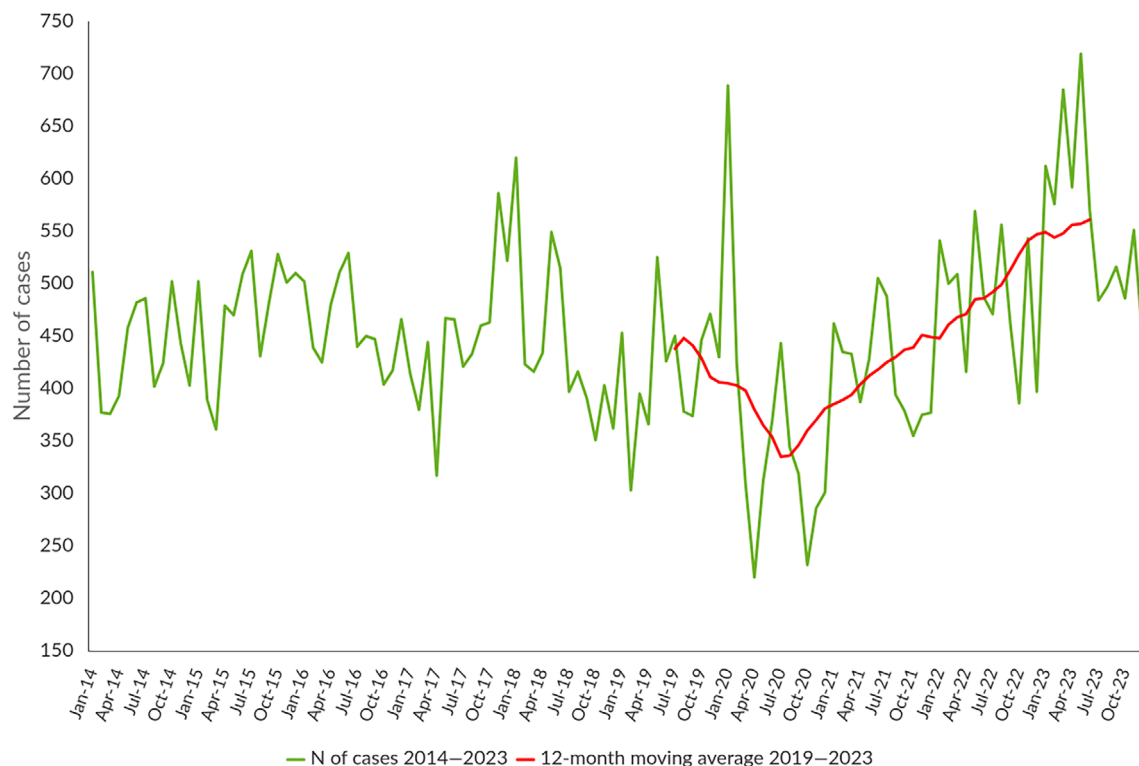
<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

<sup>b</sup>Sentinel surveillance; no information on estimated coverage. Notification rate cannot be estimated.

<sup>c</sup>No surveillance system.

<sup>d</sup>Sentinel surveillance; notification rates calculated with an estimated population coverage of 92% in 2023 and 91% in 2021–2022. No information on estimated coverage in 2019–2020, so notification rate cannot be estimated.

The trend for human yersiniosis cases in the EU for 2019–2023 showed a statistically significant increase ( $p < 0.01$ ) (Figure 22). Poland, Slovakia and Sweden reported significantly decreasing trends ( $p < 0.05$ ) during the period 2019–2023. Denmark, France, Hungary, Ireland, Italy, Portugal, Slovenia and Spain reported significantly increasing trends ( $p < 0.05$ ) over the same period.



**FIGURE 22** Trend in reported confirmed human cases of yersiniosis in the EU, by month, 2019–2023. Source: Austria, Cyprus, Czechia, Denmark, Estonia, Finland, Germany, Hungary, Ireland, Italy, Latvia, Luxembourg, Poland, Romania, Slovakia, Slovenia, Spain, Sweden.

*Yersinia* species information was provided by 21 MSs for 94.5% of confirmed cases reported in the EU, in 2023. Of these cases, 97.7% ( $N = 8021$ ) were *Y. enterocolitica* and 2.3% ( $N = 188$ ) were *Y. pseudotuberculosis*. Information on *Y. enterocolitica* bioserotypes was provided for 1975 confirmed cases (22.7%). The most common bioserotypes were 4/O3 (86.9%) and 2/O9 (10.7%).

### 1.3.3 | *Yersinia* in food

A summary table showing the occurrence of *Yersinia* in the main food categories in 2023 and over the 4-year period of 2019–2022 in the EU is provided on the EFSA Knowledge Junction at Zenodo [here](#). A distinction is made between RTE and non-RTE foods, and fresh meat. No *Yersinia*-positive sampling units were detected in any RTE foods. The proportions of *Yersinia*-positive sampling units in non-RTE categories were 10.2%. In fresh meat, 12.1% of sampling units were positive.

In 2023, most of the 314 RTE food sampling units reported by four MSs originated from ‘fruit and vegetables’ (65.3%), followed by ‘meat and meat products’ (34.4%) and only one sampling unit (0.32%) for ‘milk and milk products’. In contrast with no *Yersinia*-positive sampling units in 2023, between 2019 and 2022, of 2356 RTE sampling units analysed, 5.1% tested positive for *Yersinia*. Specifically, 5.7% of ‘meat and meat products’ were *Yersinia*-positive, with ‘mixed meat and meat products from bovine animals and pigs’ showing a 7.1% positivity rate and ‘mixed meat’ showing a rate of 4.4%.

Unlike during 2019–2022, when a few sampling units were tested for the categories ‘RTE salads’ ( $N = 4$ ), ‘other processed food products and prepared dishes’ ( $N = 23$ ) and ‘other foods’ ( $N = 4$ ), no sampling units were tested for these categories in 2023.

Despite evidence supporting the need to sample in particular RTE foods, few MSs reported monitoring this type of food for *Yersinia* to EFSA, even though these foods represent a direct risk to consumers.

Most of the results reported in 2023 by six MSs for the 1210 ‘non-RTE’ sampling units originated from the ‘meat and meat products’ (99.4%) food category, where a total of 123 (10.2%) sampling units tested positive for *Yersinia*. In 2023, no sampling was carried out for the ‘milk and milk products’ category, although in 2019–2022, ‘milk and milk products’ was the most commonly contaminated food category (11.0%), followed by ‘meat and meat products’ (6.2%).

Six MSs reported results for ‘fresh meat’ categories. The highest percentage of *Yersinia*-positive units was for ‘fresh meat from pigs’ (12.6%), which was 96.0% ( $N = 915$ ) of ‘all fresh meat’ sampling units. In 2023, the number of sampling units for the ‘non-RTE’ and ‘fresh meat’ categories increased compared with 2022, with ‘non-RTE’ sampling units rising from 404 to

1210, and 'fresh meat' sampling units increasing from 166 to 953. To detect the presence of *Yersinia* in food, microbiological methods were used for the analysis of 1296 sampling units and molecular methods for 282 sampling units, with *Yersinia*-positive rates of 8.7% and 3.5%, respectively.

### 1.3.4 | *Yersinia* in animals

A summary table showing the number of animal samples positive for *Y. enterocolitica* or *Y. pseudotuberculosis* in 2023 is provided on the EFSA Knowledge Junction at Zenodo [here](#). These data, reported by six MSs and one non-MS, span over eight different animal categories, including more than 30 animal species. The total number of animal units tested in 2023 ( $N=14,215$ ) was lower than in 2022 ( $N=23,705$ ), primarily due to a decrease in cattle units tested, which dropped from 15,764 in 2022 to 6901 in 2023. Analysis of the submitted results for 14,215 animals showed the presence of *Y. enterocolitica* and *Y. pseudotuberculosis* in a similar percentage of positive samples: 0.96% and 0.74%, respectively. In the EU, the reported data were primarily related to cattle (48.5%,  $N=6901$ ), followed by 'small ruminants' (22.3%,  $N=3172$ ) and pigs (19.1%,  $N=2718$ ). In these three animal categories, the proportion of positive samples for *Y. enterocolitica* was highest in pigs (1.5%), followed by cattle (0.97%) and 'small ruminants' (0.60%), while for *Y. pseudotuberculosis*, the highest proportion was in cattle (1.0%), followed by 'small ruminants' (0.25%) and no positive samples were detected for pigs. 'Wild animals' represented 7.8% of all animals sampled, with percentages of *Y. enterocolitica* and *Y. pseudotuberculosis*-positive samples of 0.45% and 1.4%, respectively. Although 'pet animals' comprised a very small proportion of the samples tested in 2023, the positive rates for *Y. enterocolitica* and *Y. pseudotuberculosis* were 1.4% and 2.9%, respectively. The highest positivity rate for *Y. pseudotuberculosis* in 'pet animals' was found particularly in mice and canaries. In order to assess the occurrence of *Y. enterocolitica* and *Y. pseudotuberculosis* in animal categories for which this information was available (cattle, deer, leporidae, pigs and 'small ruminants'), microbiological methods were used for the analysis of 12,793 sampling units and molecular methods for 31 samples, with *Yersinia*-positive rates of 2.1% and 25.8%, respectively.

## 1.4 | Discussion

In 2023, 26 MSs provided information on yersiniosis, which is the fourth most commonly reported food-borne gastrointestinal infection in humans in the EU. Since 2021, an increase in the notification rates and number of confirmed cases of yersiniosis has been reported. In 2023, there was a 13.5% increase in the annual notification rate compared with the year 2022. This was the highest number of cases, and the highest notification rate reported at the EU level in the last 10 years. The overall trend for human yersiniosis cases in the EU for 2019–2023 showed a statistically significant increase ( $p < 0.01$ ).

In particular, Denmark reported a steady increase in yersiniosis cases, from 221 cases (3.8 cases per 100,000 population) in 2019 to 1199 cases (20.2 cases per 100,000 population) in 2023. In Denmark, the increase of yersiniosis cases is considered a diagnostic and reporting issue and not a real increase of cases. The increase is mostly related to the increased use of culture-independent diagnostic tests in the clinical laboratories (SSI personal info).

In 2023, the MSs with the highest proportion of domestic cases, above 98.0% with available data, were Czechia, Estonia, Hungary, Ireland, Italy, Lithuania, Poland, Portugal, Slovakia and Spain. These countries remained largely the same as in 2022, except for Estonia, Ireland and Italy, where the proportion of domestic cases the year before was 96.2%, 77.8% and 80.0%, respectively.

As in previous years, in 2023, *Y. enterocolitica* was the species reported in the majority (97.7%) of human cases, while *Y. pseudotuberculosis* was notified in only 2.3% of human cases for which information on *Yersinia* species was available. Compared with the previous year, the number of *Y. pseudotuberculosis* cases increased from 98 in 2022 to 188 in 2023. Five MSs (Belgium, Finland, France, Germany and Sweden), reported the majority of *Y. pseudotuberculosis* cases in both years.

In 2023, the most common bioserotypes of *Y. enterocolitica* in humans were 4/O3 (86.9%) and 2/O9 (10.7%), like in previous years. However, little information is available on the biotypes and serotypes of *Y. enterocolitica* isolated from animals and foodstuffs. The availability of information on biotypes would allow for a better understanding of the epidemiology of human *Y. enterocolitica* infection and better investigation of relevant animal and food sources.

In 2023, few MSs reported data on *Yersinia* sampling activities in food and animals. This is probably due to the lack of mandatory monitoring plans for non-human sources, resulting in considerable differences between MSs in their approach to monitoring *Yersinia* in food and animals. The lack of homogeneity makes statistical analysis and monitoring of trends impossible.

Only four MSs provided data on *Yersinia* in RTE foods, with 314 sampling units reported in 2023, similar to the 328 units in 2022. The proportion of positive samples remained unchanged at 0% compared to 2022. This result differs from the cumulative data reported for the period 2019–2022, where the percentage of positive samples was 5.1%. Only one MS reported a single sampling unit for 'milk and milk products', while no sampling units for 'RTE salads' were reported. Nevertheless, it is important to sample RTE foods, such as 'RTE vegetables', to monitor potential *Yersinia* contamination, as these products are normally not subjected to physical interventions that will eliminate the occurrence of pathogens (EFSA BIOHAZ Panel, 2014). In this regard, two EFSA scientific opinions (EFSA BIOHAZ Panel, 2013c, 2014) have highlighted the risk of *Yersinia* contamination in non-animal origin food due to factors such as water or food handlers. Only six MSs provided data on 'non-RTE' foods for *Yersinia*, and the number of sampling units was higher ( $N=1210$ ) compared with 2022 ( $N=404$ ), with a proportion of positive samples of 10.2%, compared with 3.5% positive samples in 2022.

Only 6 MSs reported information on *Yersinia* in animals with 14,215 samples reported in 2023, fewer than the units reported in 2022 ( $N=23,705$ ). Cattle were the most represented animal category, making up 48.5% ( $N=6901$ ) of all tested units. The proportion of positive samples for cattle was similar for *Y. enterocolitica* and *Y. pseudotuberculosis*, at 0.97% and 1.0%, respectively. As expected, the highest positivity rate for *Y. enterocolitica* among the main 'farmed animals' categories (cattle, 'small ruminants' and pigs) was observed in pigs, at 1.5%. Moreover, of 953 'fresh meat' sampling units, only 'fresh meat from pigs' showed *Yersinia*-positive sampling units, with a proportion of 12.6%. Pigs are in fact the principal reservoir of *Y. enterocolitica* (Bottone, 1999), particularly for the low pathogenic bioserotype 4/O3, which is the most prevalent bioserotype in human yersiniosis in the EU. No animals positive for *Y. pseudotuberculosis* were detected in pigs. Furthermore, although 'pet animals' represented only a small proportion of the sampling units, the highest positivity rate for *Y. pseudotuberculosis* (2.9%) was found in this category, particularly in mice and canaries. This finding is consistent with the literature (see EFSA story map on *Yersinia* ([here](#)), section on 'where *Yersinia* is found').

To investigate the presence of *Yersinia* in food and animals, conventional microbiological (ISO 10273:2017) and molecular methods (ISO/TS 18867) were used (ISO, 2015b, 2017). Although few data are available on the use of molecular methods, these seem to detect *Yersinia* better in animals. Molecular methods are valid systems for screening and detection (ISO, 2015b) of *Y. pseudotuberculosis* and *Y. enterocolitica* in animals, food and environmental samples. In this context, various studies have described the application of molecular methods to detect *Y. enterocolitica* and *Y. pseudotuberculosis* in humans, food, animals and environmental samples (Rivas et al., 2021; Tast et al., 2023).

## 2 | TOXOPLASMA GONDII

The summary data which make up this chapter, and additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about *Toxoplasma gondii* and for the consultation of data collected, the following interactive tool is available:



### 2.1 | Key facts

- This chapter shows the human congenital toxoplasmosis data for 2022 due to 2-year delayed reporting of data from France. As in previous years, France accounted the majority (74.6%) of reported cases of congenital toxoplasmosis in the European Union due to its active screening approach for pregnant women.
- In 2022, there were 173 confirmed cases of human congenital toxoplasmosis, corresponding to a European Union notification rate of 5.8 cases per 100,000 live births. This was an increase of 4.2% compared with the rate in 2021 (5.6 cases per 100,000 live births).
- Overall, in the period 2018–2022, the number of human cases of congenital toxoplasmosis in the European Union (without the United Kingdom) showed a decrease, particularly during the COVID-19 pandemic (2020–2021), mainly mirroring the number of cases reported by a single Member State (France).
- In total, 13 Member States and three non-Member States reported 2023 monitoring data on *Toxoplasma gondii* infections in animals and food. Most animals tested were small ruminants, which also showed the highest overall percentage of positive samples of *T. gondii* infections in animals (21.7%), as reported by 10 Member States and the United Kingdom (Northern Ireland). Most samples with information provided on the sampling context were obtained from clinical investigations. It is impossible to accurately estimate the percentage of positive samples of *T. gondii* infections in animals due to different diagnostic methods, sampling schemes in Member States and lack of information on the animals' ages and rearing conditions.

### 2.2 | Surveillance and monitoring of *Toxoplasma* in the EU

#### 2.2.1 | Humans

Twenty MSs reported 2022 congenital toxoplasmosis data to TESSy in 2022. Surveillance of toxoplasmosis was compulsory in 19 MSs; in one (France) it was voluntary. Data from France are reported to TESSy with a 2-year delay. Seven MSs (Austria, Belgium, Denmark, Greece, Italy, the Netherlands and Sweden) do not have a surveillance system for toxoplasmosis. In

2022, 19 MSs used the EU case definition, but 1 MS (France) reported the use of another case definition. All reporting MSs had a comprehensive surveillance system with full national coverage. Spain did not have national surveillance nor provided an estimate for population coverage prior to 2022, so no notification rate was calculated before 2022. All MSs reported case-based data, except Bulgaria, which reported aggregated data.

Regarding congenital toxoplasmosis surveillance only, six countries (Austria, Belgium, France, Greece, Slovakia and Slovenia) have active surveillance of congenital cases with compulsory screening of pregnant women. However, Austria, Belgium and Greece do not report their data to ECDC. Four countries (Bulgaria, Czechia, Germany and Hungary) have voluntary screening of pregnant women. Six MSs have no screening policies and/or surveillance of congenital toxoplasmosis in pregnant women, but two of these countries (Estonia and Ireland) report to ECDC.

## 2.2.2 | Animals and food

There are no specific EU regulations concerning the surveillance and monitoring of *T. gondii* in animals and food. Therefore, the available and reported information relies on national legislation and whether the countries have a mandatory reporting system following the detection of *T. gondii*. As a result, data allow only for descriptive summaries at the EU level (Table 1). The main animal species tested are those intended for human consumption (small ruminants (goats and sheep), cattle and pigs) as well as pet animals (cats and dogs), using samples from aborted animals (ruminants) or clinically suspect animals. Mainly blood samples, but also samples from tissues and organs or faecal samples, are analysed either by direct methods, such as PCR, histology, immunohistochemistry and flotation, or by indirect antibody detection methods, including enzyme-linked immunosorbent assay, latex agglutination test, direct agglutination and immunofluorescence assay. For food testing, meat is the primary matrix to be analysed by PCR or direct agglutination.

## 2.3 | Results

### 2.3.1 | Human congenital toxoplasmosis

Twenty MSs reported congenital toxoplasmosis data in 2022 (Table 60), with 173 confirmed cases. Eleven MSs reported zero cases (Table 60). As a result of a slightly higher number of cases reported mainly by France and Poland for 2022, the notification rate in the EU (5.8 per 100,000 live births) increased by 4.2% compared with 2021 (5.6 per 100,000 live births) (Table 60). The highest notification rate was in France (18.5 per 100,000 live births), followed by Poland (9.2), Slovenia (5.3), Czechia and Slovakia (1.8 each) and Hungary (1.1) (Table 60). Three MSs (Germany, Romania and Spain) have notification rates below 1 per 100,000 live births.

France reported the highest number of congenital toxoplasmosis cases in the EU in 2022 and accounted for 74.6% of all reported cases, followed by Poland (17.3%).

Between 2018 and 2022, a constant decrease in reported cases was observed in Germany (a decrease of 72.2% in 2022 compared with 2018). In the same period (2018–2022), a marked drop in the number of reported cases was observed in France and Poland, related to the COVID-19 pandemic period (particularly 2020). However, the number of cases reported by MSs in 2022 was in line with data reported in 2019, before the COVID-19 pandemic.

**TABLE 60** Reported confirmed human cases of congenital toxoplasmosis and notification rates per 100,000 live births in EU MSs and non-MS countries, by country and year, 2018–2022.

