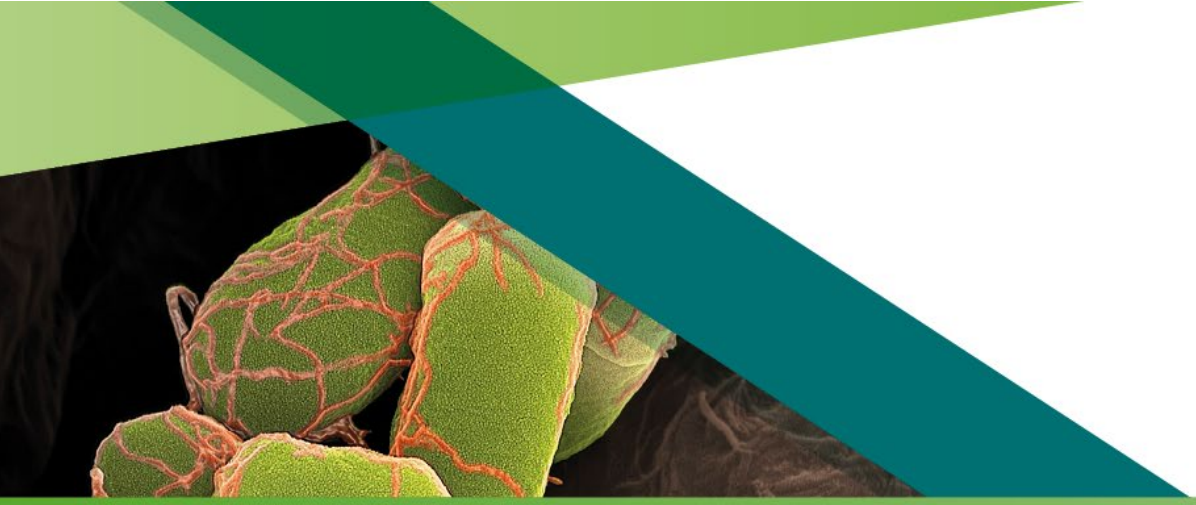


SURVEILLANCE REPORT

STEC infection cases

Annual Epidemiological Report for 2023

Key facts

- For 2023, 30 European Union/European Economic Area (EU/EEA) countries reported 10 901 confirmed cases of Shiga toxin-producing *Escherichia coli* (STEC) infection.
- The overall EU/EEA notification rate was 3.2 cases per 100 000 population, the highest annual notification rate since the start of the EU/EEA-wide surveillance.
- In 2023, the rate was highest in children under five years of age with 13.7 cases per 100 000 population for males and 13.1 cases per 100 000 population for females.
- The confirmed haemolytic-uremic syndrome (HUS) cases were comparable to 2022, when cases increased after a stable trend during the pandemic years in the EU/EEA. Among the 522 HUS cases reported, the majority were in the youngest age groups, from 0–4 years (60%) to 5–14 years (19%). However, the highest proportion of the deceased cases with HUS were over 60 years old.

Introduction

Shiga toxin-producing *Escherichia coli* (STEC) are strains of the bacterium *Escherichia coli* that can produce Shiga toxins. These toxins affect small blood vessels, such as those found in the digestive tract and the kidneys. The main reservoir of STEC is grass-feeding animals, cattle in particular. STEC infection is regularly associated with the consumption of undercooked beef which has been contaminated with animal faeces due to poor processing methods during slaughter, or other contaminated food e.g. unpasteurised milk and dairy products, vegetables, and drinking water particularly from untreated water supplies. Direct contact with infected animals, for example in petting farms and zoos, is considered an important risk of STEC infection, especially in young children. Asymptomatic carriers of STEC are regarded as potential source of STEC infection through person-to-person transmission. STEC infection often causes gastroenteritis, enterocolitis, and bloody diarrhoea, and sometimes a severe complication called haemolytic-uremic syndrome (HUS), a progressive kidney failure.

Methods

This report is based on data for 2023 retrieved from The European Surveillance System (TESSy) on 4 September 2024. TESSy is a system for the collection, analysis and dissemination of data on communicable diseases.

For a detailed description of methods used to produce this report, please refer to the Methods chapter [1]. An overview of the national surveillance systems is available online [2].

Suggested citation: European Centre for Disease Prevention and Control. STEC infection. In: ECDC. Annual epidemiological report for 2023. Stockholm: ECDC; 2025.

Stockholm, May 2025

A subset of the data used for this report is available through ECDC's online Surveillance Atlas of infectious diseases [3].

For 2023, data on STEC infections were reported by 30 EU/EEA countries. The notification of STEC infections is mandatory in all but three EU/EEA countries, where notification is either voluntary (Belgium and France) or based on another type of system (Italy). Eighteen countries used the latest case definition (EU 2018) which consider a PCR positive finding as a laboratory confirmed case, four used the previous case definition from 2012, four reported in accordance with the one from 2008 and four reported using other definitions or did not specify the case definitions used.

The surveillance systems for STEC infections have national coverage in all EU/EEA countries except for three: France, Italy, and Spain. In France, STEC surveillance is based on paediatric HUS surveillance (coverage estimated at 85% from 2016–2017); similarly in Italy, the surveillance is primarily based on the national registry for HUS [2]. Therefore, no notification rates are calculated for these two countries. The coverage of the surveillance system is estimated to be 97% in Spain in 2021–2023, so that proportion was used when calculating the national notification rate. For 2020, not all regions in Spain reported, and case numbers might therefore be lower than expected. No estimate of population coverage in Spain was provided prior to 2021, so notification rates were not calculated. All countries reported case-based data. No data for 2020–2023 were reported by the United Kingdom (UK) due to the withdrawal of the UK from the EU on 31 January 2020.

