DTU

Annual Report on Zoonoses in Denmark 2018

DTU Food
National Food Institute

Annual Report on Zoonoses in Denmark 2018

Edited by:
Birgitte Helwigh and Channie Kahl Petersen
National Food Institute
Technical University of Denmark

Luise Müller
Statens Serum Institut

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National Food Institute
Technical University of Denmark
Kemitorvet
Building 202
DK - 2800 Kgs. Lyngby
Denmark
Phone: +45 35 88 74 95
E-mail: anga@food.dtu.dk

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Contents

The Annual Report on Zoonoses presents a summary of the trends and sources of zoonotic infections in humans and animals, as well as the occurrence of zoonotic agents in food and feeding stuffs in Denmark in 2018. Greenland and the Faroe Islands are not represented. The report is based on data collected according to the Zoonoses Directive 2003/99/EC, supplemented by data obtained from national surveillance and control programmes as well as data from relevant research projects. Corrections to the data may occur after publication resulting in minor changes in the presentation of historical data in the following year's report. The report is also available at www.food.dtu.dk.

Introduction

Campylobacter continued to be the most common bacterial foodborne illness, with 4,546 confirmed human cases in 2018. Two regional outbreaks of *Campylobacter* were reported; one outbreak was caused by consumption of raw milk.

Salmonella resulted in 1,168 laboratory confirmed human infections which is a slight increase compared to 2017, where there were 1,067 human infections. As in previous years, the two most common serotypes reported were *S*. Typhimurium, including monophasic strains, and *S*. Enteritidis, with incidences of 5.3/100,000 inhabitants and 4.6/100,000 inhabitants, respectively.

Foodborne outbreaks

In total, 64 foodborne outbreaks with 1,600 patients were reported in 2018. Compared to last year, the total number of patients has increased mainly due to two large norovirus outbreaks with 135 and 150 cases. Norovirus was the most common cause with 21 outbreaks involving 839 cases. This is an increase compared to the very low level in 2017 with only 10 outbreaks; however, it is in line with previous years. One large outbreak of Enterotoxigenic *Escherichia coli* (ETEC) with 129 cases also added to the large amount of outbreak cases.

Ten of the 19 national *Salmonella* outbreaks were domestic and pork or pork products was the source of four outbreaks caused by *S*. Typhimurium/O:4,[5],12:i:-. In one national outbreak, 49 cases were registered and the main source was found to be raw pork meat sausage "medisterpølse". Nine *Salmonella* outbreaks were related to travelling abroad, which is the highest number of travel related outbreaks recorded.

Another exceptional national outbreak in 2018 was an outbreak of hepatitis A comprising 31 cases, where the source was dates imported from Iran.

In the early summer, a serious and unusual local outbreak of botulism was reported involving nine women at a private party sharing a homemade meal. The outbreak was recognised fast, thanks to an intensive corporation between the different institutions in the health care system. No further cases were detected and all the patients survived the incident.

Indicator bacteria in imported fish and prawns

A survey investigated the presence of indicator bacteria (Enterococcus and *Escherichia coli*) in imported pangasius and raw/cocked prawns from Asia. A large proportion (90%) of the frozen seafood samples was positive with at least one of the indicator bacteria suggesting contamination of faecal origin at a very high initial level. More than 70% of the cooked prawns were contaminated indicating an introduction of contaminants late in the processing chain. Consumers often consider cooked prawns as ready-to-eat food and these products are sometimes marketed in packaging that encourages direct serving, e.g. prawn rings with dips.

Salmonella in poultry

In 2018, EU granted Denmark special guarantees on *Salmonella* in broiler meat, which requires that all batches of imported broiler meat must be accompanied by a certificate and documentation that the batch does not contain *Salmonella*. Meat from Danish broiler flocks found positive with *Salmonella* has to be heat treated before it can be put on the market. Denmark achieved special guarantees for table eggs in 2012, and the prevalence for *Salmonella* in egg layer flocks has been very low (0% to 1.8%) for the last decade. In 2018, the prevalence increased to 2.6% of the flocks. The Danish Veterinary and Food Administration in collaboration with the National Food Institute at the Technical University of Denmark and the poultry industry carried out a thorough investigation of the increase in *Salmonella* positive egg laying flocks. However, no common source was revealed.

Vector-borne zoonoses

The introduction of exotic vectors and pathogens to Denmark constitute a constant risk. In 2018, a dog died from the tick borne blood parasite *Babesia canis* shortly after returning to Denmark. Two feed meadow ticks (*Dermacentor reticulatus*) removed from the dog were also positive for *B. canis*.

For the first time adult Hyalomma ticks were reported in Denmark. They were found on two horses that had not been outside Denmark for more than a year. Being a Mediterranean species, these introduced ticks may carry zoonotic and veterinary important pathogens not normally seen or expected in Northern Europe.

Raccoon dogs migrating into Denmark may carry diseases unknown to Denmark. In a survey, ticks were collected from raccoon dogs; none of the collected ticks was exotic and none of the ticks harboured tick borne pathogens not already found in Denmark.

The *Salmonella* source account

The *Salmonella* source account is not included, which is the first time since 1994. This is mainly due to technical challenges associated with data management as the model has been further developed to use whole genome sequence data instead of phenotypic data and MLVA profiles.

1. Food- and waterborne outbreaks

By the Central Outbreak Management Group

Food- and waterborne outbreaks in Denmark are reported in the Food- and Waterborne Outbreak Database (FUD). Appendix table A3 contain the outbreaks that occurred in 2018. Figure 1.1 shows the relative distribution of these outbreaks by the different causative agents. Household outbreaks and clusters not verified as common source outbreaks are excluded. Outbreak investigation procedures in Denmark are described in Chapter 7.

In 2018, 64 foodborne outbreaks were reported in FUD and the total number of persons affected by foodborne outbreaks was 1,600 with a median of twelve persons per outbreak (range 2-150). The outbreaks were mainly regional or local (64%). Fourteen outbreaks were national outbreaks of which two were part of international outbreaks. The largest outbreak, involving 150 persons, was a local outbreak caused by norovirus (NoV) (FUD 1631).

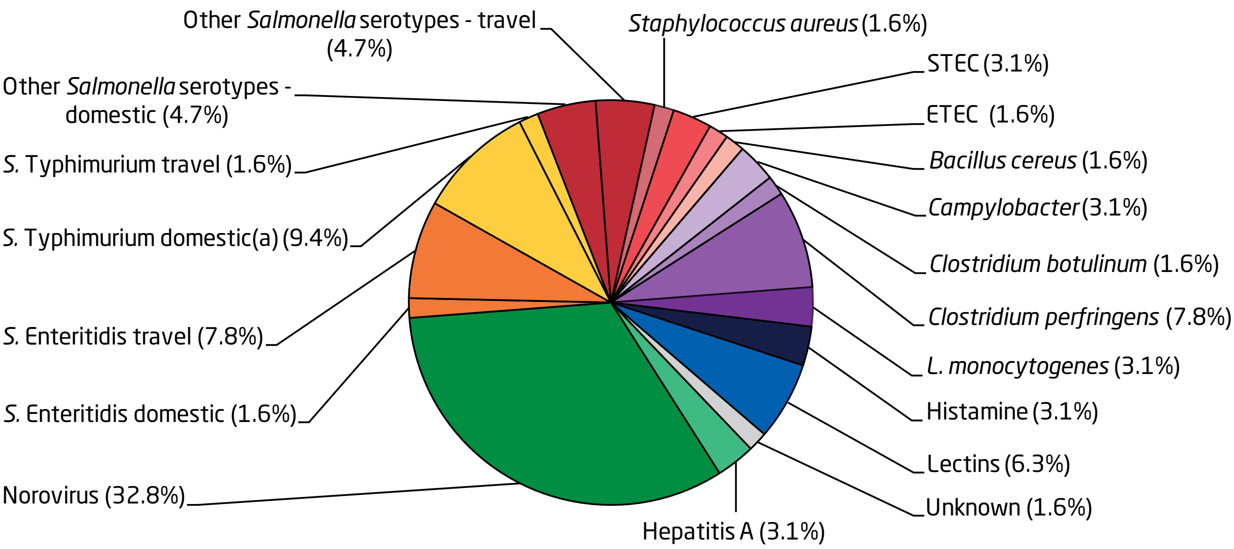
When dividing the outbreaks by reported setting, the most frequent setting was "restaurants" (31%) with 20 outbreaks affecting 435 people (mean 22 people per outbreak). Outbreaks taking place in workplace canteens and through catering (12 outbreaks) also affected a high number of people (671 people) and affected on average 56 persons per outbreak. "Composite meals" (15 outbreaks) and "buffet meals" (9 outbreaks) combined were the most frequently reported types of foods associated with outbreaks in 2018 and most often these outbreaks were caused by NoV (Appendix Table A3).

In 2018, *Clostridium perfringens* was associated with five foodborne outbreaks affecting a total of 107 people compared to 8, 7 and 11 outbreaks caused by this agent in 2017, 2016, and 2015, respectively. This is a slight decrease in numbers of outbreaks and affected persons due to this agent. Outbreaks involving *Bacillus cereus* and *Clostridium perfringens*, are traditionally caused by insufficient cooling of large portions of food items like various meat sauces. This was also the case in 2018.

1.1 Norovirus outbreaks

Norovirus was the most frequent cause of foodborne outbreaks in 2018 (21 outbreaks), and in total 839 persons were affected. This is a substantial increase compared to 2017 and is unfortunately at the same level as in 2016 (Table 1.1). The transmission routes for NoV causing foodborne outbreaks were multiple. In Table 1.1, a breakdown of the number of outbreaks and the number of people affected per route of transmission for 2016-18 is shown. The most common way of infection with NoV in 2018 was contamination from symptomatic or healthy carriers among kitchen staff. In 2018, this way of infection constituted 48% of the NoV outbreaks.

Figure 1.1. Aetiology of the 64 foodborne disease outbreaks reported with a causative agent in the Food- and waterborne Outbreak Database (FUD), 2018. Percentage of total outbreaks indicated in brackets



A: Including the monophasic strains *S.* 1,4,[5],12:i:-.
Source: Food- and waterborne Outbreak Database (FUD)

Two NoV outbreaks caused by commercially harvested Danish mussels were notified (FUD 1659 and 1726) in 2018. The mussels were harvested in open harvest zones. Both outbreaks took place at the same restaurant some months apart. The possible cause of the outbreaks was insufficient heat treatment of the mussels. Mussels are traditionally steamed or boiled before serving. However, the restaurant served the mussels lightly steamed. This possibly was insufficient to inactivate virus. In total, 65 guests became ill. Norovirus genogroups I and II were detected in a sample of the mussels and norovirus was also detected in samples from ill guests in one of the outbreaks. No samples from ill guests from the other outbreak were available.

1.2 *Salmonella* outbreaks

In 2018, 19 *Salmonella* outbreaks were registered. Nine of the outbreaks were related to travelling abroad (see Appendix table A3). Six of ten domestic outbreaks of *Salmonella* in 2018 were caused by the serotype *S.* Typhimurium or its monophasic variant: O:4,[5],12:i:-. The source of the outbreak was revealed for five *S.* Typhimurium/O:4,[5],12:i:- outbreaks and four of them were related to pork meat or pork meat products. The largest outbreak was due to *S.* O:4,[5],12:i:- (FUD 1713). In total, 49 patients were registered between October 2018 and January 2019. The patients were 23 female and 26 male in the age range of 0-97 years. The median age was 65 years. In total, 61% of the patients had been hospitalised. Extensive interviews pointed out a traditional Danish raw pork meat sausage ("medisterpølse"), intended to be heat-treated before consumption, as the possible source. This was confirmed by a case-control study, comparing analyses of consumer purchase data, and trace-back investigation. However, this sausage product could not explain the illness in all patients and it is likely that other types of pork meat could have been an additional source of infection. Furthermore investigation at the production site did not reveal a possible contamination (raw material or environmental). Several patients exhibited a risk behaviour. Six reported tasting the sausage raw or eating it undercooked and five did not boil the sausage before frying it as recommended by the Danish Veterinary and Food Administration. This message, together with advice of cooking pork meat thoroughly in general, was communicated to the public in order to control the outbreak. In the same period from October to December 2018 another outbreak occurred with 17 cases involved. The causative agent for this outbreak was *S.* O:4,[5],12:i:- clustering by WGS (ST34) (FUD 1710). Eight were female and nine were male aged 6-88 years old. Human isolates and food isolates were compared and a match was found to Danish pork meat produced by one Danish establishment in the relevant period just prior to the outbreak. All patients had eaten pork meat. However, interviews and trace-back could not point out a specific product.

S. Enteritidis caused six outbreaks in 2018. Five of these were travel-related (see Appendix table A3). The only domestic *S.* Enteritidis outbreak comprised ten cases registered from January to September 2018 (FUD 1699). The cases were 27-74 years and geographically spread throughout Denmark. The source of the outbreak could not be determined.

1.3 Other outbreaks of interest

On January 30, an outbreak of hepatitis A was declared (FUD 1636) [1]. From January to March 2018, 31 cases were registered of whom 18 were female and 13 were male aged 14-90 years. The median age was 63 years. The genotype was IIIA, which is not a common type in Denmark. This type has been identified in samples from travellers to Middle Eastern countries. Due to intensive investigation, including

Table 1.1. Norovirus outbreaks per route of transmission based on number of cases or number of outbreaks, 2016-2018

	2018		2017		2016	
Transmission route/source	No. of outbreaks	No. of persons ill	No. of outbreaks	No. of persons ill	No. of outbreaks	No. of persons ill
Ill kitchen staff or healthy carrier of virus among kitchen staff	10	408	7	168	6	258
Kitchen staff tending to ill persons at home before entering the kitchen	1	30	1	42	2	40
Ill person/guest attending a buffet	4	193	1	78	4	355
Seafood (oysters)	4	146	1	10	3	92
Frozen raspberries/strawberries	1	50	0	0	0	0
Leafy greens / lettuce	1	12	0	0	3	433
Water	0	0	0	0	0	0
Total	21	839	10	298	18	1,178

Source: Food- and waterborne Outbreak Database (FUD)

interviews, case-case study, case-control study and tracing back, the source was revealed within one week from declaring the outbreak. The source was dates from Iran of a specific brand and package size. On 6 February, the dates were recalled from consumers. Trace-back and trace-forward investigation of the dates showed that the dates were also sold in Germany and Norway. Norway reported one patient matching the genotype. Additionally, hepatitis A was found in a package of dates from one patient's home. Another outbreak of hepatitis A followed from March to June 2018, where ten people got ill with genotype IA (FUD 1668). The patients were aged 8-72 years; six were female and four were male. Sporadic cases were also reported in other European countries. Intensive interviews and a site visit in a residential institution for people with developmental disorders hypothesised that the source was fresh strawberries. However, the source could not be further verified and the outbreak stopped without the implementation of control measures.

A serious, unprecedented outbreak of botulism was seen in 2018 (FUD 1678) [2]. Further description of the outbreak can be found in the text box on the next page.

A point-source outbreak affecting 129 people took place in Jutland at an event for former students at a folk high school (FUD 1687). The causative agent was found to be Enterotoxigenic *E. coli*, O25 (ETEC). A cohort investigation pointed out a common meal at the time of exposure; however, it was not possible to establish the actual source or way of transmission. The outbreak was most likely foodborne but other sources (swimming in the nearby stream or person-person contamination) could not be excluded. The event took place in a period with warm weather.

An unusual outbreak happened in a Danish harbour in August 2018 when a German ship moored. Sixteen passengers and crewmembers became ill with explosive vomiting and diarrhoea. The persons were admitted to three different hospitals in the region for emergency treatment. The incubation period was between 1.5 to five hours with an average of 2.5 hours. The causative agent was *Staphylococcus aureus* both found in human samples and in food samples collected from the ship. The source of the outbreak was most likely potato salads made on board the ship and stored at room temperature. The ship did not have sufficient cold storage capacity.

Two *Listeria* outbreaks were detected in 2018 (FUD 1652 and FUD 1691). In the period from April to July, two patients with isolates of *L. monocytogenes* ST20 were linked by WGS to a third isolate from 2016 (FUD 1691). The patients were three women aged 78-89 years. However, no common link or exposure could be identified. From March to December, four cases of *L. monocytogenes* ST8 (FUD 1652) were identified and linked by WGS to an additional isolate from 2017. Three men and two women aged 55-87 years old. The source of the outbreak was suspected to be different products from an establishment producing meat products for catering.

Finally, two STEC outbreaks were investigated in 2018. Further description of these outbreaks can be found in chapter 3.

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Botulinum outbreak - an unusual event in Denmark

By Jens Kirk Andersen (jkia@food.dtu.dk), Luise Müller and Tenna Jensen

In the early summer of 2018 a serious outbreak of botulism was seen. The setting was a private party with nine women aged 66-81 years old sharing a homemade meal. All nine participants showed some kind of symptoms – seven were laboratory confirmed cases. Four patients became seriously ill requiring intensive care and mechanical ventilation and were hospitalised for up to eight weeks. The outbreak was recognised fast, thanks to an intensive corporation between the different institutions in the health care system. All the patients survived the incident.

The cause of the outbreak was traced to a homemade meal prepared by some of the participants including among other dishes a savory jelly dish consisting mainly of lumpfish roe, hardboiled eggs, chicken stock, mayonnaise and gelatin. Statens Serum Institut (SSI) visited the persons affected to get a more accurate account of the event including the preparation of the dishes with time and temperature conditions, which persons that ate what and how much. Samples were taken from both patients and leftovers for analyses. Botulinum toxin type A was found in patients by SSI as well as in a small amount of leftover from the savory jelly dish analysed at the National Veterinary Institute at the Technical University of Denmark. The method used was inoculation on live mice.

It was concluded, that this was an isolated incident possibly initiated by storing the dish itself or one or more of the ingredients at too high temperatures enabling *Clostridium botulinum* bacteria to grow and form toxins. The lumpfish roe used in the dish is a semi-preserved food, which requires refrigeration. It is a salted, pasteurised product with a shelf life of 12 months when stored at a maximum at 5°C. However, presence of *C. botulinum* spores in fishery products is common and this ingredient was therefore investigated further.

The Danish Veterinary and Food Administration performed an intensive inspection at the manufacturing plant of the lumpfish roe, including sampling of the products (both glasses from the same lot served and from other lots). Failures to comply with hygiene regulation was not detected and spores of *C. botulinum* was not detected in the products.

The National Food Institute at the Technical University of Denmark used predictive modelling to investigate the possibility for growth and toxin production in the foods. With consideration of statements received from patients and family members, it was concluded that some of the foods had been kept at a too high temperature for too long. It was considered most likely that the glass containing the lumpfish roe had been exposed to conditions that allowed dormant spores to grow with toxin production as a result.

It is noticeable that this outbreak was caused by Botulinum type A, which is generally considered to be associated with meat rather than fish.

2. Listeria in Denmark

By Laura Espenhain (laes@ssi.dk), Stine Thielke, Susanne Schjørring and Jette Sejer Kjelgaard

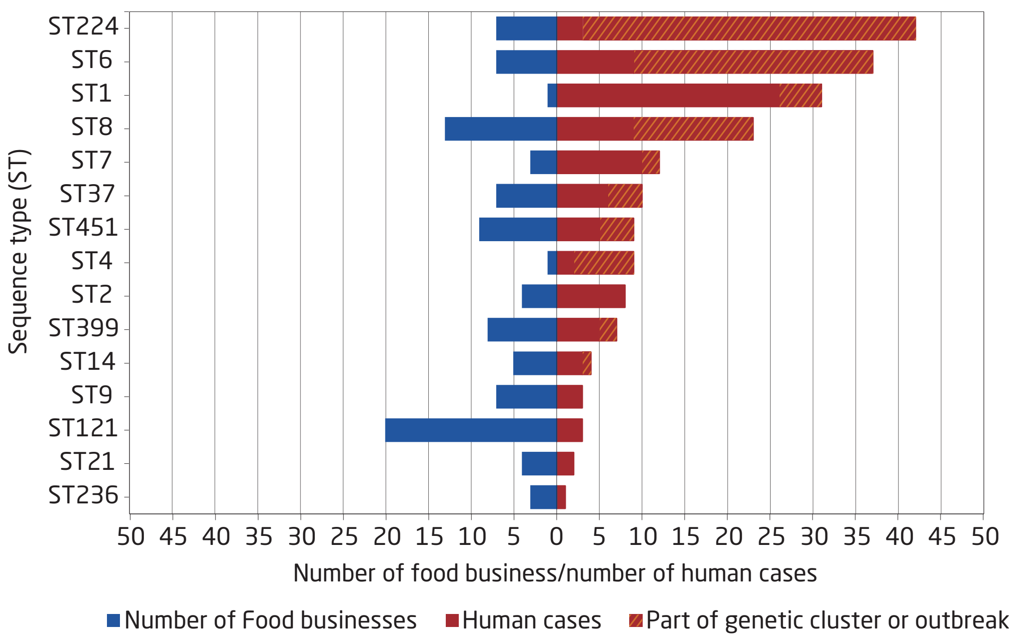
A collaboration between the Danish Veterinary and Food Administration (DVFA), Statens Serum Institut (SSI) and the National Food Institute at the Technical University of Denmark (DTU Food) constitutes a comprehensive surveillance of *Listeria monocytogenes* (*Listeria*) in Denmark. Since 2014 several initiatives have been instigated in order to enforce the *Listeria* surveillance and improve outbreak investigation and source tracing.