Country	2022		2021		2020		2019		2018			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	
Belgium <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	
Bulgaria	Y	A	0	0	0	0	0	0	0	0	0	
Croatia	Y	C	0	0	0	0	0	0	0	1	2.7	
Cyprus	Y	C	0	0	0	0	0	0	0	0	0	
Czechia	Y	C	2	1.8	4	3.7	0	0	1	0.88	0	0
Denmark <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	
Estonia	Y	C	0	0	0	0	0	0	0	1	7.2	
Finland	Y	C	0	0	0	0	0	0	0	0	0	
France	Y	C	129	18.5	117	16.9	110	15.5	134	18.8	151	20.8
Germany	Y	C	5	0.63	11	1.4	14	1.8	17	2.2	18	2.3
Greece <sup>c</sup>	–	–	–	–	–	–	–	–	0	0	0	0

TABLE 60 (Continued)

Country	2022		2021		2020		2019		2018			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Hungary	Y	C	1	1.1	1	1.1	0	0	1	1.1	0	0
Ireland	Y	C	0	0	0	0	0	0	0	0	0	0
Italy <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Latvia	Y	C	0	0	0	0	0	0	1	5.2	0	0
Lithuania	Y	C	0	0	0	0	0	0	0	0	0	0
Luxembourg	Y	C	0	0	0	0	0	0	0	0	0	0
Malta	Y	C	0	0	0	0	0	0	0	0	0	0
Netherlands <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Poland	Y	C	30	9.2	13	3.7	9	2.5	14	3.7	25	6.3
Portugal	Y	C	0	0	2	2.4	–	–	–	–	–	–
Romania	Y	C	1	0.58	0	0	0	0	0	0	1	0.48
Slovakia	Y	C	1	1.8	0	0	0	0	0	0	0	0
Slovenia	Y	C	1	5.3	0	0	0	0	1	5.1	2	9.9
Spain <sup>d</sup>	Y	C	3	0.89	2	–	0	–	0	–	2	–
Sweden <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
<b>EU Total 27</b>			<b>173</b>	<b>5.8</b>	<b>150</b>	<b>5.6</b>	<b>133</b>	<b>5.1</b>	<b>169</b>	<b>6.2</b>	<b>201</b>	<b>7.1</b>
United Kingdom	–	–	–	–	–	–	–	–	7	0.91	7	0.91
<b>EU Total</b>			<b>173</b>	<b>5.8</b>	<b>150</b>	<b>5.6</b>	<b>133</b>	<b>5.1</b>	<b>176</b>	<b>5.1</b>	<b>208</b>	<b>5.8</b>
Iceland	Y	C	0	0	0	0	0	0	0	0	0	0
Norway <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Liechtenstein <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Switzerland <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–

Abbreviations: –, Data not reported.

<sup>a</sup>Y: yes; N: no; A: aggregated data; C: case-based data.

<sup>b</sup>Not notifiable, no surveillance system in place.

<sup>c</sup>Not under surveillance.

<sup>d</sup>No information on estimated coverage prior to 2022. Notification rate cannot be estimated.

### 2.3.2 | *Toxoplasma gondii* in food and animals

#### *Toxoplasma gondii* in food

One MS (Poland) submitted monitoring results for *T. gondii* in non-ready-to-eat (non-RTE) foods in 2023. A total of 534 meat samples from minced pig meat preparation were reported. Nineteen samples (3.5%) were positive.

#### *Toxoplasma gondii* in animals

Monitoring data on *T. gondii* for 2023 in livestock, pet or zoo animals and wildlife were provided by 12 MSs and by 3 non-MSs (Norway, Republic of North Macedonia and Switzerland). Most samples with information provided on the sampling context (programme type) were obtained from clinical investigations.

In small ruminants (sheep and goats), 10 MSs (Austria, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, the Netherlands and Slovakia) and the United Kingdom (Northern Ireland) reported animal data (Table 61). In total, 4489 animals were tested, and 973 were found to be positive (21.7%). Moreover, two MSs (Italy and Spain) reported herd/flock data: 357 herds/flocks were tested and 67 (18.7%) were positive. Two non-MSs (Norway and Switzerland) reported data: 16 animals were tested and five were positive (31.2%).

In cattle, five MSs (Austria, Germany, Italy, Latvia and Slovakia) and the United Kingdom (Northern Ireland) reported data on *Toxoplasma*. In total, 643 animals were tested and 84 were found to be positive (13.1%). Moreover, one MS (Italy) reported herd/flock data: 43 herds/flocks were tested and three (7.0%) were positive. One non-MS (Switzerland) reported information on one tested animal, which was negative.

In pigs, two MSs (Austria and Germany) and the United Kingdom (Northern Ireland) reported monitoring data (Table 61). In total, 413 animals were tested and no positive results were identified. In addition, one MS (Italy) reported 73 herd/flock investigations, with 12 positive results (16.4%).

For other livestock (solipeds, alpacas, leporidae and water buffaloes), four MSs (Austria, Germany, Italy and Slovakia) and one non-MS (Switzerland) reported monitoring data. In total, 22 animals were tested and one animal (soliped) (4.5%) was positive.

In pet animals (cats, dogs and rabbits), eight MSs (Austria, Finland, Germany, Hungary, Italy, Latvia, the Netherlands and Slovakia) tested a total of 3140 animals (1901 cats, 1236 dogs and 3 rabbits). There were 334 (10.6%) positive samples with 84 (4.4%) positive samples from cats, 249 (20.1%) positive samples from dogs and 1 positive sample from rabbits. One non-MS (Switzerland) tested a total of 310 cats, with 46 (14.8%) positive samples and 59 dogs with 5 (8.4%) positive samples.

Regarding zoo animals, four MSs (Austria, Italy, Latvia and Slovakia) tested in total 66 animals and 4 (6.0%) were positive. Two non-MSs (Republic of North Macedonia and Switzerland) tested in total 14 animals and 7 (50.0%) were positive.

Three MSs (Austria, Finland and Italy) reported on testing for *T. gondii* in wildlife. In total, 41 samples (5.7%) mainly from Italy, were positive out of a total of 721 animals tested. One non-MS (Switzerland) reported on testing for *T. gondii* in wildlife.

**TABLE 61** Summary of *Toxoplasma gondii* statistics in the main animal species at the individual level, EU, 2019–2023.

Animals <sup>a</sup>	2023	2022	2021	2020	2019	Data source
<b>Small ruminants</b>						
Number of tested animals	4489	4068	4525	6113	12,120	EFSA
Number of positive animals	21.7	29.0	16.8	21.3	13.5	EFSA
Number of reporting MSs	11	11	12	10	11	EFSA
<b>Cattle (bovine animals)</b>						
Number of tested animals	643	703	726	254	664	EFSA
Number of positive animals	13.1	4.3	2.5	9.8	9.2	EFSA
Number of reporting MSs	6	7	7	4	6	EFSA
<b>Pigs</b>						
Number of tested animals	413	519	599	948	1108	EFSA
Number of positive animals	0	11.0	5.0	9.7	11.7	EFSA
Number of reporting MSs	3	6	5	3	4	EFSA
<b>Cats</b>						
Number of tested animals	1901	2361	3275	1880	1525	EFSA
Number of positive animals	4.4	3.8	9.8	6.5	5.2	EFSA
Number of reporting MSs	7	7	8	6	8	EFSA

Abbreviation: MSs, Member States.

<sup>a</sup>Summary statistics were obtained by totalling all samples from single animals (no flocks or herds included), from all sampling stages at primary production (conservation facilities, farm, hunting, natural habitat, retail, slaughterhouse, unspecified, veterinary activities, veterinary clinics and zoo), sampling strategies (convenience sampling, objective sampling, suspect sampling and unspecified) and samplers (HACCP and own-check, industry sampling, not applicable, official sampling and private sampling). Indirect and direct diagnostic methods were taken together for the summary statistics to calculate the proportion of positive units.

## 2.4 | Discussion

Cases of congenital toxoplasmosis in the EU are strongly biased by the high number of cases reported by France, which has accounted for most reported cases since 2009 (ECDC Surveillance Atlas of Infectious Diseases), representing 74.6%–82.7% of overall EU cases in 2018–2022 (excluding data from the United Kingdom). The systematic screening for toxoplasmosis in pregnant women in France, established in 1978 and then mandatory since 1992, can explain the high reporting rate for this MS. Seronegative women are followed up during pregnancy to detect seroconversion early, and congenital toxoplasmosis cases are laboratory-confirmed (ECDC, 2024).

The fluctuation of cases reported in the EU in the 2018–2022 period mainly mirrors the trend in cases reported by France. A decrease was observed between 2018 and 2020 (a reduction of 33.8% in the EU and 27.1% in France), whereas an increase was found between 2020 and 2022 (30.1% in the EU and 17.3% in France), likely because of the impact of the COVID-19 pandemic on data collection in 2020–2021.

Although the number of notified cases of congenital toxoplasmosis recorded for the year 2022 was slightly higher compared with the years during the COVID-19 pandemic (2020–2021), the overall number of cases reported in France (and in the EU) is constantly decreasing (151 in 2018 vs. 129 in 2022 in France). The lower reporting of congenital toxoplasmosis in France is likely the result of a gradual seroprevalence decrease in pregnant women (54.0% in 1995, 31.0% in 2016) and a decrease in the number of seroconversions during pregnancy (from 5.4 per 1000 at-risk pregnancies in 1995, to 2.1 in 2010 and expected to be 1.6 by 2020) (Robinson et al., 2021). An education campaign for pregnant women and reduced exposure to contaminated raw/undercooked meat (e.g. changes in food habits and improved hygiene practices in meat production) or other raw foods at risk of contamination (e.g. fresh produce, molluscs and raw milk) likely contributed to the lower incidence of *T. gondii*



infection during pregnancy in France, reflecting the lower number of congenital toxoplasmosis cases (Opsteegh et al., 2015; Robinson et al., 2021). Interestingly, despite literature data on hospital discharge records of infants in Poland indicating that the number of cases of congenital toxoplasmosis fluctuated in the 2007–2021 period (Rząd et al., 2023), the increase in cases reported to TESSy by Poland in 2018–2022 might reflect the introduction in 2018 of standards of perinatal care by the Polish Ministry of Health (Rząd et al., 2023). Surveillance for congenital toxoplasmosis in other MSs is highly variable, with countries reporting zero cases or simply not reporting to ECDC or lacking surveillance (Rząd et al., 2023). The lack of surveillance can result in abortion, stillbirth, perinatal death or congenital diseases with immediate or late manifestations (up to adolescence), including ocular diseases, seizures and learning disabilities. All possible strategies for preventing congenital toxoplasmosis, including appropriate information for pregnant women and active screening, should be reinforced.

The 2023 monitoring data from animals reported by MSs and non-MSs showed that *T. gondii* is present in most livestock species across the EU, as well as in pet/zoo animals and wildlife. Concerning the MSs, the highest proportion of positive samples was observed in small ruminants (21.7%), followed by cattle (13.1%) and pets (10.6%). Similarly, in a recent systematic review and modelling of *T. gondii* prevalence in Europe, Dámek et al. (2023) showed that the highest estimated seroprevalence was observed for outdoor sheep (63.3%), while it was as low as 5.2% for indoor pigs. When comparing the data for 2022 to 2023, a noticeable fluctuation in *T. gondii* percentage of positive samples is observed for pigs and cattle, with a remarkable decrease for pigs (from 11.0% in 2022 to 0% in 2023) and an increase for cattle (from 4.3% in 2022 to 13.1% in 2023). The situation is stable for cats, with a proportion of positive samples of 3.8% in 2022 and 4.4% in 2023. However, when comparing the data over the last 5 years (2019–2023), no clear pattern of positivity is observed in animals.

The current European surveillance system of *T. gondii* in animals is strongly affected by several important limitations: (i) the small number of tested animals, (ii) the use of different indirect and direct detection methods, which were in most cases not validated by an independent body, (iii) unknown age of the tested animals and (iv) no information on the type of husbandry system (housing). Furthermore, according to the literature, there is no relationship between the presence of anti-*T. gondii* antibodies and infecting parasites in cattle and horses (Aroussi et al., 2015; Blaga et al., 2019; Opsteegh et al., 2019). For pigs, poultry and small ruminants, serological methods could be useful for the detection of high-risk animals or herds, but serology is not an indicator of infection in individual animals, as the agreement between direct and indirect methods was estimated to be low to moderate (Opsteegh et al., 2019). The limitations associated with toxoplasmosis detection, diagnosis and surveillance mentioned above preclude direct comparison of the reported data across MSs. Therefore, findings should be interpreted with caution.

### 3 | RABIES

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about rabies and for the consultation of data collected, the following interactive tools are available:



#### 3.1 | Key facts

- In 2023, European Union Member States reported no human lyssavirus infections acquired within the European Union. During the last 5 years (2018–2022), only one European Union-acquired non rabies lyssavirus infection was reported in 2019 and was caused by European bat lyssavirus 1 (EBLV-1).
- In animals excluding bats, a total of 71 cases of rabies of autochthonous origin were reported by three Member States: 7 cases in Poland (6 foxes and 1 dog), 49 cases in Romania (28 cattle, 16 foxes, 4 dogs and 1 badger) and 15 cases in Hungary (9 foxes, 3 dogs, 2 cattle and 1 cat). The total number of reported indigenous rabies cases in non-flying animals in the European Union is stable in 2023 compared with 2022 (71 cases) but was lower than in 2021 (118 cases) and higher than in 2020 (12 cases) and 2019 (5 cases).
- Surveillance data on lyssavirus in bats were reported by 18 European Union Member States. Seven Member States (Austria, France, Germany, Hungary, the Netherlands, Poland and Spain) reported 23 positive results for lyssavirus, 22 European bat 1 lyssavirus (EBLV-1) and one Bokeloh bat lyssavirus (BBLV). One non-Member State (Switzerland) reported a positive result in a bat for European bat lyssavirus 2 (EBLV-2).

## 3.2 | Surveillance and monitoring of rabies in the EU

### 3.2.1 | Humans

For 2023, 26 MSs reported data on human lyssavirus infections. Denmark did not report data. Reporting was mandatory in all reporting countries. EU case definitions were used by 23 MSs. France, Germany and Italy declared that they did not use the EU case definition. Twenty-four MSs had passive surveillance, whereas two countries (Czechia and Slovakia) applied active surveillance.

### 3.2.2 | Animals

The objective of **passive rabies surveillance** is to detect the presence and assess the geographic distribution of the virus over time, to allow timely dissemination of information for immediate integrated control actions among different sectors, such as the public health and veterinary sectors. For rabies-free countries, surveillance aims to confirm the absence of the disease. In accordance with Regulation (EU) No 652/2014<sup>48</sup> and CDR (EU) No 2020/689, multiannual control programmes and surveillance programmes for rabies, as well as oral rabies vaccination (ORV) campaigns were conducted in 11 MSs (Bulgaria, Croatia, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia), as well as in some EU-bordering countries. Surveillance of rabies is carried out by sampling and testing 'indicator animals'; these are wild or domestic animals (foxes, raccoon dogs, jackals, badgers, dogs, cattle, cats, sheep, equines, goats, etc.) that are found dead (including road-killed) and/or suspect animals, i.e. animals showing neurological clinical signs or abnormal behaviour compatible with rabies, like biting, licking a wound or scratching a human in the absence of clear neurological signs.

To monitor the efficacy of ORV campaigns, apparently healthy animals of the wild species targeted by oral vaccination, which are foxes, raccoon dogs and golden jackals, are hunted and the animal carcasses are used to determine rabies immunity and oral vaccine bait uptake. This specific **active rabies surveillance** is traditionally designated as 'ORV monitoring' or 'monitoring' and 'active rabies surveillance' when rabies diagnosis is performed on such sampling. These hunted animals can also be tested for rabies and very few of them (below 5%) are usually found to be positive for the disease.

Imported or travel-related companion animals (mainly dogs and cats) from territories and non-EU countries not included in Annex II of Commission Implementing Regulation (EU) No 577/2013<sup>49</sup> are currently tested for rabies virus neutralising antibodies.

In accordance with CIR (EU) 2020/2002, EU MSs must notify outbreaks of infection with rabies virus in non-flying animals to the EU Animal Disease Information System, ADIS<sup>50</sup>; these are the animal species and groups of species: *Carnivora*, *Bovidae*, *Suidae*, *Equidae*, *Cervidae* and *Camelidae*, but not *Chiroptera* (bats).

The data reported here include all animals tested for rabies, and those collected for disease surveillance or for ORV monitoring (active surveillance) purposes.

## 3.3 | Results

### 3.3.1 | Overview of key statistics, EU, 2019–2023

A summary of EU-level rabies statistics in humans and in wild and domestic animals is shown in Table 62. For animals, the total number of samples analysed for passive surveillance from foxes, raccoon dogs, golden jackals, dogs, cats and bats, as well as the number of MSs from which these samples originated, are shown. A decrease was observed in the number of tested samples of foxes, which are the main reservoir of the virus in Europe, compared with 2022. The number of tested raccoon dogs remained stable compared with 2022, while the tested samples of jackals increased in 2023 compared with 2022. In 2023, the number of tested bats remained stable as compared with 2022. For cats and dogs, the numbers of samples reported increased slightly compared with those for the 2019–2022 period. The number of samples tested from domestic farmed mammals increased sharply in 2023 compared with numbers for the 2019–2022 period. Compared with previous years, the number of positive cases in 2023 increased markedly in cattle, while it decreased in red foxes and remained stable in cats and dogs.

Table 62 also displays the active surveillance (ORV monitoring) statistics for ORV target species (foxes, raccoon dogs and golden jackals). In the context of ORV monitoring, the number of tested foxes increased considerably in 2023 compared with 2022; however, the number remained stable compared with numbers for the 2019–2021 period. The number of tested raccoon dogs increased, while the number of tested jackals in two MSs decreased considerably compared with numbers

<sup>48</sup>Regulation (EU) No 652/2014 of the European Parliament and of the Council of 15 May 2014 laying down provisions for the management of expenditure relating to the food chain, animal health and animal welfare, and relating to plant health and plant reproductive material, amending Council Directives 98/56/EC, 2000/29/EC and 2008/90/EC, Regulations (EC) No 178/2002, (EC) No 882/2004 and (EC) No 396/2005 of the European Parliament and of the Council, Directive 2009/128/EC of the European Parliament and of the Council and Regulation (EC) No 1107/2009 of the European Parliament and of the Council and repealing Council Decisions 66/399/EEC, 76/894/EEC and 2009/470/EC. OJ L 189, 27.6.2014, pp. 1–32.

<sup>49</sup>Commission Implementing Regulation (EU) No 577/2013 of 28 June 2013 on the model identification documents for the non-commercial movement of dogs, cats and ferrets, the establishment of lists of territories and third countries and the format, layout and language requirements of the declarations attesting compliance with certain conditions provided for in Regulation (EU) No. 576/2013 of the European Parliament and of the Council. OJ L 178, 28.6.2013, pp. 109–148.