In addition to case-based surveillance, ECDC coordinates centralised analysis of whole genome sequencing (WGS) data for STEC when needed to support multi-country outbreak investigations.

Epidemiology

Of the 30 EU/EEA countries reporting for 2023, 29 countries reported 10 901 confirmed cases of STEC infection. One country (Cyprus) reported zero cases. The EU/EEA notification rate was 3.2 cases per 100 000 population (Table 1). This was a 22% increase compared with 2022 and the highest annual notification rate since the start of the EU/EEA-wide surveillance in 2007. The EU/EEA rate increase even in 2021–2022, when the data from Spain were included for the first time (when Spain could provide an estimate of the population covered of the surveillance system), which lowered the EU/EEA rate due to the country's large population.

The increase in 2023 was mainly due to a high increase in reported cases by two countries (Denmark and Germany), which reported the highest numbers of confirmed cases in 2023, followed by Ireland. Together, these three countries accounted for 53% of all reported cases in the EU/EEA. The highest country-specific notification rates were observed in Denmark, Ireland, Liechtenstein, Malta, and Norway, with 24.1, 20.2, 15.8, 12.2, and 12.1, cases per 100 000 population, respectively. A total of 11 southern and eastern EU/EEA countries reported ≤0.6 cases per 100 000 population (Table 1, Figure 1).

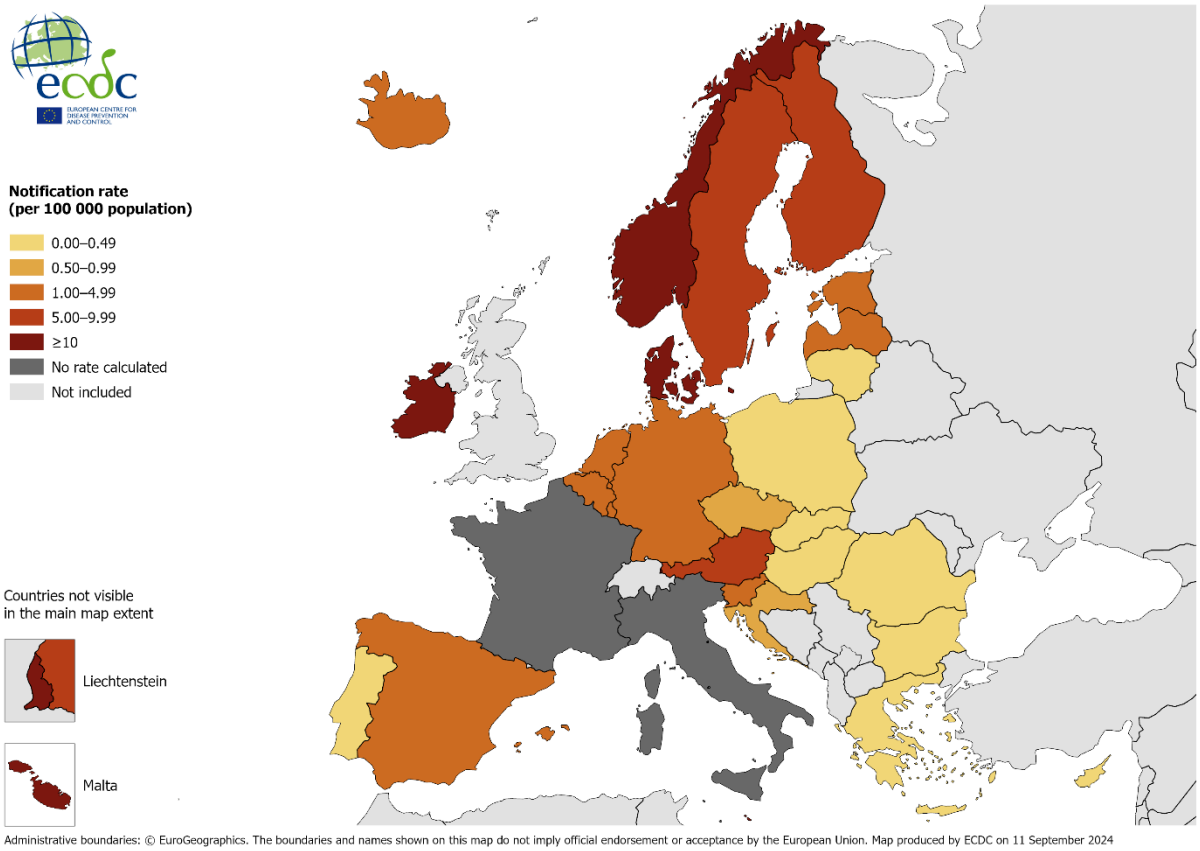
Thirty-six percent of 3 959 STEC cases with known information were hospitalised. Thirty-two of 8 247 cases with known outcome were reported to have died, resulting in a case fatality of 0.4%. Most of the deceased cases were ≥ 60 years old (63%; 20/32) and 23% had HUS. The second most affected age group were children <15 years, (37%; 12/32) and 83% had HUS. Most STEC cases reported were infected in the EU/EEA (84%). Among travel-associated cases with a known travel destination, the highest proportion of cases involved travel to Egypt (15%) and Turkey (15%).