2.1 Surveillance of human listeriosis and *Listeria* in foods and the food production environment

Whole genome sequencing (WGS) was introduced in routine typing for surveillance of listeriosis in Denmark in September 2013 and has increased the discrimination of isolates and allowed us to detect more outbreaks [1]. The possibility of making epidemiological links between patients and to possible sources is challenged by a number of factors: the long incubation period of listeriosis (typically 2-3 weeks), the nature of some outbreaks with occurrence of cases several months after the initial case, and the high mortality and severity of the disease hampering the possibility of obtaining good exposure data.

To accommodate these challenges, SSI started a project on enhanced surveillance of listeriosis in 2014. Additional to the routine WGS of all human isolates, SSI attempted to interview all patients shortly after the diagnosis about possible exposures the month prior to their listeriosis, using a standard questionnaire. As the information is collected routinely, as oppose to when a cluster is detected which can be several months after the first case, these interviews help secure reliable and timely information about potential sources of the infection. The information is used regularly to point out or verify possible sources of infection for genetic clusters or outbreaks. In 2014, a large *Listeria* outbreak occurred and since then there has been around 50 *Listeria* cases

Figure 2.1. The most frequent Listeria *sequence types in human samples (n=210 of 280) and/or in food or environmental samples[1] from food business operators (n=85), 2014-2018*



1: Includes official samples as part of the ongoing official control and surveillance of *Listeria* in the food production as well as suspect samples in relation to outbreak investigation and recalls.
Source: Statens Serum Institut and Danish Veterinary and Food Administration

per year, range 41-59 [2]. During the project period from 2014-2018 it has been possible to interview 65% of the cases or their relatives.

In 2014, SSI conducted a project comparing WGS of food- and environmental isolates obtained from the official control and surveillance of the DVFA [1]. Succeeding, in collaboration with DTU Food, the DVFA introduced routine WGS of food- and environmental isolates in 2015. The most frequent sequence types found in humans and in food or environmental samples from food business operators (FBO's) since 2014 are presented in Figure 2.1.

2.1.1 Defining genetic clusters using WGS

All produced WGS data allow for determining classical multi-locus sequence type (MLST) according to the established international nomenclature [3]. Hereafter the isolates are analysed using a core-genome-MLST (cgMLST) scheme [4]. A genetic related cluster is defined based on the population structure in the relevant ST, usually ≤7 allelic differences applying single linkage. For cluster analysis of food, environmental and veterinary samples, an in-house developed bioinformatics pipeline (CSI Phylogeny version 1.4) is applied [5], to identify clusters of bacteria related to human cases or outbreaks based on single-nucleotide polymorphism (SNP) differences.

Data from 2014-2018 show that 47% of *Listeria* isolates did not cluster genetically with any other human isolates in the period, 52% were identified as being part of a genetic cluster and amongst these 76% were investigated as an outbreak and registered in the Danish Food- and waterborne outbreak database (FUD) (Figure 2.2).

2.1.2 Outbreak investigation

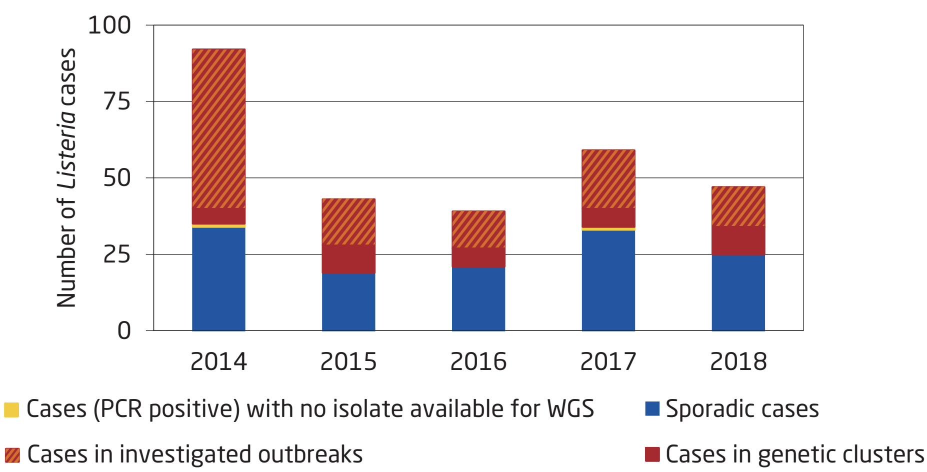
Introducing WGS of *Listeria* isolates and the comparison of genomes from human and food samples, as well as the introduction of enhanced epidemiological surveillance including an ongoing project on immediate collection of exposure data, have positively influenced our ability to detect, investigate and solve outbreaks of listeriosis. The number of outbreaks registered in FUD has increased from three in the period from 2005 – 2013 (using Pulsed Field Gel electrophoresis, PFGE, as typing method) to 15 during the period from 2014-2018 (using WGS). The overall comparison of sequences between the three institutes and the collaboration in the Central Outbreak Management Group have been a great resource and ensured smooth management of outbreaks of listeriosis, a number of them published [6, 7].

2.2 National initiatives on *Listeria*

In 2014, the DVFA instigated several initiatives to improve the national efforts toward *Listeria* with the main objectives to secure safe food and reduce the number of cases of listeriosis [1]. The overall aim of the initiatives was to increase the level of knowledge regarding the risk of *Listeria* in food. These initiatives can be divided into four themes and were implemented during the period 2014-2018:

- Groups at risk
- The FBO's and the official control
- Industry kitchens preparing food for groups at risk
- Microbiological sampling and source tracing/outbreak investigation

Figure 2.2. Number of Listeria monocytogenes *isolates from human invasive infections in Denmark (n=280), 2014-2018. Cases are distributed in sporadic infections and genetic clusters including investigated outbreaks*



Source: Statens Serum Institut

Figure 2.3. National recommendations to groups at risk of listeriosis

Pregnant

- Eat cold cuts, coldsmoked and gravad fish as fresh as possible
- Avoid unpasteurized milk and soft cheeses based on raw milk
- Follow the general guidelines and recommendations on good hygiene practice

Seriously ill/immunosuppressed people

- Eat cold cuts, coldsmoked and gravad fish as fresh as possible
- Avoid unpasteurized milk and soft cheeses based on raw milk
- Eat ready-to-eat hotmeals fuming hot
- Refrigerate food quickly at 5°C
- Discard old/expired food
- Follow the general guidelines and recommendations on good hygiene practice

Source: Danish Veterinary and Food Administration

2.2.1 Groups at risk

The purpose of this initiative was to revise the national recommendations to people at risk of listeriosis. It resulted in a specification of groups at risk in two distinct groups: pregnant and seriously ill/immunosuppressed people (often elderly). This distinction was important in order to ensure targeted information to people at risk as well as healthcare professionals. Henceforth the revised recommendations to groups at risk are divided into two separate conjunctions (Figure 2.3).

A vast effort has been put in to communicating the revised recommendations by means of periodical newsletters, newspapers, trade journals and information to healthcare divisions in local districts, amongst others. The revised recommendations can be found at the DVFA website www.foedevarestyrelsen.dk.

2.2.2 The official control and the food business operators

The purpose of this initiative was to provide information and understanding of how to manage the potential risk of *Listeria* in ready-to-eat (RTE) foods to both FBO's and the official control.

As an outcome the DVFA has published a user-friendly digital site "All about *Listeria*", including self-service tools to guide FBO's to manage the risk of *Listeria* in relation to their food production and to comply with the legislation. Additional information can be found at the DVFA website www.foedevarestyrelsen.dk/Foedevarer/AltOmListeria/Sider/default.aspx (in Danish).

Additionally, the DVFA completed specialised training courses about *Listeria* applied to official control officers, followed by implementation of a cross-sectional group of experts within the DVFA to ensure knowledge sharing.

The DVFA also implemented a practice to ensure efficient corrective measures by the food businesses and a close follow up in case of *Listeria* events. This practice entails an inspection of the FBO in question with focus on *Listeria* including sampling of environment and relevant products in case of:

- Recall/withdrawal of products due to *Listeria* findings
- Human cases with suspicion to a specific FBO

The DVFA completed 7 control campaigns all with the aim to keep focus on *Listeria* and ensure compliance to the legislation by the FBO's. The target groups of the campaigns were FBO's with production of known risk products with regards to *Listeria*. The following campaigns were completed:

- Control and prevention of *Listeria* in the production of RTE meat products (conducted in 2014)
- Control and prevention of *Listeria* in the production of RTE fish products (conducted in 2015)
- Control and prevention of *Listeria* in the production of RTE products to people at risk - part A, convenience/precooked food (conducted in 2015)
- Control and prevention of *Listeria* in the production of RTE products to people at risk - part B, frozen products (conducted in 2016)
- Control and prevention of *Listeria* in the production of RTE products to people at risk – part C, convenience/precooked food (conducted in 2016-2017)

- Control and prevention of *Listeria* in the production of RTE fish products (conducted in 2017)
- Control and prevention of *Listeria* in the production of RTE meat products, fish products and RTE products to people at risk – combined campaign (conducted in 2018)

Additional information about the control campaigns can be found at the DVFA website (www.foedevarestyrelsen.dk/Kontrol/Kontrolkampagner/Sider/Kontrolkampagner.aspx (in Danish)).

In alliance with the DVFA, the University of Copenhagen conducted a pilot project to disclose the importance of food safety culture on the actual food safety and implication on the impact of guidance and official control by the authorities. The aim of the project was amongst others to look further into the possibilities and barriers of the competent authorities with regards to guidance and support of food businesses [8].

The recommendations of this project have been used as inspiration with regards to the national *Listeria* initiatives.

2.2.3 Commercial sized kitchens preparing food primarily to groups at risk

This initiative was distinctively aimed at commercial sized kitchens preparing or delivering food to groups at risk of listeriosis.

The outcome was guidance material specific for this food sector included on the digital site "All about *Listeria*". The DVFA also initiated an increased official control effort: including three control campaigns (listed in the paragraph above) and a higher risk score related to the activity of preparing food for people at risk of *Listeria* which in term can increase the control frequency.

2.2.4 Source tracing/outbreak investigation and microbiological sampling

This initiative was conducted as a collaboration between the DVFA, DTU Food and SSI to establish a standard selection procedure of isolates based on the current situation (outbreak or no outbreak) in order to support source tracing and outbreak investigation.

The DVFA has also developed guidance material and description of principles of intelligent sampling to the food businesses, as well as inspirational sampling plans for different types of food businesses such as production of RTE meat products, RTE fish products (e.g. smoked/gravad fish) and commercial sized kitchens. This is a part of the previous mentioned digital site "All about *Listeria*".

2.3 Conclusion

The reinforcement of the national *Listeria* surveillance in Denmark over the past four years have led to improved outbreak investigation and improvement of the general control and management of *Listeria* in the food production. Nevertheless, *Listeria* remains a serious bacterial zoonosis, and it is important to uphold focus on current initiatives and future efforts to keep the number of listeriosis cases from increasing.

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3. Shiga toxin producing *Escherichia coli* (STEC)

By Charlotte Kjelsø (jel@ssi.dk), Mette Rørbæk Gantzhorn, Laura Espenhain, Susanne Schjørring, Søren Aabo, Flemming Scheutz and Gudrun Sandø

3.1 Introduction

Escherichia coli (*E. coli*) are rod shaped, Gram negative bacteria, which normally inhabit the intestinal tract of humans and animals. Most *E. coli* are harmless, but some can cause disease. Shiga toxin-producing *E. coli* (STEC) - formerly Vero cytotoxin-producing *E. coli* (VTEC) - can cause bloody diarrhoea, vomiting and mild fever. Haemolytic Uremic Syndrome (HUS) is a complication to STEC infection, and especially children are at risk [1].

The reservoir of the bacteria is ruminants: cattle, deer, sheep and goats. The human infectious dose is very low and infection usually happens through ingestion of contaminated drinking or recreational water or food, or through contact with animals or infected persons.

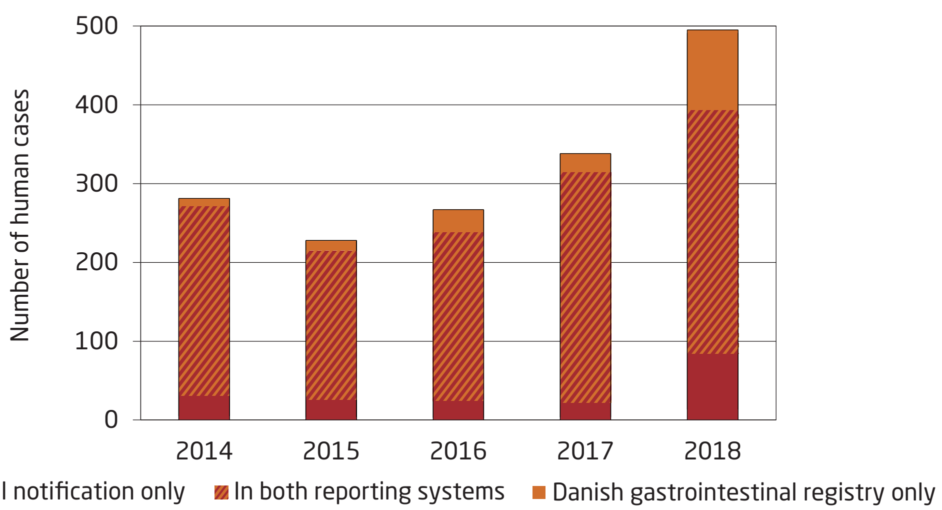
3.2 STEC in humans in Denmark 2014 – 2018

STEC and HUS are reported in two different systems: Clinical notification to the Department of Infectious Disease Epidemiology and Prevention at Statens Serum Institut (SSI) and laboratory reporting to the Danish gastrointestinal registry.

A total of 1,609 cases were reported to the two STEC surveillance systems from 2014 to 2018 (Figure 3.1). Eleven patients had the same STEC type for more than six months and eight patients were infected with more than one STEC type at the same time. Isolates from approximately 10% of STEC cases, clinically notified to the Department of Infectious Disease Epidemiology and Prevention at SSI, had not been sent from the local clinical microbiological department to SSI for further characterisation, this proportion was highest in 2018 (Figure 3.1). The total number of registered STEC cases has increased every year since 2015, and doubled from 2014 to 2018 with 281 cases in 2014 and 495 in 2018 corresponding to an incidence of 8.5 per 100,000 inhabitants. The total number of STEC cases rose markedly between 2017 and 2018, with many cases only reported in one of the two notification systems.

Table 3.1 shows the number of registered STEC cases in 2018 and the average for 2014-2017 as well as the number of cases per 100,000 inhabitants for each Danish province and in total. The number of cases per 100,000 inhabitants

Figure 3.1. Number of registered STEC cases per year, 2014-2018



Note: Clinical notification only: Clinical notification not reported to the Danish gastrointestinal registry; Danish gastrointestinal registry only: Only reported to the Danish gastrointestinal registry and not clinically notified.
Source: Statens Serum Institut

Table 3.1. Numbers and incidence of Danish STEC cases in 2018, and mean numbers and incidence in 2014-2018, per region and province

		2018		Mean 2014-2017	
Region	Province	Number	Incidence	Number	Incidence
Capital	Copenhagen City	50	6.4	29	3.9
	Copenhagen Area	34	6.2	27	5.1
	North Zealand	33	7.1	24	5.3
	Bornholm	-	-	2	5.0
Zealand	East Zealand	7	2.8	8	3.4
	West- and South Zealand	26	4.4	14	2.3
Southern Denmark	Funen	48	9.7	52	11.0
	South Jutland	67	9.2	53	7.4
Central	East Jutland	134	15.1	25	2.9
	West Jutland	51	12.0	12	2.7
North	North Jutland	41	7.0	32	5.5
Unknown		4	-	1	-
Total		495	8.5	280	4.9

Source: Statens Serum Institut

averaged 4.9 and varied in the regions from 2.3 to 11 in the period 2014-2017 and increased to 8.5 in 2018 with a variation from 2.8 to 15.1 - disregarding Bornholm where there were no cases in 2018.

The number of registered STEC cases has increased in most parts of the country except for Funen - where there was a high incidence of STEC throughout the period - and East Zealand, which had a relatively low incidence throughout the period. In 2018, STEC increased markedly in East- and West Jutland. This area is covered by the Department of Clinical Microbiology at Aarhus University Hospital (Skejby), which introduced screening for STEC by PCR on all diarrhoeal faecal samples in June 2018.

3.2.1 STEC clusters and outbreak detection using WGS in Denmark 2014 - 2018

Since November 2014, all STEC isolates received at SSI have been whole genome sequenced (WGS) and 7 gene multilocus sequence typed (MLST) according to Enterobase [2]. Hereafter, the isolates are analysed using a core genome-MLST (cgMLST) scheme (http://enterobase.warwick.ac.uk/) in BioNumerics version 7.6.3. A genetic related cluster is defined by the population structure in the relevant ST, usually within a few allelic differences applying single linkage, however a clear cut-off is not yet established.

Eighteen genetic WGS clusters with an epidemiological link were investigated as outbreaks during the period. The outbreaks were primarily related to day care institutions and/or secondary infection in families. Six of the 18 outbreaks had a possible connection with direct infection from food. Two outbreaks with serotype O111:H8 and O26:H11 had seven and 39 cases respectively. Remaining outbreaks included up to five cases each.

The outbreak caused by O111:H8 consisted of seven patients, five cases were confirmed by WGS, one case was considered as probable (O111:H8 isolate but not sequenced) and one case was through epidemiological investigations considered as possibly linked to the outbreak. Two patients were female, five were male, aged 0-54 years. Additional to the possible case, one of the confirmed cases and the probable case developed HUS. The cases lived all over Denmark and none had travelled during the two weeks prior to onset of symptoms. Hypothesis generating interviews did not disclose any common source, apart from a weak suspicion of minced beef, which was the only food all patients indicated to have eaten. During the same period, the Danish Veterinary and Food Administration (DVFA) carried out a control project on STEC in minced beef in 2018 (see below) where STEC O111 was not found. No other country reported of a WGS match to this outbreak.

The outbreak caused by an O26:H11 STEC comprised primarily children with a total of 38 confirmed cases, and one possible case. Patients primarily fell ill from late August until mid-November, and lived throughout Denmark, with an overweight in the major cities. Among the 39 cases, 18 were women/girls and 21 boys. Cases were 0-95 years, with 31 out of 39 being 0-3 years. Onset of disease for 24 cases was from August 20 to November 12 2018. Most cases were associated with day care centres or other institutions with joint food arrangements, which received food items from larger Danish catering wholesalers. Review of purchases in the institutions showed that cured dried beef sausages was delivered to most of them. Cured dried beef sausage is a known risk product for STEC as it is not heat-treated. No other obvious risk products were indicated. STEC was not detected in samples taken from the suspected types of beef sausage nor was it possible to further identify the source of infection using other epidemiological methods. Thorough investigation of the outbreak could therefore not identify the source of infection, but the weak suspicion of the product was maintained.