<sup>50</sup>EU Animal Disease Information System (ADIS). More information is available at: [https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis\\_en](https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis_en).

for the 2019–2022 period. Several countries did not report data from ORV monitoring, as rabies diagnosis in apparently healthy hunted wild animals is no longer included in EU co-funded eradication programmes.<sup>51</sup>

**TABLE 62** Summary of rabies lyssavirus statistics relating to humans and the main animal reservoirs, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	1 <sup>a</sup>	0	0	0	4	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0	0	0	0	0	ECDC
Number of reporting countries	26	26	26	26	28	ECDC
Infection acquired in the EU	0	0	0	0	1	ECDC
Infection acquired outside the EU	1 <sup>a</sup>	0	0	0	3	ECDC
Unknown travel status or unknown country of infection	0	0	0	0	0	ECDC
<b>Animals under passive surveillance</b>						
<b>Dogs (<i>Canis lupus familiaris</i>)</b>						
Number of tested animals	2167	2137	1823	1730	1901	EFSA
Number of positive animals	8	11	3	4	–	EFSA
Number of reporting MSs	21	23	21	22	22	EFSA
<b>Cats (<i>Felis catus</i>)</b>						
Number of tested animals	2723	2957	2335	2440	2389	EFSA
Number of positive animals	1	1	8	2	–	EFSA
Number of reporting MSs	25	22	20	21	22	EFSA
<b>Farmed mammals<sup>b</sup></b>						
Number of tested animals	540 <sup>c</sup>	374	406	392	394	EFSA
Number of positive animals	30	15	4	3	1	EFSA
Number of reporting MSs	16	16	17	17	15	EFSA
<b>Wild animals – Red foxes (<i>Vulpes vulpes</i>)</b>						
Number of tested animals	11,445	18,486	12,907	9805	5336	EFSA
Number of positive animals	31	43	97	6	2	EFSA
Number of reporting MSs	20	18	17	18	16	EFSA
<b>Wild animals – Raccoon dogs (<i>Nyctereutes procyonoides</i>)</b>						
Number of tested animals	1176	1096	1339	1214	1241	EFSA
Number of positive animals	–	–	2	–	–	EFSA
Number of reporting MSs	7	7	6	6	7	EFSA
<b>Wild animals – Jackals (<i>Canis aureus</i>)</b>						
Number of tested animals	913	241	230	102	42	EFSA
Number of positive animals	–	–	–	–	–	EFSA
Number of reporting MSs	7	7	5	6	5	EFSA
<b>Wild animals – Bats (order Chiroptera)</b>						
Number of tested animals	1658	1622	1316	1308	2069	EFSA
Number of positive animals	23	26	29	31	39	EFSA
Number of reporting MSs	18	16	16	15	18	EFSA
<b>Animals under active surveillance (ORV monitoring)<sup>d</sup></b>						
<b>Red foxes (<i>Vulpes vulpes</i>)</b>						
Number of tested animals	13,399	1801	10,581	14,416	17,805	EFSA
Number of positive animals	4	–	–	–	1	EFSA
Number of reporting MSs	8	6	9	10	9	EFSA

(Continues)

<sup>51</sup>Guidelines for the Union co-funded programmes of eradication, control and surveillance of animal diseases and zoonoses for the years 2021–2022, available online at [https://food.ec.europa.eu/system/files/2021-06/cff\\_animal\\_vet-progs\\_guidance\\_progs\\_erad\\_wd-2021-10502.pdf](https://food.ec.europa.eu/system/files/2021-06/cff_animal_vet-progs_guidance_progs_erad_wd-2021-10502.pdf).

TABLE 62 (Continued)

	2023	2022	2021	2020	2019	Data source
<b>Raccoon dogs (<i>Nyctereutes procyonoides</i>)</b>						
Number of tested animals	331	221	369	324	301	EFSA
Number of positive animals	–	–	–	–	–	EFSA
Number of reporting MSs	3	3	4	4	3	EFSA
<b>Jackals (<i>Canis aureus</i>)</b>						
Number of tested animals	115	1100	1499	1319	1045	EFSA
Number of positive animals	–	–	–	–	–	EFSA
Number of reporting MSs	2	1	3	3	2	EFSA

Notes: Sampling context items for historical data: Passive surveillance: clinical investigations, monitoring–passive, surveillance, control and eradication programmes; Active surveillance: monitoring–active and unspecified. Sampling context items for 2023 data: Passive surveillance: clinical investigations and monitoring–passive; Active surveillance: monitoring–active.

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States; ORV, oral rabies vaccination.

<sup>a</sup>In 2023, one case was reported by France, probably infected in Morocco.

<sup>b</sup>Included cattle (bovine animals), horses, sheep, goats, pigs and any other mammals where 'farmed' has been specified (e.g. farmed foxes, farmed minks).

<sup>c</sup>Included 124 farmed foxes reported from Germany, all negative.

<sup>d</sup>Samples collected in the framework of oral rabies vaccination (ORV) monitoring.

### 3.2.2 | Humans

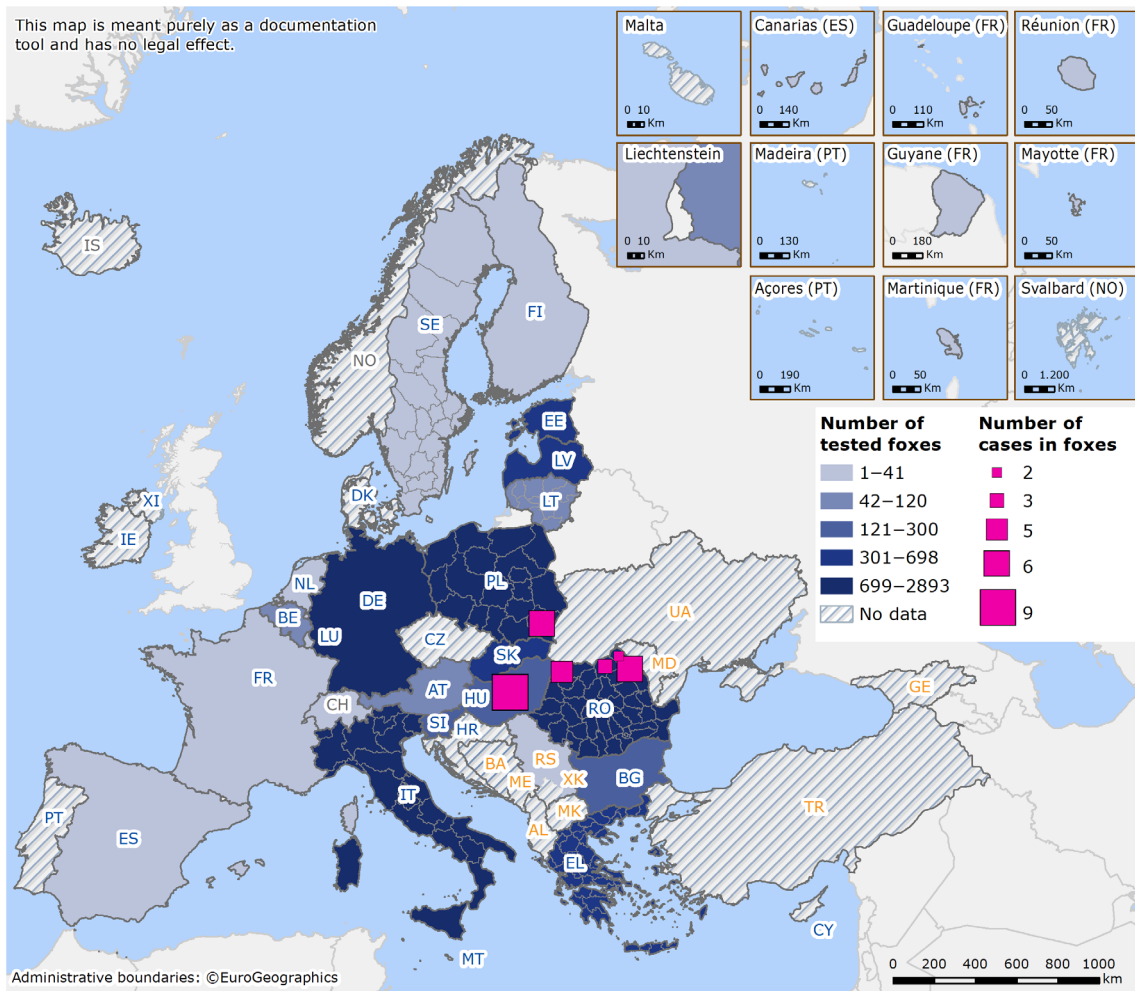
No human cases acquired within the EU were reported between 2020 and 2023. In 2023, one case was reported by France, which was probably infected in Morocco. France reported an EU-acquired infection in 2019, due to European bat lyssavirus 1 (EBLV-1).

### 3.3.3 | Animals

#### Rabies cases in wildlife

In 2023, 11,445 foxes (*Vulpes vulpes*) were tested using passive surveillance by 20 MSs. In total, 31 cases of rabies were detected in foxes in the EU: 16 cases in Romania, 9 in Hungary and 6 in Poland. The geographical distribution and number of cases in foxes per NUTS 3 (Nomenclature of territorial units for statistics),<sup>52</sup> as well as a choropleth map of the total number of foxes sampled per MS for passive surveillance, are shown in Figure 23. Three non-EU countries (Republic of North Macedonia, Serbia and Switzerland) reported a total of 14 foxes tested under passive surveillance schemes and found none to be positive.

<sup>52</sup>The NUTS are a hierarchical system divided into three levels. NUTS 1: major socio-economic regions, NUTS 2: basic regions for the application of regional policies, NUTS 3: small regions for specific diagnoses. (<https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts>).

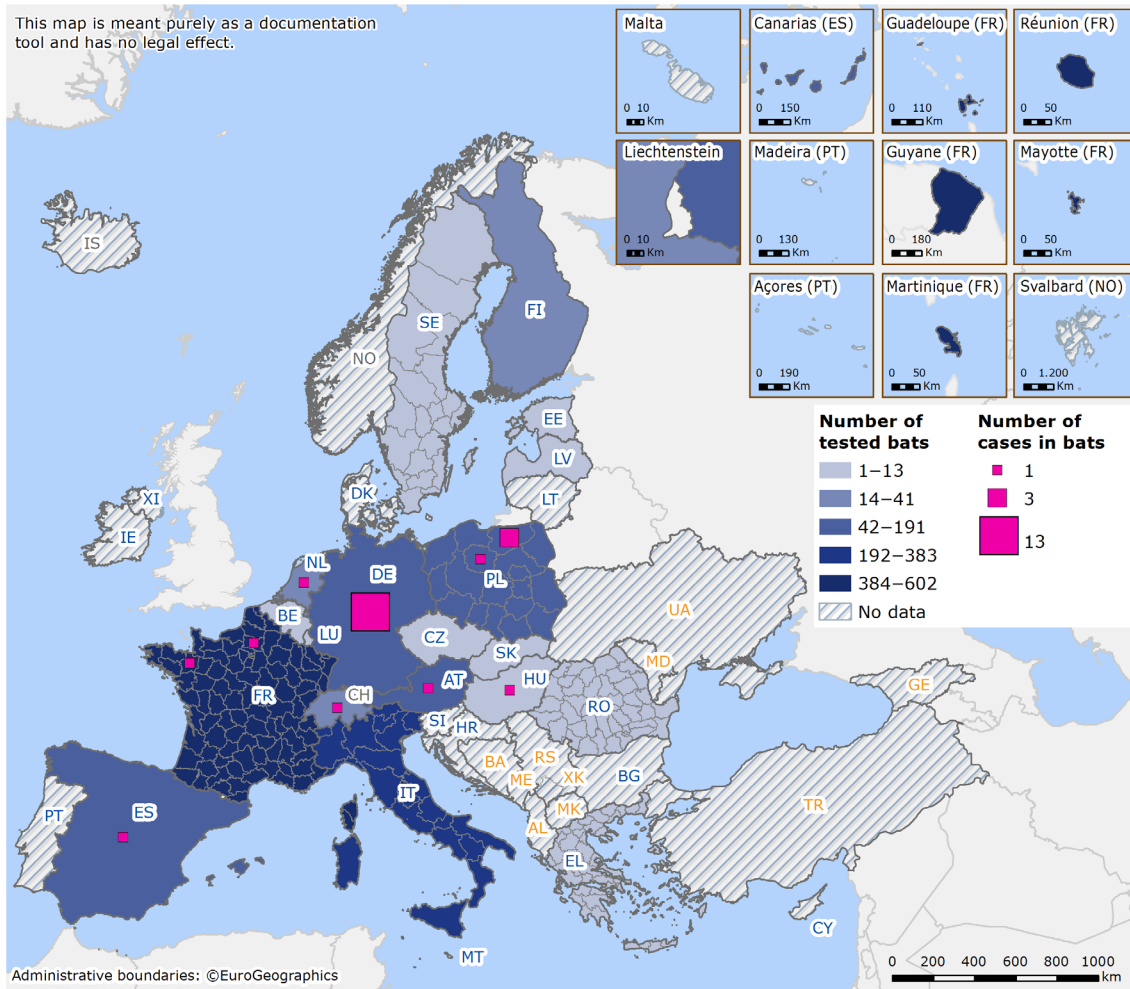


**FIGURE 23** Number of tested and positive foxes in the framework of passive surveillance and the geographical distribution of the rabies cases reported in foxes in EU MSs and non-EU countries, 2023. For Hungary, the geographical distribution of reported cases was not provided. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

In 2023, 1176 raccoon dogs (*Nyctereutes procyonoides*) were tested for rabies by seven MSs (Estonia, Finland, Italy, Latvia, Lithuania, Poland and Slovakia) and none were found to be positive. Most (93%) of these samples came from raccoon dogs originating from two MSs (Estonia and Latvia).

Eighteen MSs reported data from passive surveillance for 3912 non-flying wild animals other than foxes, raccoon dogs or golden jackals. The other most widely tested wild animal species were raccoons ( $N=1188$ ), badgers ( $N=889$ ), martens ( $N=793$ ), deer and reindeer, roe and fallow deer ( $N=346$ ) and wolves ( $N=268$ ). One badger tested positive for rabies in Romania. Other species tested included mice, lynx, otters, squirrels, hedgehogs, rats, wild boars, bears, ferrets, dormice, wild cats, wolverines, minks, beavers, polecats, alpine chamois, alpacas, guinea pigs, voles, hamsters, marine mammals, land game mammals, seals, coypus, hares, rodents, kangaroos, bison and moose. All the animals tested negative for rabies. Three non-MSs (Norway, Republic of North Macedonia and Switzerland) analysed eight wolves, one badger, one lynx, one reindeer, one beaver and one marten, and all samples tested negative.

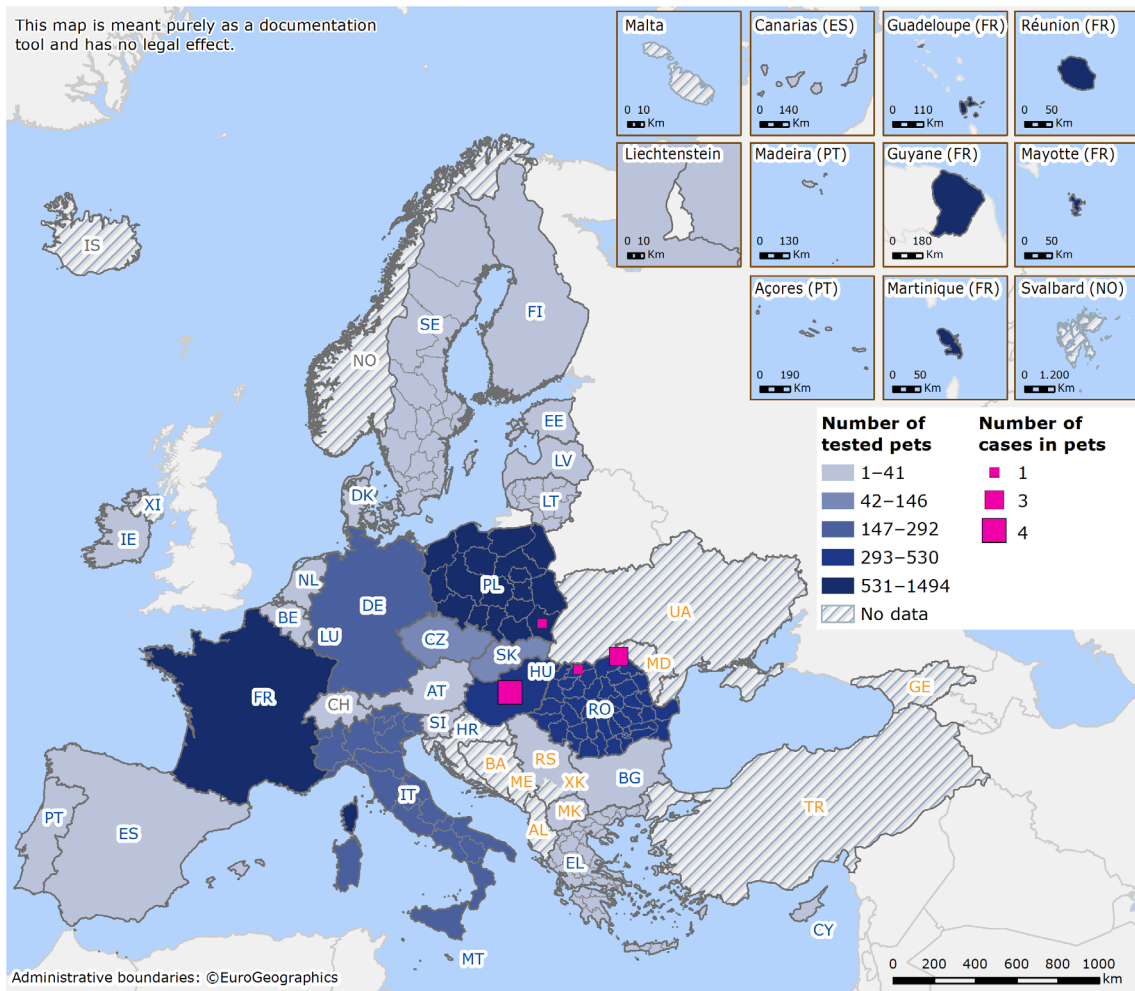
In 2023, 18 MSs and one non-MSs reported surveillance data on bats. In total, 1658 bats were investigated in the EU (Figure 24). Of these, 23 samples tested positive in seven MSs: Germany (12 EBLV-1 and 1 Bokeloh bat lyssavirus), Poland (1 EBLV-1 and 3 unspecified lyssavirus), France (2 EBLV-1), Austria (1 EBLV-1), Hungary (1 unspecified lyssavirus), Spain (1 EBLV-1) and the Netherlands (1 EBLV-1). One non-MS, Switzerland, analysed 23 bats and one bat tested positive (EBLV-2).



**FIGURE 24** Number of tested and positive bats, and the geographical distribution of the rabies cases reported in bats in EU MSs and non-EU countries, 2023. For Austria, Germany, Hungary, Spain, the Netherlands and Switzerland, the geographical distribution of reported cases was not provided. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

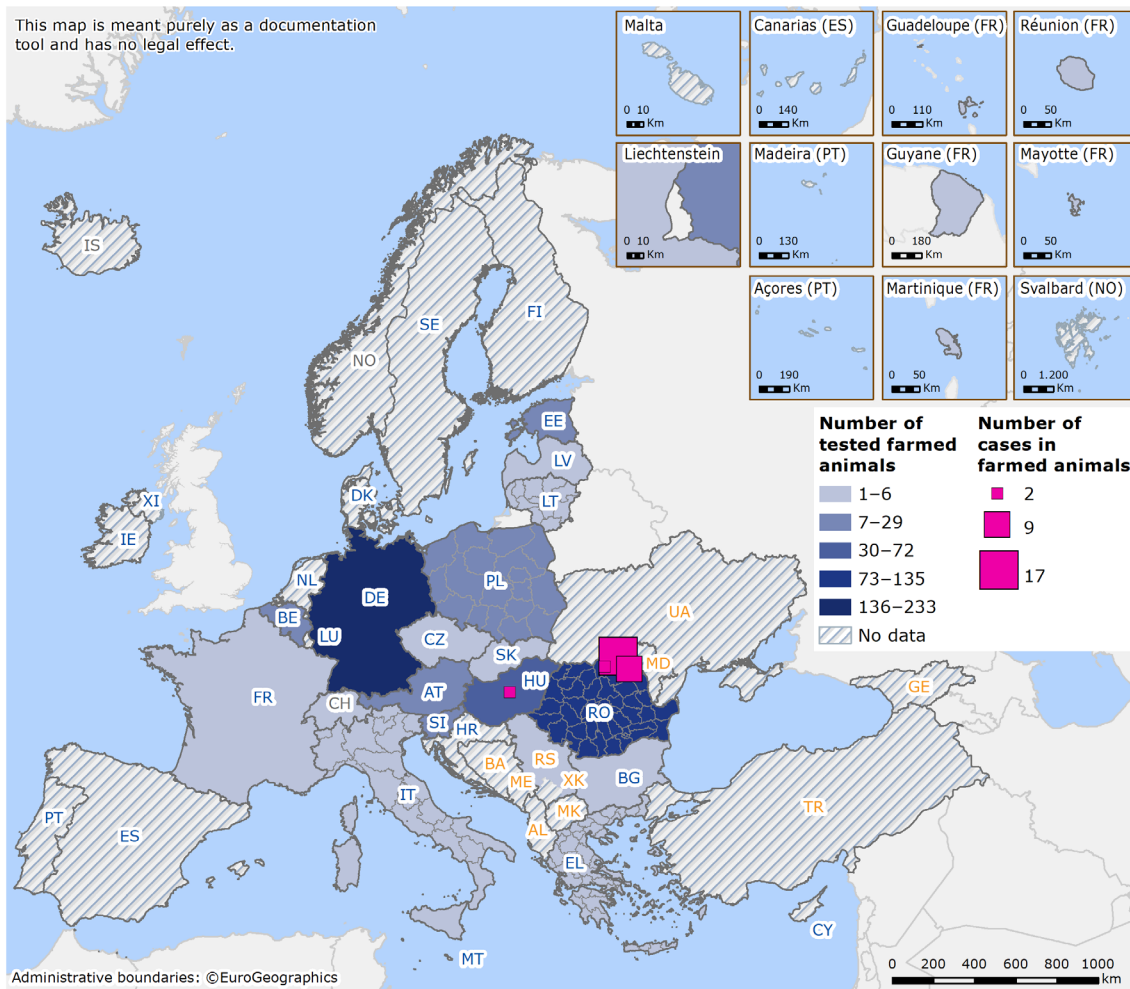
### Rabies cases in domestic animals

In 2023, 39 autochthonous domestic animals tested positive for rabies. Twenty-five MSs tested in total 4890 samples for dogs and cats: 2167 dogs (from 21 MSs) and 2723 cats (from 25 MSs). A total of eight pet dogs tested positive: in Romania four cases (RABV), in Hungary three cases (unspecified lyssavirus) and in Poland one case (RABV). One case in a pet cat (unspecified lyssavirus) was reported by Hungary. Three non-EU countries (Republic of North Macedonia, Serbia and Switzerland) reported in total results for 37 dogs and 31 cats, with no rabies positives. The geographical distribution and number of tested and reported cases in pets (dogs and cats) are shown in [Figure 25](#).