Table 1. Confirmed STEC infection cases and rates per 100 000 population by country and year, EU/EEA, 2019–2023

Country	2019		2020		2021		2022		2023	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Austria	284	3.2	288	3.2	383	4.3	469	5.2	584	6.4
Belgium	131	1.1	84	0.7	124	1.1	187	1.6	337	2.9
Bulgaria	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Croatia	22	0.6	8	0.2	12	0.3	16	0.4	23	0.6
Cyprus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Czechia	33	0.3	32	0.3	36	0.3	58	0.6	52	0.5
Denmark	623	10.7	445	7.6	928	15.9	1 329	22.6	1 431	24.1
Estonia	6	0.5	10	0.8	7	0.5	11	0.8	21	1.5
Finland	311	5.6	175	3.2	288	5.2	283	5.1	306	5.5
France	335	NRC	262	NRC	298	NRC	473	NRC	342	NRC
Germany	1 907	2.3	1 409	1.7	1 635	2.0	1 873	2.3	3 485	4.1
Greece	5	0.0	3	0.0	10	0.1	14	0.1	22	0.2
Hungary	23	0.2	8	0.1	24	0.2	26	0.3	41	0.4
Iceland	27	7.6	4	1.1	7	1.9	4	1.1	14	3.6
Ireland	798	16.3	734	14.8	878	17.5	892	17.6	833	15.8
Italy	62	NRC	45	NRC	65	NRC	118	NRC	96	NRC
Latvia	48	2.5	2	0.1	13	0.7	NDR	NRC	31	1.6
Liechtenstein	NDR	NRC	NDR	NRC	7	17.9	4	10.2	8	20.2
Lithuania	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
Luxembourg	4	0.7	0	0.0	10	1.6	9	1.4	16	2.4
Malta	53	10.7	43	8.4	68	13.2	78	15.0	66	12.2
Netherlands	459	2.7	323	1.9	484	2.8	585	3.3	576	3.2
Norway	511	9.6	331	6.2	437	8.1	518	9.5	662	12.1
Poland	14	0.0	3	0.0	7	0.0	34	0.1	75	0.2
Portugal	1	0.0	5	0.0	2	0.0	6	0.1	11	0.1
Romania	36	0.2	14	0.1	6	0.0	28	0.1	41	0.2
Slovakia	3	0.1	1	0.0	5	0.1	4	0.1	4	0.1
Slovenia	31	1.5	30	1.4	48	2.3	58	2.8	58	2.7
Spain	269	NRC	74	NRC	422	0.9	623	1.4	824	1.8
Sweden	756	7.4	491	4.8	653	6.3	857	8.2	939	8.9
EU/EEA (30 countries)	**6 752**	**2.2**	**4 824**	**1.6**	**6 857**	**2.0**	**8 557**	**2.5**	**10 901**	**3.2**
United Kingdom	1 587	2.4	NDR	NRC	NA	NA	NA	NA	NA	NA
EU/EEA (31 countries)	**8 339**	**2.2**	**4 824**	**1.6**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Source: Country reports. NDR: No data reported. NRC: No rate calculated. NA: Not applicable.
No data for 2020-2023 were reported by the United Kingdom, due to its withdrawal from the EU on 31 January 2020.

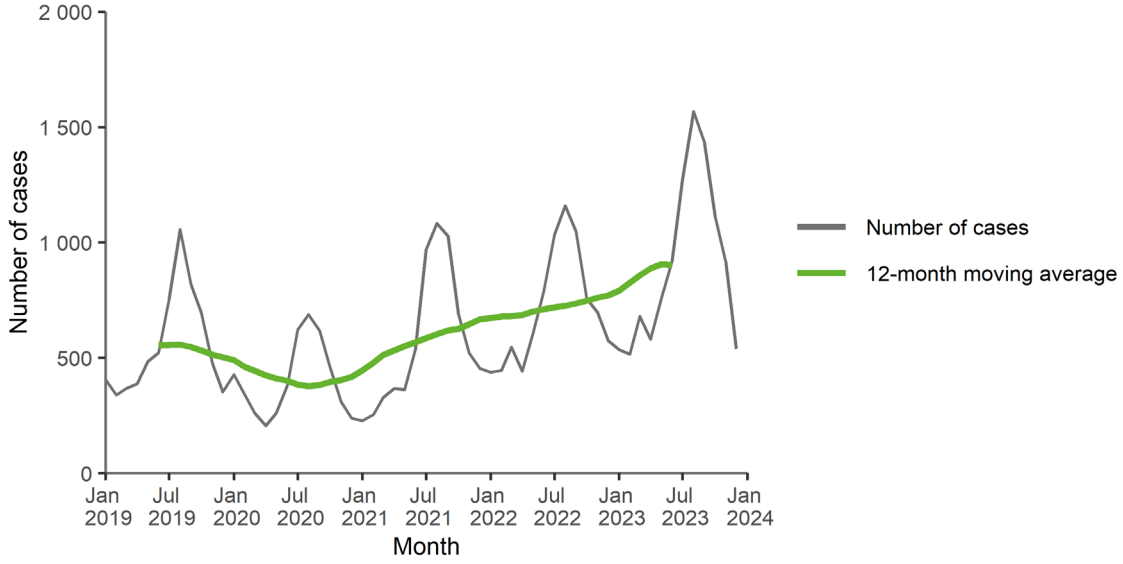
Figure 1. Confirmed cases of STEC infection per 100 000 population by country, EU/EEA, 2023



Source: Country reports.