3.2.2 Haemolytic Uremic Syndrome (HUS) in Denmark 2014 - 2018

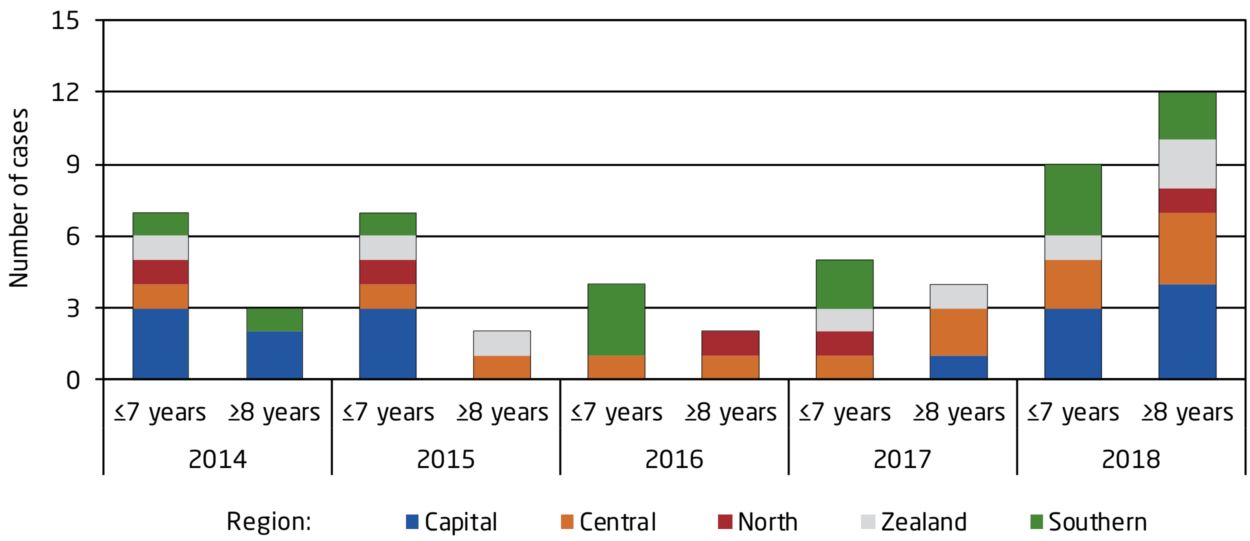
In the period from 2014 to 2018, 55 cases of STEC were associated with HUS, corresponding to 3.4% of all STEC cases (Figure 3.2). The median age for HUS cases was 6 years (range 0-80 years). In total, STEC was either isolated or confirmed by PCR at SSI from 55% (30/55) of HUS cases. For 30 HUS cases where the STEC virulence genes could be determined, *stx2a* was the predominant subtype (n=18), followed by combinations of *stx2a+stx1a* (n=9), *stx2c* (n=1), *stx2a* +*stx1a* + *stx2c* (n=1), and *stx1a* alone (n=1). Ten different O groups could be determined for 30 cases. The most common O group was O157 (n = 13) followed by O26 (n = 8). Two HUS cases clustered on WGS.

In 2018, 21 cases of STEC HUS were registered; this is the highest number ever. Seventy-five percent of these cases were reported in the period from June to September (n=16), after which no more cases were reported. On several occasions during the summer and autumn 2018, the clinical microbiological departments, paediatricians at three major hospitals in Denmark and the Danish Patient Safety Authority were informed about a higher number of HUS cases than expected. There were more cases in both age groups (children ≤7 years vs ≥8 years) in 2018 compared to 2014-2017, but particularly more cases in the group ≥8 years (Figure 3.2). The median age of HUS cases was 9 years in 2018, contrary to 4 years in the period 2014-2017.

3.2.3 Discussion of HUS cases

Two things are relevant when interpreting the increase of STEC and HUS numbers in Denmark in 2018. Firstly, the diagnostic methods used and the clinical criteria for STEC examination have changed in several departments of clinical microbiology in Denmark during 2014-2018, and in 2018 one of the bigger departments of clinical microbiology, covering the Central region introduced screening for STEC by PCR on all faecal samples, resulting in more registered cases of STEC from that region. However, as the increase in HUS cases in 2018 were not only seen in the Central

Figure 3.2. Number of HUS cases by region and age group in Denmark, 2014 - 2018



Source: Statens Serum Institut

Table 3.2. STEC isolated from hide and carcasses swab samples[1] from cattle at seven medium or large Danish slaughterhouses, 2018

Slaughterhouse	Hide			Carcasses		
	N	Positive samples (number of isolates)	Serotype (number of isolates)	N	Positive samples	Serotype
A	16	8 (14)	O121 (8) O157:H7 (4) O103 (2)	40	0	-
B, C, D and G	40	0		135	0	-
E	28	2 (3)	O157:H7 (2) O103 (1)	76	0	
F	8	0		32	1	NA
Total	92			283		

1: Isolated by initial screening for *stx1* and *stx2* by real time PCR followed by colony picking of 50 *E. coli* isolates for characterisation. Routine WGS analysis was not available.
NA = Not Available
Source: Danish Veterinary and Food Administration

region, this change does not seem to explain the increase in HUS (FIgure 3.2). Secondly, active case finding of HUS cases may have occurred after SSI, on more than one occasion, informed paediatricians at three major hospitals in Denmark, the departments of clinical microbiology and the Danish Patient Safety Authority about an acute increase in HUS cases in 2018. If so, more cases of HUS may have been identified and reported in general. However, SSI has a long-lasting and well-functioning surveillance of HUS which is already believed to be complete. In conclusion, it does not seem that we can explain the increase in HUS neither by increased diagnostic activity, active case finding nor by outbreaks.

3.3 STEC in food and animals in Denmark 2015-2018

As part of the political agreement on food safty (Fødevareforlig 3, 2015-2018), the Danish Veterinary and Food Administration (DVFA) has carried out investigations on the prevalence of STEC at different stages of the beef production chain: Slaughterhouses (2015), cutting plants (2017), and wholesale and retail (2018). At slaughterhouses, swab samples were taken from the hide of animals before slaughter and from the carcass after slaughter. At the cutting plants, meat samples were taken both from input and output meat. Minced meat was sampled at wholesale and at retail.

3.3.1 STEC on cattle hides and carcasses at slaughter

Hides and carcasses were examined for presence of STEC in seven large and medium sized slaughterhouses, and STEC was isolated in samples from three slaughterhouses. STEC was detected from 10 of 92 hide samples (11%), while only one of 283 carcass swab samples was positive for STEC (0.35%). Different serotypes were found on hide samples both between and within samples (Table 3.2).

3.3.2 STEC in meat

In 2017, the DVFA investigated the presence of STEC in meat at cutting plants. In total, 400 samples were taken from 40 batches of meat at 13 different cutting plants. From each batch, five samples were collected before cutting and five samples after cutting. STEC was detected in three samples (0.75%, N=400). Two samples were positive for STEC O136:H12, *stx1a*, *eae*-. One sample was positive for STEC O103:H2, *stx1a*, *eae*+.

In 2018, the DVFA examined samples of minced meat. Samples were from meat that had been minced at wholesale or at retail. In total, 425 samples from 85 batches (5 samples per batch) were examined. STEC was detected in 21 samples from 8 batches (9.4%, N=85), where three batches contained two different serotypes each. The distribution of *stx* subtypes and presence of *eae*/aggR was determined using the VirulenceFinder 2.0, CGE, DTU (Table 3.3). In general, the level of generic *E. coli* in samples of minced beef was low. Generic *E. coli* was more prevalent and found in higher concentrations in STEC positive samples. In STEC negative samples generic *E. coli* was below the limit of detection in 73% of samples, while it was 29% for STEC positive samples. The concentration of generic *E. coli* in minced beef samples positive for STEC was 2.5 log10 cfu/g compared to 2.0 log10 cfu/g in samples negative for STEC. 81% of batches were in compliance with the EU process hygiene criteria for *E. coli* (EC Reg No 2073/2005).

Table 3.3. STEC incl stx *gene and* eae *distribution in minced meat collected at wholesale and retail (425 samples from 85 batches), Denmark 2018*

Batch no.	Serotypes	*Stx* gene	*eae* (yes/no)	Number of isolates
A[a]	O22:H8	*stx1a*	N	5
B[b]	O157:H7	*stx2c*	Y	3
C	O116:H16	*stx2a* *stx2g*	N	1
	O55:H12	*stx1a*	N	1
D	O103:H2	*stx1a*	Y	1
	O146	Unknown	N	2
E	O113	*stx2a/d*	N	1
F	O171:H2	*stx2d*	N	1
G	O171:H2	*stx2d*	N	1
H[c]	Unknown	*stx2b/d*	N	3
		stx2c	N	2
	O175:H16	*stx2a*	N	1
Total				22

a) *Salmonella* was also detected and the batch was recalled.
b) The batch was recalled
c) Two isolates were found in the same sample.

Source: Danish Veterinary and Food Administration

3.3.3 Discussion of findings in meat

In summary, cattle at slaughterhouses seems quite often to be contaminated on hides (11 %), while STEC was rarely detected (<1%) on carcasses at slaughter and in meat in cutting plants. Despite this low occurrence, a rather large proportion (9%) of batches of minced beef contained STEC. The findings in the three studies are not directly comparable as they were carried out in different time periods and methodology was adjusted during the period. Potential fluctuations in the prevalence of STEC in cattle between time periods may influence the outcome of the studies. However, the findings of STEC in 9% of batches and in 4.9% of all samples of minced beef was higher than expected and indicate variations in hygiene including e.g. temperature during storage and processing in establishments producing minced meat or at suppliers (slaughterhouses in most cases). This is supported by the finding of 3 times higher generic *E. coli* contamination of the minced beef samples positive for STEC. However, the results showed an overall good compliance with the EU process hygiene criteria for *E. coli* in minced meat.

Introduction of routine WGS analysis made it possible to identify *stx* gene subtypes and adhesion genes in the STEC isolates from minced beef. Although not based on random single samples, the distribution of *stx* subtypes in minced beef is the first data to provide indication of *stx* subtype diversity in the cattle reservoir. Seven subtypes were detected. Based on advice from The National Food Institute at the Technical University of Denmark, the DVFA considered batches with STEC unsafe when *stx1* or *stx2* and adhesion genes (*aggR* or *eae*) were present. During 2018, FAO/WHO published a report [3], which categorised the potential of a STEC strain to cause severe disease based on the virulence gene content. It states that STEC carrying *stx2a*, in the presence of the adhesion genes *eae* and *aggR* (and also *stx2d* under certain conditions), pose an estimated potential to cause HUS. DVFA will include this in future risk management of STEC in food. All three isolates from minced beef carrying *stx2a* were *eae*/*aggR*-negative, but according to definitions by FAO/WHO [3] they could pose a potential risk for causing HUS.

3.4 Conclusion

The number of reported STEC infections in humans is increasing, particularly in 2018, though most likely due to introduction of more sensitive diagnostic methods and changed criteria for testing with inclusion of all patients with diarrhoea. Since the introduction of WGS, two severe outbreaks have been identified as genetic clusters. The introduction of WGS has allowed us to identify outbreaks, however an increasing proportion of STEC is not sent to SSI for WGS, potentially compromising the possibility to identify outbreaks.

In 2018, more than twice as many HUS cases was registered than during the previous four years. This increase does not seem to be caused by increased diagnostic activity or by outbreaks. Currently, we cannot explain the increase, but the national surveillance will continuously monitor the epidemiology and trend of STEC and HUS.

STEC is common in Danish cattle and was found in 9% of batches of minced meat. The relatively high proportion of STEC in minced meat indicates, that minced meat is a potential risk to humans if not heat-treated.

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4. Risk of importing contaminated pangasius and prawns from Asia

By Johanne Ellis-Iversen (joell@food.dtu.dk), Nanna Munck, Anne Mette Seyfarth and Helle Korsgaard

Global aquaculture production was 110.2 million tonnes in 2016 and is estimated to expand drastically as the demand for protein increases [1]. Almost 90% of the global aquaculture is produced in Asian countries supplying both the domestic and large export markets [2]. Prawns and fish are popular export products from Asia. The white pangasius fish (*Pangasianodon hypophthalmus*) is a popular product and normally exported as frozen, raw fillets. Vannemei prawns (*Litopenaeus vannamei)* is the most popular prawn product and provides an industrial farmed alternative to Black Tiger prawns due to the lower production costs (www.cbi.eu). These prawns are very popular in especially Northern European countries, who import them as whole prawns either raw or pre-cooked and often market them as ready-to-eat products.

The increased export has triggered an intensification of aquaculture in Asian countries. Consequently, the frequency of infectious bacterial disease outbreaks that require preventive and control measures, e.g. antimicrobial treatment, has increased. The hot climate in these countries also enhances the risk of diseases and antimicrobials have become an integral part of prawn farming in many places of Asia [3].

Many of the prawn-producing countries are low to middle-income countries and generally struggle with sanitation, infrastructure and separation of clean and used water [3]. Countries with a lower level of governance and less regulation are more likely to have a higher level of bacteria and thus a higher risk of developing antimicrobial resistance [2]. Despite strict requirements on products imported into the EU, it may be difficult to avoid contamination under the given production circumstances in Asia.

To examine potential microbiological contamination, we explored the presence of *Escherichia coli, Enterococcus faecalis* and *Enterococcus faecium* in pangasius fillets, raw prawns and pre-cooked prawns imported from Asia available to consumers in Danish supermarkets. These bacteria species are not native to seafood or fish and any findings are to be considered as indicators of contamination of feacal origin.

4.1 Methods

Regional food officers from the Danish Veterinary and Food Administration (DVFA) collected 300 samples of frozen pangasius (*Pangasianodon hypophthalmus*) fillets and prawns (Penaeidae family) imported from Asia between September 2017 and May 2018. The number of establishments and samples selected was proportional to the number of establishments in each region relative to the total number in the country.

Samples were kept frozen until examination of 25g thawed sample for the presence of the indicator bacteria *Enterococcus faecalis, Enterococcus faecium* and *Escherichia coli* at the DVFA laboratory. Samples were homogenised in 225ml Buffered Peptone Water (BPW) and 100µl was spread onto relevant agars from where 2-3 presumptive colonies of each bacteria species were selected for further identification. For enterococci, Slanetz and Bartley agar was used incubated at 41.5°C for 48 hours followed by a modified rtPCR assay for identification [4]. For *E. coli,* Red Violet Bile agar was used incubated at 30°C for 4-6 hours followed by incubation at 37°C overnight, and for identification Tryptone Bile Glucuronic agar incubated at 44°C overnight was used. If there was no presence of presumptive colonies, a second and similar attempt of isolation was performed from the initial suspension in BPW now incubated overnight at 37°C. This time only 10µl of the suspension was inoculated and the incubation step at 30°C for 4-6 hours for the *E. coli* isolation was not included.

4.2 Results

We collected 97 frozen, raw pangasius fillets, all originating from Vietnam of which three were repacked after import to Denmark. All samples were raised in aquaculture except two originating from wild-caught pangasius (Table 4.1).

In total, 203 frozen prawn samples were collected. Of these, 107 were pre-cooked and 96 were raw products. Most of them were raised in Vietnam (n=194), followed by Bangladesh and India, and one sample's origin was described as from "Indonesia, Vietnam or Ecuador". Almost all products were ready-packed in their country of origin, but 13 products were re-packed in Denmark and four in other EU countries. The majority of the prawns were farmed, with only 3% classified as wild-caught.

The majority of samples (90%) were contaminated with either one or more of the indicator bacteria. *E. faecalis* was detected in 87% of the samples, *E. faecium* in 22% and *E. coli* in 22% of samples.

All pangasius fillets harboured at least one *Enterococcus* spp. and enteroccoci were isolated from 94% of raw prawns

*Table 4.1. Description of 300 retail samples of pangasius (*Pangasianodon hypophthalmus*) fillets and prawns (Penaeidae family) from Asia collected in Danish supermarkets*

		Total samples	*E.coli* detected	Entercoccus detected	Neither detected
	Pangasius	97	50	97	0
	Prawns	203	17	172	31
	Total	300	67	269	31
Country of origin (n=300)	Vietnam	291	65	260	31
	India	4	0	4	0
	Bangladesh	4	2	4	0
	Other	1	0	1	0
Prawns (n=203)	Full shell	102	13	97	5
	Pre-peeled	87	4	65	22
	Tail-shell only	14	0	10	4
	Intestinal tract visible	107	13	102	5
	No intestinal tract	96	4	70	26
	Cooked prawns	107	2	82	25
	Uncooked prawns	96	15	90	6
	Farmed prawns	197	17	166	31
	Wild-caught prawns	6	0	6	0

Source: National Veterinary Institute, Technical University of Denmark

and 77% of the cooked prawn samples. *E. faecalis* was the most common enterococci and was detected in 87% of samples. Of these, 22% were also contaminated by *E. faecium.* The combined enterococci species were found in 19% of the cooked prawns and in 33% of the raw prawn products.

E. coli was detected in 75% of the pangasius fillets and 25% of the prawns. Most of the *E. coli* contaminated prawn samples were raw, but *E. coli* was detected in two cooked samples originating from Bangladesh and Vietnam, respectively. All of the *E. coli* contaminated samples were also contaminated with enterococci.

4.3 Discussion

We found enterococci and/or *E. coli* in a large proportion (90%) of the frozen seafood samples analysed and imported into Denmark, suggesting some contamination of faecal origin.

More than 70% of the cooked prawns were contaminated with either enterococci or *E. coli*, suggesting that the contamination is introduced late in the processing chain. Consumers often consider cooked prawns as ready-to-eat food and these products are sometimes marketed in packaging that encourages direct serving, e.g. prawn rings with dips. The detection of enterococci and *E. coli* in this many samples and even after freezing, suggests a very high initial level of contamination. Furthermore, other enteric pathogens such as foodborne pathogens may be present and survive in these types of products. Apart from the risk of pathogen introduction to the Danish market via these products, importing antimicrobial resistance either in pathogens or in indicator bacteria may pose yet another problem. The risk of importing antimicrobial resistance via these products is assessed in DANMAP 2018 [5].

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5. Vectorborne zoonoses

By René Bødker (rebo@sund.ku.dk), Lene Jung Kjær and Kirstine Klitgaard Schou

The National Veterinary Institute at the Technical University of Denmark (DTU Vet) monitors vectors and vector-borne diseases in animals in Denmark on behalf of the Danish Veterinary and Food Administration. Up to 2018, DTU Vet has been responsible for the national surveillance of key vector species and for quantifying and mapping ticks and tick-borne pathogens. The surveillance focus on endemic vectors but also screens for exotic vectors.

Mosquitoes and biting midges have been monitored weekly during the vector season since 2011 and 2012, respectively, as a part of the national vector surveillance program. Mechanical vectors (Tabanidae) have been monitored weekly and tick vectors (*Ixodes ricinus*) has been monitored regularly since 2017. Data are continuously updated at www.myggetal.dk (in Danish).

Like elsewhere in northern Europe the summer season in Denmark 2018 was exceptionally warm and record dry. After normal vector abundances in June the dry weather resulted in the lowest mosquito and biting midges (*Obsoletus* spp. and *Pulicaris* spp.) abundance recorded from July to October since surveillance of the two vector groups was initiated in 2011 and 2012, respectively (Figure 5.1, 5.2 and 5.3). *Obsoletus* spp. and *Pulicaris* spp. are the two major groups of biting midges in Northern Europe. They usually have distinct generation peaks from April to October.

The warm weather however facilitated the spread of West Nile virus and partly Usutu virus in northern Europe.

Photo 5.1. Adult Hyalomma tick removed from a horse in Denmark in September 2018. This is the first record of the Mediterranean Hyalomma ticks in Denmark

Source: National Veterinary Institute, Technical University of Denmark

Both vira were recorded from northern Germany immediately south of Denmark [1], but none of the two vira made it across the border possibly because of the exceptionally low abundance of all *Culex* species in Denmark in August.

The abundance of *Ixodes ricinus* ticks was less affected by the dry weather, but the almost Mediterranean summer in northern Europe resulted in a large number of adult Hyalomma ticks being reported from Germany [2] and Sweden (press release from the Swedish Veterinary Institute). Hyalomma ticks are introduced regularly as larvae/nymphs on migrating birds in spring but usually fail to mature into adults due to the cool climate. However, the warm dry summer in 2018 may have allowed a large number of nymphs to develop into adult ticks in northern Europe. In September two adult Hyalomma ticks were removed from a horse in western Zeeland (Photo 5.1). None of the horses on the farm had been outside Denmark for more than a year. Being a Mediterranean species, these introduced ticks may carry zoonotic and veterinary important pathogens not normally seen or expected in Northern Europe.

A Danish dog accompanying the owners to Slovakia died of the tick borne blood parasite *Babesia canis* shortly after returning to Denmark. On examination, two feed meadow ticks (*Dermacentor reticulatus*) were removed from the dog. Both ticks tested positive for *B. canis.* Meadow ticks and *B. canis* are exotic to Denmark. Introduction of meadow ticks and their specific pathogens constitutes a growing risk of these establishing in Denmark.

