

JOINT ECDC-EFSA RAPID OUTBREAK ASSESSMENT

Multi-country outbreak of *Salmonella* Virchow ST16 infections linked to the consumption of meat products containing chicken meat

30 March 2023

Abstract

Since June 2017, a persistent cross-border outbreak of *Salmonella* Virchow ST16 has been ongoing in five European Union/European Economic Area (EU/EEA) countries, the United Kingdom (UK), and the United States (US). A total of 210 cases have been reported from the following countries: Denmark (2), France (111), Germany (26), Ireland (4), the Netherlands (34), the UK (32), and the US (1). Among the interviewed cases (55), hospitalisation rates ranged from 16.7% (2/12) in the UK, to 29.4% (5/17) and 38.5% (10/26) in France and Germany, respectively. No deaths have been reported. A majority of cases have been linked to local restaurants serving kebab meat. The number of confirmed cases represents only a small proportion of all infections in the EU/EEA, partly due to the varying sequencing capacities of countries.

The comparison of the representative outbreak strains with the available genome profiles of *S. Virchow* ST16 from non-human isolates, revealed that most of the matching isolates belonged to broiler meat and broiler-related environments, thereby supporting the hypothesis of chicken meat as a vehicle of infections.

The available information from case interviews, traceback investigations, and whole genome sequencing (WGS) cluster analysis, showed that kebab meat products containing contaminated chicken meat are the likely vehicles of infections, and that the clone has been circulating in the EU poultry meat production chain at least in France, Germany, and the Netherlands. In the absence of batch numbers of the contaminated kebab products and related *Salmonella* testing information, the source(s) of the infections could not be established.

New infections are likely to occur in the EU/EEA affecting any age group, until further investigations are performed to identify the source(s) and point(s) of contamination along the chicken meat production chain, including the primary production upstream lines. This will allow appropriate control measures to be implemented.

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Event background

On 12 January 2023, France reported a cluster of 52 cases with *Salmonella* Virchow infection between 28 August 2022 and 13 December 2022 (peak in week 43) in the European surveillance portal for infectious diseases (EpiPulse, 2023-FWD-00004) [1]. In the subsequent weeks, Denmark, Germany, the Netherlands, the United Kingdom (UK), and the United States (US) reported cases belonging to the same microbiological cluster. The French outbreak strain is genetically similar to a previously reported multi-country outbreak of *S. Virchow* by the Netherlands in 2020, with chicken meat as the suspected vehicle of infection (EpiPulse, 2020-FWD-00014). This pointed to a persistent source(s) of contamination in the food chain, and triggered the initiation of a joint Rapid Outbreak Assessment by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA).

Outbreak strain characterisation

The representative French outbreak strain is characterised as follows:

- *Salmonella* serotype Virchow, sequence type (ST) 16;
- The Enterobase core genome multilocus sequence typing (cgMLST) hierarchical cluster designation for the outbreak isolates is HC5_82819 [2,3];
- The genomes of the following **four representative French isolates** are available in the European Nucleotide Archive (ENA) or Sequence Read Archive (SRA):
 - 202203970 ERR10804483
 - 202208694 ERR10804484
 - 202211572 ERR10804485
 - 202212665 ERR10804486.

European outbreak case definition

A confirmed outbreak case definition is as follows:

- A laboratory-confirmed *Salmonella* Virchow ST16 case with disease onset on or after 1 January 2017 (the date of sampling or the date of receipt by the reference laboratory if the date of onset is not available).

AND

- Fulfilling at least one of the following laboratory criteria:
 - within five allelic differences (AD) from at least one of the four representative French outbreak strains by the national cgMLST pipeline;
 - OR
 - clustering within five allelic differences in a single linkage analysis in a centralised whole genome sequencing (WGS) analysis;
 - OR
 - belonging to the cgMLST HC5_82819 hierarchical cluster by the Enterobase scheme;
 - OR
 - belonging to a 10-SNP (single-nucleotide polymorphism) single linkage cluster with SNP designation (1.46.52.53.53.%), according to the pipeline in the UK Health Security Agency (UKHSA) [4].

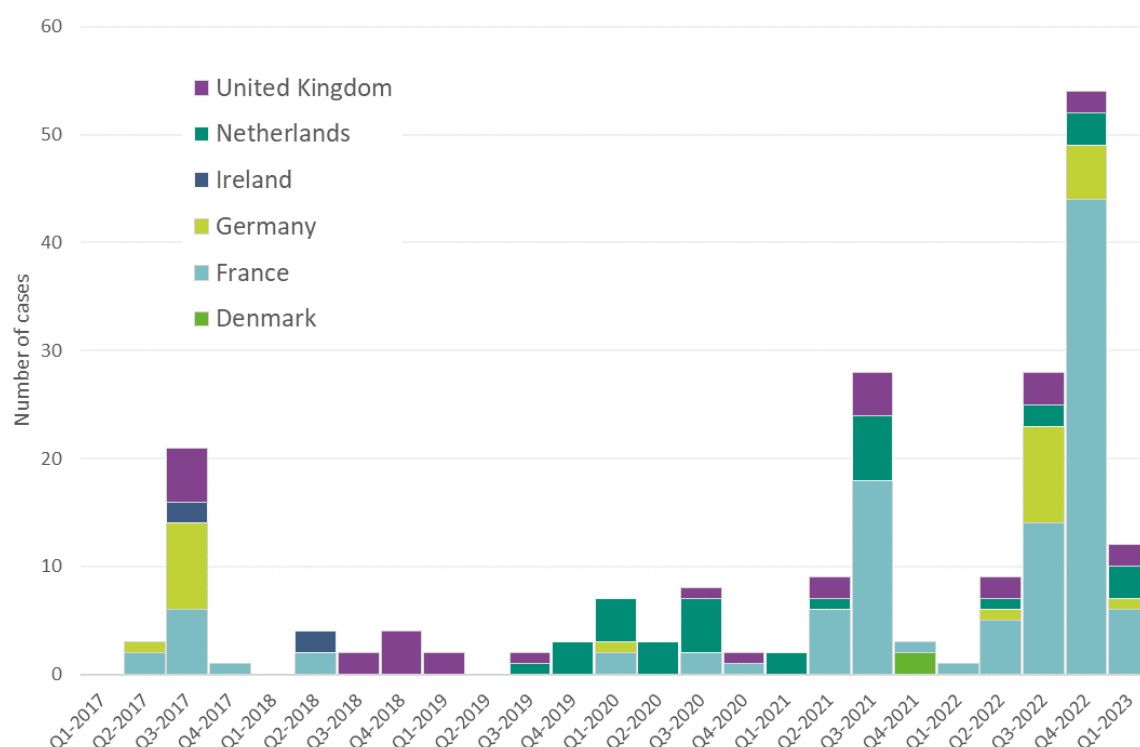
Epidemiological and microbiological investigations of human cases

Since June 2017, 210 cases of *S. Virchow* ST16 have been reported in five EU countries, the UK, and the US: Denmark (2), France (111), Germany (26), Ireland (4), the Netherlands (34), the UK (32), and the US (1) (Table 1). The case in the US had a travel history to Paris in 2019. Cases are reported over a wide age range from below one year to 92 years with the median age ranging from 22–80 years, depending on the country (Table 1). Based on available information from case interviews, moderate-to-high hospitalisation proportions were reported by countries: 16.7% (2/12) in the UK, 29.4% (5/17) in France, 38.5% (10/26) in Germany, and 100% in Ireland where all four cases were hospitalised (Table 1). No deaths due to *S. Virchow* infection were reported. There was no difference by gender with a male-to-female ratio of 1.2:1.