The number of cases with STEC infection increased in 2021–2023 after a decrease in 2020 due to the COVID-19 pandemic (Figure 2). The overall trend for STEC in 2019–2023 showed a significant increasing trend ($p < 0.05$). Fifteen countries (Austria, Belgium, Denmark, Germany, Greece, Finland, France, Hungary, Luxembourg, Malta, the Netherlands, Poland, Spain, Slovenia, and Sweden) reported a significant increasing ($p < 0.05$) trend in the same time period. No countries reported decreasing trends from 2019 to 2023 [4].

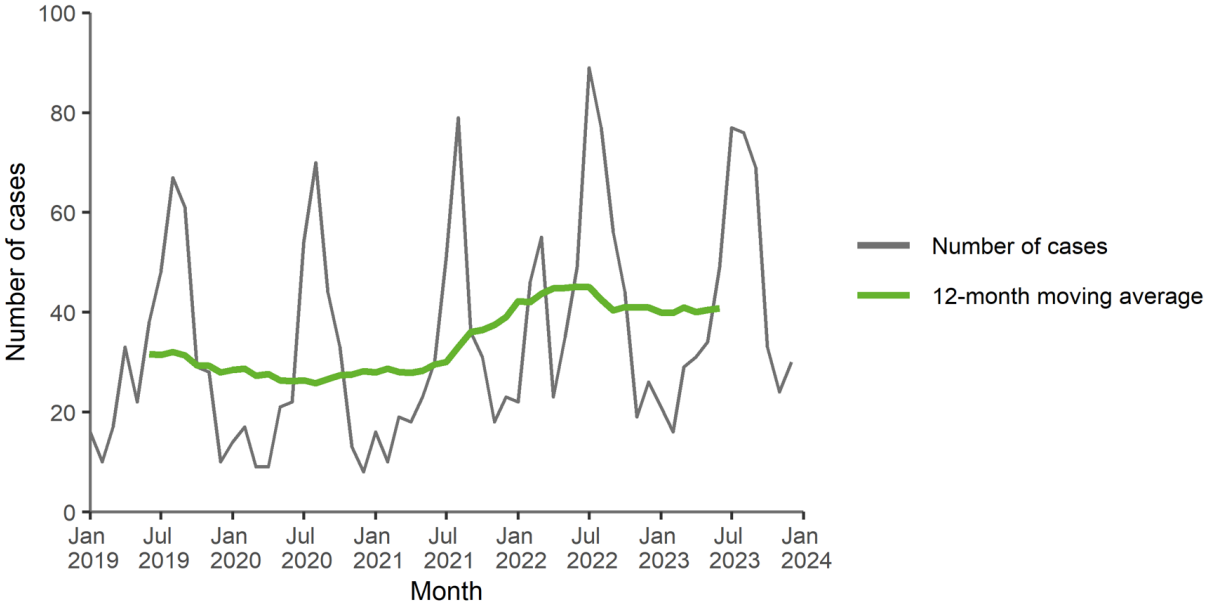
Figure 2. Confirmed STEC infection cases by month, EU/EEA, 2019–2023



Source: Country reports from Austria, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

In 2023, the number of confirmed STEC cases with HUS were comparable to number of cases in 2022 (Figure 3). The EU/EEA trend of HUS cases was stable during the pandemic years and the number of reported HUS cases did not decrease in 2020 as did the STEC cases. In 2023, HUS cases peaked in July–August similarly than in previous years. Among the 522 HUS cases reported, the majority were in the youngest age groups, from 0–4 years (60%) to 5–14 years (19%).

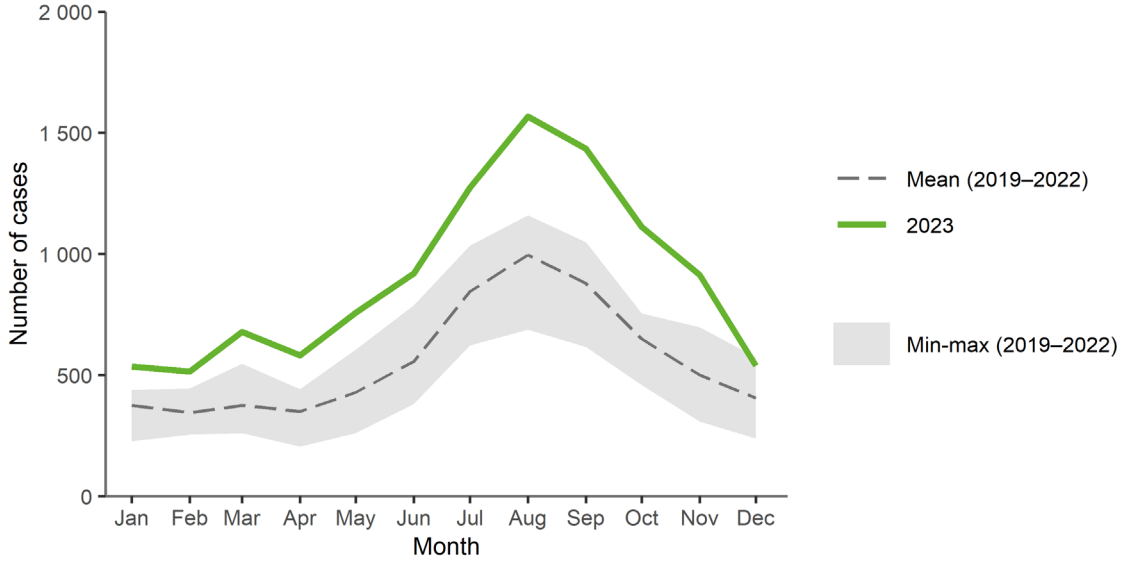
Figure 3. Confirmed STEC cases with HUS by month, EU/EEA, 2019–2023



Source: Country reports from Austria, Belgium, Cyprus, Czechia, Denmark, Estonia, France, Germany, Ireland, Italy, Malta, the Netherlands, Norway, Poland, and Sweden.