Raccoon dog is a recent invasive species in Denmark and the population is rapidly growing in numbers. As the species has emigrated from Germany, there is a risk that they may introduce new tick species or new tick borne pathogens. We therefore screened 150 tick larvae and 40 nymphs removed from 15 different raccoon dogs submitted to the national wildlife surveillance programme. None of the ticks were exotic and none of the 190 ticks harbored tick borne pathogens not already found in Denmark.

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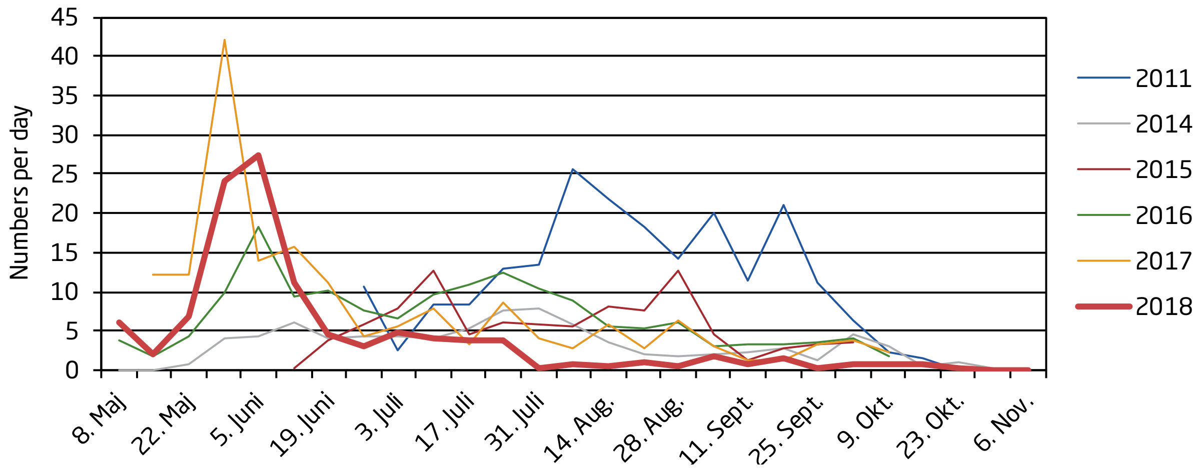
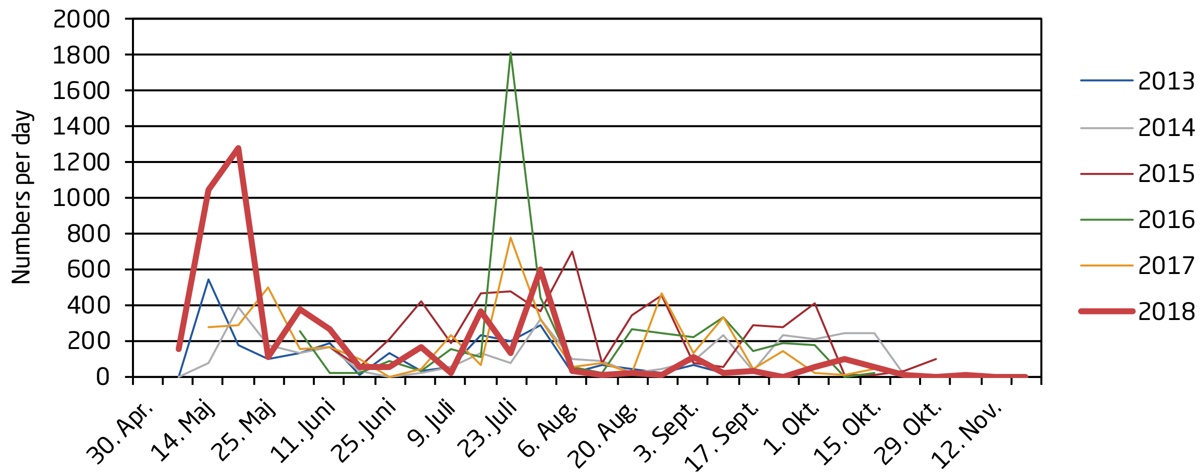
1. Ziegler U, Lühken R, Keller M, et al. (2019). West Nile virus epizootic in Germany, 2018. Antiviral Research 162; 39-43.
2. Chitimia-Dobler L, Schaper S, Rieß R, et al. (2019). Imported Hyalomma ticks in Germany in 2018. Parasites and Vectors 12:134.

Figure 5.1. Number of man biting mosquitoes recorded from five sentinel traps during the summer, 2011 and 2014-2018



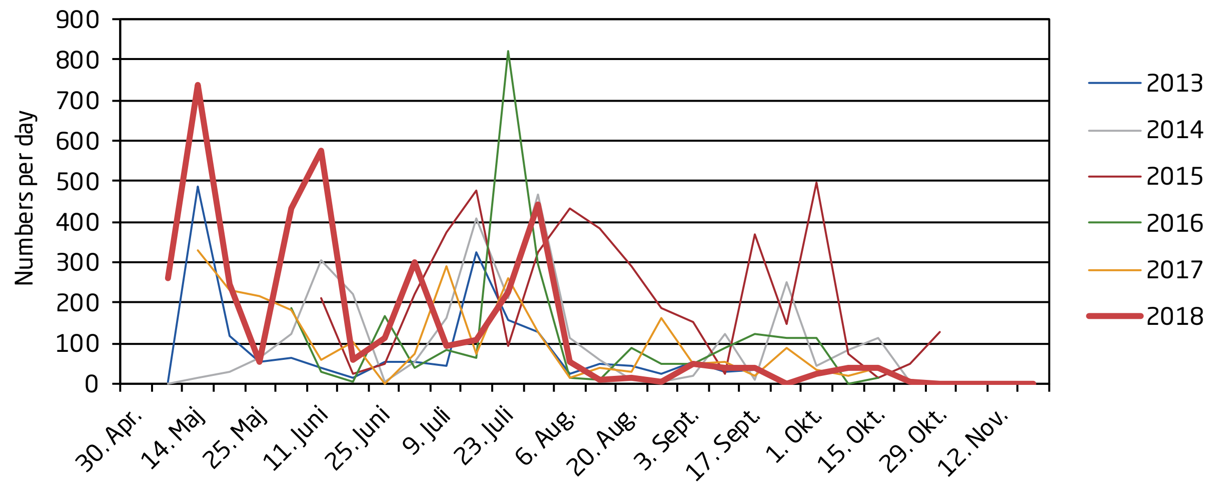
Note: The high mosquito abundance in 2011 was the result of a single extreme rainfall event in early July.
Source: National Veterinary Institute, Technical University of Denmark

*Figure 5.2. Number of biting midges (*Obsoletus *spp.) recorded from five sentinel traps during the summer, 2013-2018*



Source: National Veterinary Institute, Technical University of Denmark

*Figure 5.3. Number of biting midges (*Pulicaris *spp.) recorded from five sentinel traps during the summer, 2013-2018*



Source: National Veterinary Institute, Technical University of Denmark

6. International topics

By Mette Rørbæk Gantzhorn (merga@fvst.dk)

6.1 Special guarantees on *Salmonella*

Salmonella causes the second highest number of food-borne human cases in Denmark. Since the early 1990s, action plans have been in place to control *Salmonella*, and plans have been established in the poultry, pig and cattle production. *Salmonella* has been reduced effectively in the broiler and table egg production; e.g. the *Salmonella* prevalence in broiler flocks has been reduced from 20-30% in 1994 down to a stable level of 1-2% in 2000 and maintained until today.

In 2007, Denmark applied for special guarantees on *Salmonella* in table eggs and broiler meat. Denmark achieved special guarantees regarding *Salmonella* in table eggs in 2012 (Regulation (EC) No 427/2012). Thereby Denmark can refuse to receive table eggs with *Salmonella,* and batches of table eggs destined for Denmark must be accompanied by a certificate verifying that the eggs originates from flocks that have been tested and found free from *Salmonella*.

In 2018, Denmark achieved special guarantees on *Salmonella* in broiler meat (Comission Implementing Regulation (EU) No 2018/307). Since then, all batches of broiler meat must be accompanied by a certificate and documentation that samples of meat from that batch have been tested and found negative of *Salmonella*. The special guarantee on broiler meat extends to fresh, cooled or frozen chicken meat including minced chicken meat.

The special guarantees have been obtained as a result of an impressive effort of the industry to combat *Salmonella* in all stages of the production of eggs and broilers. The special guarantees on table eggs and chicken meat reinsures the Danish consumers that chicken meat and tables eggs on the Danish market is safe and free of *Salmonella*.

6.2 EU targets

Harmonised regulation on targets and surveillance in the poultry production has been laid down by the Commission. An overview is presented in Appendix Table A27.

According to Regulation (EC) No 1190/2012, the EU target for *Salmonella* in breeding and fattening turkey flocks is 1% positive for *S.* Typhimurium or *S.* Enteritidis. In Denmark, no turkey flocks were positive with *S.* Typhimurium or *S.* Enteritidis in 2018 (Appendix Table A8).

In breeding flocks of *Gallus gallus*, Regulation (EC) No 200/2010 lays down a target of maximum 1% adult flocks positive for *S.* Typhimurium including the monophasic *S.* 1,4,[5],12:i:- strains, *S.* Enteritidis, *S.* Hadar, *S.* Infantis and *S.* Virchow. In the legislation no distinction is made between breeding flocks from the table egg and broiler production lines. In Denmark, two breeding flocks were positive for target serovars in 2018; one with *S.* Typhimurium and one with *S.* Infantis (Appendix Table A5 and A7). Thereby 0.8% of the breeding flocks of *G. gallus* in Denmark were positive for target serovars.

Regulation (EC) No 517/2011 lays down targets for the reduction of *Salmonella* in laying flocks. The targets are Member States specific and are set either as an annual 10-40% reduction of positive adult flocks dependent on the prevalence of adult flocks in the Member State the previous year or a maximum of 2% adult flocks positive. For Denmark, the target is a maximum of 2% adult flocks positive for *S.* Typhimurium (including the monophasic *S.* 1,4,[5],12:i:- strains) and *S.* Enteritidis. The prevalence in Denmark has been below 2% since 2004. However, in 2018, 10 flocks (2.2 %) were found positive with target serovars (Appendix table A5).

In order to do everything possible to rectify the situation and find the source(s) of the contamination the Danish Veterinary and Food Administration (DVFA) has carried out a thorough investigation of the increase in *Salmonella* in flocks of laying hens in 2018. The investigation has been carried out in cooperation with the National Food Institute at the Technical University of Denmark and the poultry industry. However so far, no common source has been revealed. For some producers insufficient biosecurity are the most probable cause. In addition, it cannot be ruled out, that the warm summer might have stressed the animals and reduced their immune system. The DVFA will follow the situation closely.

In broiler flocks of *G. gallus*, Regulation (EC) No 200/2012 lays down a target at a maximum of 1% flocks positive for *S.* Enteritidis and *S.* Typhimurium including the monophasic *S.* 1,4,[5],12:i:- strains. Denmark has had intensive *Salmonella* control programmes since the 90's and the target of 1% was reached in 2000. In 2018, 0.7% of broiler flocks was positive with target serovars (Appendix Table A7).

7. Surveillance and control programmes

The collaboration on zoonoses between national and regional authorities, the industry and non-governmental organizations in Denmark is presented in Figure 7.1. According to the Danish legislation, 41 infectious diseases are clinically notifiable in Denmark. An overview of the notifiable and non-notifiable human and animal diseases, presented in this report, is provided in Appendix Table A28 and Table A29, respectively, including reference to the relevant legislation.

7.1 Surveillance of human disease

Information on human cases due to zoonotic pathogens presented in this report is reported to Statens Serum Institut (SSI) through different channels depending on the disease:

- Notifiable through the laboratory surveillance system: *Salmonella, Campylobacter, Yersinia*, Shiga toxin-producing *E. coli* (STEC) and *Listeria*.
- Individually notifiable zoonotic pathogens: *Chlamydia psittacci* (ornithosis), *Leptospira* (Weils disease), *Mycobacterium*, Bovine Spongform Encephalopathy (BSE) prions (var. Creutzfeldt-Jakob Disease), Shiga toxin-producing *E. coli* (STEC) and Lyssavirus (rabies).
- Non-notifiable zoonotic pathogens: *Brucella*.

In Denmark, the physicians report individually notifiable zoonotic diseases to the Danish Patient Safety Authority and the Department of Infectious Disease Epidemiology and Prevention at SSI. Physicians send specimens from suspected cases to one of the clinical microbiology laboratories depending on the geographical region. Positive cases diagnosed by a clinical microbiological laboratory are reported through the laboratory surveillance system to the Department of Bacteria, Parasites and Fungi at SSI. The laboratories must report positive results to SSI within one week. Furthermore, all *Salmonella* and STEC isolates are sent to the reference laboratory at SSI for further sero- and genotyping. The results are recorded in the Register of Enteric Pathogens maintained by SSI. Cases are reported as episodes, i.e. each patient-infectious agent combination is only recorded once in any six-month period. Overviews of results from the Register of Enteric Pathogens are presented as follows:

- All laboratory confirmed human cases are presented in Appendix Table A1.
- STEC O-group distribution in humans is presented in Appendix Table A2.
- The *Salmonella* serovar distribution is presented in Appendix Table A4.

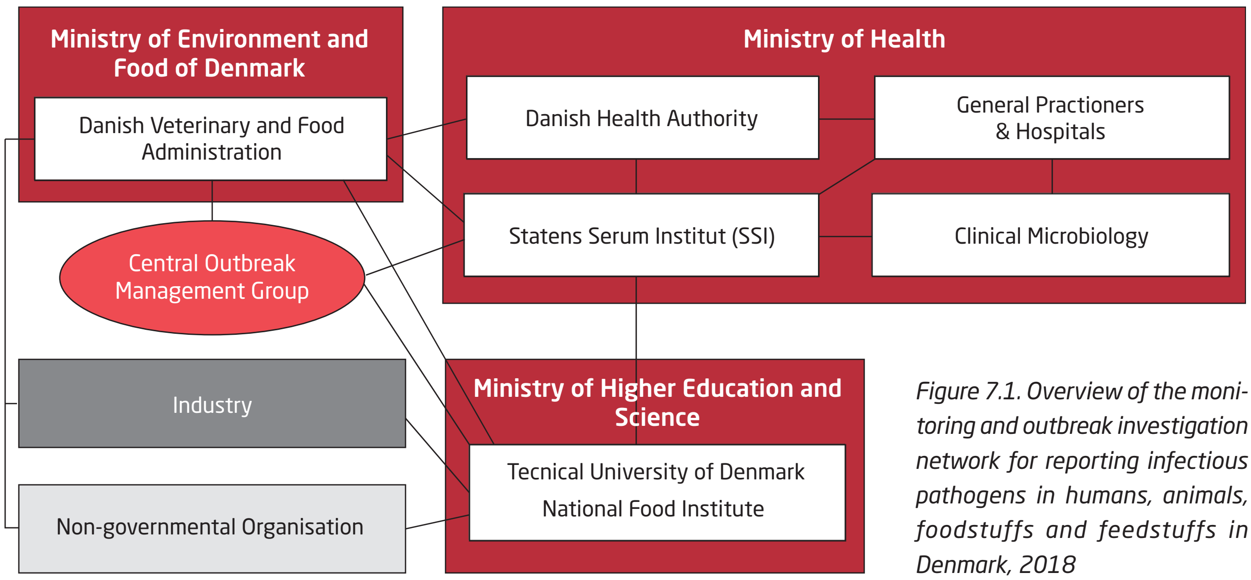


Figure 7.1. Overview of the monitoring and outbreak investigation network for reporting infectious pathogens in humans, animals, foodstuffs and feedstuffs in Denmark, 2018

7.2 Outbreaks of zoonotic gastrointestinal infections

In Denmark, local and regional foodborne outbreaks are typically investigated by the Food Inspection Unit in collaboration with the Public Health Medical Officers at the Danish Patient Safety Authority, and the regional clinical microbiology laboratories. National outbreaks are investigated by SSI, the National Food Institute at the Technical University of Denmark (DTU Food) and the Danish Veterinary and Food Administration (DVFA) in collaboration. These institutions may also aid in the investigation of regional or local outbreaks. Representatives from these institutions meet regularly in the Central Outbreak Management Group to discuss surveillance results, compare the reported occurrence of zoonotic agents in animals, food and feedstuffs with that in humans, and coordinate the investigation of outbreaks. The formal responsibility of investigating food- or waterborne outbreaks is currently divided between two ministries based on the outbreak source: the Ministry of Health for infectious diseases; the Ministry of Environment and Food for foodborne and animal related diseases, and for waterborne diseases. The latter are investigated in collaboration with the municipalities.

Outbreaks may be detected in various ways. Clusters of cases may be noted in the local clinical laboratory or identified at SSI through the laboratory surveillance system of gastrointestinal bacterial infections through subtyping of bacterial isolates from patients. Food handlers are obliged to contact the DVFA if the food they served are suspected to have caused illness. Individuals who experience illness related to food intake in settings such as restaurants or work place cafeterias may report these incidents directly to the Food Inspection Unit. General practitioners and hospitals are obliged to report all suspected food- and waterborne infections to the Danish Patient Safety Authority and to SSI.

A list of verified outbreaks (not including household outbreaks) reported to the Food- and waterborne Outbreak Database are presented in Appendix Table A3 and some of the outbreaks from 2018 are outlined in Chapter 1.

7.3 Surveillance and control of animals and animal products

In Denmark, action plans and programmes on zoonoses have been in place for more than 25 years. The first plan targeted *Salmonella* in the broiler production and was developed as a response to an increase in the number of human cases related to eating chicken meat. Since then, plans have been developed for *Salmonella* in pigs and pork, *Salmonella* in layers (eggs), *Campylobacter* in broilers and *S.* Dublin in cattle and beef.

All plans have been outlined in cooperation between industry, research institutes and authorities, and are followed by a technical working group and a steering committee. This ensures progress, that new knowledge is incorporated in the plans, and an assessment of achievement of targets.

At EU level, harmonised surveillance programmes and common targets have been set for the broiler and laying egg production. An overview on the status on the targets can be seen in Table A27.

Salmonella surveillance and control programmes for poultry, pigs and cattle are presented in Appendix Tables A30-A35. Sample analysis is performed at the DVFA laboratory for all isolates except poultry. *Salmonella* isolates are forwarded to the DTU Food for serotyping, some isolates are also subtyped by WGS as well as tested for antimicrobial resistance. An overview of the methods used for subtyping is presented in Appendix Table A36.

Overviews of results from surveillance and control of *Salmonella* are presented as follows:

- Results from the table egg production are presented in Appendix Tables A5-A6.
- Results from the broiler production are presented in Appendix Tables A4, A7 and A14.
- Results from the duck and turkey productions are presented in Appendix Tables A4 and A8.
- Results from the pig production are presented in Appendix Tables A4, A11, A14 and Figures A1-A3.
- Results from the cattle production are presented in Appendix Tables A4, A12-A13 and Figure A4.
- Results from the feed production are presented in Appendix Tables A15-A16.
- Results from the rendering plants are presented in Appendix Table A17.
- Results based on suspicion of diseases in pets, zoo animals and wild life are presented in Appendix Tables A22-A23.

Overviews of results from monitoring and control of *Campylobacter* are presented as follows:

- Results from the broiler production are presented in Appendix Tables A9-A10 and A14.
- Results based on suspicion of diseases in pets, zoo animals and wild life are presented in Appendix Tables A22-A23.

a) The Danish Veterinary and Food Administration (DVFA) is one authority that operates from more locations throughout the country. To be able to distinguish the locations the terms DVFA is used synonymous with the location in Glostrup and Food Inspection Unit followed by the location synonymous with the location in question.

Pig and cattle carcasses are screened for *Mycobacterium* and *Echinococcus* during meat inspection at the slaughterhouse. Although swine kept under controlled housing conditions in Denmark are exempted from examination for *Trichinella* at slaughter, all slaughter pigs, sows and boars are still examined at slaughter. Free range pigs, horses, wild game (e.g. wild boar) and other species susceptible to *Trichinella* must still be tested. In addition, boars and bulls are tested for *Brucella* and bulls are tested for *Mycobacterium* at semen collection centres. All positive results for notifiable infectious diseases are reported to the DVFA. Results are presented in Appendix Table A11-A12.

Results from the surveillance for Bovine Spongiform Encephalopathy (BSE) in cattle, and Transmissible Spongiform Encephalopathy (TSE) in sheep/goat are presented in Appendix Tables A24-A25.