The epidemic curve with data from EU/EEA countries and the UK shows multi-country peaks at irregular intervals since 2017, with the highest peak in the last quarter of 2022 (Figure 1). The case numbers represent an under-estimation, as, for example, Germany did not sequence any *S. Virchow* isolates between 2018–2019. After 2020, only a proportion of isolates were sequenced in the German NRC. Significant consecutive increases between quarters could be seen in 2017 (Q2–Q3), 2021 (Q2–Q3) and 2022 (Q2–Q4) (Figure 1). The most recent cases have been reported in France and the Netherlands in February 2023.

Table 1. Number of confirmed cases, gender distribution, and age range of 210 *Salmonella* Virchow ST16 cases, by country in five EU/EEA countries, the UK, and the US, as of 16 March 2023

Country	Total number of confirmed cases	Male	Female	Age range in years (median)	Comments
Denmark	2	2	0	46–52 (49)	Infections were domestically acquired.
France	111	60	51	< 1–80 (22)	In 2022–23, five of 17 (29.4%) cases were hospitalised.
Germany	26	18	8	1–76 (28)	Of 26 cases, 10 (38.5%) were hospitalised. In 2017, nine cases of <i>S. Virchow</i> (without sequencing confirmation) were linked to an outbreak, and five of these were hospitalised. In addition, three cases of <i>S. Virchow</i> without sequencing data were linked to a local outbreak in August 2022.
Ireland	4	1	3	55–84 (80)	All four cases were hospitalised. All four cases reported no international travel.
Netherlands	34	18	16	< 1–92 (46)	The source of infection is unknown.
Total EU/EEA	177	99	78		
United Kingdom	32	15	17	< 1–81 (26)	Of 12 cases with hospitalisation information available, two (16.7%) were hospitalised. Of 16 cases with travel information available, five reported travel: two cases in 2018 reported travel to Spain (confirmed), one case in 2018 reported travel to Romania (unconfirmed), one case in 2022 reported travel to Greece (confirmed), and one case in 2022 reported travel to Italy (confirmed).
United States	1	0	1	36	The case reported travel to Paris for the entirety of the incubation period. The case was hospitalised.
Total	210	114	96		

Figure 1. Number of confirmed *S. Virchow* ST16 cases, by country and quarter-year in five EU/EEA countries and the UK (n=209), 2017–2023, as of 16 March 2023

Public health authorities in the affected countries reported the following:

- **France** reports **111** *Salmonella* Virchow HC5_82819 cases since June 2017 with a marked increase in the number of cases in 2022. The most recent case has a sampling date of February 2023. Cases have a median age of 22 years (range <1 to 80 years), with a gender distribution of 60 males and 51 females. The French outbreak in 2022 is mainly linked to local kebab restaurants in one French region. Forty-two cases (81%) were residents in a single region. In 2021, an outbreak caused by the same *S. Virchow* strain occurred in France, which was associated with a single kebab restaurant in a different region.
- **Denmark** reports **two** male cases with matching isolates, in November and December 2021. No detailed interview data are available, and no travel is reported.
- **Germany** reports **26** cases with disease onset dates from June 2017 to January 2023, most recently in the federal state of North Rhine-Westphalia (NRW, 18 cases). One case is from Bavaria. Six cases in NRW belong to an outbreak linked to a local pizzeria-kebab restaurant. Previously, an outbreak of *S. Virchow* was linked to chicken meat in the summer of 2017. In Germany, not all *Salmonella* isolates are sent to the national reference centre (NRC). In 2018 and 2019, the NRC did not sequence any *S. Virchow* isolates. From 2020 to July 2022, only part of the isolates received at the NRC were sequenced.
- **Ireland** reports **four** cases: two in 2017 and two in 2018. Age of the cases range from 55–84 years with a median of 80 years. One is male and three are females. All cases were hospitalised, but no deaths were reported. Two cases reported contact with pet dogs, and one case lived on a farm with exposure to cattle. One of the four cases is possibly a secondary case, likely infected via a household transmission.
- **Netherlands** reports **34** cases: four cases were reported in 2019, 12 in 2020, nine in 2021, six in 2022, and three in 2023. The median age is 46 years (range: <1 to 92 years), with a gender distribution of 18 males and 16 females. The source of infection is unknown.
- **United Kingdom** reports **32** cases between July 2017 and January 2023. The ages range from <1 to 81 years (median: 26 years), with a gender distribution of 15 males and 17 females. Of 12 cases with available information, two were hospitalised. Information on travel was available for 16 cases, of which five cases reported travel. One case from August 2018 and one from October 2018 reported travel to Spain (both confirmed), one case from December 2018 reported travel to Romania (unconfirmed), one case from June 2022 reported travel to Greece (confirmed), and one case from September 2022 reported travel to Italy (confirmed).
- **United States** reports **one** case from California with travel to Paris (France) in November 2019, covering the entire incubation period. The case was hospitalised.

Information from patient interviews

In **France**, the results of the questionnaires identify the consumption of kebab with chicken meat, in the days preceding the date of onset of the symptoms, by 19 out of the 24 cases interviewed (79%) – of which 14 (74%) cited the same kebab restaurant in one region.

In **Germany**, the most recent case with symptom onset on 9 January 2023 reported consumption of shawarma with chicken meat.

The case from **United States** reported the following food exposures during the case's travel to Paris in November 2019: eggs and chicken purchased in Paris, but prepared by the case for a pasta dish.

Microbiological and environmental investigations of food and control measures

On 11 January 2023, France opened a Rapid Alert System for Food and Feed (RASFF) notification (News 2023.0274) to inform the food safety authorities about the food investigations related to a genomic cluster of infections caused by *Salmonella* Virchow. As of 9 March 2023, 18 European Commission validated follow-ups (*fup*) were shared by countries through the RASFF platform.

A visual representation describing the traceability of the meat products (kebab) linked to the restaurants visited by the cases, based on food exposure information, and the microbiological findings as reported by the involved countries under RASFF News 2023.0274 (as of 9 March 2023) is provided in **Figure 2**.