**FIGURE 25** Number of tested and positive pets, and the geographical distribution of the rabies cases reported in pets in EU MSs and non-EU countries, 2023. For Hungary, the geographical distribution of reported cases was not provided. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

A total of 540 samples from farmed mammals (Figure 26) were tested by 16 MSs (reports included mainly cattle, small ruminants and domestic solipeds). Of these, 30 samples from cattle tested positive: 28 cases (RABV) in Romania and two cases in Hungary (unspecified lyssavirus). Two non-EU countries reported three samples tested from farmed ruminants (Serbia (one bovine) and Switzerland (two bovines)); all of them tested negative.



**FIGURE 26** Number of tested and positive farmed animals, and the geographical distribution of the rabies cases reported in farmed animals in EU MSs and non-EU countries, 2023. For Hungary, the geographical distribution of reported cases was not provided. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

### 3.4 | Discussion

In Europe, human rabies is a rare disease, with the last autochthonous EU case of RABV human infection dating back to 2012 (Romania). Although non-RABV lyssavirus infections are rare, the identification of an EU-acquired human case due to EBLV-1 (France, 2019) from an infected bat underlines the need to continue monitoring the occurrence of this fatal encephalitis in EU Member States. Five human deaths have been reported so far in Europe, more specifically in Ukraine (1977: species not characterised), Russia (1985: EBLV-1), Finland (1985: EBLV-2), the United Kingdom (2002: EBLV-2) and the recent case acquired in France (2019: EBLV-1) (Fooks et al., 2003; Regnault et al., 2021).

All these infections were linked to direct exposure to infected bats; however, human exposure to bat lyssaviruses by contact with infected domestic animals such as free-roaming cats (they have been occasionally found infected by bat lyssavirus) leading to secondary transmission must not be overlooked as, even if never documented, could theoretically be possible. In this context, the absence of prevention and control tools for divergent lyssaviruses circulating in European bats must be highlighted (Echevarría et al., 2019). Nowadays, RABV infections are mainly acquired abroad in countries where dog rabies is endemic and development of the disease is due to the absence of pre-exposure prophylaxis or late/inappropriate/incomplete administration of post-exposure prophylaxis.

The EU programmes for rabies eradication include disease surveillance, oral vaccination campaigns, monitoring of ORV and awareness activities. Results in 2023 (71 rabies cases reported from passive surveillance) show maintenance of the infection in Romania (in total 49 cases, including wildlife and domestic species, more particularly cattle with 28 reported cases) and in Poland (in total 7 cases, including foxes and a dog). The disease is also maintained in Hungary (15 cases in 2023 compared with 4 cases in 2022), which lost its rabies-free status in 2022. This MS had reported the last cases in 2017. The epidemiological data localised these cases close to the borders with Ukraine and Romania. In Romania, the data for 2023 show a markedly increased number of cases (49 compared with 26 cases in 2022) and an extension of the infected areas. Most cases were detected in bordering areas with Moldova, Ukraine and Hungary. The situation seems to have improved in Poland (36 cases detected in 2022 and 7 cases in 2023), but the overall situation in the EU shows how fragile



the epidemiological context of a country is, and how it is linked to that of neighbouring countries. The cases still being reported over several years in the few remaining MSs with infections, or re-emergence of rabies, highlight the importance of a sustainable surveillance programme and awareness campaigns for the general public and professionals, to ensure the early detection of any potential cases. They also stress the importance of implementing ORV programmes in all infected areas on a biannual basis (in spring and autumn) and establishing cross-border collaborations to achieve disease-free status. Data relating to passive rabies surveillance in wildlife, mainly in foxes and raccoon dogs, show relative stability in the number of samples tested over the 2019–2023 period, due to the surveillance efforts maintained by most rabies-free and infected MSs for early detection of the virus and for controlling the last foci.

Data relating to active surveillance (ORV monitoring) are reported for foxes, raccoon dogs and jackals. This surveillance is conducted by hunting apparently healthy animals and using the animal carcasses to assess the efficacy of vaccination campaigns in infected and rabies-free countries involved in eradication programmes. A sample size linked to the area covered by vaccination is recommended. The data reveal a substantial decrease in the number of analysed foxes between 2019 and 2022, reflecting the decrease in the size of vaccinated areas in the EU, hence the success of ORV programmes. However, in 2023, the data show a marked increase in the number of analysed foxes in the infected countries compared to 2022. In 2023, three MSs reported four positive foxes sampled during ORV monitoring.

Regarding rabies surveillance in bats, the number of tests was stable in 2023 compared with 2022, despite a higher number of MSs reporting. Positive results obtained in the framework of bat surveillance (23 cases) are in line with the findings of the previous years and confirm that European bats act as reservoirs for lyssaviruses other than rabies virus, reaffirming the public recommendation to handle bats with utmost caution, if at all. The public health hazard of bat lyssaviruses in Europe should not be underestimated.

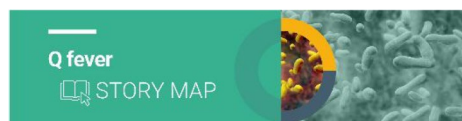
As rabies is still endemic in countries bordering the EU, in areas not far from the borders, several MSs are involved in collaborations with these countries for the implementation of vaccination and testing schemes in buffer zones. The Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs) created a Standing Group of Experts on Rabies (SGE RAB) in 2019, and the fifth meeting was organised in 2023 with the goal of coordinating rabies control and improving surveillance activities, primarily in the Balkan sub-region, where a case was detected in a dog in 2020.

Maintaining appropriate surveillance is of paramount importance for all MSs, due to regular resurgence of the disease in rabies-free areas and the persistence of active foci in Hungary, Poland and Romania. Apparent disappearance of the virus has been achieved in most EU territories and maintaining appropriate surveillance efforts and relevant ORV implementation remain the most challenging issues to attaining rabies elimination in the EU.

## 4 | Q FEVER

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about Q fever and for the consultation of data collected, the following interactive tool is available:



### 4.1 | Key facts

- In 2023, there were 805 confirmed cases of human Q fever, corresponding to a European Union notification rate of 0.19 cases per 100,000 population. This was an increase of 11.5% compared with 2022 (0.17 cases per 100,000 population).
- The overall trend for human *Coxiella burnetii* infections did not show any significant increase or decrease in the 2019–2023 period.
- In 2023, 17 Member States and five non-Member States reported data for *C. burnetii* in animals. Cattle and small ruminants were predominantly sampled during clinical investigations and passive monitoring of animals with suspected infection. At the European Union level, among the animals tested using direct detection methods ( $N=3738$ ), the proportion of positive cases was 4.7% in sheep, 11.2% in goats and 6.0% in cattle. For herds tested using direct detection methods ( $N=5256$ ), the positive proportion was 23.8% for sheep, 20.0% for goats and 8.5% for cattle. Serological testing revealed that 27.0% of sheep, 25.9% of goats and 6.0% of cattle were seropositive among the 8722 animals tested. At the herd level, 0.75% of sheep flocks, 4.8% of goat herds and 6.4% of cattle herds tested seropositive out of 5429 herds.
- Among other farmed, domestic and wild animals tested ( $N=528$  animals,  $N=21$  herds from nine reporting countries), positivity was reported mainly in Italy, in donkeys, horses, mouflons, water buffalos, dogs and deer. Additionally, Belgium reported one positive deer holding.

## 4.2 | Surveillance and monitoring of *Coxiella burnetii* in the EU

### 4.2.1 | Humans

For 2023, 25 MSs provided data on Q fever in humans. No surveillance system is in place in Austria. Denmark did not report data for 2020–2023. Surveillance is mandatory in 24 MSs and voluntary in France. Moreover, in 2023, France adopted the EU case definition. The EU case definition was used by 23 countries; two MSs (Germany and Italy) reported use of another case definition. Disease surveillance is comprehensive and generally passive except in Czechia and Slovakia. The Q fever surveillance systems cover the whole population in all reporting MSs. All countries reported case-based data except Belgium, Bulgaria and Croatia, which provided aggregated data.

### 4.2.2 | Animals

Q fever is a 'Category E' disease, for which there is a need for surveillance and annual reporting of confirmed cases by MSs in *Bison ssp.*, *Bos ssp.*, *Bubalus ssp.*, *Ovis ssp.* and *Capra ssp.* (CIR (EU) 2018/1882, CIR (EU) 2020/2002).

However, since neither surveillance nor reporting of animal Q fever has been harmonised in the EU, data may not be representative of the disease situation in each European country and should not be used for tracking or assessing EU-level temporal and spatial trends (Table 63).

The primary animal categories tested for *C. burnetii* were sheep, goats and cattle. Most samples were blood, placental tissue, vaginal swabs and samples from foetuses and stillborn animals suspected of infection, along with bulk milk samples used for screening. Testing methods included serological assays to detect antibodies indicating past or recent exposure to *C. burnetii*, and direct detection methods like PCR, which identify bacterial material indicating carriage. In most MSs, testing was conducted during clinical investigations and passive monitoring. However, a few countries – Belgium, Bulgaria, the Netherlands, Poland, Slovenia – implemented planned surveillance in cattle and small ruminants. Poland ( $N=4871$  herds) and Slovenia ( $N=84$  herds) used ELISA serological tests on serum, along with Sweden and Norway to check for sporadic cases. Belgium and the Netherlands regularly carried out PCR tests on bulk tank milk from dairy sheep and goats, while Iceland used serological tests on this type of sample. Some countries reported very low numbers of tests, typically linked to local surveys or selective investigations. In addition, samples were collected from other farmed and domestic animals, particularly water buffalos in Italy, as well as wild animal species in zoos or natural habitats.

## 4.3 | Results

### 4.3.1 | Overview of key statistics, EU, 2019–2023

Table 63 summarises EU-level statistics on human Q fever, and on the occurrence of *C. burnetii* in animals, for the period 2019–2023. More detailed descriptions of these statistics are provided in the subsections below.

**TABLE 63** Summary of *Coxiella burnetii* statistics relating to humans and the main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	805	719	470	547	1021	ECDC
Total number of confirmed cases/100,000 population (notification rates)	0.19	0.17	0.11	0.13	0.20	ECDC
Number of reporting EU MSs	25	25	25	25	27	ECDC
Infection acquired in the EU	622	597	366	364	804	ECDC
Infection acquired outside the EU	19	5	3	6	15	ECDC
Unknown travel status or unknown country of infection	164	117	101	177	202	ECDC
<b>Animals<sup>a</sup></b>						
<b>Sheep<sup>b</sup></b>						
<b>Animals</b>						
<b>Serology<sup>c</sup></b>						
Number of tested animals	1891	526	750	911	666	EFSA
% positive animals	27.0	11.4	10.3	11.4	9.9	EFSA
Number of reporting MSs	7	8	8	8	9	EFSA

TABLE 63 (Continued)

	2023	2022	2021	2020	2019	Data source
<i>Direct detection<sup>d</sup></i>						
Number of tested animals	1040	752	85	358	224	EFSA
% positive animals	4.7	3.6	5.9	8.7	18.3	EFSA
Number of reporting MSs	7	7	5	4	4	EFSA
<i>Other methods/unknown</i>						
Number of tested animals	0	0	521	1555	2244	EFSA
% positive animals	–	–	0	21.7	13.3	EFSA
Number of reporting MSs	–	–	1	2	2	EFSA
<b>Herds</b>						
<i>Serology<sup>c</sup></i>						
Number of tested herds	2270	128	2238	17	25	EFSA
% positive herds	0.75	97.7	18.9	5.9	28.0	EFSA
Number of reporting MSs	3	1	1	2	1	EFSA
<i>Direct detection<sup>d</sup></i>						
Number of tested herds	1947	2812	3130	2890	2902	EFSA
% positive herds	23.8	4.9	4.1	1.4	1.2	EFSA
Number of reporting MSs	4	6	5	4	4	EFSA
<i>Other methods/unknown</i>						
Number of tested herds	0	0	0	39	53	EFSA
% positive herds	–	–	–	15.4	30.2	EFSA
Number of reporting MSs	–	–	–	1	1	EFSA
<b>Goats</b>						
<b>Animals</b>						
<i>Serology<sup>c</sup></i>						
Number of tested animals	135	140	540	651	656	EFSA
% positive animals	25.9	17.9	24.6	25.0	18.0	EFSA
Number of reporting MSs	7	8	6	7	8	EFSA
<i>Direct detection<sup>d</sup></i>						
Number of tested animals	661	961	200	248	189	EFSA
% positive animals	11.2	2.1	16.5	11.3	9.5	EFSA
Number of reporting MSs	7	7	4	4	4	EFSA
<i>Other methods/unknown</i>						
Number of tested animals	0	0	777	831	845	EFSA
% positive animals	–	–	0.13	0	0	EFSA
Number of reporting MSs	–	–	1	2	2	EFSA
<b>Herds</b>						
<i>Serology<sup>c</sup></i>						
Number of tested herds	976	–	4	141	30	EFSA
% positive herds	4.8	–	50.0	78.7	73.3	EFSA
Number of reporting MS	3	–	1	1	1	EFSA
<i>Direct detection<sup>d</sup></i>						
Number of tested herds	1200	1189	1283	1175	1167	EFSA
% positive herds	20.0	3.5	2.0	1.2	2.8	EFSA
Number of reporting MSs	4	5	5	4	4	EFSA
<i>Other methods/unknown</i>						
Number of tested herds	0	82	0	12	207	EFSA
% positive herds	–	62.2	–	0	84.1	EFSA
Number of reporting MSs	–	1	–	1	1	EFSA

(Continues)

TABLE 63 (Continued)

	2023	2022	2021	2020	2019	Data source
<b>Cattle (bovine animals)</b>						
<b>Animals</b>						
<i>Serology<sup>c</sup></i>						
Number of tested animals	6696	7031	3405	4664	8722	EFSA
% positive animals	6.0	2.8	12.2	9.6	10.5	EFSA
Number of reporting MSs	8	9	11	9	11	EFSA
<i>Direct detection<sup>d</sup></i>						
Number of tested animals	2037	1260	458	842	739	EFSA
% positive animals	6.0	2.7	5.2	3.8	3.0	EFSA
Number of reporting MSs	8	5	4	5	4	EFSA
<i>Other methods/unknown</i>						
Number of tested animals	0	0	343	3860	4240	EFSA
% positive animals	–	–	0.29	0.08	0.66	EFSA
Number of reporting MSs	–	–	1	2	2	EFSA
<b>Herds</b>						
<i>Serology<sup>c</sup></i>						
Number of tested herds	2101	113	1201	312	551	EFSA
% positive herds	6.7	30.1	15.1	14.4	30.7	EFSA
Number of reporting MSs	4	3	1	2	2	EFSA
<i>Direct detection<sup>d</sup></i>						
Number of tested herds	2109	3934	4311	3571	3673	EFSA
% positive herds	8.5	7.7	4.8	6.7	6.3	EFSA
Number of reporting MSs	8	6	8	5	5	EFSA
<i>Other methods/unknown</i>						
Number of tested herds	0	6	0	0	43	EFSA
% positive herds	–	100	–	–	95.3	EFSA
Number of reporting MSs	–	1	–	–	1	EFSA

Abbreviations: ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>Number of tested animals and herds were obtained by totalling respectively the animal sampling unit, and the herd or holding sampling units, of all sampling stages (backyard, border control posts, farm, hunting, natural habitat, unspecified, veterinary activities and zoo), sampling strategies (census, convenience sampling, objective sampling selective sampling and suspect sampling) samplers (HACCP and own-check, industry sampling, official sampling, not applicable and private sampling) and sampling contexts (clinical investigations, monitoring, outbreak investigation, surveillance, survey and unspecified).

<sup>b</sup>'Sheep' also includes the 'sheep and goats' category (NB, some countries reported both livestock types together).

<sup>c</sup>Serology includes the complement fixation test (CFT), ELISA, competitive ELISA (C-ELISA), indirect ELISA (I-ELISA), IgG ELISA and the immunofluorescence antibody test (IFAT).

<sup>d</sup>Direct detection methods include fluorescent in situ hybridisation (FISH), immunohistochemistry (IHC), microbiological tests, multiplex PCR, PCR, real-time PCR, real-time PCR (CEN TC 275/WG 6).

### 4.3.2 | *Coxiella burnetii* in humans

For 2023, 25 EU MSs reported a total of 805 confirmed cases of Q fever, with a notification rate of 0.19 cases per 100,000 population. This is an increase of 11.5% compared with the rate in 2022 (0.17 per 100,000 population). More than 50% of cases were reported by Romania and Spain, while Estonia, Finland, Latvia, Lithuania and Malta reported zero cases. The highest notification rate was recorded in Bulgaria (0.73 per 100,000 population) and Hungary (0.72 per 100,000 population), followed by Spain and Romania, with 0.69 and 0.64 cases per 100,000 population, respectively (Table 64).

Of those with available travel status information ( $N=641$ ), most Q fever cases (97.0%,  $N=622$ ), were reported to have been acquired in the EU, representing a slight decrease compared with 2022 (99.2%). Nineteen cases (2.4%) were acquired outside the EU, and 20.4% ( $N=164$ ) were reported as unknown travel status or unknown country of infection (Table 64).

A total of 32 imported cases were registered in nine MSs (Czechia, France, Germany, Hungary, the Netherlands, Slovakia, Slovenia, Spain and Sweden) and for 12 cases the most probable country of infection was documented.

In 2023, cases occurred year-round. Most Q fever cases occurred from March to August, in line with the spring/summer seasonal pattern (Figure 27).