Results from the monitoring of *Coxiella burnetii* (Q fever) in cattle are presented in Appendix Table A12.

Results based on suspicion of diseases with *Chlamydia psittacci*, *Cryptosporidium*, *Trichinella*, classical rabies and European Bat *Lyssavirus* in zoo animals, pets and wild life are presented in Appendix Table A22-A23.

8.4 Official testing of zoonotic pathogens in foodstuffs

In Denmark, control of zoonotic microorganisms in foodstuffs is mainly carried out as projects which are coordinated at the central level of the DVFA. Sampling and testing are carried out with the following purposes:

- To verify that food business operators comply with microbiological criteria laid down in the legislation.
- To verify the microbiological safety of food for which no microbiological criteria are laid down at EU Community level.
- To monitor the effect of established risk management procedures in order to evaluate if these provide the desired results or need to be reconsidered.
- To generate data for the preparation of risk profiles and risk assessments to support microbial risk management
- To discover emerging problems with microbiological contaminants.

Appendix Table A26 provides information on the centrally coordinated studies conducted in 2018.

For further information, consult the website of the DVFA, www.foedevarestyrelsen.dk (in Danish).

The *Salmonella* Dublin Control Programme and Initiatives from 2018

By Mette Gantzhorn (merga@fvst.dk), Hans Murillo Hansen and Johanne Ellis-Iversen

The aim of the national control programme is eradication of *Salmonella* Dublin from Danish cattle production. The overall principles and methods were described in the Annual Report on Zoonoses in Denmark from 2013. The programme is mandatory and supported by the Danish Order no. 1687 of 18/12/2018. In the programme herds are classified as level 1 (assumed free), level 2 (suspected infected) and level 3 (infected).

The control programme has been subjected to major and minor changes during the years as the working group and steering committee continuously adjust the programme to fit the current situation. Regionalisation into a 'high prevalence' and a 'low prevalence' zone was implemented in 2013. By 2017, the prevalence of *S.* Dublin had decreased, and the further effect of regionalisation was considered limited. Assessments conducted by the National Food Institute at the Technical University of Denmark and Copenhagen University suggested that initiatives other than regionalisation would have nearly the same effect and would be easier to administrate. The regionalisation was repealed in 2018 and substituted by additional sampling at farms newly entering level 1 as well as other new control measures directed towards dairy herds in levels 2 and 3. Restrictions on the movement of animals from herds in *Salmonella* Dublin-level 2 were implemented. Dairy herds which had been in level 2 or 3 for the last two years, and from which more than 15% of quarterly blood samples were positive, were classified as a "high-risk infectious herd" prompting a mandatory control visit from the Danish Veterinary and Food Administration (DVFA). From 2019, DVFA will impose specialised veterinary counselling on dairy and non-dairy farms that persistently or recurrently are classified as high-risk infectious herds. It is also expected that the rules for level 2 herds will be tightened further from 2020 to encourage farmers to control *Salmonella* in their herds.

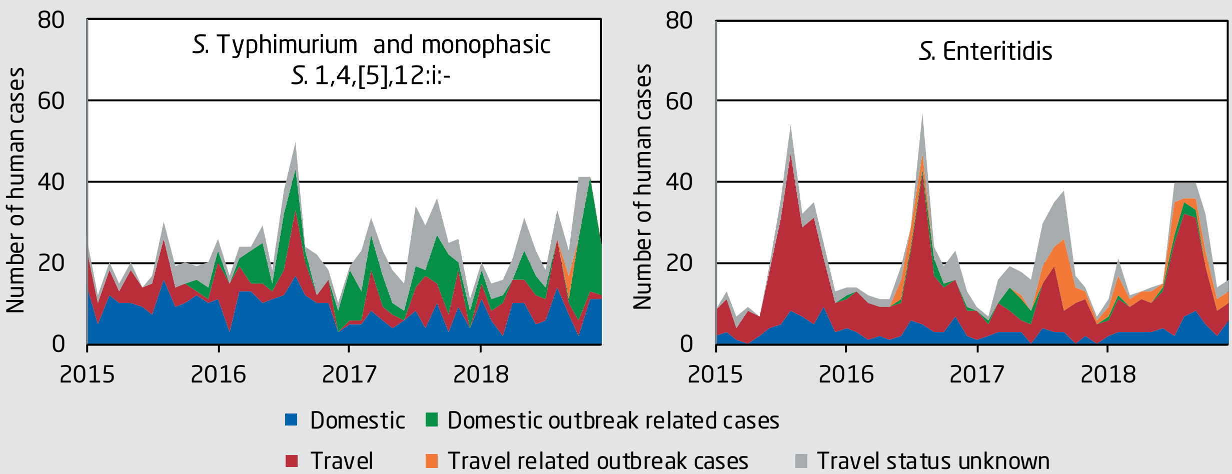
In 2018, as in the previous years, Statens Serum Institut attempted to interview all registered *Salmonella* cases where no travel information was reported by the general practitioner. The patients were asked about the date of disease onset and whether they had travelled abroad within a seven-day period prior to disease onset. This information was complemented with information from general practitioners' reports. Travel information was obtained from a total of 75.8% of the *Salmonella* cases in 2018. Among the cases with known travel history, 54.8% were infected abroad (Table 7.1). However, the proportion of travel-related cases varied greatly between the different serotypes, hence 75.0% of the *S.* Enteritidis cases, 45.6% of the *S.* Typhimurium cases, 22.6% of the monophasic *S.* 1,4,[5],12:i:- cases and 55.5% of cases with other serotypes were infected abroad. Similar to previous years, the majority of travel-related cases in 2018 travelled to Turkey and Thailand. Nine travel-related outbreaks were identified (see chapter 1 and Appendix Table A3).

Table 7.1. Top 10 Salmonella *serotypes in humans and information about travel abroad, 2017-2018*

2018	Number of patients (%)	% of patients[a] infected Abroad[b]	Domestcally	2017	Number of patients (%)	% of patients[a] infected Abroad[b]	Domestically
Enteritidis	268 (22.9)	75.0	25.0	Enteritidis	226 (21.2)	75.6	24.4
1,4,[5],12:i:-	196 (16.7)	22.6	77.4	1,4,[5],12:i:-	175 (16.4)	24.0	76.0
Typhimurium	110 (9.4)	45.6	54.4	Typhimurium	115 (10.8)	30.5	69.5
Stanley	32 (2.7)	84.6	15.4	Stanley	33 (3.1)	91.7	8.3
Newport	30 (2.6)	58.3	41.7	Dublin	25 (2.3)	8.3	91.7
Dublin	26 (2.2)	6.7	93.3	Newport	25 (2.3)	41.2	58.8
Kottbus	21 (1.8)	35.7	64.3	Agona	20 (1.9)	18.8	81.3
Virchow	20 (1.7)	94.1	5.9	Kentucky	20 (1.9)	94.4	5.6
Java	18 (1.5)	100.0	0	Virchow	17 (1.6)	100.0	0.0
Mikawasima	16 (1.4)	20.0	80.0	Infantis	16 (1.5)	28.6	71.4
Other serotypes	431 (36.9)	53.3	46.7	Other serotypes	395 (37.0)	48.2	51.8
Total	1,168	54.8	45.2	Total	1,067	49.5	50.5

a) Patients with unknown travel information (24.2% of all patients in 2018 and 30.5% in 2017) were excluded from the percent calculations.
b) Infected abroad is defined as travel abroad in a seven-day period prior to disease onset.
Source: Statens Serum Institut

Figure 7.2. Monthly distribution of S. *Enteritidis and* S. *Typhimurium incl. monophasic* S. *1,4,[5],12:i:- cases, 2015-2018*



Source: Statens Serum Institut

Human disease and outbreak data

Table A1. Zoonoses in humans, number of laboratory-confirmed cases, 2013-2018

	Incidence per 100,000 inhabitants	Reported no. of cases					
Zoonotic pathogen	2018	2018	2017	2016	2015	2014	2013
Bacteria							
Brucella abortus/melitensis[a,b]	-	3	3	3	6	4	4
Campylobacter coli/jejuni[c]	78.5	4,546	4,257	4,677	4,348	3,782	3,766
Chlamydia psittaci[c]	0.3	16	14	24	25	16	12
Leptospira spp.[c]	0.3	19	22	10	5	10	3
Listeria monocytogenes[c]	0.8	47	58	39	43	92	50
Mycobacterium bovis[c]	0.0	1	2	2	1	1	0
Salmonella total[c]	20.2	1,168	1,067	1,074	925	1,122	1,136
S. Enteritidis[c]	4.6	268	226	246	258	268	346
S. Typhimurium[c,d]	5.3	306	290	320	233	427	337
Other serotypes[c]	10.3	594	551	508	434	427	453
STEC total[c,e]	8.5	495	346	269	228	248[e]	186
O157	0.7	43	50	37	33	37	23
Other O-groups or non-typeable	4.3	259	215	204	195	192	163
Yersinia enterocolitica[c]	6.3	366	354	573	539	432	345
Viruses							
Lyssavirus[c]		0	0	0	0	0	0

a) Not notifiable, hence the incidence cannot be calculated.
b) Data presented are from one laboratory (Statens Serum Institut) only, representing a proportion of the Danish population. The proportion of the population represented varies from year to year, thus results from different years are not comparable. Testing for these pathogens is carried out only if specifically requested on the submission form.
c) Notifiable.
d) *S.* Typhimurium and the monophasic *S.* 1,4,[5],12:i:- strains.
e) Includes also only notified cases.
Source: Statens Serum Institut

Table A2. STEC O-group distribution in humans[a], 2018

O-group	Number of episodes	Proportion of total (%)	O-group	Number of episodes	Proportion of total (%)
O26	61	12.3	O27	10	2.0
O157	43	8.7	O63	10	2.0
O103	26	5.3	O117	10	2.0
O146	17	3.4	O80	7	1.4
O128	15	3.0	Other	68	13.7
O145	14	2.8	Unknown O-group	6	1.2
O91	13	2.6	Not verifyed[b]	48	9.7
O111	12	2.4	Notification[c]	135	27.3
Continued in the next column			Total	495	

a) All O-groups that resulted in five or more episodes are listed.
b) Cases sent for verification at SSI but not possible to verify and/or determine O-group.
c) Cases not sent for verification at SSI and/or only notified through the clinical notification system.
Source: Statens Serum Institut

Table A3. Food- and waterborne disease outbreaks reported in the Food- and waterborne Outbreak Database (FUD) (n=64), 2018

Pathogen	No. of patients	Patients laboratory confirmed	Setting	Source	FUD no.[b]
Bacillus cereus	3		Restaurant	Composite meal	1701
Campylobacter	20	1	Institution	Raw milk	1700
Campylobacter	5	5	Regional	Unknown	1673
Clostridium botulinum, toxintype A	9	7	Private party	Savoury jelly dish (homemade)	1678
Clostridium perfringens	39		Restaurant	Buffet meal	1716
Clostridium perfringens	6		Restaurant	Buffet meal	1696
Clostridium perfringens	20	2	Restaurant	Composite meal	1751
Clostridium perfringens	27		Restaurant	Composite meal	1674
Clostridium perfringens	15		Restaurant	Composite meal	1752
ETEC O25:H16	129	3	Private party	Composite meal	1687
Hepatitis A, type IA	10	10	Regional	Unknown	1668
Hepatitis A, type IIIA	31	31	National	Dates (imp)	1636
Histamine	2	2	Restaurant	Tuna fish (imp) in Salad nicoise	1703
Histamine	2		Restaurant	Tuna fish (imp) in sandwich	1723
Lectins (beans)	50		Canteen	Composite meal	1730
Lectins (beans)	9		National	Raw green beans (Bobby beans)	1679
Lectins (beans)	6		Canteen	White dried beans (imp)	1712
Lectins (beans)	40		Catering	White pre-cooked beans (imp)	1688
Listeria monocytogenes, ST20[a]	4	4	Regional	Unknown	1691
Listeria monocytogenes, ST8	5	5	National	Unknown	1652[c]
Norovirus	10	5	Canteen	Buffet meal	1745
Norovirus	16		Canteen	Buffet meal	1739
Norovirus	135		Canteen	Buffet meal	1669
Norovirus	18	1	Catering	Buffet meal	1692
Norovirus	150	3	Catering	Buffet meal	1631
Norovirus	20	2	Restaurant	Buffet meal	1738
Norovirus	80		Canteen	Composite meal	1740
Norovirus	30	4	Catering	Composite meal	1705
Norovirus	29		Regional	Composite meal	1664
Norovirus	26		Restaurant	Composite meal	1724
Norovirus	34	3	Restaurant	Composite meal	1720
Norovirus	10	7	Restaurant	Composite meal	1708
Norovirus	48		Restaurant	Composite meal	1693
Norovirus	12	2	Restaurant	Composite meal	1682
Norovirus	15		Restaurant	Mussels	1726
Norovirus	50	13	Restaurant	Mussels	1659
Norovirus	50	1	Canteen	Non-alc. Beverage with raspberries	1736
Norovirus	9		Restaurant	Open sandwiches	1725
Norovirus	16		Restaurant	Open sandwiches	1722
Norovirus	16		Restaurant	Oysters (imp)	1658

Continued on the next page

Table A3. Food- and waterborne disease outbreaks[a] reported in the Food- and waterborne Outbreak Database (FUD) (n=64), 2018 (Continued from previous page)

Pathogen	No. of patients	Patients laboratory confirmed	Setting	Source	FUD no.[b]
Norovirus	65	5	Restaurant	Oysters (imp)	1655
Salmonella O:4,[5],12:i:-, ST34	11	5	Private party	Pork meat	1681
Salmonella Enteritidis, ST11	10	10	National	Unknown	1699
Salmonella Kottbus, ST212	12	12	National	Unknown	1690
Salmonella Mikawasima, ST1815	9	9	National	Unknown	1689
Salmonella Newport, ST45	5	5	National	Unknown	1765
Salmonella O:4,[5],12:i:-, ST34	17	17	National	Pork meat	1710
Salmonella O:4,[5],12:i:-, ST5296	43	43	National	Raw pork sausage, pork meat	1713[c]
Salmonella Typhimurium, ST19	4	4	National	Pork meat	1666
Salmonella Typhimurium, ST19	6	6	National	Unknown	1762
Salmonella Typhimurium, ST36	8	8	National	Leafy greens, rocket	1675
Staphylococcus aureus	16	2	Ship	Composite meal	1683
STEC O111:H8, ST16	7	5	National	Unknown	1702
STEC O26:H11, ST21	39	38	National	Cured dried beef sausage	1707
Unknown	86		Catering	Buffet meal	1630
Outbreaks related to travel					
Salmonella Chester, ST195	6	6	Travel (Morocco)	Unknown	1764
Salmonella Typhimurium, ST19	6	6	Travel (Turkey)	Unknown	1763
Salmonella Enteritidis, ST11	5	5	Travel (Egypt)	Unknown	1761
Salmonella Enteritidis, ST11	5	5	Travel (Turkey)	Unknown	1760
Salmonella Enteritidis, ST11	12	12	Travel (Egypt)	Unknown	1759
Salmonella Enteritidis, ST11	4	4	Travel (Eastern Europe)	Unknown	1758
Salmonella Enteritidis, ST11	5	5	Travel (Turkey)	Unknown	1757
Salmonella Virchow, ST16	8	8	Travel (Turkey)	Unknown	1706
Salmonella Stanley, ST2299	5	5	Travel (Thailand)	Unknown	1667
Total	1600	336			

Note: (imp)= imported product.
a) ST=MLST Sequence Type.
b) Additional outbreak cases in 2018; FUD 1593: 2 cases; FUD 1600: 2 cases, FUD 1628: 6 cases, FUD 1645: 2 cases.
c) Additional outbreak cases in 2019 at time of reporting; FUD 1652: 1 case, FUD 1713: 6 cases.

Source: Food- and waterborne Outbreak Database (FUD)

Monitoring and surveillance data

Table A4. Top 15 (humans) serotype distribution (%) of Salmonella *from humans, animals, carcasses, Danish and imported meat, 2018. N=number of culture positive units[a]*

Serotype	Human cases N=1168	Pig[b] animals N=87	Pork[c] batches N=92	Beef[d] batches N=8	Broiler[e] flocks N=35	Broiler meat[f] batches N=1	Layer[e] flocks N=12	Imported meat (batches) Pork[g] N=13	Imported meat (batches) Broiler[g] N=3	Imported meat (batches) Turkey[g] N=3
Enteritidis	22.9	0	0	0	11.4	0	50	0	0	0
4,[5],12:i:-	16.8	31.0	32.6	0	45.7	0	0	38.5	0	66.7
Typhimurium	9.4	6.9	14.1	0	28.6	0	33.3	23.1	0	0
Stanley	2.7	0	0	0	0	0	0	0	0	0
Newport	2.6	0	0	0	2.9	0	8.3	0	0	0
Dublin	2.2	0	0	50	0	0	0	0	0	0
Kottbus	1.8	0	0	0	0	0	0	0	0	0
Virchow	1.7	0	0	0	0	0	0	0	0	0
Java	1.5	0	0	0	0	0	0	0	0	0
Mikawasima	1.4	0	0	0	0	0	0	0	0	0
Infantis	1.2	2.3	3.3	0	0	0	0	0	33.3	0
Chester	1.0	0	0	0	0	0	0	0	0	0
Saintpaul	1.0	0.0	0.0	0	0	0	0	0	0	0
Derby	1.0	56.3	47.8	12.5	2.9	0	0	23.1	0	0
Agona	0.9	0	0	0	0	0	0	0	0	0
Other	17.6	3.4	1.1	0	8.6	0	8.3	15	66.7	33.3
Unknown	14.0	0	1.1	25	0	100	0	0	0	0
Total	100	100	100	100	100	100	100	100	100	100

a) One isolate per serotype per unit is included, thus the number of isolates may exceed the number of units.
b) Isolates collected from coecum samples taken randomly at slaughter. Where more than one *Salmonella* positive pig with different serotypes was randomly selected from a herd, one pig per serotype was included.
c) Sampling of pork carcasses at slaughterhouses according to the surveillance programme (Table A35).
d) Sampling of beef carcasses at slaughterhouses according to the surveillance programme (Table A34).
e) Sampling of production flocks prior to slaughter according to surveillance programmes (Tables A31).
f) Sampling of broiler meat (neck skin) at slaughterhouses according to the surveillance programme (Table A31).
g) Case-by-case control of imported meat. For further information regarding case-by-case control programme see Annual Report on Zoonoses in Denmark, 2007.

Source: Danish Veterinary and Food Administration, Statens Serum Institut, and National Food Institute

Table A5. Occurrence of Salmonella *in the table egg production[a], 2008-2018*

	Rearing period[b] (parent flocks)		Adult period[c] (parent flocks)		Pullet-rearing flocks		Table egg layer flocks	
	N	Positive	N	Positive	N	Positive	N	Positive
2008	10	0	6	0	258	1	508	4
2009	13	0	6	0	253	0	454	8
2010	15	0	9	0	225	0	455	8
2011	8	0	9	0	195	0	410	2
2012	9	0	8	0	197	1	359	3
2013	10	0	7	0	173	0	373	4
2014	22	0	8	0	150	0	347	2
2015	15	0	8	0	123	0	344	0
2016	15	0	10	0	132	0	426	3
2017	7	0	8	1	138	1	446	3
2018	7	0	6	0	124	1[d]	454	12[e,f]

a) See Tables A30 and A32 for description of the surveillance programmes.
b) *Salmonella* was not detected in grandparent flocks during rearing period (3 flock).
c) *Salmonella* was not detected in grandparent flocks during adult period (4 flocks).
d) *S.* 4.12:I: (1).
e) *S.* Enteritidis (6), *S.* Typhimurium (4), *S.* Newport (1), *S.* Give (1).
f) The flock positive with *S.* Give was not declared infected according to Danish Order no. 1422 of 30/11/2018 because the following suspicion-sampling did not verify an infection with *S.* Give.

Source: Danish Agriculture and Food Council, and Danish Veterinary and Food Administration

Table A6. Occurrence of Salmonella *in the table egg layer flocks sorted by type of production, 2008-2018*

	Deep litter		Free range		Organic		Battery	
	N	Positive	N	Positive	N	Positive	N	Positive
2008	151	0	61	2	145	1	135	1
2009	133	1	78	0	130	4	110	3
2010	117	0	45	2	136	1	157	5
2011	109	0	40	0	130	1	131	1
2012	101	0	37	1	136	1	131	1
2013	108	0	37	1	137	3	94	0
2014	97	0	30	0	125	1	95	1
2015	108	0	29	0	172	0	86	0
2016	125	1	31	0	196	1	74	1
2017	126	0	42	1	217	2	61	0
2018	139	4[a]	46	1[b]	227	4[c]	42	3[d]

a) *S.* Typhimurium (3), *S.* Newport (1).
b) *S.* Give (1).
c) *S.* Enteritidis (3), *S.* Typhimurium (1).
d) *S.* Enteritidis (3).