The public health authorities in three EU Member States informed via the EpiPulse platform (event 2023-FWD-00004) that food isolates matching the representative outbreak strain by their national pipelines were found in their national databases. Specifically, Germany mentioned two food isolates from poultry meat (May 2022) and from a kebab spit containing turkey meat (November 2022) with 1–3 allelic differences (AD) from the representative outbreak strain; Luxembourg informed about one animal isolate from a dog originating in Belgium (2020) with 3 AD from the representative outbreak strain; and the Netherlands mentioned two recent isolates from broilers and a few historical ones (years not specified), all originating from chicken.

France

Following the public health investigation and food exposure information from the French cases, the food safety authority in France informed in RASFF that three restaurants, namely the French Restaurant A, the French Restaurant B, and the French Restaurant C (visited by the cases between August and November 2022) had been supplied with kebab meats by three German suppliers. Specifically, the German Company A supplied the French Restaurant A via the French Wholesaler A (*fup18*, RASFF 2023.0274); the German Company B supplied the French Restaurant B via the French Wholesaler B; and the German Company C supplied the French Restaurant C via the French Wholesaler C (RASFF 2023.0274, *fup16* RASFF 2023.0274).

Two other restaurants were visited by the cases, namely the French Restaurant D and the French Restaurant E. The French Restaurant D was supplied by the French Wholesaler D which received the frozen kebab from the German Company D and by the French Wholesaler G which received the frozen kebab from the German Company E via the French Wholesaler E. The French Restaurant E was supplied by the French Wholesaler F which received the kebab from the Polish Company F (*fup7*, *fup11*, RASFF 2023.0274).

On 20 January 2023, the food safety authority in France informed that isolates of *S. Virchow* genetically related to the representative cluster strain were identified in 2022 in two French farms in the context of the *Salmonella* national control programme for the species *Gallus gallus*. The broilers from these two French farms, namely the French Farm A and the French Farm B, had been slaughtered at the Belgian Slaughterhouse A in May–July 2022 and September 2022 (Farm A), and in January 2022 and August–October 2022 (Farm B) (*fup1*, RASFF 2023.0274).

Germany

On 20 January 2023, the food safety authority in Germany informed in RASFF (*fup2*, RASFF 2023.0274) that the German Company A that was linked to the French Restaurant A (between August and December 2022) via the French Wholesaler A (*fup18*, RASFF 2023.0274) was supplied with raw materials by three companies: the Italian Company G (veal meat, August–September 2022), the German Company I (turkey meat, August–September 2022), and the Dutch Company K (chicken meat, August–November 2022) (*fup2*, RASFF 2023.0274). The German Company I received turkey meat (turkey thigh with bone) from the Polish Slaughterhouse B and turkey meat from the Polish Slaughterhouse C (August–September 2022) (*fup2*, *fup14*, and *fup15*, RASFF 2023.0274).

On 27 January 2023, the food safety authority reported in RASFF (*fup3*, RASFF 2023.0274) that the German Company C that had delivered to the French Restaurant C was supplied with raw materials by three companies: the Belgian Company L, the German Company H, and the Dutch Company J (*fup3*, RASFF 2023.0274). The kebab products (döner cockerel) produced at the German Company C are intended to be cooked before eating, as the food safety authority informed in RASFF (*fup3*, RASFF 2023.0274).

On 30 January 2023, in the frame of further food investigation, the food safety authority reported that the German Company B had no business connections with the Belgian Slaughterhouse A and neither did they have business connections with the French Farm A and the French Farm B (*fup5*, RASFF 2023.0274). These farms were found to be *Salmonella* Virchow-positive in the context of the *Salmonella* national control programme in France (*fup1*, RASFF 2023.0274).

Additionally, on 9 February 2023, the food safety authority informed that the German Company D, that had supplied, via the French Wholesaler D, one of the restaurants visited by the French cases (French Restaurant D), had no business relations with the Belgian Slaughterhouse A (*fup9*, RASFF 2023.0274). The German Company D supplies a total number of 18 wholesalers in France but does not deliver directly to French restaurants and snack bars.

Poland

On 17 February 2023, the food safety authority in Poland informed (*fup12*, RASFF 2023.0274) about the outcome of an official control performed at the Polish Company F that had supplied the kebab to the French Restaurant E. Between the summer of 2022 and the end of 2022 (the relevant period of infections as reported by the French authorities), no *Salmonella*-positive findings were identified at the Polish Company F. *Salmonella* food analyses at the manufacturing plant are performed according to the following frequency: once per month for raw materials (poultry meat), every two weeks for poultry meat after cutting/trimming, and twice a month for the final products such as raw kebab. Environmental swabs and samples from 15 sites of the plant are also collected at the frequency of once a month. They are tested for total bacteria count and *Enterobacteriaceae*.

On 7 March 2023, the food safety authority informed about the outcome of an official control performed at the Polish Slaughterhouse B and the Polish Slaughterhouse C.

No *Salmonella*-positive findings were identified from turkey neck skin samples collected in July, September, October, and December 2022 at the Polish Slaughterhouse B (*fup14*, RASFF 2023.0274).

No *Salmonella*-positive findings were identified from samples collected at the Polish Slaughterhouse C from turkey neck skins, turkey meat, and the production environment in the period from August–September 2022 (*fup15* and *fup17*, RASFF 2023.0274). In addition, the food safety authority informed that the origins (turkey farms) of the birds delivered to the Polish Slaughterhouse C were identified (additional information on the identified farms was not available in RASFF), and no *Salmonella*-positive findings were recorded.

The two Polish Slaughterhouses B and C had supplied the turkey meat to the German Company I. The German Company I delivered the meat to the German Company A which was the kebab meat supplier of one of the restaurants visited by the cases (the French Restaurant A).

Belgium

On 30 January 2023, the food safety authority in Belgium informed in RASFF (*fup4*, RASFF 2023.0274) that besides the wide distribution, the Belgian Slaughterhouse A did not deliver meat to the three German suppliers (the German Company A, the German Company B, nor the German Company C). These companies had supplied the French restaurants visited by the French cases.

Italy

On 9 February 2023, as a follow up to the traceback investigation performed in Germany, the food safety authority in Italy informed that an official control was performed at the Italian Company G (*fup8*, RASFF 2023.0274) and results for *Salmonella* detection were satisfactory. The Italian Company G supplied the German Company A with raw materials (veal meat) that was linked the French Restaurant A via the French Wholesaler A (*fup18*, RASFF 2023.0274).

The Netherlands

On 13 February 2023, the food safety authority in the Netherlands informed (*fup10*, RASFF 2023.0274) that five *Salmonella* Virchow ST16 isolates from chicken meat were detected between 2018 and 2022. Among them, two isolates originated from broilers (country of origin: the Netherlands) sampled in July 2022 at two different slaughterhouses. The broilers were traced back to flocks belonging to farms located in the Netherlands.