A clear seasonal trend in the number of confirmed STEC cases was observed between 2019 and 2023, with more cases reported during the summer months from June to September. In 2023, the number of reported cases was higher than the average in all months compared to 2019–2022 (Figure 4).

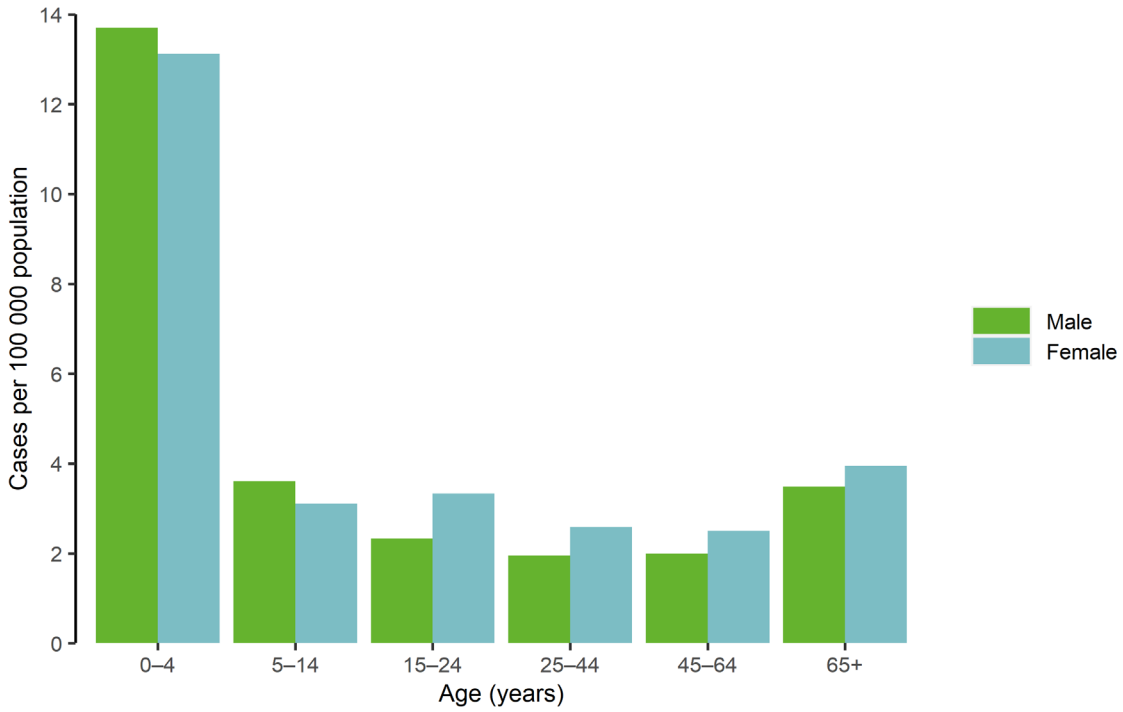
Figure 4. Confirmed STEC infection cases by month, EU/EEA, 2023 and 2019–2022



Source: Country reports from Austria, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Among the 10 873 (99.7%) confirmed STEC cases for which gender was reported, 46% were males and 54% were females, with a male-to-female ratio of 0.8:1. The highest notification rate per 100 000 population was observed in the age group 0–4 years (13.7 for males and 13.1 for females) followed by age group ≥65 years (3.5 for males and 3.9 for females per 100 000 population). These two age groups accounted for 2 221 (20%) and 2 537 (23%), respectively of the 10 872 cases for whom information on age was available. Rate was higher in males in age 0-14 while from 15 and older, the rate was higher in women (Figure 5).

Figure 5. Confirmed STEC infection cases per 100 000 population, by age and gender, EU/EEA, 2023