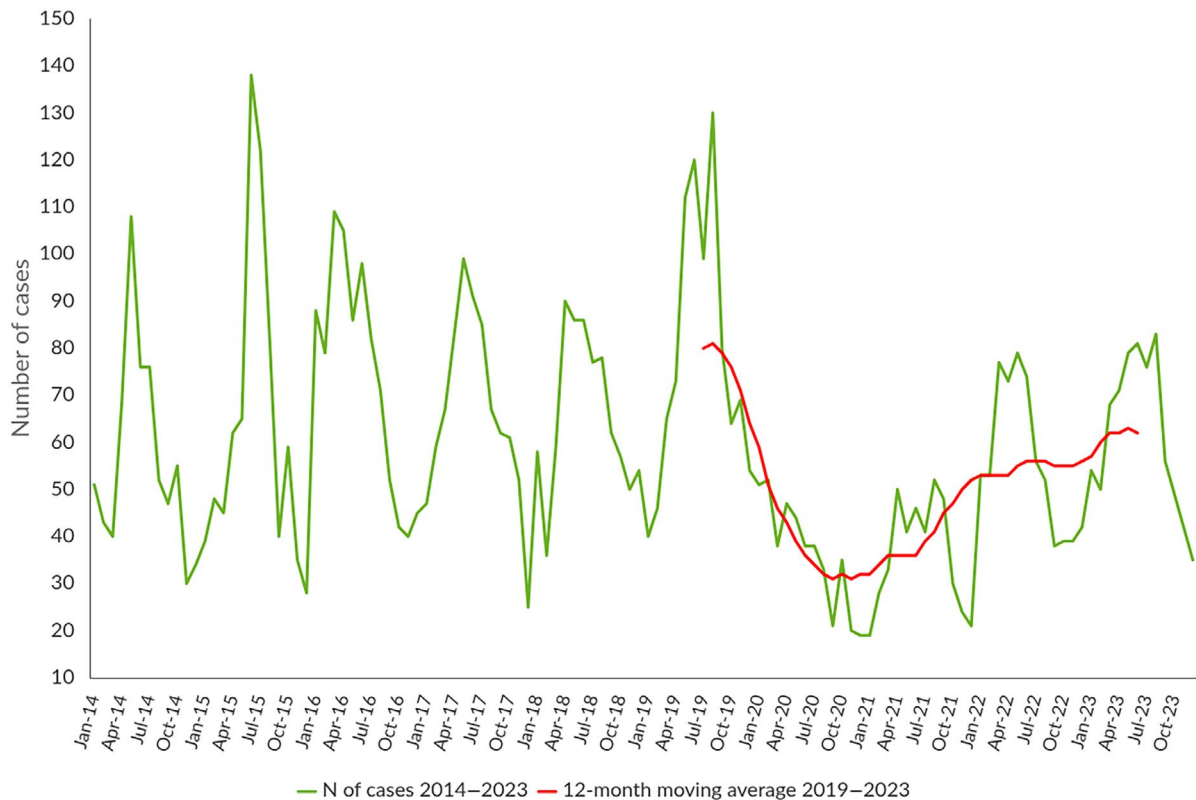
The number of Q fever cases increased compared with 2022. However, the overall Q fever trend in 2019–2023 did not show a significant increase or decrease in the EU. At the country level, a significant increasing trend was observed in Hungary ( $p < 0.05$ ).

**TABLE 64** Reported human cases of Q fever and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	National coverage <sup>a</sup>	Data format <sup>a</sup>	2023		2022		2021		2020		2019	
			Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate	
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Austria <sup>b</sup>	–	–	–	–	–	–	–	–	–	–	–	–
Belgium	Y	A	4	0.03	6	0.05	6	0.05	4	0.03	10	0.09
Bulgaria	Y	A	47	0.73	13	0.19	31	0.45	103	1.5	36	0.51
Croatia	Y	A	2	0.05	22	0.57	0	0	2	0.05	8	0.20
Cyprus	Y	C	2	0.22	2	0.22	2	0.22	1	0.11	1	0.11
Czechia	Y	C	2	0.02	2	0.02	1	0.01	1	0.01	1	0.01
Denmark <sup>c</sup>	Y	C	–	–	–	–	–	–	–	–	0	0
Estonia	Y	C	0	0	0	0	0	0	0	0	0	0
Finland	Y	C	0	0	0	0	0	0	0	0	2	0.04
France	Y	C	75	0.11	127	0.19	92	0.14	96	0.14	156	0.23
Germany	Y	C	74	0.09	65	0.08	99	0.12	55	0.07	148	0.18
Greece	Y	C	10	0.10	10	0.10	4	0.04	4	0.04	14	0.13
Hungary	Y	C	69	0.72	67	0.69	41	0.42	34	0.35	47	0.48
Ireland	Y	C	4	0.08	0	0	0	0	2	0.04	2	0.04
Italy	Y	C	7	0.01	0	0	0	0	0	0	6	0.01
Latvia	Y	C	0	0	2	0.11	0	0	1	0.05	0	0
Lithuania	Y	C	0	0	0	0	0	0	0	0	0	0
Luxembourg	Y	C	1	0.15	3	0.46	0	0	2	0.32	0	0
Malta	Y	C	0	0	2	0.38	1	0.19	0	0	1	0.20
Netherlands	Y	C	4	0.02	12	0.07	6	0.03	7	0.04	16	0.09
Poland	Y	C	6	0.02	2	0.01	0	0	0	0	4	0.01
Portugal	Y	C	33	0.32	25	0.24	18	0.17	22	0.21	32	0.31
Romania	Y	C	122	0.64	49	0.26	5	0.03	12	0.06	109	0.56
Slovakia	Y	C	4	0.07	0	0	2	0.04	5	0.09	1	0.02
Slovenia	Y	C	3	0.14	1	0.05	0	0	1	0.05	6	0.29
Spain	Y	C	334	0.69	303	0.64	159	0.34	194	0.41	402	0.86
Sweden	Y	C	2	0.02	6	0.06	3	0.03	1	0.01	10	0.10
<b>EU Total 27</b>			<b>805</b>	<b>0.19</b>	<b>719</b>	<b>0.17</b>	<b>470</b>	<b>0.11</b>	<b>547</b>	<b>0.13</b>	<b>1012</b>	<b>0.23</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	9	0.01
<b>EU Total</b>			<b>805</b>	<b>0.19</b>	<b>719</b>	<b>0.17</b>	<b>470</b>	<b>0.11</b>	<b>547</b>	<b>0.13</b>	<b>1021</b>	<b>0.20</b>
Iceland	Y	C	0	0	0	0	0	0	0	0	0	0
Norway	Y	C	3	0.05	4	0.07	4	0.07	5	0.09	8	0.15
Liechtenstein	Y	C	1	2.5	0	0	0	0	53	0.61	102	1.2
Switzerland <sup>d</sup>	Y	C	101	1.1	89	1.0	111	1.3				

Abbreviation: –, Data not reported.

<sup>a</sup>Y: yes; N: no; A: aggregated data; C: case-based data.<sup>b</sup>Not notifiable, no surveillance system exists.<sup>c</sup>Denmark did not report data in 2020–2023.<sup>d</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years from 2019 to 2020.



**FIGURE 27** Trend in reported confirmed human cases of Q fever in the EU by month, 2019–2023. *Source:* Cyprus, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

### 4.3.3 | *Coxiella burnetii* in animals

#### Overview of key statistics, main animal species, EU, 2019–2023

Animal data of interest were grouped into three main species categories (sheep, goats and cattle) and aggregated by year for the period 2019–2023, to provide an annual summary of the submitted data (Table 63). The total number and the proportions of positive cases – at both the individual animal level and the herd, holding or flock level – were further categorised based on the analytical testing method used (serology or direct detection).

In 2023, compared to 2022, the number of individual animal samples submitted by EU MSs increased for cattle (+5.3%,  $N=8733$ ) and sheep (+129.3%,  $N=2931$ ), but decreased for goats (–27.7%,  $N=796$ ). Concomitantly, the number of sampled herds increased by 3.9% for cattle ( $N=4210$  in 2023), 43.4% for sheep ( $N=4217$  in 2023) and 71.2% for goats ( $N=2176$  in 2023). Compared to 2022, the overall number of samples submitted at both the animal and herd levels increased by 4.9% for cattle ( $N=12,943$  in 2023), 25.3% for goats ( $N=2972$  in 2023) and 69.5% for sheep ( $N=7148$  in 2023), reaching the highest submission level in the past 5 years.

The proportions of positive serological tests varied greatly across years and sampling contexts. From 2019 to 2023, the overall proportion of positive animal samples ranged from 9.9% to 27.0% for sheep (27.0% in 2023), 17.9% to 25.9% for goats (25.9% in 2023) and 2.8% to 12.2% for cattle (6.0% in 2023). At the herd level, positive serological tests ranged from 0.75% to 97.7% for sheep (0.75% in 2023, primarily based on 2251 herds reported by Poland, whereas data had been reported from direct tests in 2022), from 4.8% to 78.7% for goats (4.8% in 2023, based largely on 887 herds from Poland, whereas data had been reported from direct tests in 2022) and from 6.7% to 30.7% for cattle (6.7% in 2023, based on 1733 herds reported by Poland, whereas data had been reported from direct tests in 2022).

The range and the proportions of positive direct detection tests were generally lower than those of serological tests but were slightly higher in 2023 compared to the previous 4 years, particularly for sheep and goat herds. This increase was mostly driven by data from Spain which reported 1374 tests for sheep (28.9% positivity) and 504 tests for goats (39.7% positivity). For cattle, the increased proportion of positive direct detection tests was driven by Ireland (1071 tests, 4.9% positivity) and Austria (389 tests, 9.3% positivity). Overall, during 2019–2023, the proportion of positive animal samples ranged from 3.6% to 18.3% for sheep (4.7% in 2023), from 2.1% to 16.5% for goats (11.2% in 2023) and from 2.7% to 6.0% for cattle (6.0% in 2023). At the herd level, positive direct detection results ranged from 1.2% to 23.8% for sheep (23.8% in 2023), from 1.2% to 20.0% for goats (20.0% in 2023) and from 4.8% to 8.5% for cattle (8.5% in 2023).

## Overview of key statistics, main animal species, EU, 2023

### Sheep

Eleven MSs and three non-MSs (Republic of North Macedonia, Serbia and Switzerland) reported data for a total of 3157 animals and 4217 flocks. At the animal level, serological tests – primarily ELISA ( $N=1891$ , 27.0% positive) – were used more frequently than direct detection methods ( $N=1266$ , 5.8% positive). The Netherlands conducted one-third of the direct detection tests ( $N=442$ , 0% positive), while Italy performed the largest number of ELISA tests ( $N=1294$ ), with 29.0% positivity. At the herd level, most serological tests were from Poland ( $N=2251$ , 0.18% positive), while Spain accounted for most direct detection tests ( $N=1374$ , 28.9% positive).

### Goats

Ten MSs and one non-MS (Switzerland) reported data for 949 animals and 2176 herds. At the animal level, direct detection tests ( $N=814$ , 12.3% positive) were used more frequently than serological tests ( $N=135$ , 25.9% positive). The Netherlands ( $N=419$ , 0% positive), Italy ( $N=203$ ; 32.0% positive) and Switzerland ( $N=153$ , 17.0% positive) conducted most direct detection tests. Serological tests were primarily carried out by Italy ( $N=61$ , 24.6% positive), Austria ( $N=26$ , 19.2% positive), Bulgaria ( $N=25$ , 60.0% positive) and Slovakia ( $N=23$ , 0% positive). At the herd level, Spain led direct detection testing ( $N=504$ , 39.7% positive), followed by the Netherlands ( $N=404$ , 0% positive) and Belgium ( $N=228$ , 10.1% positive). Poland reported the most serological tests ( $N=887$ , 0.34% positive) while Italy reported 83 serological tests with 48.2% positivity.

### Cattle

Seventeen MSs and five non-MSs (Iceland, Norway, Republic of North Macedonia, Serbia and Switzerland) provided data, covering a total of 12,585 animals and 4292 herds. At the animal level, direct detection tests ( $N=5581$ , 9.3% positive) were less often used than serological tests ( $N=7004$ , 5.8% positive). Italy ( $N=3314$ , 4.0% positive), Austria ( $N=1825$ , 6.5% positive), Slovakia ( $N=948$ , 1.2% positive) and Bulgaria ( $N=360$ , 34.2% positive) accounted for nearly 89% of serological testing. Switzerland and Ireland conducted the highest number of direct detection tests ( $N=3542$  and  $N=1071$ , respectively), with positivity rates of 11.2% and 4.9%. At the herd level, most direct detection tests were reported by Belgium ( $N=1830$ , 2.7% positive), while Poland contributed most serological tests ( $N=1733$ , 3.6% positive).

### Other animal species

Data on species other than sheep, goats and cattle were reported by seven MSs (Austria, Belgium, Ireland, Italy, Slovakia, Slovenia and Sweden) and two non-MSs (Norway and Switzerland) covering 19 species. In total, 528 animals and 21 herds were tested, primarily by Italy, from a variety of domestic and wild species including other ruminants (buffaloes, alpacas, mouflons, deer), solipeds, pigs, pets (dogs) and other species. Italy reported positivity in several species: buffaloes ( $N=261$ , 1.5% positive), deer ( $N=47$ , 2.1% positive), dogs ( $N=89$ , 2.2% positive), mouflons ( $N=24$ , 8.3%), horses ( $N=13$ , 15.4% positive) and donkeys ( $N=2$ , 50.0% positive). At the herd level, Italy also reported positivity in horses ( $N=7$ , 28.6%) and in buffaloes ( $N=13$ , 15.4%), while Belgium documented one positive deer herd ( $N=1$  herd, 100% positive).

## 4.4 | Discussion

Q fever, caused by *C. burnetii*, affects humans and animals. Due to its microbial characteristics that include high virulence, environmental resistance and aerosol dissemination, it is classified as a potential biological weapon. Humans mainly acquire the infection through environmental contamination arising from bacterial shedding in infected animals, but also possibly through tick-borne transmission and a food-borne route (Basanisi et al., 2022). In Europe, most clinical cases are sporadic. However, several outbreaks among humans have been reported. Up to 2016, France and Germany reported most of the confirmed cases and in 2017, two outbreaks were reported from Bulgaria (Genova-Kalou et al., 2019). Year 2021 saw the lowest number of human Q fever cases recorded in the EU. Since 2017, Spain has reported the highest number of cases annually, mostly explained by a change in their reporting system from voluntary to mandatory (Christodoulou et al., 2023). In 2022, the number of human Q fever cases increased compared with the 2020–2021 pandemic years and an outbreak of Q fever was recorded in Croatia (Tomljenovic et al., 2023).

In 2023, the number of human Q fever cases increased compared to 2022, with 90% of cases occurring in Bulgaria, France, Germany, Hungary, Romania and Spain. Overall, the Q fever trend for the 2019–2023 period did not show any significant increase or decrease in the EU. Spain accounted for the largest proportion (41.5%) of cases, and, historically, the Basque Country reports most of the cases and outbreaks (Hurtado et al., 2023). Moreover, seroprevalence studies have confirmed Q fever endemicity in the Basque and the Canarian populations. In the Basque provinces of Biscay and Alava, a significant association was found between *C. burnetii*-positive farm dust samples and human cases (Cifo et al., 2024). Additionally, recent research highlights the importance of indirect transmission, especially in urban communities without evidence of conventional risk factors, leading to an underestimation of Q fever diseases (Tan et al., 2024). Outside of

occupational exposure, human infection may be influenced by environmental and meteorological conditions. Wind speed direction and geographical dispersion are important risk factors to consider as a source of infection and environmental microbial maintenance (Clark & Soares, 2018).

The results obtained from animals – primarily from small ruminants and cattle – remain insufficient for analysing trends for Q fever at the EU level. The start of annual EU reporting in 2021, after Q fever was classified as a 'Category E' disease in the new EU Animal Health Law, has yet to result in consistent harmonisation across MSs countries. The results submitted by different MSs and non-MSs are not directly comparable, mainly due to differences in sampling strategy (sample types, testing methods, coverage of the monitoring), data completeness and sensitivity of the surveillance method. France and Germany, for example, still do not report data on Q fever in animals, further complicating the ability to analyse trends.

While progress has been made in familiarising countries with testing methods, challenges persist. The lack of standardised case definitions for animals and herds, along with confusion between reporting at the animal and herd levels, complicates the ability to conduct coherent and comparative analyses in domestic ruminants. This not only impedes accurate intra- and inter-herd evaluations, but also hinders the identification of key positive and negative factors influencing Q fever seroprevalence. Monitoring these factors is crucial, especially in the context of climate change, which may influence disease transmission dynamics.

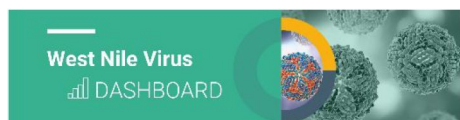
Moreover, bulk tank milk sampling is increasingly used as a method for monitoring *C. burnetii* in dairy herds. However, questions remain about its sensitivity, particularly in relation to herd size and the number of lactating females raising concerns about its overall efficacy as a surveillance tool.

In addition to farmed ruminants, other animals – including pets and wild species – may act as potential reservoirs for *C. burnetii* and should be included in epidemiological investigations, if needed (Alessiani et al., 2024; Georgiev et al., 2013). In the coming years, it will be crucial to investigate sources of *C. burnetii* infection and understand how environmental contamination persists (Carrié et al., 2019; Hurtado et al., 2023). A key challenge will be reducing human exposure to this zoonosis through a preventive 'One Health' approach. In Spain, where Q fever cases have been notably high, a surveillance programme for ruminant herds was updated in 2023. As a result, new control measures have been introduced to mitigate human outbreaks, with plans to harmonise these actions at the national level in the near future (Cifo et al., 2024).

## 5 | WEST NILE VIRUS

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about West Nile virus and for the consultation of data collected, the following interactive tool is available:



### 5.1 | Key facts

- In 2023, there were 751 confirmed and probable cases of human West Nile virus infections, corresponding to a European Union notification rate of 0.17 cases per 100,000 population. This represented a decrease of 37.2% in the European Union rate of locally acquired cases (0.16 case per 100,000), compared with 2022 (0.25 cases per 100,000 population).
- In 2023, 320 birds and 182 equines tested positive for West Nile virus, as reported to EFSA. This represents a decrease of 25.8% and an increase of 9.6%, respectively, compared with 2022.
- In 2023, 425 outbreaks in animals were reported to the European Union Animal Disease Information System by nine Member States, with the number of avian outbreaks ( $N=266$ ) reported for 2023 being as high as the number reported by Member States in 2022. Austria, Bulgaria, France, Germany, Greece, Hungary, Italy and Spain reported outbreaks in birds, with Italy accounting for 79.7% of the total number of avian outbreaks reported in 2023.
- Seven Member States reported 159 outbreaks in equids to European Union Animal Disease Information System, with the highest proportions in France and Spain accounting for 30.8% and 23.9% of the total number of outbreaks, respectively.



## 5.2 | Surveillance and monitoring of West Nile virus in the EU

### 5.2.1 | Humans

In 2023, 27 MSs reported data on West Nile virus infection in humans. Surveillance is mandatory in 24 EU Member States, voluntary in France and Belgium and in Germany, this information was not specified. The EU case definition was used by 25 MSs, France reported a different case definition and Germany did not specify the case definition used. All countries had a comprehensive surveillance system, except for Germany, which did not provide details. In all EU Member States, the West Nile virus surveillance systems have national coverage. Croatia reports aggregated data, while the remaining EU Member States conducting West Nile virus surveillance report case-based data.

For the human disease due to West Nile virus (WNV), ECDC uses the term WNV infection in line with WHO ICD-11. This includes the febrile form, West Nile fever (WNF) and the neurological form, West Nile neuro-invasive disease (WNND), as well as asymptomatic infections.

### 5.2.2 | Animals

From a veterinary standpoint, WNV is the causative agent of West Nile Fever (WNF), a disease that develops into asymptomatic forms, benign forms (flu-like syndrome) and neuro-invasive forms (WOAH, 2023) in line with the World Organisation for Animal Health (WOAH) terminology. WNV surveillance in animals is mostly passive, including surveillance based on the diagnosis of neuro-invasive cases in equids, although some countries implement active surveillance of equids and/or captive birds and/or wild birds. Active surveillance involves actively looking for cases (symptomatic and asymptomatic) from targeted groups of animals to provide better insight into WNV ecology and circulation. Furthermore, EU MSs and Switzerland submit reports to EFSA on animal surveillance and monitoring activities. Two sources of information are used to complete this reporting. Firstly, data are submitted to EFSA by EU MSs and Switzerland from annual surveillance and monitoring activities in accordance with Directive 2003/99/EC. WNV is listed in Annex I, Part B (viruses transmitted by arthropods) as a virus to be monitored, according to the epidemiological situation in a MS, in compliance with Article 4.1 of the same Directive. Secondly, it is mandatory for MSs to notify outbreaks of equine and avian WNV to ADIS,<sup>53</sup> in accordance with CIR (EU) 2020/2002.

## 5.3 | Results

### 5.3.1 | Overview of key statistics, EU, 2019–2023

In 2023, WNV cases were reported in humans, equids and birds. Over the past 5 years, the number of countries reporting surveillance data in animals and humans has been relatively stable (Table 65).