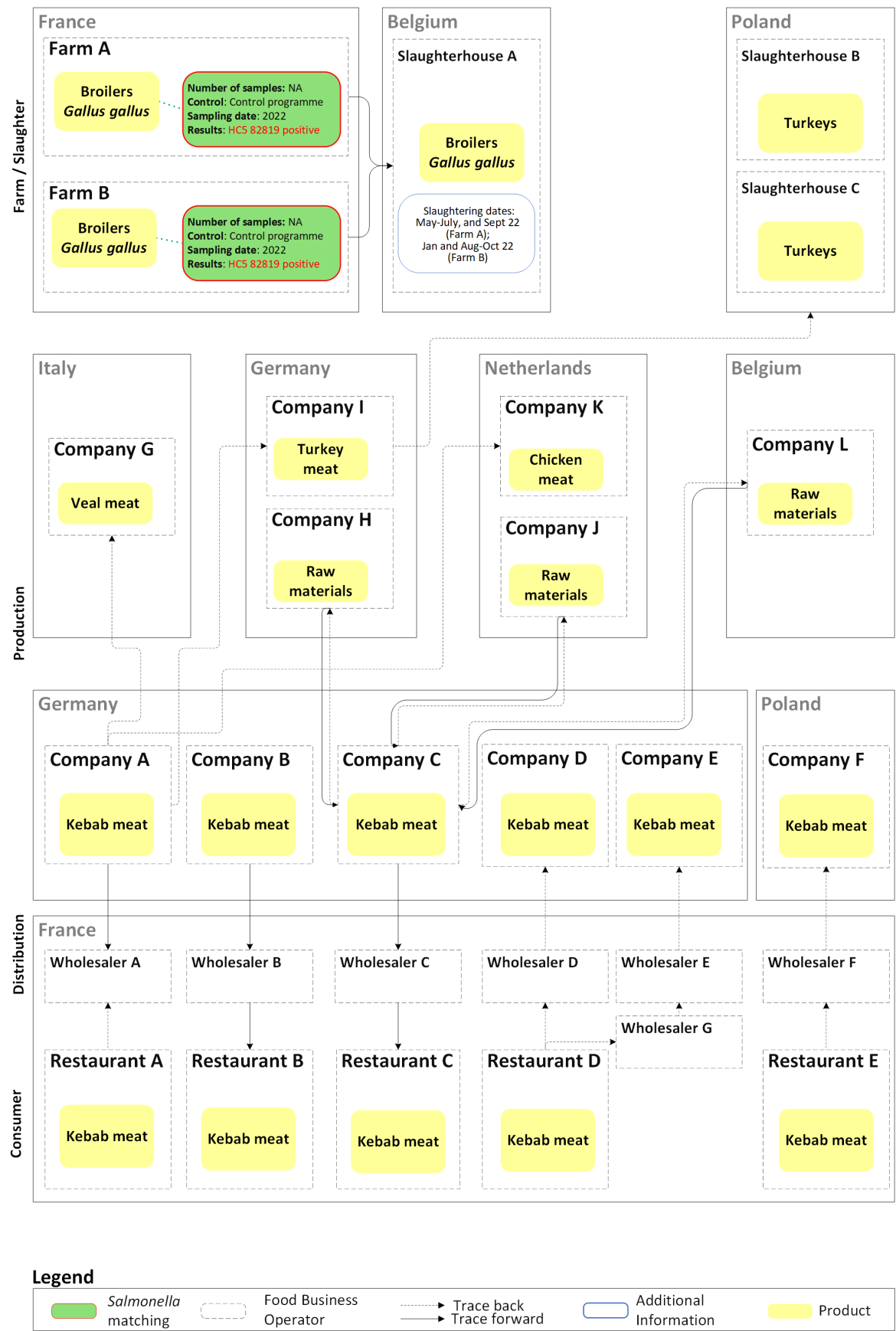
The other three *Salmonella* Virchow ST16 isolates were collected in the frame of a 2020 national outbreak investigation, and they were related to imported chicken meat, chicken meat preparation, and chicken thigh meat (*fup10*, RASFF 2023.0274). Traceback analysis of the imported chicken meat revealed that the origin of the batch was Brazil, and that the chicken meat was sampled in 2018 (RASFF 2020.1266). Food investigations on the point of contamination were performed at the Brazilian producer in 2020 and corrective measures were reported in RASFF (*fup6*, RASFF 2020.1266).

The chicken meat preparation and the chicken thigh meat were both sampled in the Netherlands in 2019 (in a retail store and a meat wholesaler, respectively). The traceback analysis of the two chicken meats pointed to flocks raised in the EU (country not specified) (*fup10*, RASFF 2023.0274).

The food safety authority in the Netherlands informed that the source of the 2020 national outbreak could not be identified and an epidemiological link could not be established among the involved food business operators.

Food traceability and analyses

Figure 2. Graphical representation of the traceability of the meat products (kebab) linked to restaurants visited by the cases, based on the food exposure information, and the microbiological findings as reported by the involved countries under RASFF News 2023.0274 (as of 9 March 2023)



European whole genome sequencing analysis of human and non-human isolates

For cross-sectorial analysis, the cgMLST analysis was performed in both ECDC and EFSA as previously described [5]. Briefly, genome profiles were calculated from assembled genomes using chewBBACA version 2.8.5 (<https://hub.docker.com/layers/ummidock/chewbbaca/tags>; <https://github.com/B-UMMI/chewBBACA>), using the schema as described by Rossi et al. 2018 [6] for *Salmonella enterica* made available by the Chewie Nomenclature Server (ChewieNS) [7] at <https://chewbbaca.online/species/8>. Isolates with more than 10% of missing loci (325 over a total of 3 255 loci) were excluded from the analysis.

A total of 23 profiles of non-human isolates have been shared in the EFSA One Health WGS system by eight countries in two different calls for data.

On 17 January 2023, EFSA launched an ad-hoc call for data, inviting Germany to share, with the EFSA One Health WGS System, the genomic information of the *S. Virchow* ST16 food isolates that had been mentioned in the EpiPulse event, 2023-FWD-00004, by the public health authority in Germany. There have been two genomic data submissions (poultry cuts sampled in May 2022, and döner kebab sampled in November 2022) as responses to this call.

On 6 February 2023, EFSA launched a standard call for data, inviting all EU/EEA Member States to submit to the EFSA One Health WGS System genomic information regarding *S. Virchow* ST16 food isolates collected between 2021 and 2023, focusing on isolates collected from meat products including chicken meat. By 21 March 2023, eight countries had replied: Austria, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, and Sweden. There have been 21 genomic data submissions (nine sequences from broiler chicken boot swabs from France, two sequences from poultry kebab and chicken cuts from Germany, one sequence from chicken cuts processed in Ireland using imported chicken meat, one sequence from poultry meat from Luxembourg, two sequences from poultry meat and four from fresh chicken meat from the Netherlands, and two sequences from broiler chicken boot swabs from Sweden). Austria and Denmark informed that there were no *S. Virchow* isolates available.