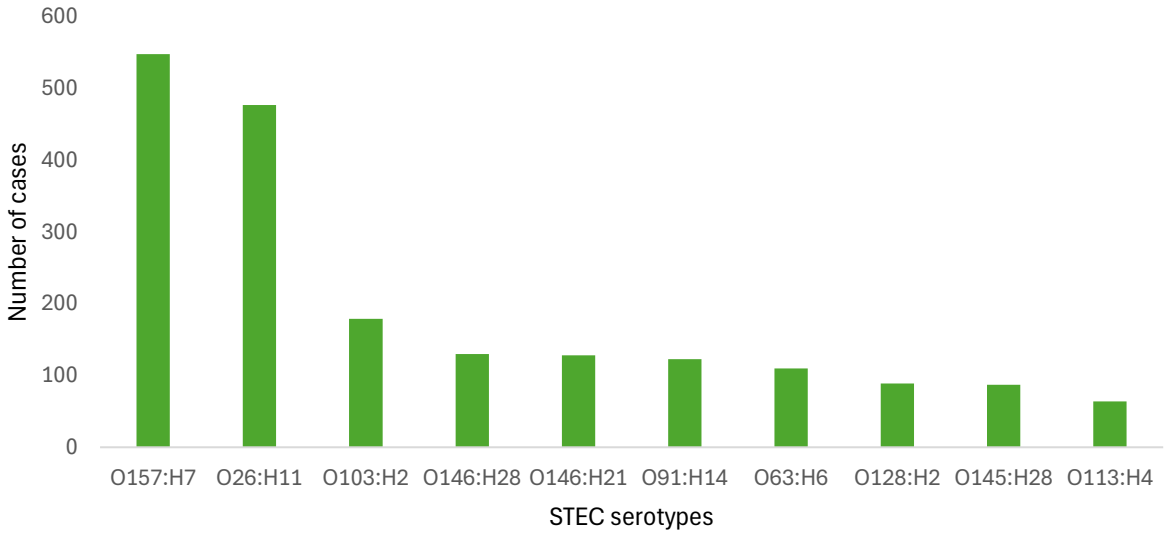


Source: Country reports from Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Microbial surveillance

Information on STEC serogroups was reported by 24 countries for 3 945 confirmed cases (36.2%) in the EU/EEA in 2023. Note that the data reported are affected by outbreaks and countries' possibility for isolation and characterisation of STEC isolates. The six most frequently reported serogroups were O157 (19.8%), O26 (16.7%), O146 (5.7%), O103 (5.4%), O145 (4.5%), and O91 (4.0%). These serogroups together accounted for over 55% of the total number of confirmed STEC cases with known serogroups in 2023. During the last 15 years, since the start of EU-level surveillance of STEC, a continuous increase had been seen, especially for four of the most common serogroups reported: O26, O146, O145, and O103. For 3 027 cases (27.8%) the full serotype was reported, i.e. both the O type and the H type. The most common serotype was O157:H7 (18.1%) followed by O26:H11 (15.8%) and O103:H2 (5.9%) (Figure 6). For cases with STEC-associated HUS, serogroup was reported for 367 (70%) cases; O26 was most frequently reported (41.1%) followed by O157 (21.5%), O145 (7.4%) and O80 (5.2%).

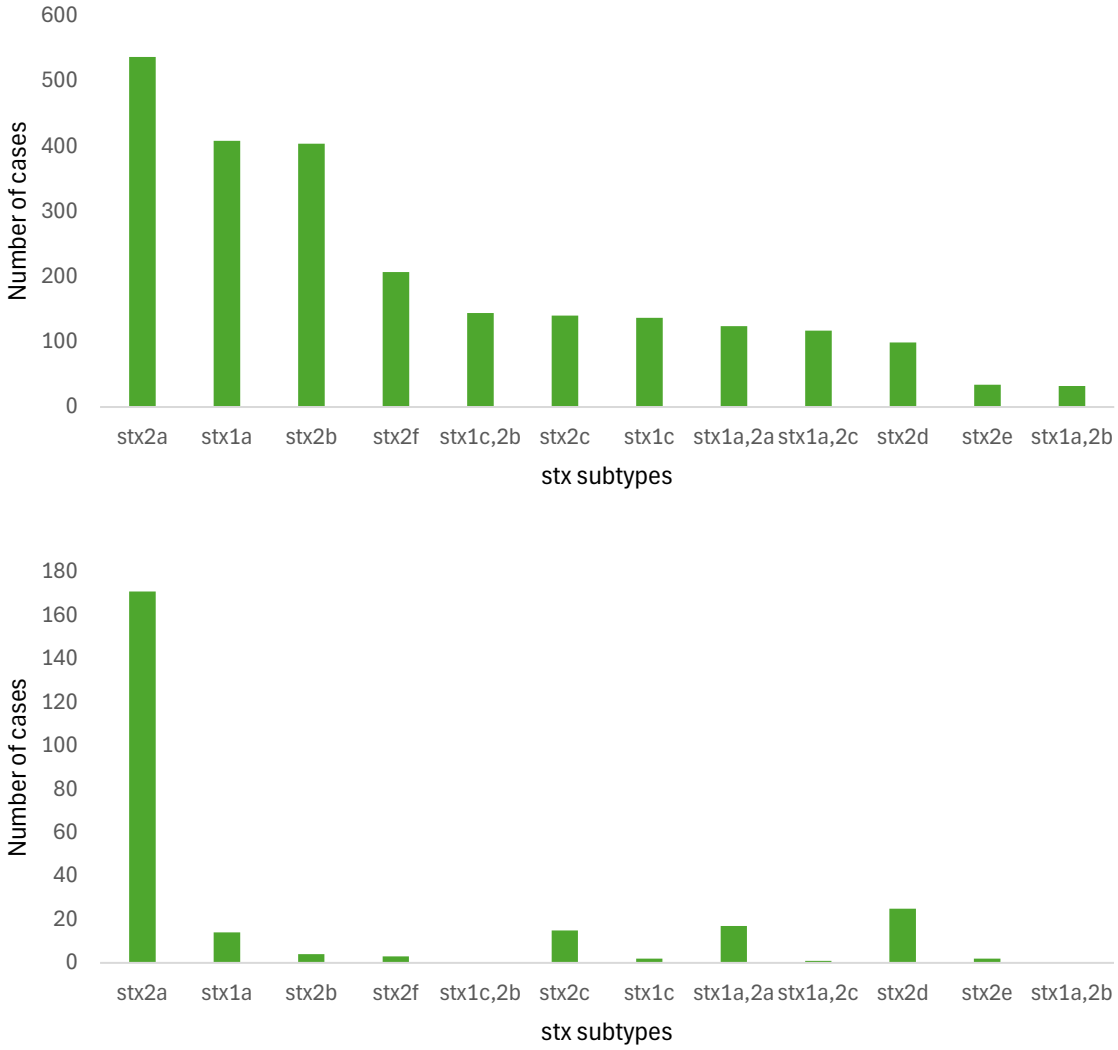
Figure 6. The 10 most common STEC serotypes reported in the EU/EEA, 2023



Source: Country reports from Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Romania, Slovenia, Spain, and Sweden.