The number of probable and confirmed human cases of WNV infection reported in 2023 was 751, corresponding to an EU notification rate of 0.17 per 100,000 population.

While the number of tested equids decreased drastically in 2023, there has been an overall increase in the number of tested birds since 2020, which intensified in 2023 thanks to the contribution of surveillance data from the Netherlands, reflecting a strengthening of the surveillance system in place.

More detailed descriptions of these statistics are provided in the subsections below.

**TABLE 65** Summary of West Nile virus (WNV) infection statistics relating to humans, birds and equids, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed and probable cases	751	1140	158	333	443	ECDC
Total number of confirmed and probable cases/100,000 population (notification rates)	0.17	0.26	0.04	0.08	0.09	ECDC
Number of reporting MSs <sup>a</sup>	27	27	26	26	27	ECDC
Infection acquired in the EU	725	1129	153 <sup>b</sup>	331	435	ECDC
Infection acquired outside the EU	13	8	5	2	5	ECDC
Unknown travel status or unknown country of infection	13	3	0	0	3	ECDC

(Continues)

<sup>53</sup>EU Animal Disease Information System (ADIS). More information is available at: [https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis\\_en](https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system-adis_en).

TABLE 65 (Continued)

	2023	2022	2021	2020	2019	Data source
<b>Animals</b>						
<b>Birds</b>						
Number of animals tested <sup>c</sup>	32,086	18,882	19,640	11,141	14,932	EFSA
Number of positive animals by PCR-based methods	320	431	146	165	104	EFSA
Number of MSs reporting surveillance/monitoring data to EFSA	15	14	13	11	13	EFSA
Number of outbreaks notified to ADIS	266	266	8	2	53	ADIS
Number of MSs notifying outbreaks to ADIS	8	5	2	1	2	ADIS
<b>Equids</b>						
Number of animals tested	1829	4336	6114	6749	5563	EFSA
Number of positive animals by PCR <sup>d</sup> -based methods	0	0	1	1	4	EFSA
Number of animals positive for IgM by ELISA	182	166	47	209	74	EFSA
Number of MSs reporting surveillance/monitoring data to EFSA	12	13	14	14	14	EFSA
Number of outbreaks notified to ADIS	159	101	44	190	99	ADIS
Number of MSs notifying outbreaks to ADIS	7	9	7	8	8	ADIS

Abbreviations: ADIS, Animal Disease Information System; ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; ELISA, enzyme-linked immunosorbent assay; MSs, Member States; PCR, polymerase chain reaction.

<sup>a</sup>Data from the United Kingdom were taken into account for 2017–2019, because the United Kingdom was an EU MS, but it became a third country on 1 February 2020.

<sup>b</sup>One case reported from the EU was later found to have originated in Mayotte.

<sup>c</sup>Samples tested using an unspecified analytical method are not included. The number of animals tested corresponds to the number of samples tested, irrespective of the analyses carried out by each Member State as part of its surveillance activities. The number of positive cases corresponds solely to positive cases reported specifically for a given method (PCR-based methods, IgM ELISA).

<sup>d</sup>PCR: Polymerase Chain Reaction.

### 5.3.2 | West Nile virus infections in humans

Among all reported confirmed and probable WNV infections, 725 (96.5%) were acquired in the EU (Table 65), 13 cases (1.7%) were acquired outside the EU and in 13 cases (1.7%), the travel status or country of infection was unknown (Table 65).

Among the 725 cases acquired within the EU, 713 were locally acquired, i.e. within the reporting MS (Table 66) and 12 were imported from another EU country, namely from France, Germany, Hungary, Italy and Slovenia. The EU notification rate for locally acquired cases decreased by 37.2% compared with 2022 (Table 3).

Eight EU MSs (Cyprus, France, Germany, Greece, Hungary, Italy, Romania and Spain) reported at least one locally acquired confirmed or probable human case of WNV infection in 2023. Most of the locally acquired infections were reported by Italy and Greece, accounting respectively for 47.8% and 22.7% of the total number of probable/confirmed cases acquired locally in the EU.

TABLE 66 Locally acquired human West Nile virus (WNV) infection cases (confirmed and probable) and notification rates per 100,000 population in EU MSs and non-MS countries, by country and year, 2019–2023.

Country	2023			2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases	Total cases and rate		Total cases and rate		Total cases and rate		Total cases and rate			
				Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Austria	Y	C	0	0	0	6	0.07	3	0.03	0	0	4	0.05
Belgium	Y	C	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	Y	C	0	0	0	1	0.01	0	0	1	0.01	5	0.07
Croatia	Y	A	0	0	0	5	0.13	0	0	0	0	0	0
Cyprus	Y	C	5	5	0.54	0	0	0	0	0	0	23	2.6

TABLE 66 (Continued)

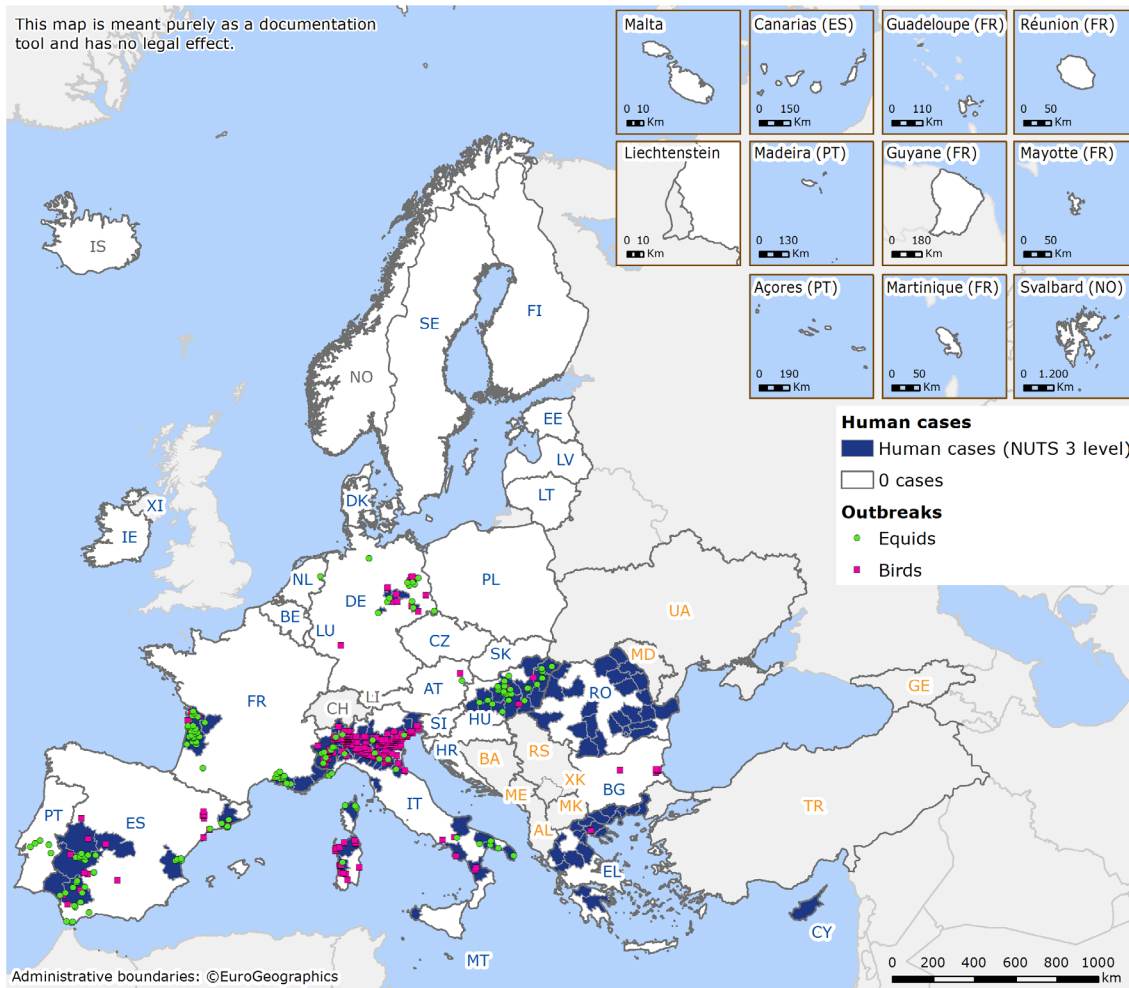
Country	2023				2022		2021		2020		2019		
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases	Total cases and rate		Total cases and rate		Total cases and rate		Total cases and rate			
				Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Czechia	Y	C	0	0	0	0	0	0	0	0	1	0.01	
Denmark	Y	C	0	0	0	–	–	–	–	–	–	–	
Estonia	Y	C	0	0	0	0	0	0	0	0	0	0	
Finland	Y	C	0	0	0	0	0	0	0	0	0	0	
France	Y	C	33	43	0.06	6	0.01	1	<0.01	0	0	2	<0.01
Germany	Y	C	7	7	0.01	17	0.02	4	<0.01	22	0.03	5	0.01
Greece	Y	C	99	162	1.6	286	2.7	59	0.55	144	1.3	227	2.1
Hungary	Y	C	22	30	0.31	14	0.14	7	0.07	3	0.03	36	0.37
Ireland	Y	C	0	0	0	0	0	0	0	0	0	0	0
Italy	Y	C	341	341	0.58	723	1.2	65	0.11	69	0.12	54	0.09
Latvia	Y	C	0	0	0	0	0	0	0	0	0	0	0
Lithuania	Y	C	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	Y	C	0	0	0	0	0	0	0	0	0	0	0
Malta	Y	C	0	0	0	0	0	0	0	0	0	0	0
Netherlands	Y	C	0	0	0	0	0	0	0	8	0.05	0	0
Poland	Y	C	0	0	0	0	0	0	0	0	0	0	0
Portugal	Y	C	0	0	0	0	0	0	0	0	0	0	0
Romania	Y	C	83	104	0.55	53	0.28	7	0.04	6	0.03	67	0.35
Slovakia	Y	C	0	0	0	1	0.02	0	0	0	0	1	0.02
Slovenia	Y	C	0	0	0	0	0	0	0	0	0	0	0
Spain	Y	C	15	21	0.04	4	0.01	6	0.01	77	0.16	0	0
Sweden	Y	C	0	0	0	0	0	0	0	0	0	0	0
<b>EU Total 27</b>	–	–	<b>605</b>	<b>713</b>	<b>0.16</b>	<b>1116</b>	<b>0.25</b>	<b>152</b>	<b>0.03</b>	<b>330</b>	<b>0.07</b>	<b>425</b>	<b>0.10</b>
United Kingdom	–	–	–	–	–	–	–	–	–	–	–	0	0
<b>EU Total</b>	–	–	<b>605</b>	<b>713</b>	<b>0.16</b>	<b>1116</b>	<b>0.25</b>	<b>152</b>	<b>0.03</b>	<b>330</b>	<b>0.07</b>	<b>425</b>	<b>0.08</b>
Iceland	Y	C	0	0	0	0	0	0	0	0	0	0	0
Norway	Y	C	0	0	0	0	0	0	0	0	0	0	0
Liechtenstein	Y	C	0	0	0	0	0	0	0	1	0.01	1	0.01
Switzerland <sup>b,c</sup>	Y	C	1	1	0.01	0	0	0	0	0	0	0	0

Abbreviation: –, Data not reported.

<sup>a</sup>Y: yes; N: no; A: aggregated data; C: case-based data.

<sup>b</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

<sup>c</sup>Switzerland communicated that the cases reported in 2019, 2020 and 2023 were not locally acquired.



**FIGURE 28** Geographical distribution of locally acquired West Nile virus infections among humans (NUTS 3 level<sup>54</sup>) and outbreaks notified to ADIS among equids and birds (X, Y coordinates) across the EU, 2023 transmission season. EU MSs and the United Kingdom (Northern Ireland) were represented with a blue label, the EFTA/EEA countries were represented with a grey label, and all the candidate countries were represented with an orange label. The designation of Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

### 5.3.3 | West Nile virus infections in animals

In 2023, 18 EU MSs and Switzerland submitted WNV monitoring and surveillance data from birds and/or equids to EFSA. Belgium and Poland did not submit WNV data to either ADIS or EFSA in 2022.

Figure 28 displays the geographical distribution of outbreaks in animals (ADIS data) together with the geographical distribution of locally acquired West Nile virus infections among humans.

In birds, 15 MSs reported a total of 32,086 analysed samples as part of their surveillance and monitoring activities (Table 65). Italy and the Netherlands submitted 50.7% and 31.5% of these data, respectively, while a total of 320 infected birds were reported to EFSA by Austria, Bulgaria, France, Germany, Greece, Hungary, Italy and Spain. WNV infections occurred in crows, doves, goshawks, jays, magpies, owls, passerines, pheasants, pigeons and starlings. The same MSs that reported infected birds also notified avian outbreaks to ADIS. Italy notified the highest numbers of outbreaks in birds, accounting for 79.7% of the total number of avian outbreaks reported in 2023. Switzerland, a non-EU country, reported 15 analyses with no PCR-positive animals to EFSA.

In equids, 12 MSs reported a total of 1829 analysed samples to EFSA as part of their surveillance and monitoring activities (Table 65). Seven MSs reported a total of 182 equid cases that were confirmed by IgM ELISA. France reported 49 IgM ELISA positive animals, accounting for 26.9% of the total number of WNV-positive animals reported to EFSA. One non-EU country, Switzerland, reported 13 analyses with no PCR-confirmed positives. Seven MSs (Austria, France, Germany, Hungary, Italy, Portugal and Spain) reported a total of 159 equid outbreaks to ADIS. The highest numbers of outbreaks were reported by France and Spain, accounting for 30.8% and 23.9% of the total number of outbreaks, respectively. Moreover, Austria and Denmark reported a total of 11 tested domestic ruminant and wild ungulate samples and 144 bat samples to EFSA, as part of their surveillance and monitoring activities. Austria reported a PCR-positive alpaca to EFSA. No bats were found to be infected by West Nile virus.

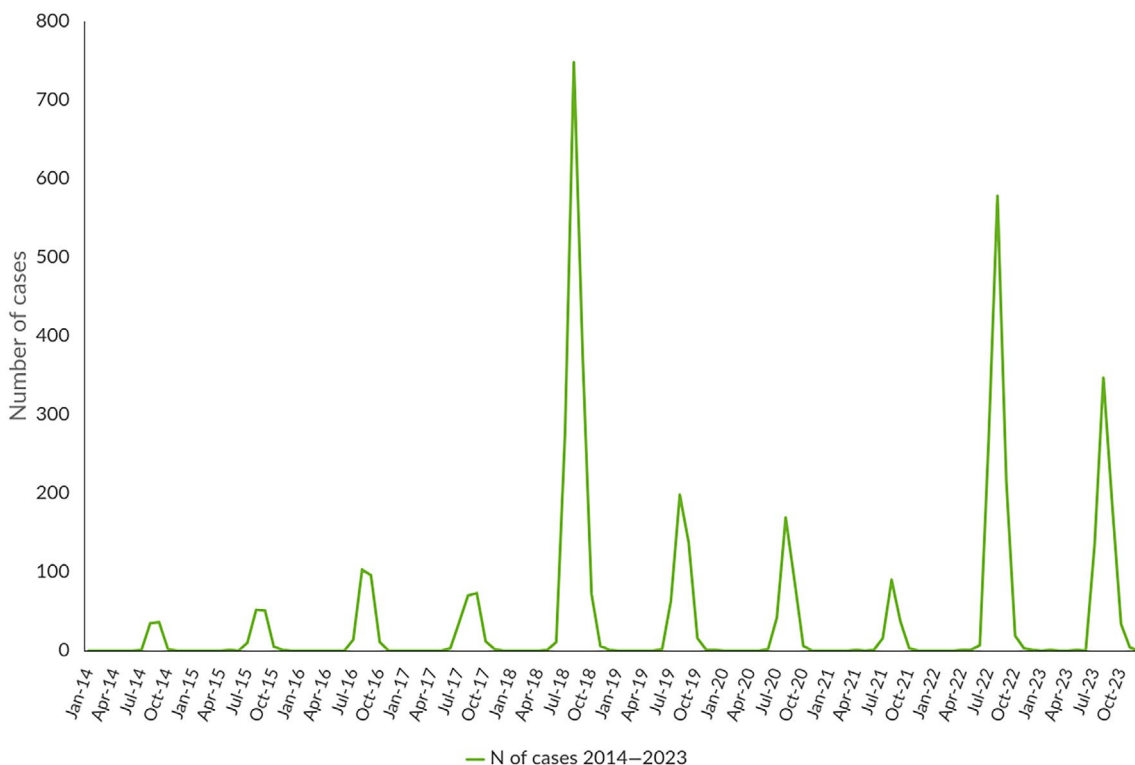
See dashboard referenced at the start of the chapter.

<sup>54</sup>The NUTS (Nomenclature of territorial units for statistics) is a hierarchical system divided into three levels. NUTS 1: major socio-economic regions, NUTS 2: basic regions for the application of regional policies, NUTS 3: small regions for specific diagnoses. (<https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts>).

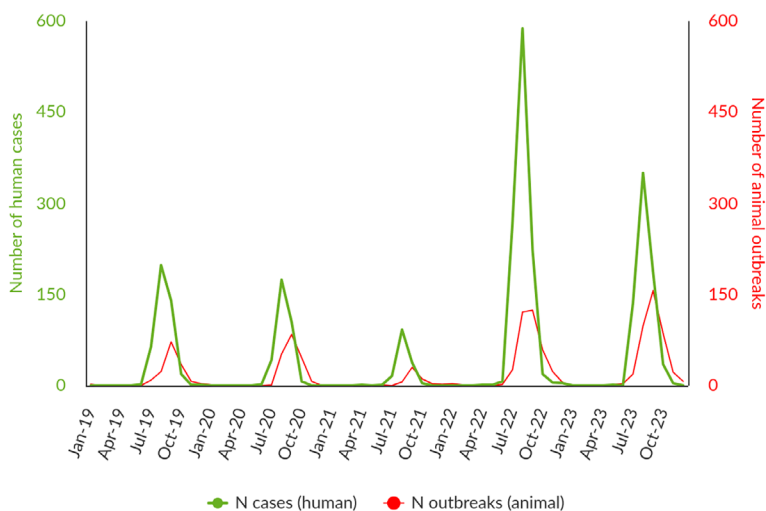
### 5.3.4 | Joint analysis of seasonality

WNV is endemic in several EU Member States and both animal and human cases of WNV infections are reported every year (Figure 29). Infections in Europe occur seasonally, with most cases being reported between July and September. During the period 2019–2023, one unusually intense transmission season was documented in 2022. In 2023, the EU notification rate of reported cases of locally acquired WNV human infections (N total=713; Table 66; Figure 29) decreased by 37.2% compared with 2022.

In 2023, the WNV transmission season among animals started earlier than in years with lower notification rates. WNV outbreaks in animals (N total=392; Figure 30) were higher than the number reported in 2022. The WNV outbreak detection trend in birds and equids was similar to that observed in 2022. The first multiple animal outbreaks were reported within Europe in June, with outbreaks peaking, as in previous years, in September (156 outbreaks, Figure 30). Consistently with previous years, the number of reported human infections in 2023 peaked in August, preceding the peak in the notification of animal outbreaks (Figure 30).



**FIGURE 29** Reported locally acquired human cases of West Nile virus infection in EU MSs, by month, 2014–2023. Source: Austria, Belgium, Bulgaria, Cyprus, Czechia, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden.



**FIGURE 30** Reported locally acquired human cases of West Nile virus infection and outbreaks in birds and equids, in the EU, by month, 2019–2023.

## 5.4 | Discussion

WNV circulation is influenced by environmental conditions, such as low precipitation in winter and high spring temperatures (Farooq et al., 2022; Marini et al., 2021), and by factors related to land use (Lu et al., 2024). Climate change has been shown to be one of the drivers of the increased risk of WNV circulation in Europe (Erazo et al., 2024). These conditions can contribute to the density of *Culex* mosquitoes and the movement of reservoir hosts (Fornasiero et al., 2020; Lu et al., 2024; Reisen et al., 2006). Over the past years, the number of EU MSs reporting local WNV transmission has increased (Young et al., 2021).