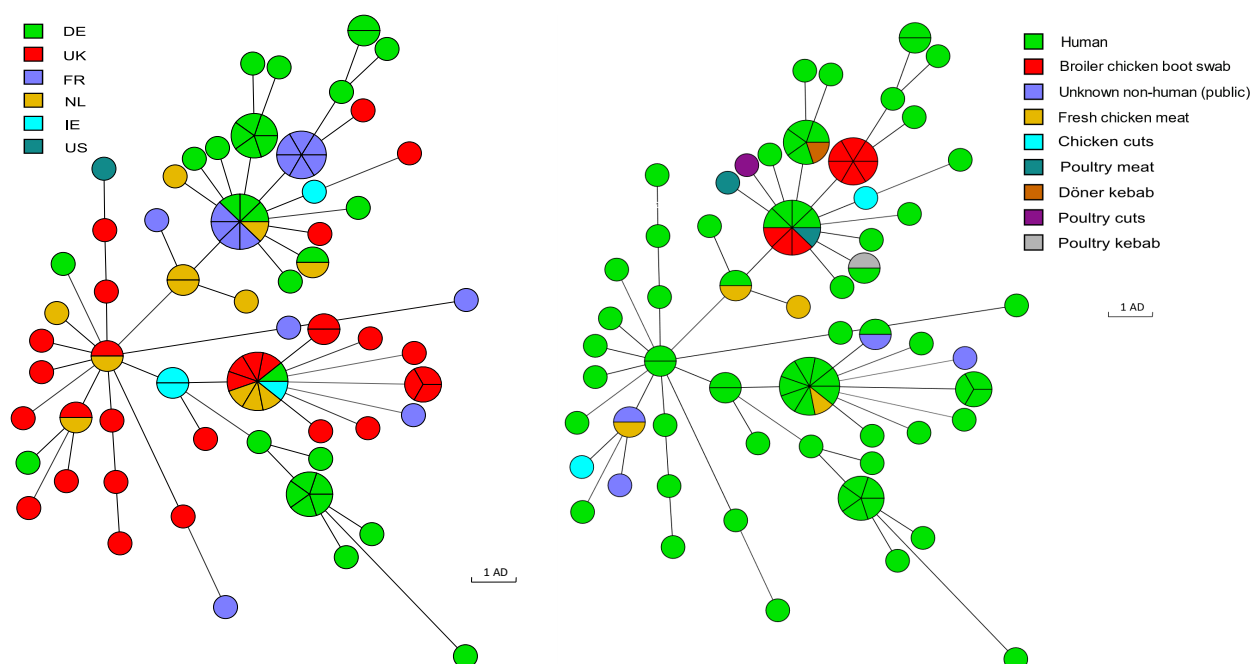
At the time of the cluster analysis, the EFSA One Health WGS System contained 49 cgMLST genomic profiles of *S. Virchow* ST16 isolates collected from food, feed, animals, and related environments. Out of these 49 profiles, 26 were generated from sequences retrieved from the public repository, European Nucleotide Archive (ENA), and 23 profiles were submitted to the EFSA One Health WGS System by EU Member States as a response to the two data calls launched on 17 January 2023 and 6 February 2023.

ECDC queried the EFSA One Health WGS System on 21 March 2023, using the cluster of 51 human *S. Virchow* ST16 isolates as reference genomes. This comparison revealed 24 allelic profiles of *S. Virchow* ST16 non-human isolates with AD lower or equal to five against any profiles of human isolates in the query. Of these, four non-human profiles were generated from sequences collected from the public repository, ENA. The remaining 20 profiles of isolates shared by Member States were from the following matrices: fresh chicken meat (4), poultry/chicken cuts (3), broiler chicken boot swabs (9), poultry meat (2), döner kebab (1), and poultry kebab (1). The closest eight non-human isolates detected in the query submitted by ECDC are 0 AD from at least one member of the outbreak cluster in a single-linkage cluster analysis.

Two minimum spanning trees were generated using BioNumerics, based on CRC32-hashed cgMLST allele sequences called using ChewBBACA and the ChewieNS scheme for *Salmonella* [7]. In total, 94 *S. Virchow* ST16 sequences from human (n=70) and non-human isolates (n=24, see above) were included in the single linkage cluster. The human isolates were collected in Germany (n=28), the UK (n=26), France (n=6), the Netherlands (n=6), Ireland (n=3), and the US (n=1). The human isolates' sequences were collected between July 2017 to January 2023. The two minimum spanning trees visualise the distribution of reporting countries and origins of the isolates, respectively (Figure 3). All isolates are within 5 AD in single linkage clustering.

The comparison of the representative outbreak strains with the available genome profiles of *S. Virchow* ST16 from non-human isolates revealed that most of the matching isolates belonged to broiler meat and broiler-related environments at least in France, Germany, and the Netherlands.

Figure 3. The minimum spanning trees of 94 *S. Virchow* ST16 sequences from human (n=70) and non-human isolates (n=24), by country (left) and by the origin of isolates (right). Human isolates were collected in Germany (n=28), the UK (n=26), France (n=6), the Netherlands (n=6), Ireland (n=3) and the US (n=1). The non-human isolates originated from fresh chicken meat (4), poultry/chicken cuts (3), broiler chicken boot swabs (9), poultry meat (2), döner kebab (1), poultry kebab (1), and unknown non-human source (4), July 2017 – January 2023, as of 21 March 2023



ECDC and EFSA risk assessment for the EU/EEA

A persistent outbreak of *Salmonella* Virchow ST16 has been ongoing in at least five EU/EEA countries and the UK since June 2017, and as of 16 March 2023, 210 cases have been reported in Denmark (2), France (111), Germany (26), Ireland (4), the Netherlands (34), the UK (32), and the US (1).

Following the food exposure information of the interviewed cases and after having consulted five of the restaurants visited by the cases, the food safety authority in France could identify and trace back the food business operators involved in the production of the kebab products in the five implicated restaurants at the time of the outbreak investigation. These food business operators were: five kebab producers in Germany and one in Poland with meat suppliers in Belgium, Germany, Italy, the Netherlands, and Poland. The batch numbers of the kebab products consumed by the cases and the information on the *Salmonella* testing of these products, were not available in RASFF. Hence, the role of the traced producers of kebab products, their meat suppliers, and the possible involvement of other food operators, as sources of the infections could not be established or ruled out. Thus, in the absence of the identification of the batch numbers and any microbiological evidence, the source(s) of the infections and the point(s) of contamination of the consumed kebab products could not be established.

The identified circulation of the outbreak strain in the EU poultry meat production chain is further supported by its detection in two broiler farms (Farms A and B) and in other farms in France (isolates retrieved from the 2022 *Salmonella* national control programme). However, this microbiological evidence was not followed by any epidemiological link between the *Salmonella*-positive broiler Farm A and Farm B and the food operators traced back (e.g. trading business).