Source: Danish Agriculture and Food Council, and Danish Veterinary and Food Administration

Table A7. Occurrence of Salmonella *in the broiler production[a], 2008-2018*

	Rearing period[b] (parent flocks)		Adult period[c] (parent flocks)		Broiler flocks		Slaughterhouse (flocks/batches)	
	N	Positive	N	Positive	N	Positive	N	Positive
2008	146	0	293	2	3,845	43	518[g]	3
2009	140	0	225	4	3,767	35	375	3
2010	126	0	200	5	3,773	43	346	1
2011	114	0	213	0	3,795	47	306	0
2012	123	0	183	0	3,448	27	368	0
2013	128	0	152	1	3,498	34	288	0
2014	121	2	131	3	3,470	26	277	4
2015	91	0	289	1	3,631	23	148	0
2016	184	0	182	3	3,606	21	203	1
2017	170	2	250	1	4,290	25	259	0
2018	184	1[d]	149	1[e]	4,245	35[f]	249	1[h]

a) See Tables A30-A31 for description of the surveillance programmes.
b) *Salmonella* was not detected in grandparent flocks during rearing period (10 flocks).
c) *Salmonella* was not detected in grandparent flocks during adult period (8 flocks).
d) *S.* Infantis (1).
e) *S.* Typhimurium (1).
f) *S.* 4.5.12:I:- (5), *S.* 4.12:I:- (10), *S.* Enteritidis (4), *S.* Wangata (1), *S.* Seftenberg (2), *S.* Newport (1), *S.* Derby (1), *S.* Typhimurium (10), double infection with *S.* Typhimurium and *S.* 4.5.12:I:- (1).
g) From 2008, meat from all AM positive flocks are heat treated at slaughter. Sampling is now carried out as verification of the AM results of the negative flocks.
h) *Salmonella* spp.

Source: Danish Agriculture and Food Council, and Danish Veterinary and Food Administration

Table A8. Occurrence of Salmonella *in turkey flocks, 2008-2018*

	Turkey flocks[a]	
	N	Positive
2008	10	1
2009	15	0
2010	24	1
2011	38	1
2012	23	0
2013	56	3
2014	10	0
2015	80	1
2016	76	0
2017	24	1
2018	13	0

a) See Table A34 for description of the surveillance programme for turkey flocks. The major turkey slaughterhouse in Denmark closed down in 2004. Therefore, most commercially reared turkey flocks are transported abroad for slaughter.

Source: Danish Veterinary and Food Administration

Table A9. Occurrence of Campylobacter *in broiler flocks, 2008-2018*[a]

	Cloacal swabs at slaughter		Sock samples at farm	
	N (Flocks)	% pos	N (Flocks)	% pos
2008	4,950	26.3	-	-
2009	4,591	29.4	-	-
2010	-	-	3,132	16.5
2011	-	-	3,379	14.4
2012	-	-	3,376	11.6
2013	-	-	3,508	13.1
2014	3,474	27.7	-	-
2015	3,274	19.6	-	-
2016	3,184	20.8	-	-
2017	3,316	16.6	-	-
2018	3,411	24.6	-	-

a) See Table A31 for description of the surveillance programmes. In 2014 the sampling method changed back from boot swabs collected in the stable 7-10 days before slaughter to cloacal swabs at slaughter according to Danish Order no. 1512 of 13/12/2013.

Source: Danish Agriculture and Food Council and National Veterinary Institute (until 2009)

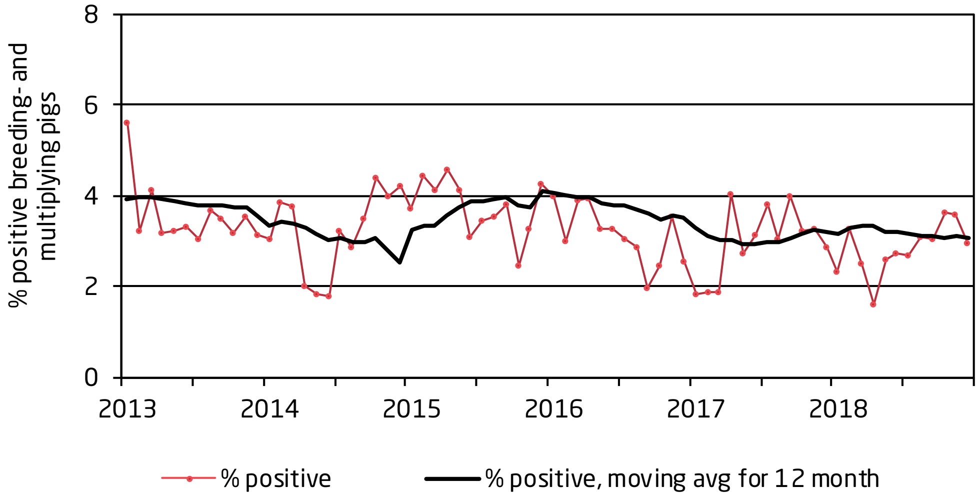
Table A10. Occurrence of Campylobacter *in non-heat treated chilled broiler meat samples at slaughter and retail*[a]*, 2013-2018*

		At slaughter[b]		At retail			
		Denmark		Denmark		Import	
		N (samples)	% pos	N (samples)	% pos[b]	N (samples)	% pos[c]
2013	Conventional	870	28.2	849	12.1	170	12.8
	Organic-free-range	93	90.3	35	42.9	38	71.1
	In total	-	-	884	17.8	208	31.9
2014	Conventional	927	25.7	-	-	-	-
	Organic/free-range	108	75.0	-	-	-	-
2015	Conventional	960	20.1	-	-	-	-
	Organic/free-range	115	78.2	-	-	-	-
2016	Conventional	999	21.3	1,339	12.8	232	37.9
	Organic/free-range	117	87.2	93	71.0	245	78.8
	In total			1,432	17.4	477	57.5
2017	Conventional[d]	1,258	25.0	-	-	-	-
	Organic/free-range[d]	203	79.0	-	-	-	-
2018	Conventional	1,250	31.0	-	-	-	-
	Organic/free-range	199	91.0	-	-	-	-

a) Centrally coordinated studies (see Table A26 and section 7.4 for description). Limit of quantification: 10 cfu/g.
b) Leg-skin samples.
c) The prevalence is calculated as a mean of quarterly prevalences, except organic/free-range results.
d) In 2017, data from additional slaughterhouses (one conventional and one organic) were included, which influenced the overall percentage of positive samples. Using data from the slaughterhouses included in previous year, the number of samples and % positive were: conventional N=1005, 15% positive; organic N=98, 86% positive.

Source: National Food Institute and Danish Veterinary and Food Administation

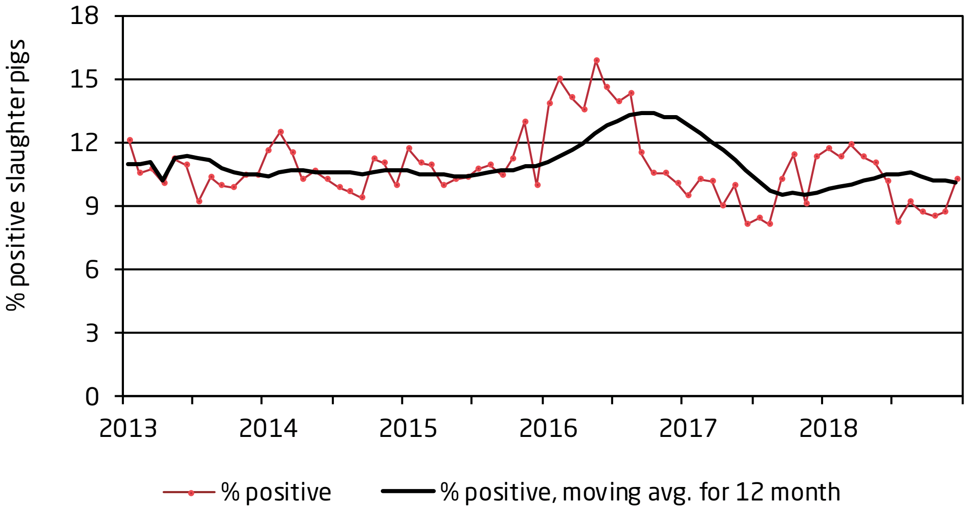
Figure A1. Serological surveillance of Salmonella *in breeding and multiplying pigs[a] based on monthly testing of blood samples, 2013-2018*



a) For more information about the surveillance programme, see Table A35.

Source: Danish Agriculture and Food Council

Figure A2. Serological surveillance of Salmonella *in slaughter pigs[a], 2013-2018. Percentage of seropositive meat juice samples (first sample per herd per month)*



a) For more information about the surveillance programme, see Table A35.

Source: Danish Agriculture and Food Council

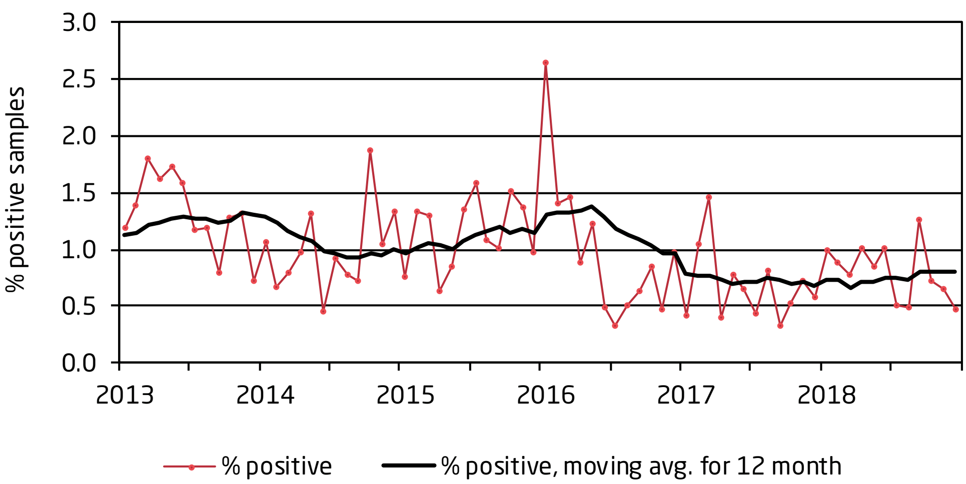
Table A11. Occurrence of zoonotic pathogens in pigs and pork in Denmark, 2018

Zoonotic pathogen	Herds N	Herds Pos	Animals/Samples N	Animals/Samples Pos	Animals/Samples % pos
At farm					
Brucella abortus[a]	-	-	29,730	0	0
Leptospira spp.[b] based on suspicion	66	0	-	-	-
Leptospira spp.[c]	84	50	-	-	-
At slaughterhouse (slaughter pigs)					
Salmonella spp.[d,e]	5,803	238[j]	-	-	-
Salmonella spp.[d,f] (slaughtering >30.000 pigs/year)	-	-	18,685	-	0.8[k]
Salmonella spp.[d,f] (slaughtering 1.000 or more and less than 30.000 pigs/year)	-	-	309	-	0
Salmonella spp.[d,g]	-	-	553	87	15.7
Trichinella spp.[h]	-	-	17,447,042	0	-
Mycobacterium bovis[i]	-	-	18,108,470	0	-
Echinococcus granulosis/multilocularis[h]	-	-	18,108,470	0	-

a) 5-8 ml blood samples were analysed using either the SAT, RBT or ELISA methods.
b) Sampling is based on suspicion of leptospirosis due to increased abortions or other reproductive problems in a herd. Samples are investigated using immunoflourescence techniques.
c) Serological analyses were performed for different serotypes (*Leptospira bataciae, L. bratislava, L. grippotyphosa, L. hardjo, L. tarassovi, L. icterohaemorrhagiae, L. pomona* and *L. sejroe)* depending on the purpose of sampling. Antibodies were detected against *L. bratislava* in 46 herds, against *L. bratislava* and *L. icterohaemorrhagica* in 1 herd, against *L. bratislava and L. pomona* in 2 herds, and against *L. pomona* in 1 herd.
d) See Table A36 for description of the *Salmonella* surveillance programme.
e) Data are from December 2018. Slaughter pig herds monitored using serological testing of meat juice samples collected at slaughter.
f) Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2).
g) Coecum samples are randomly collected from slaughter pigs at slaughter.
h) Samples collected from slaughter pigs at slaughter were examined using the method described in Regulation (EU) 2015/1375. In 2014, an amendment to EU regulation (EC) No 2075/2005 came into force stating that slaughter pigs, sows and boars kept under "controlled housing conditions" in Denmark are extempted testing for *Trichinella*. Free range pigs must be tested for *Trichinella*.
i) Slaughter pigs were examined by meat inspectors at slaughter.
j) Includes herds belonging to *Salmonella* level 2 and 3 only (See Table A35).
k) When estimating the prevalence of *Salmonella*, both the loss of sensitivity and the probability of more than one sample being positive in each pool are taken into consideration. A conversion factor has been determined on the basis of comparative studies, as described in Annual Report 2001.

Source: Danish Veterinary and Food Administration, National Veterinary Institute and National Food Institute, Technical University of Denmark

Figure A3. Salmonella *in pork, monitored at slaughterhouses*[a]*, 2013-2018*



a) For more information about the surveillance programme, see Table A35.

Source: Danish Veterinary and Food Administration

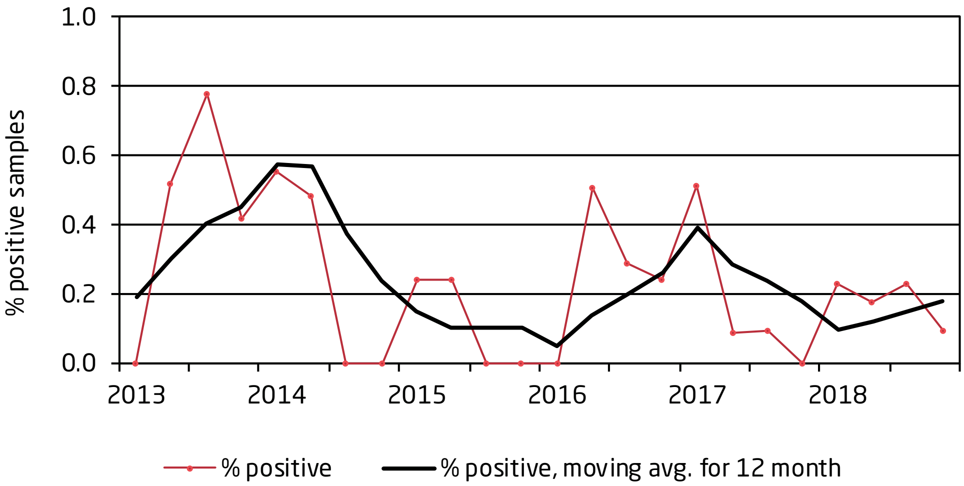
Table A12. Occurrence of zoonotic pathogens in cattle and beef in Denmark, 2018

	Animals/Samples		
Zoonotic pathogen	N	Pos	% pos
At farm			
Brucella abortus[a]	1,223	0	-
Mycobacterium bovis[b, c]	761	0	-
Coxiella burnetii	58[g]	2	-
At slaughterhouse			-
Salmonella spp.[d,e](slaughtering >=7.500 cattle/year)	5,990	-	0.2[h]
Salmonella spp.[d,e] (slaughtering 250 or more and 7.500 or less cattle/ year)	366	-	0.3
Mycobacterium bovis[b, f]	490,600	0	-
Echinococcusus granulosis/multilocularis[f]	490,600	0	-

a) Denmark has been declared officially brucellosis free since 1979. The last outbreak was recorded in 1962. 5-8 ml blood samples were analysed using either the SAT or CFT methods. In addition 55 aborted fetuses were tested, none were positive.
b) Denmark has been declared officially tuberculosis free since 1980. The last case of TB in cattle was diagnosed in 1988.
c) Analysis using the interdermal tuberculin test. Including samples from bulls (examined at pre-entry, every year, and prior to release from semen collection centres) and samples collected in connection with export.
d) Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)
e) See Table A34 for description of the surveillance programme.
f) Slaughtered cattle were examined by the meat inspectors at slaughter.
g) Samples analysed using an ELISA method. Animals were tested by blood samples. In 2018, further 2 herds were tested by bulk tank milk sampling, none were positive.
h) When estimating the prevalence of *Salmonella*, both the loss of sensitivity and the probability of more than one sample being positive in each pool are taken into consideration. A conversion factor has been determined on the basis of comparative studies, as described in Annual Report 2001.

Source: Danish Veterinary and Food Administration, National Veterinary Institute, and National Food Institute, Technical University of Denmark

Figure A4. Salmonella *in beef, monitored at slaughterhouses[a], 2013-2018*



a) For more information about the surveillance programme, see Table A34.

Source: Danish Veterinary and Food Administration

Table A13. Cattle herds in the Salmonella *Dublin surveillance programme[a], December 2018*

Salmonella Dublin level			Non-milk producing herds N	%	Milk producing herds N	%
Level 1		On the basis of milk samples			2,611	91.6
		On the basis of blood samples	13,115	97.6		
	Total	Probably *Salmonella* Dublin free	13,115	97.6	2,611	91.6
Level 2		Titer high in blood- or milk samples	117	0.9	179	6.3
		Contact with herds in level 2 or 3	127	0.9	26	0.9
		Other causes	70	0.5	24	0.8
Level 3		Salmonellosis, official supervision	12	0.1	9	0.3
	Total	Non *Salmonella* Dublin free	326	2.4	238	8.4
Total number of herds			13,441		2,849	

a) See Table A34 for description of the surveillance programme.

Source: SEGES

Table A14. Results from the intensified control of Salmonella *and* Campylobacter *in fresh meat based on case-by-case risk assessments, 2018*

		Batches tested	No. of batches positive	No. of batches deemed unsafe based on a risk assessment	Batches deemed unsafe based on other criteria[a]	Mean prevalence in positive batches[b]
Campylobacter						
Danish	Broiler	121	31	0	-	26[c]
Imported	Broiler	126	57	12	-	45[c]
Salmonella						
Danish	Pork	153	27	6	-	25[d]
	Broiler	100	1		1	100[e]
Imported	Pork	86	11	2	-	20[d]
	Broiler	24	3		0	53[e]
	Turkey	24	3		2	53[e]

a) Microbiological criteria specified in regulation (EC) No 2073/2005 as amended. For Danish broiler meat there is a zero-tolerance for *Salmonella* and all positive batches must be heat-treated before being put on the marked (Danish Order no. 77 of 20/01/2017).
b) Calculated as the risk relative to a batch of the same size with a mean prevalence (weighted average in Danish and imported meat) of *Campylobacter* or of a *Salmonella* type with an average impact to cause human infection.
c) The *Campylobacter* prevalence in each batch of broiler meat is based on the proportion of positive samples (12 samples per batch). Include all positive batches.
d) The *Salmonella* prevalence in each batch of pork is based on the proportion of positive pooled samples (1-4 subsamples per pool, 10 pools per batch). Include all positive batches.
e) The *Salmonella* prevalence in each batch of broiler meat and turkey meat is based on the proportion of positive samples (5 samples per batch). Include all positive batches.