There is evidence that frequent introductions of West Nile virus lineages 1a and 2 have occurred in the past few decades in Europe (Koch et al., 2024), followed by local spread and evolution. Lineage 2 emerged in different European countries between 2004 and 2012 (Hernández-Triana et al., 2014) and has become the dominant lineage. It has been associated with significant human epidemics (Beck et al., 2020; Hernández-Triana et al., 2014; Pacenti et al., 2020; Papa et al., 2011). Both WNV lineages are currently co-circulating in Europe (Koch et al., 2024).

During the period 2019–2023, an intense level of transmission was documented in 2022 (Pervanidou et al., 2023; Riccardo et al., 2022).

In 2023, the number of reported animal outbreaks was similar to 2022. The majority of EU MSs reported cases in birds and equids to either EFSA or ADIS. Nevertheless, some countries did not submit monitoring and surveillance data this year. There is substantial under-detection/under-reporting of clinically asymptomatic and/or mildly symptomatic WNV infections, for humans as well as animals, which should be considered when reading the data presented. Similarly, most EU countries limit screening of WNV in animals to suspected symptomatic cases. It would be expected that the seasonal peak in animals should precede the one in humans. Indeed, WNV is maintained in nature through a transmission cycle primarily involving mosquitoes and birds. WNV activity in birds and mosquitoes often peaks earlier in the season compared to human cases. Human infections tend to occur later in the season. Moreover, animal surveillance is not uniform across all MSs, which may mask the presence of the virus in certain areas and lead to under-reporting of cases. These limitations highlight the importance of interpreting surveillance data between humans and animals with caution as implemented surveillance systems are not harmonised between MSs.

The observed findings on the occurrence of WNV infection in birds reported by MSs performing an active surveillance as Italy underscore the importance of monitoring birds' infection as an early detection system of the pathogen. The Netherlands carried out, in 2023, an extensive active screening for WNV in birds, with no positive results, indicating that the virus is not circulating in the country. These two examples highlight the importance of continued surveillance and monitoring of bird population to detect WNV circulation.

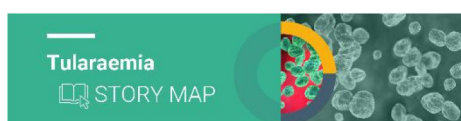
Although the number of tested equines reported to EFSA in 2023 was the lowest since 2019, the number of positive animals was one of the highest. This suggests an ongoing circulation of the virus and the potential for significant yearly variations in case numbers highlighting the complex epidemiology of WNV across different host species (Beck et al., 2020; Mingione et al., 2023; Valleriani et al., 2024).

The ECDC Technical report 'Surveillance, prevention and control of West Nile virus and Usutu virus infections in the EU/EEA', published in September 2023 (ECDC and EFSA, 2023d), gave an overview of the WNV epidemiological situation in the EU/EEA. It described the laboratory diagnostic, surveillance systems and preventive measures applied to ensure the safety of substances of human origin, as well as pinpointing the gaps that need to be addressed for a better understanding of the changing epidemiology of WNV in Europe.

## 6 | TULAREMIA

The summary data which make up this chapter, as well as additional information on related projects and internet sources, are published for this report on the EFSA Knowledge Junction at Zenodo [here](#). Summary statistics on human surveillance data with downloadable files are retrievable using the ECDC Surveillance Atlas of Infectious Diseases available [here](#).

For additional information about tularaemia, the following interactive tool is available:



### 6.1 | Key facts

In 2023, there were 1185 confirmed cases of human tularaemia, corresponding to a European Union notification rate of 0.27 cases per 100,000 population. This was an increase of 89.3% compared with the rate in 2022 (0.14 per 100,000 population).

In 2023, *Francisella tularensis* was detected in three animal categories across three Member States, encompassing a total of five species. The majority of samples tested in the European Union were from hares ( $N=145$ ), with 20.7% testing positive. Other species sampled, such as monkeys and squirrels, showed no positive results. However, 32.3% of leporids ( $N=31$ ) and 50% of dogs tested ( $N=8$ ) were positive.

## 6.2 | Surveillance and monitoring of tularaemia in the EU

### 6.2.1 | Humans

For 2023, 25 EU MSs provided data on tularaemia in humans. There is no surveillance system in place for tularaemia in Denmark and Luxembourg did not report for 2023. Surveillance is mandatory in all reporting MSs and is mostly passive, except in Czechia and Slovakia, where it is active. Surveillance systems are comprehensive with full national coverage in all reporting countries. The EU case definition was used by 23 MSs, while Germany and Italy reported using other case definitions. All countries reported case-based data except Belgium, Bulgaria and Croatia, which reported aggregated data.

### 6.2.2 | Animals

Monitoring data for *F. tularensis* in animals is voluntarily submitted to EFSA by EU MSs and non-MS countries. For 2023, data were provided by three EU MSs – Austria, Finland and Sweden – along with one non-MS country, Switzerland. Surveillance was mostly passive.

## 6.3 | Results

### 6.3.1 | Overview of key statistics, EU, 2019–2023

Table 67 summarises EU-level statistics on tularaemia in humans and in major animal species, respectively, for 2019–2023. More detailed descriptions of these statistics are provided in the subsections below.

**TABLE 67** Summary of *Francisella tularensis* statistics relating to humans and the main animal species, EU, 2019–2023.

	2023	2022	2021	2020	2019	Data source
<b>Humans</b>						
Total number of confirmed cases	1185	624	881	693	1321	ECDC
Total number of confirmed cases/100,000 population (notification rate)	0.27	0.14	0.20	0.16	0.26	ECDC
Number of reporting MSs	25	26	26	26	27	ECDC
Infection acquired in the EU	1022	480	722	514	1204	ECDC
Infection acquired outside the EU	7	1	2	2	3	ECDC
Unknown travel status or unknown country of infection	156	143	157	177	114	ECDC
Number of food-borne outbreak-related cases	0	0	0	0	0	EFSA
Total number of food-borne outbreaks	0	0	0	0	0	EFSA
<b>Animals<sup>a</sup></b>						
<b>Hares</b>						
Number of sampled animals	145	363	317	222	211	EFSA
Number of positive animals	30	36	70	81	67	EFSA
% of positive animals	20.7	9.9	22.1	36.5	31.8	EFSA
Number of reporting MSs	2	3	3	3	2	EFSA
<b>Animals other than hares</b>						
Number of sampled animals	43	107	18	5	152	EFSA
Number of positive animals	14	8	5	1	8	EFSA
% of positive animals	32.6	7.5	27.8	20.0	5.3	EFSA
Number of reporting MSs	2	3	3	1	1	EFSA

Abbreviations: –, Data not reported; ECDC, European Centre for Disease Prevention and Control; EFSA, European Food Safety Authority; MSs, Member States.

<sup>a</sup>The number of sampled animals was obtained by totalling all animal-level results, sampling stages (natural habitat, unspecified, veterinary activities, veterinary clinics and zoo), sampling strategies (convenience sampling, selective sampling and suspect sampling) and samplers (industry sampling, not applicable and official sampling).





TABLE 68 (Continued)

Country	2023		2022		2021		2020		2019			
	National coverage <sup>a</sup>	Data format <sup>a</sup>	Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate		Confirmed cases and rate			
			Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate		
Norway	Y	C	149	2.7	58	1.1	95	1.8	99	1.8	183	3.4
Liechtenstein	Y	C	1	2.5	1	2.5	2 <sup>c</sup>	5.1	131	1.5	153	1.8
Switzerland <sup>d</sup>	Y	C	109	1.2	119	1.4	227	2.6				

Abbreviations: –, Data not reported.

<sup>a</sup>Y, yes; N, no; A, aggregated data; C, case-based data.

<sup>b</sup>No surveillance system.

<sup>c</sup>Liechtenstein communicated that one case was notified in 2021.

<sup>d</sup>Switzerland provided data directly to EFSA. The human data for Switzerland include data from Liechtenstein for the years 2019–2020.

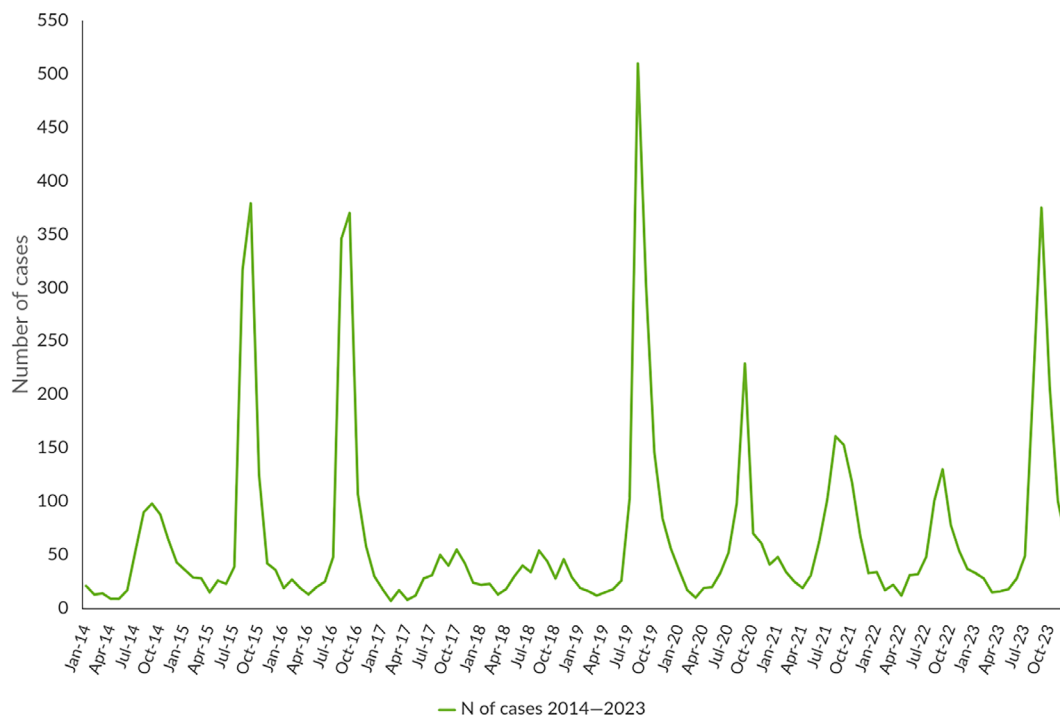


FIGURE 31 Number of confirmed human cases of tularaemia in the EU, by month and year, 2014–2023. Source: Austria, Cyprus, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Malta, Poland, Romania, Slovakia, Slovakia, Spain, Sweden.

### 6.3.3 | Tularaemia in animals

For 2023, overall, three EU MSs (Austria, Finland and Sweden) reported 30 hares, 10 leporids and 4 dogs positive for tularaemia, while Switzerland (non-EU MS) reported three positive hares. The number of samples and number of animal species tested were lower than in 2022, data are provided on the EFSA Knowledge Junction at Zenodo [here](#).

## 6.4 | Discussion

Tularaemia is widely distributed throughout most of Europe and is endemic in Scandinavian countries (Hennebique et al., 2019; Hestvik et al., 2015; Yeni et al., 2021). In the EU, for the years 2019–2022, Sweden and Finland reported notification rates ranging from 0.87 to 8.0 cases per 100,000 population. In the course of the same period, several human cases occurred in Austria, Czechia, France and Germany, while very few cases (up to 0.1 cases per 100,000 inhabitants) were recorded in Belgium, Bulgaria, Croatia, Italy, Latvia, the Netherlands and Portugal. From 2019 to 2022, no cases were reported from Cyprus, Greece, Ireland, Malta or Romania.

In 2023, the number of human tularaemia cases increased compared with 2022; Finland, France, Germany and Sweden accounted for the majority of cases. About 55.0% of cases were reported by Sweden.

Early disease detection and surveillance systems are crucial for preventive measures and to promptly intercept a resurgence of the disease related to risk factors such as environmental alterations, intensification of exposure and contaminated sources of infection.

Wildlife continues to play a role in maintaining *F. tularensis* in the ecological cycle, and also in the occurrence of human cases. *Francisella* spp. are present in wild animals (such as hares) and in vectors (e.g. ticks and mosquitoes), which can be sources of infections for humans (Maurin & Gyuranecz, 2016; WHO, 2007).

The circulation of *F. tularensis* among wild animals has been reported in numerous countries across north-central Europe, where the pathogen is considered endemic (Faber et al., 2018; Hestvik et al., 2015; Seiwald et al., 2020), as well as in Spain (Mínguez-González et al., 2021). Over the past 5 years, data from reporting Member States showed an increasing trend in hare testing (from 211 to 363 samples) until 2022. However, in 2023, testing decreased despite an increase in human cases, with 20.7% positive hares. Positive cases were also reported in leporids (32.3%) and dogs (50.0%). This finding is notable, as dogs, due to their close contact with humans, may share similar exposure risks to *F. tularensis* (Kwit et al., 2020).

It is important to recognise that passive tularaemia surveillance does not provide a comprehensive overview of the disease in entire animal populations. For instance, the positivity rate reported in dogs in 2022 and 2023 may not accurately reflect the prevalence of the disease in this population.

Notably, risks of exposure and/or new outbreaks in humans are often preceded by the appearance of the disease in animals, particularly wildlife such as hares, which serve as reliable indicators of *F. tularensis* activity. Thus, monitoring wildlife is essential. Due to the complex nature of tularaemia, effective control requires strong cooperation between veterinary and human health sectors. Coordinated epidemiological, laboratory and clinical investigations are crucial for early detection of tularaemia cases and to prevent further human exposure. Timely communication between these sectors is key, as disease outbreaks in one often serve as a warning of pathogen circulation in the other. Human cases, for instance, can signal the presence of *F. tularensis* in wild animals or the environment.

## 7 | OTHER ZONOOSES AND ZONOTIC AGENTS

The summary data which make up this chapter are published as supporting information for this report on the EFSA Knowledge Junction at Zenodo [here](#).

In 2023, data on *Bacillus*, *Chlamydia*, *Clostridium*, *Klebsiella*, *Erysipelothrix*, non-pathogenic *Escherichia coli*, *Proteus*, *Staphylococcus*, *Streptococcus*, *Vibrio*, caliciviruses, flaviviruses other than West Nile virus, hepatitis virus, *Cysticercus*, *Leishmania*, *Leptospira* and *Sarcocystis* were reported to EFSA.

### 7.1 | *Bacillus* spp.

Italy and Luxembourg submitted data on *Bacillus cereus* in various foods collected at retail establishments, canteens or workplace catering establishments, mobile food retailers, collective catering establishments (restaurant or cafe or pub or bar or hotel or catering service), schools or kindergartens, and from manufacturing plants. Of the 4852 sampling units, only 60 (1.2%) were positive. The contaminated food categories were primarily 'other processed food products and prepared dishes', 'ready-to-eat salads' and 'soups'.

Greece reported data on *B. anthracis* in 15 animals, including bovine animals, goats, sheep and pigs. One bovine animal and one goat tested positive.

### 7.2 | Caliciviruses (including norovirus)

Six MSs (Bulgaria, Croatia, France, Portugal, Romania and Slovenia) reported data on caliciviruses, testing a total of 24 batches and 304 individual sampling units, from fish, fruits, spices and herbs, and vegetables. No positive samples were detected.

### 7.3 | *Chlamydia* spp.

Two MSs (Austria and Denmark) and one non-MS (Republic of North Macedonia) reported data on *Chlamydia* spp. in various animal species. Austria reported 211 (12.4%) positives out of 1695 samples, Denmark reported 44 (59.5%) positives out of 74 samples, and the Republic of North Macedonia reported 13 (22.8%) positives out of 57 samples.

### 7.4 | *Clostridium* spp.

Three MSs (Italy, Lithuania and Romania) and one non-MS (Republic of North Macedonia) provided data on *Clostridium* spp. in foods, testing a total of 295 sampling units. No positive sampling units were detected.

Greece and the Republic of North Macedonia reported data on *Clostridium* spp. from various ruminant species, with a total of 51 samples collected during clinical investigations. Greece detected 29 (65.9%) positives out of 44 animal samples, while the Republic of North Macedonia detected one (14.3%) positive out of seven samples.

Additionally, Romania reported *Clostridium botulinum* neurotoxins in two of three (66.7%) 'meat from pig' sampling units collected during a botulism outbreak investigation at the household level.

## 7.5 | Hepatitis virus

Four MSs (Bulgaria, France, Slovenia and Romania) provided data on hepatitis A virus in fruit (both pre-cut and non-pre-cut), spices and herbs, and leafy vegetables collected from the primary production, manufacturing and distribution (wholesale and retail) levels. None of the 257 sampling units tested were positive.

## 7.6 | *Proteus* spp.

Greece tested 168 sampling units of milk collected from dairy cows, goats and sheep for *Proteus* spp. during clinical investigations, and found nine positives (5.4%).

## 7.7 | *Staphylococcus* spp.

Five MSs (Croatia, Germany, Greece, Italy and Spain) reported data on *Staphylococcus* spp. (including reports on *Staphylococcus*, unspecified *Staphylococcus* spp. and on *S. aureus*) in various food matrices ( $N=6700$ ) and animals ( $N=8913$ ). Overall, 5.4% of the food sampling units and 10.8% of the animal samples tested positive. The food categories with the highest number of positive results included 'raw milk', 'other processed food products and prepared dishes', 'meat products – ready-to-eat' and 'cheeses fresh, hard, soft and semi-soft' and 'butter'.

## 7.8 | *Cysticercus* spp.

Eight MSs (Belgium, Finland, Luxembourg, Malta, Slovakia, Slovenia, Spain and Sweden) provided data on *Cysticercus* spp. in various animal species.

- Belgium collected 774,684 bovine carcasses from slaughterhouses and found 769 positive samples (0.10%).
- Finland reported no positive samples out of 1,989,652 carcasses from bovine animals, pigs or farmed wild boars.
- Luxembourg detected 59 positive bovine carcasses (0.23%) out of 26,135 samples.
- Malta reported no positives out of 59,645 bovine animal, pig, sheep and goat samples.
- Slovakia found no positive bovine carcasses out of 30,620 samples, no positive pig carcasses out of 517,310 samples and 169 positive sheep carcasses (0.39%) out of 43,039 samples.
- Slovenia tested 112,994 bovine and 212,577 pig carcasses, detecting only two positive bovine samples ( $< 0.01\%$ ).
- Spain reported data on *Cysticercus* spp. in various animal species, with the following results: 805 positive samples (0.03%) out of 2,349,746 bovine animals; 145,270 positive samples (2.5%) out of 5,923,776 sheep; 12,996 positive samples (1.6%) out of 830,300 goats; 3825 positive samples (0.01%) out of 38,431,328 pigs; two positive samples (0.05%) out of 4247 domestic solipeds; 89 positive samples (0.05%) out of 190,118 wild boars; and four positive samples ( $< 0.01\%$ ) out of 230,790 deer. No positives were found in 9004 mouflons and 1 mountain goat.
- Sweden reported no positive samples out of 421,420 bovine and 2,571,350 pig carcasses.

## 7.9 | *Leishmania*

Greece reported data on *Leishmania* from 3669 blood samples of dogs, detecting 605 positive cases (16.5%). The Republic of North Macedonia, a non-MS, collected blood samples from 3901 stray dogs and 71 pet animals, finding 185 positive cases (4.7%) among the strays and eight positive cases (11.3%) among the pets.

## 7.10 | *Sarcocystis* spp.

Belgium reported data from 774,684 bovine animals collected at the slaughterhouse, with 100 samples (0.01%) testing positive for *Sarcocystis* spp.

## 7.11 | Other

Greece provided data on *Erysipelothrix* spp. in pigs, with none of the five samples collected during a clinical investigation testing positive.

Three MSs (Greece, Malta and Latvia) and one non-MS (Republic of North Macedonia) reported data on *Escherichia coli* and non-pathogenic *E. coli* in various food matrices and animals. Out of 506 food sampling units, six (1.2%) tested positive. Among 555 animal samples, 473 (85.2%) tested positive.