The previous cross-border outbreak strain detected in the Netherlands in 2020 is genetically close to this outbreak strain. In the 2020 outbreak, *S. Virchow* was microbiologically linked to chicken products imported from Brazil (sampled in 2018) and chicken meat (two samples from 2019) with origin in the Netherlands. However, they were traced back to flocks raised elsewhere in the EU. Later on, in 2022, two *S. Virchow* ST16 samples were reported from broiler flocks raised in the Netherlands. Genomic information on these five isolates were not available for the EU WGS cluster analysis. However, this microbiological evidence suggests a wider distribution and circulation of this clone within the EU/EEA and also outside the EU poultry meat production chain.

The comparison of the representative outbreak strains with the available genome profiles of *S. Virchow* ST16 from non-human isolates revealed that most of the matching isolates belonged to broiler and broiler-related environments, supporting the hypothesis of chicken meat as a vehicle of infections, and highlighting the circulation of the clone in the EU at least in France, Germany, and the Netherlands.

S. Virchow is one of the monitored serovars in poultry farms in the EU, as it is considered relevant for public health (target serovar). According to the most recent European Union One Health Zoonoses Report 2021, *S. Virchow* was reported in breeding flocks of *Gallus gallus* during the production period by one Member State (Greece) and accounted for 0.02% of the EU prevalence (three positive samples out of 13 983 tested flocks in the EU) [8].

Based on the available information from case interviews, traceback investigations, and the WGS cluster analysis, kebab meat products containing contaminated chicken meat are the likely vehicles of infections, with contaminated chicken meat alone being another possible vehicle of infection. The contamination could possibly have taken place at the farm level and possibly higher up at the breeding level, thus leading to multiple distribution routes for contaminated chicken meat.

New infections are likely to occur in the EU/EEA, affecting any age group, until further investigations are performed by public health and food safety authorities to identify the source(s) of the infections in various countries and the possible point(s) of contamination along the chicken meat production chain, including the primary production upstream lines. This will allow appropriate control measures to be implemented.

Recommendations and options for response

ECDC encourages countries to sequence *S. Virchow* isolates from domestically acquired human infections and interview cases with *S. Virchow* ST16 infections, focusing on the consumption of various chicken/poultry meat and related products. ECDC can support countries with the sequencing of isolates. Further investigations and analyses are recommended in cooperation with food safety authorities to facilitate traceback analyses. ECDC encourages countries to update their country's case information in the EpiPulse event, [2023-FWD-00004](#).

EFSA encourages Member States to perform the sequencing of *S. Virchow* ST16 food isolates linked to the present cluster either microbiologically (serotype or ST) or epidemiologically (e.g. reported consumption of meat products including chicken meat by human cases). EFSA also recommends the submission of genomic data of *S. Virchow* ST16 isolates from any kind of food, feed, animals, and related environment to the EFSA One Health WGS System. Preparation of kebab meat products should be performed in accordance with the manufacturers' instructions.

Source and date of request

ECDC sent a request to EFSA on 1 February 2023 to produce a Joint Rapid Outbreak Assessment (ROA). EFSA accepted the request on 2 February 2023.

Consulted experts and national contact points

ECDC experts (in alphabetical order): Áine Collins, Cecilia Jernberg, Johanna Takkinen.

Public health experts consulted for the validation of data and facts:

Denmark: Eva Litrup (Statens Serum Institute);

France: Maria Pardos de la Gandara (Institut Pasteur, Centre National de Référence des *E. coli*, *Shigella* et *Salmonella*); Catarina Krug, Nathalie Jourdan-da Silva and Henriette de Valk (Santé publique France);

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Ireland: Aoife Colgan (Health Protection Surveillance Centre) and Niall De Lappe (National *Salmonella*, *Shigella* and *Listeria* Reference Laboratory, University Hospital Galway);

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Disclaimer

This rapid outbreak assessment was written jointly by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA).

ECDC issued this outbreak assessment document in accordance with Article 20 of Regulation (EU) 2022/2371 on serious cross-border threats to health, Articles 7(1) and 8a of Regulation (EC) No 853/2004 establishing a European Centre for Disease Prevention and Control. EFSA's contribution is based on a mandate from the European Commission requesting EFSA to provide scientific assistance from EFSA in the investigation of multinational food-borne outbreaks (Ares (2013) 2576387, Mandate M-2013-0119, 4 July 2013) in accordance with Article 31 of 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.

The specific purpose of an ECDC-EFSA rapid outbreak assessment is to present an analysis of a cross-border food-borne threat to health and to provide science-based recommendations and options for response. The responsibility for the choice of which options to pursue and which actions to take at national level, following ECDC and EFSA's recommendations, lies with EU Member States and European Economic Area (EEA) countries.

All data published in this rapid outbreak assessment are data collected from EU and/or EEA countries concerned by the outbreak until the date this assessment was produced. Maps and figures published do not represent statements from ECDC or EFSA on the legal or border status of the countries and territories shown but constitute the information on which this rapid outbreak assessment is based.

Annex 1. Disease background

Disease characteristics

Background information about salmonellosis can be found on the websites of ECDC, US CDC, and WHO [9–11].

Disease surveillance for [disease/pathogen] in the EU/EEA

Salmonella Virchow isolation in humans

This section summarises country-specific data on human *S. Virchow* cases as reported to The European Surveillance System (TESSy) by EU Member States in accordance with the ECDC founding regulation (Regulation (EC) 851/2004) and Decision No 1082/2013/EU on serious cross-border threats to health.

S. Virchow is reported as part of salmonellosis surveillance in the EU/EEA. Notification of non-typhoidal salmonellosis is mandatory in most of the EU Member States, as well as in Iceland and Norway. Reporting is voluntary in four Member States (Belgium, France, Luxembourg, and the Netherlands). The surveillance systems for salmonellosis have national coverage in all Member States except three (Belgium, the Netherlands and Spain). The population coverage in 2021 was estimated to be 85% in Belgium and 64% in the Netherlands. For Spain, the population coverage was not reported for 2021. Food poisoning is a notifiable disease under national legislation in all the countries of the UK except for Scotland. Under this legislation, reporting of *Salmonella* spp. isolated from human samples in public health laboratories is also mandatory throughout the UK.

Between 2007 and 2021, 8 638 cases of *S. Virchow* were reported to The European Surveillance System (TESSy) by 29 EU/EEA countries and the UK (data as of 25 January 2023). The average number of cases per year was 576. The number of reported cases between 2007 and 2021 ranged from 126 in 2020 and 1 200 in 2007 (Figure 4). The United Kingdom accounted for 32% (n=2 734) of all cases, followed by Germany with 15% (n=1 313), and France with 11% (n=946). Among cases with known importation status (n=5 964), 49% (n=2 924) were reported as domestically acquired infections. Among imported cases with known probable country of infection (n=2 735), 26% (n=702), 20% (n=551) and 10% (n=270) reported travel to Egypt, Thailand and India, respectively.

In 2020 and 2021, 126 and 236 cases of salmonellosis were reported to TESSy, respectively. It is possible that the cases in 2020 and 2021 were underreported as compared to the previous years due to the impact of the COVID-19 pandemic. Further, for 2020–2021, no data were reported by the United Kingdom (UK) due to its withdrawal from the EU on 31 January 2020. During all the years of surveillance, *S. Virchow* ranked 10 out of 1 205 reported serotypes.