Source: Danish Veterinary and Food Administration, and National Food Institute

Table A15. Feed business operators own sampling of Salmonella *in compound feeds, feed processing and feed material (batch-based data), 2016-2018*

	2018		2017		2016	
	N	Positive	N	Positive	N	Positive
Feed processing plants (process control):						
Ordinary inspections - clean zone[a]	8,018	6[d]	7,263	7	7,062	9
Ordinary inspections - unclean zone[a]	1,231	24[e]	1,130	26	10,009	30
Compound feed, farm animals	1,534	2[f]	657	0	700	0
Feed materials, farm animals[b]	1,734	18[g]	1,445	22	1,386	13
Transport vehicles, clean zone/hygiene samples[c]	1,141	1[h]	1,216	0	1,166	1
Transport vehicles, unclean zone/hygiene samples[c]	165	7[i]	123	4	144	4

Note: Data are from one feed and grain trade organisation only, representing a proportion of feed at the Danish market.
a) Presence of *Salmonella* in compound feed is indirectly monitored by environmental samples collected during feed processing.
b) Predominantly products of soy (e.g. soybean meal) but also products of rape (e.g. rapeseed cake) and sunflower (e.g. sunflower meal).
c) Samples from transport vehicles (hygiene samples) prior to loading of feed compounds.
d) S. Idikan, *S.* Nyborg, *S.* Falkensee, *S.* Riisen.
e) S. Putten, *S.* Falkensee, *S.* Infantis, *S.* 23:-:-.
f) S. Falkensee.
g) S. Livingstone, *S.* Mbandaka, *S.* Minnesota, *S.* Senftenberg, *S.* Idik, *S.* Müenster, *S.* Soerenga, *S.* Jerusalem, *S.* Tennesee, *S.* Havana, *S.* Lexington.
h) S. Derby.
i) S. Putten, *S.* Havana, *S.* Kedougeu, *S.* 23:-:-.

Source: Danish Veterinary and Food Administration and the feed business operators

Table A16. Control of Salmonella *in feed processing and feed material (batch-based data), 2016-2018*

	2018		2017		2016	
	N	Positive	N	Positive	N	Positive
Feed processing plants (process control)[a]:						
Ordinary inspections[b]	195	0	277	8	278	7
Feed materials, farm animals[c]	62	1[d]	62	3	64	1

a) Presence of *Salmonella* in compound feed is indirectly monitored by environmental samples collected during feed processing. Companies are sampled one to four times per year.
b) Primarily findings of *Salmonella* in the unclean zone.
c) Predominantly soybean meal and rapeseed cake.
d) S. Infantis. 1 sample of rapeseed cake.

Source: Danish Veterinary and Food Administration

Table A17. Salmonella *in three categories of meat and bone meal by-products not intended for human consumption[a], 2018*

Category of processing plant	Own-check samples		Product samples	
	N	Positive	N	Positive
1+2: By-products of this material cannot be used for feeding purposes	267	23	17	0
2: By-product of this material may be used for feed for fur animals	260	5	73	5
3: By-products from healthy animals slaughtered in a slaughter-house. Products of these may be used for petfood[b] and for feed for fur animals	357	11	600	0
Total	884	39	690	5

a) Regulation (EC) No 1774 of 03/10/2002 as amended.
b) For cats and dogs. Only by-products from pigs are used in this pet food.

Source: Daka Denmark A/S

Table A18. Pathogens in batches[a] of ready-to-eat vegetables[b], 2018

		Salmonella		*E. coli*	
	Type of sample	N	Pos	N	>100 cfu/g[c]
Conventional	Vegetables				
	Iceberg	13	0	13	-
	Lolo Bionda	2	0	2	1
	Romaine	8	0	8	-
	Rucola	5	0	5	-
	Various salads	18	0	18	-
Organic	Iceberg	5	0	5	-
	Lolo Bionda	1	0	1	-
	Romaine	5	0	5	-
	Rucola	4	1[d]	4	-
	Various salads	7	0	7	-
Conventional	Herbs				
	Basil	3	1[e]	3	-
	Chives	1	0	1	-
	Coriander	4	0	4	-
	Dill	2	0	2	-
	Parsley	2	0	2	-
	Sage	1	0	1	-
	Spearmint	4	0	4	-
	Tarragon	1	0	1	-
	Thyme	1	0	1	-
Organic	Basil	2	0	2	1
	Chives	1	0	1	-
	Parsley	5	0	5	-
	Spearmint	1	0	1	-

a) Five samples per batch.
b) Centrally coordinated study (See section 7.4 for description) to control and investigate *Salmonella, Campylobacter* and *E. coli* in Danish and imported ready-to-eat vegetables, sprouts and herbs.
c) Batches with >100 cfu/g in one or more samples.
d) *S.* Enterica subspecies houtenae 43:z4,z23:- from Italy.
e) *S.* Napoli from Thailand.

Source: Danish Veterinary and Food Administration

Table A19. Listeria monocytogenes *in Danish produced ready-to-eat (RTE) foods[a], 2018*

		Samples analysed by a qualitative method[b]				Samples analysed by a quantitative method	
		Batches		Single samples		Batches	
Food category	Sampling place	N	Positive	N	Positive	N	Positive[c]
Egg and egg products	At processing	6	0	-	-	3	0
Cheese, RTE	At processing	16	0	-	-	19	0
Products made from pork, RTE	At processing	10	1	-	-	18	0
	At retail	8	1	-	-	18	0
Products made from beef, RTE	At processing	1	0	-	-	2	0
	At retail	1	0	-	-	1	0
Fruit, RTE	At processing	2	0	-	-	2	0
Vegetables, RTE	At processing	13	0	-	-	4	0
Fruit juice	At processing	0	0	-	-	4	0
Fish and Fishery products, RTE	At processing	11	0	-	-	13	0
	At retail	1	0	-	-	1	0
Other RTE products	At processing	4	1	-	-	29	0
Suspect product samples, RTE[d]	At processing	33	6	-	-	35	2
Suspect environmental samples	At processing	-	-	16	6	-	-
Total		106	9	16	6	149	2

a) Samples are collected by the local food control offices according to EU Regulation (EC) No 2073/2005.
b) *Listeria monocytogenes* present in a 25 g sample of the product.
c) Levels > 10 cfu/g.
d) The majority of the batches have been analyzed by both a qualitative and a quantitative method.

Source: Danish Veterinary and Food Administration

Table A20. Histamine in batches of Danish and non-Danish fish products[a], 2018

	Danish		Non-Danish[b]	
Food category	N	Positive	N	Positive
Canned mackerel	1	0	2	0
Canned tuna	-	-	41	0
Fresh herring	1	1[c]	1	1[c]
Fresh mackerel	2	0	1	0
Frozen fish, unspecific	-	-	3	0
Frozen mackerel	-	-	11	0
Frozen sardines	-	-	1	0
Frozen tuna	-	-	3	0
Herring, marinated	-	-	1	0
Smoked herring	3	0	2	0
Total	7	1	66	1

a) Samples are collected by the local food control offices according to EU Regulation (EC) No 2073/2005.
b) Samples from China, Colombia, Ecuador, Ghana, Greece, Greenland, Indonesia, Madagascar, Mauritius, Norway, Phillippines, Poland, Seychelles, Spain, Thailand and United Kingdom. The positive sample was imported from Norway.
c) The findings of histamine did not exceed the limits acording to EU Regulation (EC) No 2073/2005.

Source: Danish Veterinary and Food Administration

Table A21. Salmonella *in batches of Danish and non-Danish produced food items*[a], 2018

		Danish		Non-Danish[b]	
Food category	Sampling place	N	Positive	N	Positive
Egg and egg products	At processing	9	0	-	-
Cheese, RTE[c]	At processing	14	0	-	-
Products made from pork, RTE[c]	At processing	15	0	-	-
Products made from beef, RTE[c]	At processing	1	0	-	-
Products made from duck, RTE[c]	At border inspection	-	-	3	0
Fish and Fishery products, RTE[c]	At processing	6	0	-	-
	At border inspection	-	-	39	0
Mixed meat, RTE[c]	At processing	3	0	-	-
Products made from broiler meat, intended to be cooked	At processing	4	1[d]	-	-
Products made from pork, intended to be cooked	At processing	15	1[d]	-	-
Products made from beef, intended to be cooked	At processing	136	10[e]	-	-
	At border inspection	-	-	2	0
Mixed meat, intended to be cooked	At processing	5	0	-	-
Total		208	12	24	0

a) Samples are collected by the local food control offices according to EU Regulation (EC) No 2073/2005.
b) Samples from Argentina, Brazil, Canada, Chile, China, Greenland and Vietnam.
c) Ready-to-eat.
d) *Salmonella* spp.
e) *S.* Dublin (5), *S.* Typhimurium (1).

Source: Danish Veterinary and Food Administration

Table A22. Occurrence of zoonotic pathogens in pets and zoo animals in Denmark[a], 2018

	Pet animals						Zoo animals			
	Dogs		Cats		Others		Mammals & reptiles		Birds	
Zoonotic pathogen	N	Pos	N	Pos	N	Pos	N	Pos	N	Pos
Salmonella spp.	0	0	0	0	1[b]	0	6[f]	2[g]	0	0
Chlamydia psittaci	-	-	-	-	34[c]	13[d]	-	-	-	-
Cryptosporidium spp.	2	0	1	0	0	0	0	0	0	0
Lyssavirus (classical)	-	-	-	-	2[e]	0	-	-	-	-
European Bat *Lyssavirus*	-	-	-	-	2[e]	0	-	-	-	-

a) All samples are analysed based on suspicion of disease, and does not reflect the country prevalence.
b) Pigeon (1 pooled sample from a flock).
c) Pigeon (11 single samples, 1 pooled sample from a flock), Duck (4), Psittacidae (18).
d) Pigeon (4 single samples, 1 pooled sample from a flock), Duck (4), Psittacidae (4).
e) Sheep (2).
f) Reptiles.
g) *S.* Abaetetuba (1), *S.* Enterica subspecies houtenae 45:g,z51:- (1).

Source: National Veterinary Institute, Technical University of Denmark, and Danish Veterinary and Food Administration

Table A23. Occurrence of zoonotic pathogens in wild and farmed wildlife in Denmark[a], 2018

	Farmed wildlife						Wildlife			
	Wild boar		Mink and chinchillas		Birds		Mammals		Birds	
Zoonotic pathogen	N	Pos	N	Pos	N	Pos	N	Pos	N	Pos
Salmonella spp.	-	-	20[c]	0	-	-	64[e]	1[f]	11[k]	0
Chlamydia psittaci	-	-	-	-	30[d]	18[d]	-	-	-	-
Cryptosporidium spp.	-	-	0	0	-	-	24[g]	0	0	0
Echinococcus multilocularis	-	-	-	-	-	-	203[h]	1[h]	-	-
Trichinella spp[b]	528	0	0	0	-	-	17[i]	0	0	0
Lyssavirus (classical)	-	-	-	-	-	-	20[j]	0	-	-
European Bat *Lyssavirus*	-	-	-	-	-	-	20[j]	0	-	-
West Nile virus	-	-	-	-	-	-	-	-	323[l]	2[m]

a) All samples are analysed based on suspicion of disease or risk based and does not reflect the country prevalence.
b) In 2014, an amendment ot EU regulation (EC) No 2075/2005 came into force stating that slaughter pigs, sows and boars kept under "controlled housing conditions" in Denmark are extempted testing for *Trichinella*. Free range pigs, horses and wild game and other species susceptible to *Trichinella* must be tested.
c) Mink (Samples taken from uterus and liver for each of the 20 minks (40 samples) 1 additional sample taken from one mink spleen).
d) Duck (Mallards from two holdings, one holding consisting of ducklings sold from the other holding).
e) Wild boar (59), badger (4), hedgehog (1).
f) Hedgehog (1).
g) Western roe deer (14), red deer (1), raccoon dog (8), hedgehog (1).
h) Fox.
i) Seal (12), porpoise whale (3), badger (1), dolphin (1).
j) Bat (17), mink (1), fox (2).
k) Starling (5), crow (3), rook (3).
l) Migratory birds.
m) Positive for WNV-specific antibodies, not virus.

Source: National Veterinary Institute, Technical University of Denmark, and Danish Veterinary and Food Administration

Table A24. The Bovine Spongiform Encephalopathy (BSE) surveillance programme[a] for cattle, 2018

Type of surveillance	N[b]	Positive
Active surveillance	-	-
Healthy slaughtered animals	63	0
Risk categories:	-	-
Emergency slaugthers	1,565	0
Slaughterhouse antemortem inspection revealed suspicion or signs of disease	-	-
Fallen stock	22,272	0
Animals from herds under restriction	-	-
Passive surveillance	-	-
Animals suspected of having clinical BSE	1	0
Total	23,901	0

a) According to the EU Regulation (EC) 999/2001 as amended, Commission Decision 2009/719/EC as amended and Danish Order no. 878 of 01/07/2013 as amended.
b) Samples (brain stem material) are tested using a IDEXX technique. Confirmatory testing is carried out using histopathology or immunohistochemistry. Further confirmation on autolysed material is performed at the European Union TSE reference laboratory.

Source: National Veterinary Instistute, Technical University of Denmark, and Danish Veterinary and Food Administration

Table A25. The Transmissible Spongiform Encephalopathy (TSE) surveillance programme[a] for sheep and goats, 2018

Type of surveillance	N[b]	Positive
Active surveillance	-	-
Slaugthered for human consumption	2	0
Fallen stock (>18 months)	534	0
Animals from herds under restriction	-	-
Passive surveillance	-	-
Animals suspected of having clinical TSE	1	0
Total	537	0

a) According to the EU Regulation (EC) 999/2001 as amended, Commission Decision 2009/719/EC as amended and Danish Order no. 1288 of 20/12/2011 as amended.
b) Samples (brain stem material) are tested using a IDEXX technique. Confirmatory testing is carried out using histopathology or immunohistochemistry. Further confirmation on autolysed material is performed at the European Union TSE reference laboratory.

Source: National Veterinary Institute, Techncal University of Denmark, and Danish Veterinary and Food Administration

Table A26. Centrally coordinated studies conducted in 2018

Title of project	No. of planned samples	Pathogen surveyed	Further information
Antibiotic resistance in pig/pork production - cutting plant	200	*Enterobacteriaceae, E. coli,* carbapenemase-producing *E. coli*	Data are being processed
Antibiotic resistance in pig/pork production - at retail	300	*Enterobacteriaceae, E. coli,* carbapenemase-producing *E. coli*	Data are being processed
Antibiotic resistance in fish and shellfish	180	*Entrococcus spp., Enterobacteriaceae, E.coli*	Data are being processed
Baseline *Norovirus* in samples of oysters from Danish expedition center	5	*Norovirus, E. coli*	To be published by Cefas
Baseline *Norovirus* in samples of oysters from Danish production sites	75	*Norovirus, E. coli*	To be published by Cefas
BU microbiology - Slaughteries	50	*Salmonella spp., Clostridium* and other pathogens	Not published
Campylobacter in danish and foreign strawberries	400	*Campylobacter* spp.	To be published[a]
Surveillance of *Campylobacter* in minced beef	450	*Campylobacter* spp.	To be published[a]
Campylobacter spp. in fresh, chilled Danish broiler meat at slaughteries (conventional)	1,250	*Campylobacter* spp.	To be published[a]
Case-by-case and *Salmonella* criteria - samples	6,190	*Salmonella* spp.	To be published[a]
Case-by-case and *Salmonella* criteria - samples, clarifying and tightening control, DK, import, trade	250	*Salmonella* spp.	To be published[a]
DANMAP - Antibiotic resistance in poultry, pork and cattle	336	*E. coli, Campylobacter* spp., *Salmonella* spp., *ESBL, AmpC,* carbapenemase-producing *E. coli*	To be published in the DANMAP report
DANMAP and EU surveillance of antibiotic resistance in broiler, pork and cattle meat at retail (coecum samples)	850	*E. coli, Campylobacter* spp., *ESBL, AmpC,* carbapenemase-producing *E. coli*	Data are being processed
ESBL in Danish poultry production	200	*ESBL, AmpC,* carbapenemase-producing *E. coli*	Data are being processed
ESBL/CPE *E.coli* in imported and danish herbs and salads 2018	480	*ESBL, AmpC,* carbapenemase-producing *E. coli*	Data are being processed
ESBL/CPE in imported broiler meat	150	*ESBL, AmpC,* carbapenemase-producing *E. coli*	Data are being processed
EU surveillance of antibiotic resistance in retail	300	*ESBL, AmpC,* carbapenemase-producing *E. coli*	Data are being processed
Export - USA - environmental samples	100	*Listeria monocytogens*	Not published
Export - USA - swab samples	468	*Salmonella* spp.	Not published
Import - Intensified control of Brazilian beef and poultry meat	5	*Listeria monoctogenes, Salmonella* spp.	To be published[a]
Import - Microbiologic control of fish, fish products and bivale molluscan shellfish from 3rd. countries	140	*Listeria monoctogenes, Salmonella* spp.	To be published[a]
Import - Microbiologic control of some fish-products - Greenland	2	*Listeria monoctogenes, Salmonella* spp.	To be published[a]
Import - Microbiological control of food of animal origin, excluding fish	25	*Listeria monoctogenes, Salmonella* spp.	To be published[a]

Continued on the next page

Table A26. Centrally coordinated studies conducted in 2018 (Continued from previous page)

Title of project	No. of planned samples	Pathogen surveyed	Further information
Import - Special control microbiology - not animal Reg. (669/2009)	100	*Salmonella* spp. *and virus*	To be published[a]
Intratraded - *Listeria* in foreign ready-to-eat food	500	*Listeria monocytogenes*	To be published[a]
Listeria in foods spceially for medical purposes	120	*Listeria monocytogenes*	To be published[a]
Listeria monocytogenes, Salmonella spp., *Escherichia coli* and *Staphylococci* in fish producs from Greenland	100	*Listeria monocytogenes, Salmonella* spp., *E. coli, staphylococci*	To be published[a]
Listeria WGS of isolates from official samples and follow-up on outbreaks	120	*Listeria monocytogenes*	To be published[a]
Microbiologic classification of mussel production areas in Denmark	60	*Salmonella* spp., *Escherichia coli*	To be published[a]
Microbiological samples, feed material	1	*Salmonella* spp.	To be published[a]
Microbiological samples, feed processing area	10	*Salmonella* spp.	To be published[a]
Part 2: Prepared meat - wholesale	300	According to Reg. 2073/2005	To be published[a]
Part 3: Ready-to-eat meat products - wholesale	250	According to Reg. 2073/2005	To be published[a]
Part 4: Milk and dairy products - wholesale	250	According to Reg. 2073/2005	To be published[a]
Part 5: Egg products - wholesale	50	According to Reg. 2073/2005	To be published[a]
Part 6: Fish and fish products - wholesale	200	According to Reg. 2073/2005	To be published[a]
Part 7: Fruit and vegetable - wholesale	200	According to Reg. 2073/2005	To be published[a]
Part 8: *Listeria monocytogenes* in other ready-to-eat products - wholesale	200	*Listeria monocytogenes*	To be published[a]
Pathogens in Danish and imported ready-to-eat vegetables	240	*Salmonella* spp., *STEC, E. coli, Listeria monocytogenes*	To be published[a]
Pathogens in Danish and imported ready-to-eat vegetables - wholesale	240	*Salmonella* spp., *STEC, E. coli, Listeria monocytogenes*	To be published[a]
Pathogens in food produced in retail	250	*Salmonella* spp., *Listeria monocytogenes*	To be published[a]
Salmonella and hygieine criteria on small pig and cattle slaughterhouses	250	*Salmonella* spp., *E. coli*	To be published[a]
Salmonella and resistance in pig/pork - surveillance	380	*Salmonella* spp.	To be published[a]
Salmonella and *STEC* in minced beef	450	*Salmonella* spp., *STEC*	To be published[a]
Salmonella in feed materials from feed companies	60	*Salmonella* spp.	To be published[a]
Salmonella in intratraded shell eggs - retail	25	*Salmonella* spp.	To be published[a]
Salmonella in intratraded shell eggs - wholesale	25	*Salmonella* spp.	To be published[a]
Salmonella process samples from feed companies	280	*Salmonella* spp.	To be published[a]
Salmonella spp. and *Escherichia coli* in raw frozen scallops from Greenland	25	*Salmonella* spp., *E. coli*	To be published[a]

a) Results will be published on the DVFA website www.fvst.dk (in Danish).