Data on virulence gene combinations (based on shiga toxin-coding genes *stx1*, *stx2* and intimin-coding gene *eae*) were provided for 3 958 (32.3%) STEC cases. The most frequently reported virulence gene combination was *stx2* and *eae*-positive (30%) and *stx2* positive and *eae*-negative (19.7%). In strains isolated from severe cases (HUS, bloody diarrhoea and/or hospitalised cases), 44.0% were positive for *stx2* and *eae*. For 2 491 cases, *stx* gene subtypes were reported. The most common *stx* subtypes were *stx2a* (21.6%), *stx1a* (16.4%), *stx2b* (16.2%), and *stx2f* (8.3%). For cases with HUS with *stx* gene subtyping data (n=267), *stx2a* was the most commonly reported (64.0%) followed by *stx2d* (9.4%) (Figure 7).

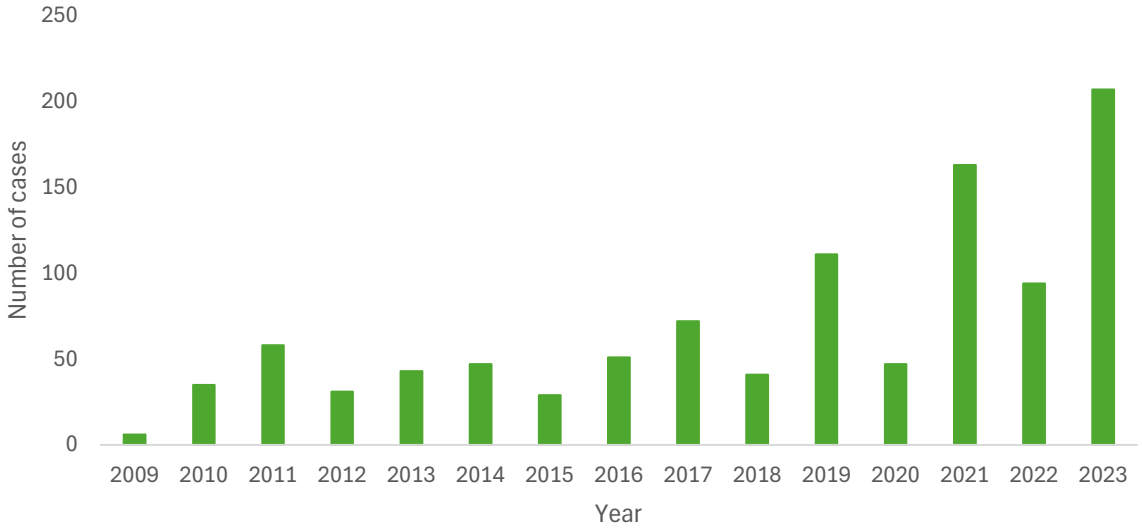
Figure 7. The 12 most common *stx* gene subtypes for confirmed STEC cases with complete subtyping data (top panel) and for the corresponding STEC-associated HUS cases (bottom panel), in EU/EEA, 2023



Note: subtypes with < 30 isolates for all reported STEC cases not included.
Source: Country reports from Austria, Belgium, Czechia, Denmark, France, Hungary, Italy, Luxembourg, the Netherlands, Norway, Romania, Slovenia, Spain, and Sweden.

In 2023, the highest number of cases with *stx2f* positive isolates (207 cases) since start of reporting (2009) was observed. The most common serotype associated with *stx2f* was O63:H6 (48.0%), the seventh most common serotype reported in 2023. Between 2009 and 2023, a total of 1 035 *stx2f* cases were reported in the EU/EEA, with an increasing trend in the last five years (Figure 8). Seventy-five percent of the cases were reported from Denmark, the Netherlands, Norway, and Belgium.

Figure 8. Reported number of confirmed STEC cases carrying *stx2f* positive isolates in the EU/EEA between 2009–2023



Source: Country reports from Austria, Belgium, Czechia, Denmark, Estonia, France, Italy, the Netherlands, Norway, Romania, Slovenia, Spain and Sweden.

Outbreaks and other threats

In 2023, 16 events on STEC infection were reported through ECDC's EpiPulse platform. Seven genetically related multi-country STEC clusters, with serogroups/serotypes O26:H11 (three clusters), O157 (two clusters) and O146:H28 (two clusters), involved at least 11 countries, with almost 400 cases in total. In two clusters, the suspected vehicle of infection was raw (unpasteurised) milk cheese and in one cluster ready-to-eat salad/ iceberg lettuce.

In 2023, 68 foodborne STEC outbreaks with 306 cases were reported to the European Food Safety Authority's (EFSA) annual zoonoses data collection by 11 EU/EEA countries and Northern Ireland [4,5]. This was five outbreaks fewer (7% decrease) than in 2022. Information on the STEC serogroup was available for 24 of the outbreaks and of those, serogroup O157 was the most common (11 outbreaks). The remaining outbreaks were with serogroups O26 (six outbreaks), O145 (three), O103 (two), O146 (two), and O63 (one). A food vehicle was reported in eight strong-evidence foodborne outbreaks; of three outbreaks with STEC O26, one outbreak was linked to the consumption of buttermilk, one to cheese made from unprocessed/unpasteurised cows' milk, and one from bovine meat. Bovine meat was also reported in two O157 strong-evidence outbreaks. In three outbreaks from dairy products, the STEC serogroup was not reported [4,5].