Among cases with known gender (n=8 508), 49% (n=4 210) were male. There was no clear difference in the number of male cases compared to the number of female cases in the years between 2007–2021 (Figure 5). Among domestically acquired infections, a similar gender distribution was observed (Figure 6). When stratified by age group, there is some evidence of a difference in the number of male cases versus female cases in the 5–14 years, 15–24 years and 65+ years age groups (Figure 7). In the period between 2007–2021, 52% (n=4 530) of the cases were reported during the summer and autumn (July to November) (Figure 8).

Further information can be found in ECDC's annual epidemiological report for salmonellosis for 2021 [12], and the online 'Surveillance Atlas of Infectious Diseases' [13].

Figure 4. Distribution of *S. Virchow* cases by year, EU/EEA and the UK (up to 2019), 2007–2021, (n=8 638)

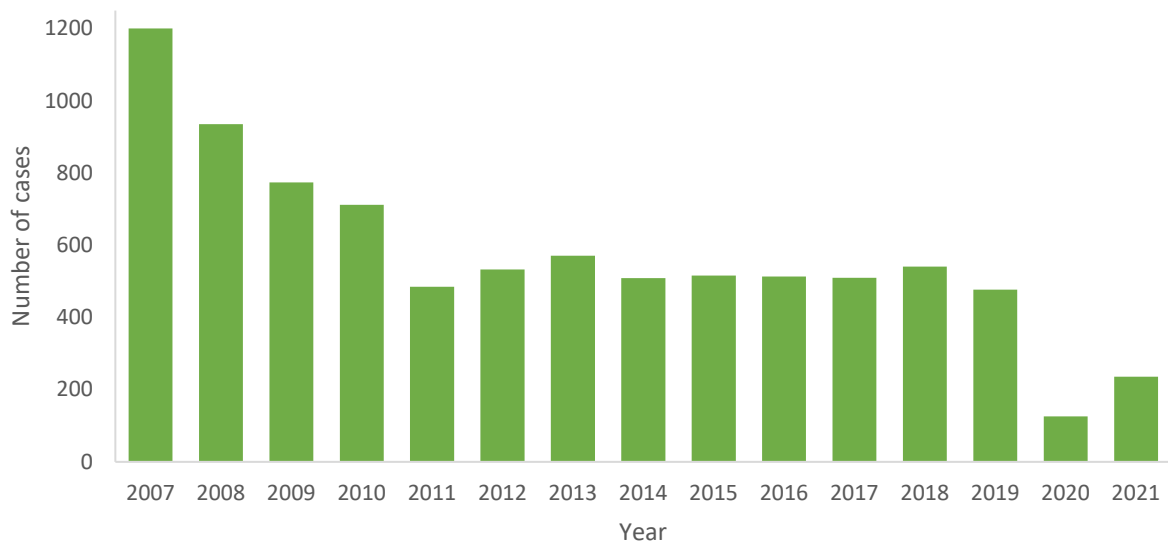


Figure 5. Distribution of *S. Virchow* cases by gender and year in the EU/EEA countries and the UK (up to 2019), 2007–2021 (n=8 508)



Figure 6. Distribution of domestically acquired *S. Virchow* infections by gender and year in the EU/EEA and the UK (up to 2019), 2007–2021 (n=5 499)

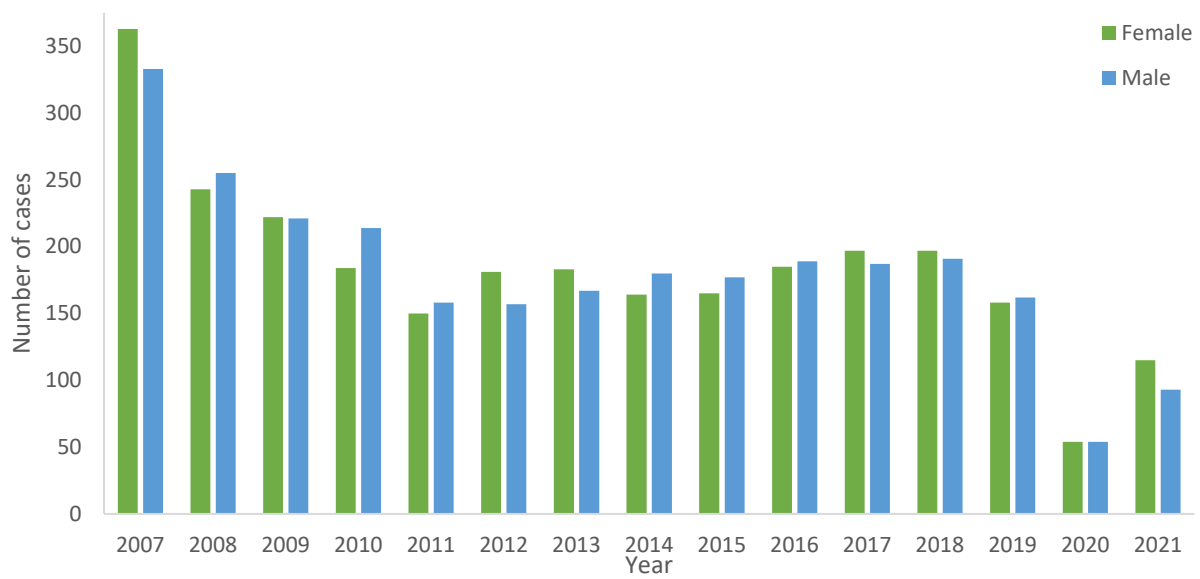


Figure 7. Distribution of *S. Virchow* cases by age group and gender in the EU/EEA and the UK (up to 2019), 2007–2021 (n=8 216)