Two MSs (Cyprus and Italy) and one non-MS (Switzerland) provided data to verify the presence of flaviviruses other than West Nile virus in various animal species. Cyprus detected 25 positive cases (19.5%) out of 128 domestic solipeds and 17 positive cases (3.5%) out of 484 birds. Italy tested 348 wild birds and 30 domestic solipeds with no positives detected, while Switzerland reported no positives from 28 domestic solipeds and birds.

Greece reported data on *Klebsiella* spp. in milk from various ruminants (dairy cows, goats, sheep), detecting two positives (1.2%) out of 168 sampling units.

Greece also provided data on *Streptococcus* spp. in milk from bovine animals and small ruminants, detecting 19 positives (11.1%) out of 171 sampling units.

Three MSs (Greece, Netherlands and Portugal) tested for *Vibrio* spp. in 16 single sampling units and 592 batches of 'raw fish' 'live molluscs', 'crustaceans – shrimp' and 'other foods' collected at border control posts and processing plants. *Vibrio cholerae* was detected in 53 batches, and *V. parahaemolyticus* was found in 8 single sampling units and 35 batches. Overall, 74 positive results (12.2%) were detected out of 608 tested sampling units.

Two MSs (Bulgaria and Slovenia) provided data on *Leptospira* in various animal species. Bulgaria reported no positives out of 6981 samples, while Slovenia detected four positives (2.5%) out of 162 samples.

## MICROBIOLOGICAL CONTAMINANTS SUBJECT TO FOOD SAFETY CRITERIA (COMMISSION REGULATION (EC) NO 2073/2005)

This chapter summarises the 2023 data and information provided by reporting countries on microbiological contaminants in food for which food safety criteria (FSC) have been set down in EU legislation (Commission Regulation (EC) No 2073/2005): histamine, staphylococcal enterotoxins and *Cronobacter sakazakii*.

In accordance with the Regulation (EU) 2017/625, competent authorities (CAs) are required to use methods that comply with relevant internationally recognised standards or protocols, including those accepted by the European Committee for Standardization (CEN). This is achieved through the use of EN ISO methods, which are ISO methods recognised by CEN. Therefore, unlike in previous legislation, CAs are no longer permitted to use alternative methods listed in Commission Regulation (EC) No 2073/2005 when conducting official controls to verify the correct implementation of the provisions of this Regulation by food business operators (FBOs).

For the first time in 2022, EFSA applied requirements of Regulation (EU) 2017/625 in the collection of zoonosis data.

## 1 | HISTAMINE

### 1.1 | Histamine data in the context of Commission Regulation (EC) No 2073/2005

Histamine is a thermostable biogenic amine occurring naturally in the human body that plays a role in key physiological functions. However, when ingested in high concentrations through food, histamine can cause health disorders such as scombroid poisoning. Scombroid, which resembles an allergy, remains a relevant concern in seafood safety.

The amino acid histidine is decarboxylated to histamine by bacterial or tissue enzymes.

In histidine rich foods, such as some fish species, high amounts of histamine can be found due to microbial contamination, inadequate conditions during food processing or storage, so its concentration can be used as a parameter of process hygiene and food spoilage/quality.

EU legislation has therefore set maximum limits for histamine in fish and fish products.

Commission Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs sets FSC for histamine in three categories at the retail level:

- 'Fishery products from fish species associated with a high amount of histidine' (food category 1.26),
- 'Fishery products which have undergone enzyme maturation treatment in brine, manufactured from fish species associated with a high amount of histidine' (food category 1.27) and
- 'Fish sauce produced by fermentation of fishery products' (food category 1.27a).

At the manufacturing level, information is collected to ensure the proper application of good manufacturing practices (GMP) and the maintenance of the cold chain, which are crucial for preventing the development or increase of histamine in fish and fish products.

Histamine data were reported by 14 MSs (Bulgaria, Czechia, Denmark, Estonia, France, Germany, Italy, Latvia, Lithuania, Luxembourg, Romania, Slovakia, Slovenia and Spain) and one non-MS (Albania).

### **Fishery products from fish species associated with a high amount of histidine (food category 1.26)**

Among 5438 official control samples for histamine in food category 1.26 *at the distribution level*, 0.99% exceeded 200 mg/kg of histamine, 0.80% had histamine levels between 100 and 200 mg/kg, and 10.8% had detectable levels above the limit of detection, up to 100 mg/kg. Of the total samples, 33.1% originated from EU countries (including Denmark, Italy, Latvia, Lithuania, Norway, Romania, Spain), 18.3% were from non-EU countries (including Colombia, Ecuador, Ghana, Greenland, Japan, Madagascar, Maldives, Mauritius, Morocco, Philippines, Seychelles, Thailand, the United Kingdom, Vietnam), while origin information was unavailable for 48.4%. In total, 43.2%, 33.0%, 12.9% and 0.85% of samples were taken from retail, wholesale, border control posts and Restaurant or Cafe or Pub or Bar or Hotel or Catering service respectively. For 10.1% of the samples, no specific source information was provided.

In terms of product type, 9.4% of samples were from canned fish, 9.2% from raw fish, while 81.3% lacked detailed product information.

*At the manufacturing level*, 424 official control sampling units were collected from processing plants. Of these, 0.70% had histamine levels above the limit of detection, but less than or equal to 100 mg/kg. Of the total samples, 87.0% were from the EU (Italy), while for 13.0%, origin information was unavailable. Regarding product types, 26.4% of the samples came from canned fish, 5.7% from raw fish and for 67.9%, no product details were reported.

### **Fishery products which have undergone enzyme maturation treatment in brine, manufactured from fish species associated with a high amount of histidine (food category 1.27)**

For food category 1.27, a total of 1583 official control samples were collected at the distribution level and 129 at the manufacturing level. *At the distribution level*, 8.2% of samples had a histamine concentration of up to 200 mg/kg, while 0.25% had histamine levels between 200 and 400 mg/kg. Of the total samples, 11.4% originated from EU countries (Denmark, Romania), 10.2% from non-EU countries and for 78.4% of samples, origin information was not provided. In terms of sample collection locations, 48.3%, 28.5% and 16.3% of samples were taken from border control posts, retail and wholesale, respectively. For 6.9% of samples, no specific collection information was available.

*At the manufacturing level*, all 129 samples tested negative. Of these, 98.4% were of EU origin (Italy), with origin details missing for the remaining 1.6%.

### **Fish sauce produced by fermentation of fishery products (food category 1.27a)**

For food category 1.27a *at the distribution level*, 12 official control samples were reported. Of these, 50.0% had a histamine content between the limit of detection and 400 mg/kg, while none exceeded 400 mg/kg. Regarding the origin of the samples, 16.6% were from non-EU countries (Thailand), with no origin information provided for the remaining 83.4%.

The histamine results from the 2023 official food control samples, collected under Commission Regulation (EC) No 2073/2005, are comparable to those of the previous year and do not appear to have been impacted by the implementation of Regulation (EU) 2017/625.

## **1.2 | Other surveillance, monitoring or outbreak investigation data for histamine**

MSs also collected and analysed fishery products for surveillance, monitoring or outbreak investigation purposes, outside the scope of Commission Regulation (EC) 2073/2005 on microbiological criteria for foodstuffs.

### **Surveillance**

A total of 2267 single sampling units and 3176 batches were collected as part of *surveillance activities*, reported by 10 MSs (Austria, Belgium, Estonia, Greece, Italy, Poland, Portugal, Romania, Slovakia and Spain) and one non-MS (Serbia). This included 936 single sampling units and 227 batches *at the distribution level*, and 1331 sampling units and 90 batches *at the manufacturing level*.

*At the distribution level*, 76.2%, 23.3% and 1.1% of the 936 sampling units were categorised as 1.26, 1.27 and 1.27a, respectively. In category 1.26, 1.5% of the sampling units had histamine levels exceeding 200 mg/kg, while 10.0% of category 1.27a sampling units contained histamine levels over 400 mg/kg. In total, 40.0%, 14.4%, 2.1% and 4.5% of sampling units were taken from retail, border control posts, wholesale and Restaurant or Cafe or Pub or Bar or Hotel or Catering service, respectively, while for 39.0% no specific information was reported. Regarding origin, 30.9% were from EU countries (Austria, Italy, Portugal), 14.7% from non-EU countries (Ecuador, Seychelles, Sri Lanka, South Africa, Morocco), while 54.4% had no origin information available.

All the batches ( $N=227$ ) taken at border control posts were categorised as 1.26, with 4.0% showing histamine levels above 200 mg/kg. All batches were of non-EU origin (Ecuador, Morocco, Thailand, Türkiye).

*At the manufacturing level*, 1331 samples were taken at processing plants or packing centres. Of these, 84.4% were categorised as category 1.26 and 15.6% as category 1.27. Only 0.89% of category 1.26 samples had histamine levels exceeding 200 mg/kg, and all sampling units in category 1.27 were negative. In terms of origin, 91.1% were from EU countries (Estonia, Italy, Portugal, Poland, Romania) and 4.1% from non-EU countries (the United Kingdom and others), with 4.8% unreported.

All batches ( $N=90$ ) taken at processing plants were categorised as 1.26, originating from the EU (Greece). Of these, 23.3% had histamine levels above the detection limit but below or equal to 100 mg/kg.

## Monitoring

Two single sampling units were collected as part of *monitoring activities*; reported by Czechia. Both sampling units were taken at retail: one was categorised as 1.26 of non-EU origin (Vietnam), while the other was categorised as 1.27a, with no origin information available.

## Outbreak investigation

Eight sampling units were collected as part of *outbreak investigations*, reported by Romania and Croatia. All sampling units were taken from Restaurant or Cafe or Pub or Bar or Hotel or Catering service and were of EU origin (Croatia, Romania and EU countries). Of the total, 12.5% and 87.5% were categorised in categories 1.26 and 1.27, respectively. All category 1.26 sampling units had a histamine level exceeding 200 mg/kg and all category 1.27 sampling units had a histamine concentration less than or equal to 200 mg/kg.

## 2 | STAPHYLOCOCCAL ENTEROTOXINS

### 2.1 | Staphylococcal enterotoxin data in the context of Commission Regulation (EC) No 2073/2005

Seven MSs (Bulgaria, Greece, Italy, Romania, Slovenia, Slovakia and Spain) reported data on staphylococcal enterotoxins. At the *distribution level*, 2557 official control samples were tested, with five positive results (0.2%) detected by Spain. The positive food category identified was 'hard cheeses made from sheep's milk' collected at both wholesale and retail level. At the *manufacturing level*, 1076 official control samples were tested, with eight positive results (0.7%) detected by Italy and Romania. The food categories with positive results included 'soft and semi-soft cheeses made from cows' milk' and 'unspecified cheeses made from mixed milk from cows, sheep and/or goats' collected at processing plants.

### 2.2 | Other surveillance data for staphylococcal enterotoxins

Twelve MSs reported data on staphylococcal enterotoxins collected outside the scope of Commission Regulation (EC) No 2073/2005. Of the 5316 sampling units tested, 20 (0.38%) were positive. Positive food categories included 'other processed food products and prepared dishes', 'hard, and soft and semi-soft cheeses made from cows' milk', and 'unspecified cheeses made from raw or low heat-treated milk from sheep'. These positive sampling units were predominantly collected at the distribution and manufacturing levels.

## 3 | CRONOBACTER SAKAZAKII

### 3.1 | Cronobacter sakazakii data in the context of Commission Regulation (EC) No 2073/2005

Seven Member States (Cyprus, Czechia, Hungary, Italy, Slovenia, Slovakia and Spain) reported data on *Cronobacter sakazakii* in 'Infant formulae' and 'Foodstuffs intended for special nutritional uses' collected *at the distribution level*. Out of 678 samples tested, none were positive. No samples were collected at the manufacturing level.

### 3.2 | Other surveillance data for Cronobacter sakazakii

Thirteen MSs reported data on *Cronobacter* spp. collected outside the scope of Commission Regulation (EC) No 2073/2005. Sampling units included 'Infant formulae', 'Foodstuffs intended for special nutritional uses' and 'Dairy products, excluding cheeses'. These sampling units were collected from retail, processing plants, wholesale levels or from hospital or medical care facilities for surveillance or monitoring purposes. In total, 1392 single sampling units and 126 batches were tested. Only one sample (0.06%) – a 'dairy product (excluding cheeses) – milk powder and whey powder' collected by Germany at a processing plant – tested positive.

## KEY DEFINITIONS

### Definitions adopted by TESSy (ECDC) for describing surveillance systems

Legal character of surveillance:

- 'Compulsory' (Co): the surveillance system has a legal basis (at the national administrative level or other) under which reporting of cases of the disease(s) under surveillance is compulsory
- 'Voluntary' (V): the surveillance system is based on a voluntary agreement (at the national level or other) by which reporting of cases of the disease(s) under surveillance is voluntary
- 'Other' (O): any system that does not fall under one of the above descriptions
- 'Unknown': not specified/unknown

Comprehensiveness of surveillance:

- 'Comprehensive' (Cp): reporting is based on cases occurring within the whole population of the geographical area where the surveillance system is set up (national, regional, etc.),
- 'Sentinel' (Se): reporting is based on a selected group of physicians/hospitals/laboratories, or other institutions' notifications, and/or cases occurring within a selected population defined by age group, gender, exposure or other selection criteria,
- 'Other' (O): reporting is based on a part of the population or group of physicians (or other institutions) which is not specified, for example reporting from laboratories with no selection criteria,
- 'Unknown': not specified/unknown

National coverage

- Defined as covering the entire population of the country, or a part of it. May be unknown when not specified.

Origin of human cases

- Domestic/Locally acquired cases are defined as cases declared in the dataset as 'not imported'
- Travel-related cases (or imported cases) are defined as cases declared in the dataset as 'imported'
- Place of infection is defined in the dataset as the probable country of infection
- Cases of infection acquired in the EU (domestic cases + travel in EU)
- Active/Passive (human surveillance):
- 'Active' (A): the surveillance system is based on the public health officials' initiative to contact the physicians, laboratory or hospital staff, or other relevant sources to report data
- 'Passive' (P): the surveillance system relies on the physicians, laboratory or hospital staff, or other relevant sources to take the initiative to report data to the health department
- 'Unknown': not specified/unknown

### Active/Passive (for monitoring of rabies in animals)

- Definitions for Active and passive will be given in accordance with the current regulations
- The following definitions are used to describe data provided to EFSA in the EUOHZ 2023:
- **Surveillance:** This programme type term infers to a careful observation of one or more food or feed businesses, food or feed business operators or their activities (in the context of Regulation (EU) 2017/625). In general, it means a close and continuous observation for the purpose of control. As opposed to monitoring, active control measures are frequently taken when positive cases are detected. This type of programme does not necessarily have a defined target for reducing the occurrence of diseases/contamination.
- **Surveillance, based on Regulation 2073:** This programme type term is used to report the samples collected and analysed in accordance with the Commission Regulation (EC) No 2073/2005 on microbiological criteria. These samples can be taken either to check the compliance with Process hygiene criteria (*Salmonella* in carcasses (2.1.3, 2.1.4, 2.1.5)) or with Food Safety criteria (*Salmonella* in meat and meat products (1.4 to 1.20, 1.22; 1.23; 1.28), *Listeria monocytogenes* (1.1, 1.2, 1.3), Staphylococcus enterotoxins (1.21), Cronobacter (1.24), Histamine (1.26; 1.27;1.27a), STEC (1.29)).
- **Active rabies surveillance:** This specific rabies programme type term is used for reporting of data on active testing in the context of the monitoring of the efficacy of oral rabies vaccination (ORV) campaigns in wildlife (i.e. in foxes, raccoon dog and/or jackals).
- **Monitoring:** This programme type term infers to a system of collecting, analysing and disseminating data on the occurrence of zoonoses, zoonotic agents and antimicrobial resistance related thereto. As opposed to surveillance, no active control measures are taken when positive cases are detected (Directive 2003/99/EC).
- **Objective sampling:** Objective sampling – planned strategy based on the selection of a random sample, which is statistically representative of the population to be analysed. Each unit, within the framework population, has a specified

probability of being selected. This strategy provides data from which statistical inference can be implemented. That means that the results inferred are comparable. Objective sampling is often the case in monitoring and surveillance schemes as well as in surveys.

### Terms used to describe prevalence or proportion-positive values for EFSA data

In the EUOHZ report a set of standardised terms are used to characterise the proportion of positive sample units or the prevalence of zoonotic agents in animals and foodstuffs:

- Rare: < 0.1%
- Very low: 0.1%–1%
- Low: > 1%–10%
- Moderate: > 10%–20%
- High: > 20%–50%
- Very high: > 50%–70%
- Extremely high: > 70%
- Majority of MSs: 60% (in 2023 this was 17 MSs)
- Most MSs: 75% (in 2023 this was 21 MSs)

### ABBREVIATIONS

A	aggregated data
ADIS	Animal Disease Information System
AE	alveolar echinococcosis
AHAW	Animal Health and Welfare
AHL	Animal Health Law
AMR	antimicrobial resistance
ANSES	French Agency for Food, Environmental and Occupational Health & Safety
ATLAS	Surveillance Atlas of Infectious Diseases
BBLV	Bokeloh bat lyssavirus
BIOHAZ	EFSA Scientific Panel on Biological Hazards
C	case-based data
CA	competent authority
CDR	Commission Delegated Regulation
CE	cystic echinococcosis
CEN	European Committee for Standardization
CFU	colony forming units
cgMLST	core genome multi-locus sequence typing
CI	confidence interval
CIR	Commission Implementing Regulation
DCF	EFSA's Data Collection Framework
DFS	disease-free status
EBLV	European bat lyssavirus
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EFTA	European Free Trade Association
ELISA	enzyme-linked immunosorbent assay
EU MS	EU Member State
EU-FORS	European Union Foodborne Outbreak Reporting System
EUOHZ	The European Union One Health Zoonoses Report
EURL	European Reference Laboratory
EVD	emerging and vector-borne Diseases
FAO	Food and Agricultural Organization
FBO	food-borne outbreak
FBOp	food business operator
FBOs	food-borne outbreaks
FNAO	foods of non-animal origin
FSC	food safety criteria
FWD	Food and Waterborne Diseases and Zoonoses
GAP	good agricultural practices
GF-TADs	The Global Framework for the Progressive Control of Transboundary Animal Diseases
GMP	Good Manufacturing Practices
HACCP	hazard analysis and critical control point



HUS	haemolytic-uraemic syndrome
IgG	immunoglobulin G
IgM	immunoglobulin M
ISO	International Organization for Standardization
MS	Member State
MSM	mechanically separated meat
MSs	Member States
MTBC	<i>Mycobacterium tuberculosis</i> complex
NCP	National control programme
non-RTE	non-ready-to-eat
NS	not significant
NUTS	Nomenclature of territorial units for statistics
ORV	oral rabies vaccination
PCR	polymerase Chain Reaction
PHC	process hygiene criteria
RABV	Rabies virus
ROA	rapid outbreak assessment
ROC	receiver operating characteristic
RTE	ready-to-eat
SGE RAB	Standing Group of Experts on Rabies
SSI	Staten Serum Institut
ST	sequence types
STEC	shiga toxin-producing <i>Escherichia coli</i>
TB	tuberculosis
TESSy	The European Surveillance System
UEP	under eradication programme
WGS	whole genome sequencing
WHO	World Health Organization
WNF	West Nile Fever
WNND	West Nile Neuro-Invasive Disease
WNV	West Nile Virus
WOAH	World Organisation for Animal Health
ZOE	Zoonoses under a One health perspective in the EU

## COUNTRY CODES

### EU Member States

Austria	AT
Belgium	BE
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czechia	CZ
Denmark	DK
Estonia	EE
Finland	FI
France	FR
Germany	DE
Greece	GR
Hungary	HU
Ireland	IE
Italy	IT
Latvia	LV
Lithuania	LT
Luxembourg	LU
Malta	MT
Netherlands	NL
Poland	PL
Portugal	PT
Romania	RO
Slovakia	SK
Slovenia	SI
Spain	ES

Sweden	SE
United Kingdom (Northern Ireland)	XI

### EU non-MS countries

Albania	AL
Bosnia and Herzegovina	BA
Iceland	IS
Kosovo <sup>55</sup>	XK
Liechtenstein	LI
Montenegro	ME
Norway	NO
Republic of North Macedonia	MK
Serbia	RS
Switzerland	CH
Turkey	TK

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