Discussion

In 2023, STEC was the third most commonly reported foodborne zoonotic disease in the EU/EEA [3,4]. It was also the third most frequent bacterial pathogen detected in food- and waterborne outbreaks in the EU [4,5]. The trend for STEC in the EU/EEA was significantly increasing between 2019 and 2023. In 2023, the highest number of cases and the highest notification rate were reported since STEC surveillance started in the EU in 2007 [3]. Fifteen countries reported an increasing trend in 2019–2023, although a slight decrease in cases was observed in 2020 due to the COVID-19 pandemic. The general increase in STEC cases is at least partly due to the shift in diagnostic methods, with PCR amplification of Shiga toxin-coding genes (*stx*) being more commonly used for the detection of STEC cases instead of diagnosis based on cultivation [6]. The highest increase in 2023 compared to previous years were reported in Denmark, Germany and Norway, which all mentioned multiplex PCR panels used in primary diagnostic laboratories as an influencing factor for increase of cases [Anonymous, 2024[1]]. Using PCR panels allow for more samples to be tested for STEC due to lower costs and ease of use, and not only selected samples from certain patient groups (e.g. children), or only bloody stools. In addition, all strain variants (serotypes) can be detected, since it is not dependent upon selective media.

[1] ECDC FWD Net annual data validation in 2024.

Ruminants are the main natural reservoir of STEC. Over the years, several STEC outbreaks among children have been reported in petting farms and zoos due to direct contact with STEC-positive animals. Undercooked ground beef or other meats were found to be a significant risk factor for acquiring sporadic foodborne STEC infection, most often caused by serogroup O157 [7]. Beef and fresh produce (fruit and vegetables) were incriminated as the most important sources of STEC infections in Europe in a source attribution study, each estimated to account for 30% of the cases [8]. Reported outbreaks also highlight a risk of STEC infections associated with raw milk and cheese made from unpasteurised milk [9]. Most STEC isolates from food belonged to the top 20 STEC serogroups reported in human infections in EU [4].

In 2023, STEC O26 was the most reported serogroup among HUS cases, as observed since 2016. Most of the HUS cases caused by this serogroup were reported by three countries (France, Italy, and Norway), two of which mainly base their surveillance of STEC infections on the detection of HUS cases (France and Italy). The HUS cases reported by Norway constituted the highest number of cases compared to any previous years, and almost all were caused by serogroup O26 [10]. This was due to one of the country's largest STEC outbreaks, where the source was minced (ground) meat. Serogroups O145 and O80 were the third and fourth most common serogroups to cause HUS in 2023, and the majority were reported by France. Most of the isolates carried the *stx2a* or *stx2d* gene, which is known to cause more severe disease. In general, the high proportion of HUS cases due to non-O157 serogroups points towards an emerging risk of severe infections caused by serogroups other than O157 [9].

A recent pathogenicity assessment of STEC affirms that serogroup is not a marker of pathogenicity, but it still has some importance as an epidemiological marker, and it is still useful to observe the circulation of the different STEC serogroups in food and human cases of disease [11]. Analysis of the virulence gene combinations (*stx* and *eae*), particularly the subtyping of the *stx* genes, allows for the identifying of STEC virulotypes that have a higher frequency of association to severe disease in humans (hospitalised cases, bloody diarrhoea, and HUS cases). Since 2012, there has been a steady increase in the reporting of *stx* and *eae* virulence genes to TESSy. The majority (>75%) of severe human cases were reported with information on *stx* gene subtypes; *stx2a* and *stx2d* are clearly associated with more severe disease, and specifically HUS, as also shown in 2023. An increase in reporting of *stx2f* was seen in 2023, with the highest level since the start of reporting for this subtype. Three cases of HUS were reported for this subtype. This variant is genetically more distant from the other subtypes within *stx2*. The general PCR primers targeting the *stx2* genes in primary diagnostics could therefore leave *stx2f* undetected. In recent years, an increase in awareness of this subtype could have resulted in more clinical laboratories complementing their PCR panels to also target this variant [6]. In general, subtyping of shiga toxin genes is still far from being comprehensive enough for food and animal isolates to allow risk assessment of STEC circulating in the vehicles of infections [4].

Public health implications

STEC infections affects people of all ages, but children and older people have a higher risk of contracting severe disease and complications.

STEC infection is mainly acquired through the consumption of contaminated food and contact with animals and/or their faeces, but also through person-to-person transmission from symptomatic or asymptomatic carriers. Good hygiene practices in food processing and good handling practices in premises dealing with animals, as well as guidance on hand hygiene for visitors in petting farms and zoos, can decrease the risk of infections and further outbreaks. Standard hygiene measures, including good hand and toilet hygiene, are sufficient for the general control of STEC infections to prevent human-to-human spread. Adequate cooking of food at home, particularly beef, and the use of pasteurised dairy products and further avoiding cross-contamination from raw to cooked food may reduce the risk of foodborne STEC infections. The STEC serogroups most frequently found in food samples are also those most commonly reported in human infections, highlighting the role of contaminated food as a source of human infections.

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