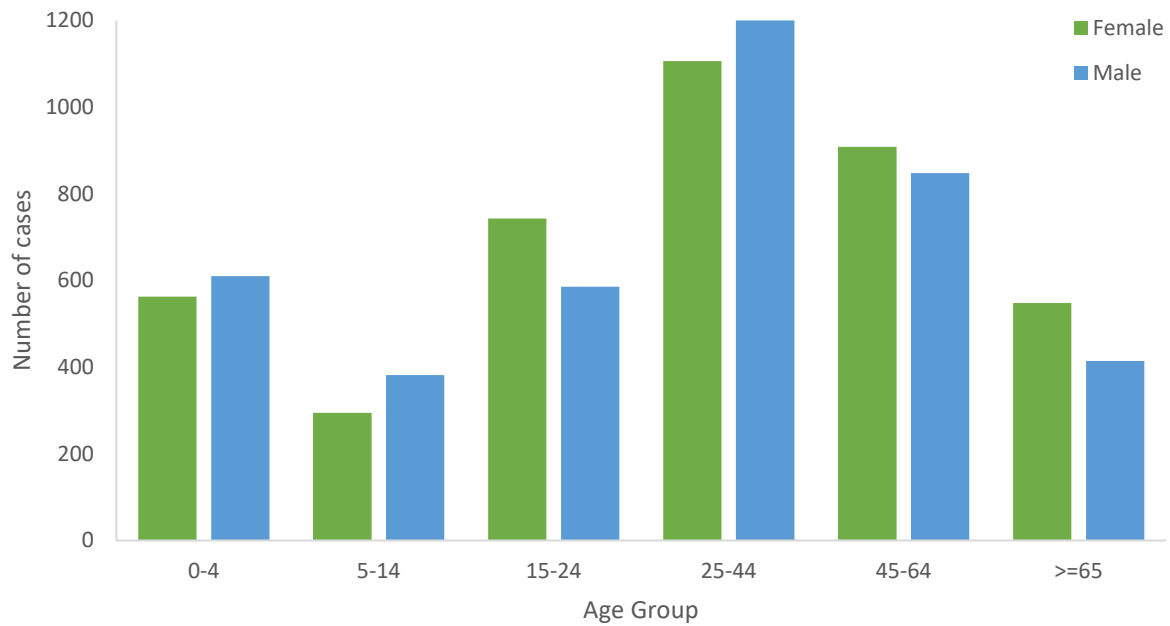
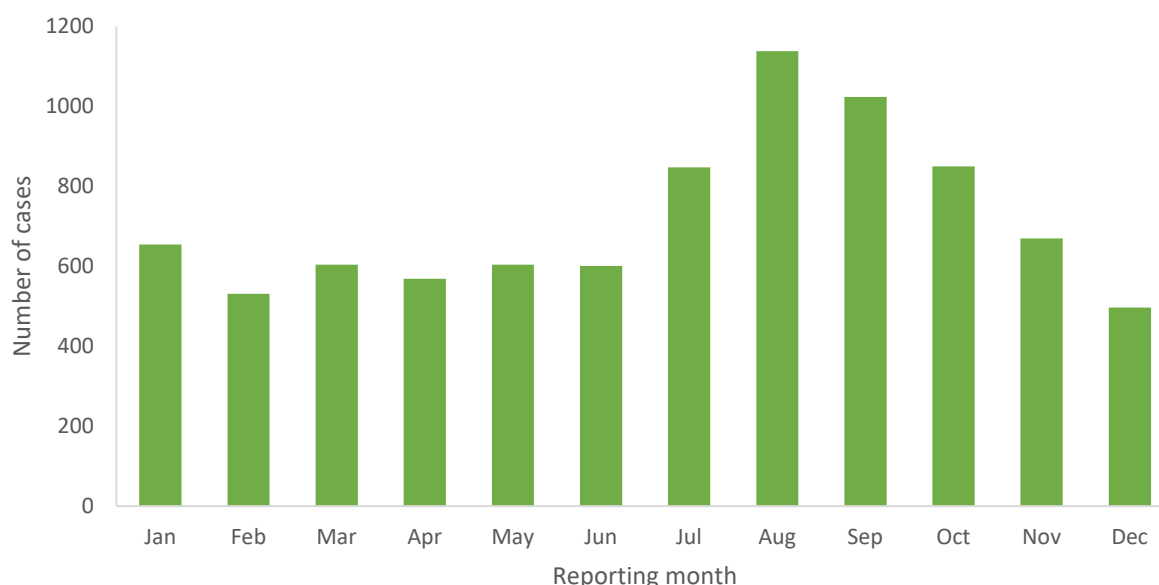


Figure 8. Distribution of *S. Virchow* cases by month in the EU/EEA and the UK (up to 2019), 2007–2021 (n=8 638)



Food-borne outbreaks caused by *S. Virchow*

This section summarises country-specific data on food-borne outbreaks associated with *S. Virchow* as reported from 2017–2021 to EFSA by EU Member States, in accordance with the Zoonoses Directive 2003/99/EC.

During these five years, three strong-evidence food-borne outbreaks caused by *S. Virchow* were reported by Poland in 2017, Spain in 2018 and the Netherlands in 2019. The reported food vehicles were '**Eggs and egg products**', '**Fish and fishery products**' and '**Meat and meat products**', respectively. In total, 38 human cases were reported (three cases in Poland, 29 cases in Spain, and six in the Netherlands). Among the reported outbreaks, there were three hospitalised patients registered in Poland and no deaths. During these five years, two weak-evidence food-borne outbreaks caused by *S. Virchow* were reported by Denmark in 2018 and Poland in 2021. The food vehicles for both outbreaks are '**Unknown**'. In total, 34 human cases were reported (eight cases in Denmark and 26 in Poland). A total of four hospitalisations were recorded, all in Poland. No deaths were registered.

S. Virchow prevalence in food

This section summarises country-specific data on the occurrence of *S. Virchow* for the matrices, 'Food RTE' and 'Food non-RTE' from 2017 to 2021, as reported to EFSA by the EU Member States in accordance with the Zoonoses Directive 2003/99/EC.

During these five years, 87 units positive for *S. Virchow* out of 27 895 total units tested (0.31%) were reported to EFSA for the overall matrices, 'Food RTE' and 'Food non-RTE' by eight **EU Member States** (Cyprus, Czechia, France, Germany, Greece, Italy, the Netherlands, and Spain).

The **two** units positive for *S. Virchow* out of the five total units tested (40%) for the matrix '**Food RTE**' were reported by one EU Member State (Cyprus). One unit positive belonged to '**Other processed food products and prepared dishes - fish and seafood-based dishes**' and one unit positive belonged to '**Ready-to-eat salads - containing mayonnaise**' (both reported in 2018).

The **85** units positive for *S. Virchow* out of the 27 890 total units tested (0.30%) for the matrix '**Food non-RTE**' belonged to the following matrices: **77** units positive from '**Meat from broilers (*Gallus gallus*)**' (five units from Cyprus in 2018, one unit from France in 2018, two units from Germany in 2017 and 2021, five units from Greece in 2019, 37 units from the Netherlands from 2018 to 2021, and 27 units from Spain from 2017 to 2021); **two** units positive from '**Meat, mixed meat - meat preparation - intended to be eaten cooked**' (one unit reported by Czechia and one unit by Spain, both in 2018); **two** units positive from '**Eggs - table eggs**' (both from Spain in 2018 and 2020); **one** unit positive from '**Meat from pig - carcass**' (reported by Italy in 2018); **one** unit positive from '**Meat from other animal species or not specified - fresh**' (reported by Italy in 2020); **one** unit positive from '**Crustaceans - shrimps**' (reported by the Netherlands in 2020); **one** unit positive from '**Meat from turkey - meat preparation - intended to be eaten cooked**' (reported by Spain in 2018).

In the same period of time, one non-EU Member State (Albania), reported to EFSA a total of one unit tested, which was positive for *S. Virchow*. This unit was reported in 2019 and belonged to the matrix, '**Food non-RTE**', more specifically to '**Meat from bovine animals and pig - meat preparation - intended to be eaten cooked**'.

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