Source: Danish Veterinary and Food Administration

Table A27. Status on targets for Campylobacter *and* Salmonella, 2018

National Action Plans	Target	Status
Campylobacter in broilers 2018-2021		
Flocks at farm	Maintaining low prevalence in flocks of 17.3%	The prevalence in flocks in 2018 was 24.6%
Fresh meat at slaughterhouse	Reduction of the relative human risk (RR) by 50% compared to the level in 2013[a]	A reduction in relative risk of 8% was obtained in 2018 compared to 2013
Salmonella in poultry[b]		
Laying hen flocks of *Gallus gallus*	Initially eradication, later a reduction strategy in the table egg production	12 positive flocks (Table A5-A6) Eggs from positive flocks are destroy-ed or heat treated
Carcasses at slaughterhouse	Initially eradication, later a reduction strategy in the broiler production Zero-tolerance in Danish broiler meat.	1 positive batch (Table A7) Positive batches are heat treated
Salmonella in pigs 2014-2017		
Carcasses at slaughterhouse	Max. 1% *Salmonella* at carcass level	0.8% (Table A11)
Salmonella Dublin in cattle 2017-2020		
Herds at farm	Eradication of *S.* Dublin in all herds, i.e. all herds in level 1[c]	8.3% of milk-producing herds and 2.4% of non-milk producing herds are in level 2 or 3 (January 2, 2019) (Table A13)
EU Regulations		
Regulation (EC) No. 1190/2012		
Breeding and fattening turkey flocks	Max. 1% positive for *S.* Enteritidis and *S.* Typhimurium[d]	No fattening flocks positive with target serovars (N=13) (Table A8)
Regulation (EC) No. 200/2010		
Breeding flocks of *Gallus gallus*	Max. 1% adult flocks positive for *S.* Typhimurium[d], *S.* Enteritidis, *S.* Hadar, *S.* Infantis and *S.* Virchow	0.8% (2 flocks)[e] (Table A5 and A7)
Regulation (EC) No. 1168/2006		
Laying hen flocks of *Gallus gallus*	MS specific targets, for Denmark: Max. 2% adult flocks positive for *S.* Typhimurium[d] and *S.* Enteritidis	2.2% (10 flocks) positive with target serovars (Table A5)
Regulation (EC) No. 646/2007		
Broiler flocks of *Gallus gallus*	Max. 1% positive *S.* Typhimurium[d] and *S.* Enteritidis	0.7% (30 flocks) positive with target serovars (Table A7)

a) 2013 is agreed as the baseline since 2012 data are not compareable with data from 2013 and onwards due to a nessessary improvent in the data collection.
b) Supplementary to EU-regulations.
c) See Table A34 for explanation of the herd levels.
d) Including the monophasic strains *S.* 1,4,[5],12:i:-.
e) One flock positive for *S.* Infantis, one flock positive for *S.* Typhimurium.

Source: Danish Veterinary and Food Administration

Monitoring and surveillance programmes

Table A28. Overview of notifiable and non-notifiable human diseases presented in this report, 2018

Patogen	Notifiable	Notification route
Bacteria		
Brucella spp.	no	-
Campylobacter spp.	1979[a]	Laboratory[b]
Chlamydophila psittaci (Ornithosis)	1980[a]	Physician[c]
Listeria monocytogenes	1993[a]	Physician
Leptospira spp.	1980[a]	Physician
Mycobacterium bovis/ tuberculosis	1905[a]	Physician (and laboratory[d])
Coxiella burnetii	no	-
Salmonella spp.	1979[a]	Laboratory
STEC	2000[a]	Physician and laboratory
Yersinia enterocolitica	1979[a]	Laboratory
Parasites		
Cryptosporidium spp.	no	-
Echinococcus multilocularis	no	-
Echinococcus granulosus	no	-
Trichinella spp.	no	-
Viruses		
Lyssavirus (Rabies)	1964[a]	Physician (via telephone)
Prions		
BSE/Creutzfeld Jacob	1997[a]	Physician

a) Danish Order no. 277 of 14/04/2000. Cases must be notified to Statens Serum Institut.
b) The regional microbiological laboratories report confirmed cases.
c) The physician report individually notifiable infections.
d) The laboratories voluntarily report confirmed cases.

Source: Statens Serum Institut

Table A29. Overview of notifiable and non-notifiable animal diseases presented in this report, 2018

Patogen	Notifiable	EU legislation	Danish legislation
Bacteria			
Brucella spp.	1920[a]		
Cattle	OBF in 1979[b]	Decision 2003/467/EC	Order no 305 of 3/5/2000
Sheep and goats	ObmF in 1995[c]	Decision 2003/467/EC	Order no. 739 of 21/8/2001
Pigs	No cases since 1999	Directive 2003/99/EC	Order no. 575 of 29/5/2018
Campylobacter spp.	no	-	-
Chlamydophila psittaci	-	-	-
Birds and poultry	1920	-	Order no. 575 of 30/5/2017
Listeria monocytogenes	no	-	-
Leptospira spp. (only in production animals)	2003	-	Order no. 532 of 25/5/2018
Mycobacterium bovis/tuberculosis	1920[a]		
Cattle	OTF in 1980[d]	Decision 2003/467/EC	Order no. 1417 of 11/12/2007 (Order no. 1079 of 6/10/2014)
Coxiella burnetii	2005	-	Order no. 532 of 25/5/2018
Salmonella spp.	1993[e]		
Cattle		-	Order no. 1326 of 29/11/2017
Swine		-	Order no. 604 of 01/06/2017
Eggs for consumption		-	Order no. 1413 of 04/12/2017
Hatching eggs		-	Order no. 1355 of 29/11/2017
Poultry for slaugther		-	Order no. 77 of 20/01/2017
STEC	no	-	-
Yersinia enterocolitica	no	-	-
Parasites			
Cryptosporidium spp.	no	-	-
Echinococcus multilocularis	2004	Council Directive 64/433/EC	Order no. 532 of 25/5/2018
Echinococcus granulosus	1993	Council Directive 64/433/EC	Order no. 532 of 25/5/2018
Trichinella spp.	1920[a]	Regulation (EU) 2015/1375	Order no. 1714 of 15/12/2015
Viruses			
Lyssavirus (Rabies)	1920	-	Order no. 330 of 14/04/2011
Prions			
TSE			
Sheep and goats	yes	Regulation 999/2001/EC (as amended)	Order no. 1288 of 20/12/2011
BSE			
Cattle	yes[f]	Regulation 999/2001/EC (as amended)	Order no. 1326 of 26/11/2015

a) Clinical cases, observations during the meat inspection at the slaughterhouse, positive blood samples or finding of agents are notifiable.
b) Officially Brucellosis Free (OBF) according to Council Directive 64/432/EC as amended and Commision Decision 2003/467/EC. No cases in since 1962.
c) Officially *Brucella melitensis* Free (ObmF) according to Council Directive 91/68/EC and Commision Decision 2003/467/EC. The disease has never been detected in sheep or goat.
d) Officially Tuberculosis Free (OTF) according to Council Directive 64/432/EC as amended and Regulation (EC) No 1226/2002, and Commission Decision 2003/467/EC. No cases in since 1988 or in deer since 1994.
e) Only clinical cases notifiable.
f) Denmark was recognized as a country with neglible risk for BSE at World Organisation for Animal Health (OIE) general session in May 2011.
Source: Danish Veterinary and Food Administration

Table A30. Salmonella *surveillance programme for the rearing flocks and adult flocks of the grandparent and parent generation of the broiler and table egg production, 2018*

Time	Samples taken	Material	Material
Rearing flocks		*Grandparent generation*	*Parent generation*
Day-old[a,b,c]	Per delivery	5 transport crates from one delivery: crate liners (>1 m^2 in total) or swab samples (>1 m^2 in total). Analysed as one pool	5 transport crates from one delivery: crate liners (>1 m^2 in total) or swab samples (>1 m^2 in total). Analysed as one pool
1st & 2nd week[b, c]	Per unit	-	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g
4th week[a,b,c]	Per unit	5 pairs of boot swabs (analysed as two pooled samples), or 1 faeces sample consisting of 2x150 g	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g
8th week[b,c]	Per unit	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g
2 weeks prior to moving[a,c,d]	Per unit	5 pairs of boot swabs (analysed as two pooled samples), or 1 faeces sample consisting of 2x150 g	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g
Adult flocks		*Grandparent generation*	*Parent generation*
Every two weeks[a,b,c,e] (Every 16th week)[d]	Per flock	Hatcher basket liners from 5 baskets (>1 m^2 in total) or 10 g of broken eggshells from each of 25 hatcher baskets (reduced to 25 g sub-sample). Analysed as one pool	Hatcher basket liners from 5 baskets (>1 m^2 in total) or 10 g of broken eggshells from each of 25 hatcher baskets (reduced to 25 g sub-sample). Analysed as one pool
After each hatch[b,c]	Per hatch	Wet dust samples. Up to four hatchers of the same flock can be pooled	Wet dust samples. Up to four hatchers of the same flock can be pooled
Every week[b,c]	Per unit	-	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample of 60 g
0-4 weeks after moving, 8-0 weeks before slaughter	Per unit	5 pairs of boot swabs (analysed as two pooled samples), or 1 faeces sample consisting of 2x150 g	5 pairs of boot swabs (analysed as two pooled samples), or 1 faeces sample consisting of 2x150 g
After positive findings[c,d,f]	Per unit	5 pairs of boot swabs (analysed as two pooled samples), 2 dust samples (250 ml) and 5 birds (analysed for antimicrobial substances)	5 pairs of boot swabs (analysed as two pooled samples), 2 dust samples (250 ml) and 5 birds (analysed for antimicrobial substances)

a) Sampling requirements set out by Regulation (EC) No 200/2010.
b) Samples collected by the food business operator.
c) Sampling requirements set out by Danish Order no. 1355 of 29/11/2017.
d) Samples collected by the Danish Veterinary and Food Administration.
e) When eggs from a flock exceed the capacity of one incubator, each incubator should be sampled as described.
f) If samples are negative, sampling is repeated 14 days later.

Source: Danish Veterinary and Food Administration

Table A31 Salmonella *and* Campylobacter *surveillance programme for the broiler flocks, 2018*

Time	Samples taken	Material
Salmonella		
15 - 21 days before slaughter[a,b,c]	Per flock	5 pairs of boot swabs
7 - 10 days before slaughter[d,e]	Per flock	5 pairs of boot swabs
After slaughter[b,d,f]	Per batch	From slaughterhouses slaughtering 1,000 chickens or hens pr day or more: 300 neck skin samples of 1 gram, pooled into subsamples of 60 gram from one batch per week. From slaughterhouses slaughtering less than 1,000 chickens or hens pr day: 15 neck skin samples of approx. 10 gram pooled into 5 subsamples of 25 gram from one batch every fifth day of slaughter
Campylobacter		
After slaughter[b,d]	Per flock	12 cloacal swabs from 24 animals, analysed in one pool[h,g]
After slaughter[b,f]	Per batch	From slaughterhouses slaughtering 1,000,000 chickens or more per year: 15 neck skin samples of approx 10 gram, pooled into five subsamples of 25 gram from one batch per week. From slaughterhouses slaughtering less than 1,000,000 chickens per year and more than 10,000: 15 neck skin samples of approx. 10 gram pooled into 5 subsamples of 25 gram from one batch every tenth day of slaughter

a) Sampling requirements set out by Regulation (EC) 200/2012.
b) Samples collected by the food business operator.
c) Once a year, one pair of socks is collected by the Danish Veterinary and Food Administration.
d) Sampling requirements set out by Danish Order no. 77 of 20/01/2017 replacing 1644 af 14/12/2016 replacing 1512 of 13/12/2013 replacing 1105 of 18/09/2013 replacing 1462 of 16/12/2009.
e) Samples are collected by a representative of the slaughterhouse, laboratorium or the Danish Veterinary and Food Administration.
f) Sampling requirements set out by Regulation (EC) 2073/2005.
g) For flocks to be slaughtered outside Denmark, 1 pair of boot swabs is collected by the owner 10 days before slaughter at the latest.
h) If the flock is slaughtered over several days, the last batch is sampled.

Source: Danish Veterinary and Food Administration

Table A32. Salmonella *surveillance programme for the pullet-rearing, table egg layer and barnyard/hobby flocks in the table egg production, 2018*[a]

Time	Samples taken	Material
Pullet-rearing		
Day-old[a,b]	Per delivery	5 transport crates from one delivery: Crate liner (> 1 m^2 in total) or swab samples (> 1 m^2 in total) (Analysed as one pooled sample)
4 weeks old[a,b]	Per flock	5 pairs of boot swabs (analysed as two pooled samples) or 5 faeces samples of 60 gram
2 weeks before moving[a,c]	Per flock	5 pairs of boot swabs (analysed as two pooled samples) or 5 faeces samples of 60 gram. 60 blood samples (serology)
Table egg layers (Production for certified packing stations)		
24 weeks old[a,c]	Per flock	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample consisting of 2x150 g. 250 ml (100 g) dust or a dust sample by a cloth of min. 900 cm^2
Every 2 weeks from age 20 weeks[a,b,d,]	Per flock	2 pairs of boot swabs (analysed as one pooled sample) or 1 faeces sample consisting of 2x150 g.
After positive serological findings[c]	Per flock	5 pairs of boot swabs (analysed as two pooled samples) or 5 faecal samples consisting of 60 gram each
After positive findings of other serotypes than *S.* Enteritidis, *S.* Hadar, *S.* Infantis, *S.* Virchow or *S.* Typhimurium including the monophasic strains *S.* 1,4,[5],12:i:-[c]	Per flock	5 pairs of boot swabs (analysed as two pooled samples) or 5 faeces samples consisting of 60 gram each, 2 dust samples (250 ml) and 5 birds (analysed for antimicrobial substances)
Barnyard and hobby flocks[e]		
Every 18 weeks[a,b,f]	Per flock	Egg samples (serology)

a) Sampling requirements set out by Danish Order no. 1413 of 04/12/2017.
b) Samples collected by the food business operator.
c) Samples collected by the Danish Veterinary and Food Administration.
d) According to Regulation (EC) 2160/2003 sample collection must be carried out every 15 weeks as a minimum.
e) Voluntary for hobby flocks.
f) For flocks with 30 birds or less: No testing if only delivered to a well-known circle of users.

Source: Danish Veterinary and Food Administration

Table A33. Salmonella *surveillance programme for the turkey flocks, 2018*

Time	Samples taken	Material
Turkey production		
Max. 21 days before slaughter[a,b]	Per flock	2 pairs of boot swabs. Analysed individually

a) Sampling requirements set out by Regulation (EC) 584/2008 and Danish Order no. 77 of 20/01/2016.
b) Samples collected by the food business operator or the local food control offices.

Source: Danish Veterinary and Food Administration

Table A34. Salmonella *surveillance programme[a] for the cattle production, 2018*

No. of samples	Samples taken	Purpose/Comment
Milk producing herds		
4 samples distributed over 18 months	Bulk tank samples	Calculation of herd level[b]
Non-milk producing herds		
1 sample every 3 months at slaughter[c]	Blood samples	Calculation of herd level[b]
1 sample every 6 months in farms with only heifer herds	Blood samples	Calculation of herd level[b]
4-8 samples depending on herd size[d]	Blood samples	Consecutive negative samples required for level 1[d]
Beef carcasses at the slaughterhouse		
5 samples daily, pooled into one analysis	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering 7.500 or more cattle per year
5 samples every second month, analyzed individually	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering 2.500 or more and less than 7.500 cattle per year
5 samples every 6th month, analyzed individually	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering 250 or more and less than 2.500 cattle per year
No sampling		Slaughterhouses slaughtering less than 250 cattle per year

a) Danish Order no. 1326 of 29/11/2017 as amended. In 2013 and 2014, the programme for eradication of *Salmonella* Dublin from the Danish cattle production was intensified. This implies regionalisation of the country according to prevalence and compulsory eradication plans in Level 2 herds.
b) Herd levels based on serological testing (blood and milk):
Level 1: Herd assumed free of infection based on bulk milk samples (milk producing herd) or blood samples (non-milk producing herd).
Level 2: Herd not assumed free of infection.
Level 3: Herd infected based on culture and clinical signs or bacteriological findings in the intensified sampling.
c) No samples are taken, if the herd has been tested for *S.* Dublin within the last 3 months.
d) Number of samples equals total number of animals in the herd minus 2 (max. 8 animals, min. 4 animals).

Source: SEGES

Table A35. Salmonella *surveillance programme[a] for the pig production, 2018*

Time	Samples taken	Purpose/Comment
Breeding and multiplier herds		
Every month	10 blood samples per epidemiological unit	Calculation of *Salmonella*-index based on the mean seroreaction from the last three months with more weight to the results from the more recent months (1:3:6)[b]
Max. twice per year	Herds with *Salmonella*-index 5 or above: Pen-faecal samples	Clarify distribution and type of infection in the herd[c]
Sow herds		
When purchaser of piglets is assigned to level 2 or 3, max. twice per year	Pen-faecal samples	Clarify distribution and type of infection in the herd, and possible transmission from sow herds to slaughter pig herds
Herds positive with *S.* Typhimurium, *S.* Infantis, *S.* Derby and *S.* Choleraesuis are considered positive for the following 5 years[d]	No samples are collected from the herd during the 5 year period when the herd is considered positive, unless the herd is proven negative	Reduce repeated sampling in positive herds infected with a persistent serotype
Slaughter pigs, herds		
At slaughter	Meat juice, 60-100 samples per herd per year. Herds in RBOV[e]: one meat juice sample per month	Calculation of slaughter pig index based on the mean proportion of positive samples from the last three months with most weight to the result from the most recent month (1:1:3)[f]. Assigning herds to level 1-3 and assigning herds to risk-based surveillance (RBOV)[e, f]
Slaughter pigs, animals		
At slaughter[g]	Coecum samples, avg. 25 samples per month, 12 months per year	Random collection of samples for monitoring of the distribution of serotypes and antimicrobial resistance.
Pork carcasses at the slaughterhouse		
5 samples daily, pooled into one analysis	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering more than 30.000 pigs per year
5 samples every second month	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering 10.000 or more pigs and less than 30.000 pigs per year
10 samples per year, 5 each 6 month	Swab samples from 4 designated areas after 12 hours chilling (4x100cm^2)	Slaughterhouses slaughtering 1.000 or more pigs and less than 10.000 pigs per year
No sampling		Slaughterhouses slaughtering less than 1000 pigs per year

a) Sampling requirements set out by Danish Order no. 539 of 03/06/2016, replaced by Danish Order no. 604 of 01/06/2017.
b) Herds with index above 10 have to pay a penalty for each pig sold.
c) The herd owner must inform buyers of breeding animals about the type of *Salmonella*.
d) These serotypes are primarily spread by live trade, and are known to persist in herds. *S.* Typhimurium includes the monophasic *S.* 1,4,[5],12:i:-.
e) RBOV: risk-based surveillance in herds with a slaughter pig index of zero (no positive samples in the previous three months) the sample size is reduced to one sample per month.
f) Pigs from herds with highest level of infection (Level 3) must be slaughtered under special hygienic precautions.
g) Centrally coordinated study (Table A26).

Source: Danish Veterinary and Food Administration

Table A36. Typing methods used in the surveillance of foodborne pathogens in Denmark, 2018

Methods	Human	Food	Animal
Salmonella enterica			
Serotyping	All isolates (mainly WGS)	All isolates (by WGS)	All isolates (by WGS)
Phage typing	None	None	Few
Antimicrobial resistance testing	All *Salmonella* except *S.* Enteritidis	Almost all isolates	Almost all isolates
MLVA	In relation to International outbreak	None	None
WGS	All isolates	All isolates	All isolates
Campylobacter coli/jejuni			
Antimicrobial resistance testing	Isolates from 4 districts for DANMAP surveillance	Isolates for DANMAP, EFSA and the case-by-case program	Isolates for DANMAP and EFSA
WGS	Outbreaks investigations, research	None	None
STEC			
Serotyping	All isolates (mainly WGS)	All isolates (by PCR & WGS)	All O157 isolates
Virulence profile	All isolates (mainly WGS)	All isolates (by PCR & WGS)	All O157 isolates
PFGE	None	None	Outbreak investigations
WGS	All isolates	All isolates	None
Listeria			
WGS	All isolates	Selected isolates (ST typing and outbreak investigations)	None
Yersinia Enterocolitica			
O-group	All isolates sent to SSI	None	None
WGS	Outbreaks investigations, research	None	None

Source: Statens Serum Institut and the Laboratory of the Danish Veterinary and Food Administration

Population and slaughter data

Table A37. Human population, 2018

Age groups (years)	Males	Females	Total
0-4	123,467	116,869	240,336
5-14	336,741	320,084	656,825
15-24	374,237	356,964	731,201
25-44	731,783	712,656	1,444,439
45-64	765,494	762,530	1,528,024
65+	517,998	608,807	1,126,805
Total	2,849,720	2,877,910	5,727,630

Source: Statistics Denmark, 1 July 2018

Table A38. Number of herds/flocks, livestock and animals slaughtered, 2018

	Herds/flocks (capacity)	Livestock (capacity)	Number slaughtered
Slaughter pigs	5,880	5,596,264	18,108,470
Cattle	17,636	1,522,757	490,600
Broilers	248	21,639,518	103,689,500
Layers (excl. barnyard)	294	4,882,254	-
Turkeys	28	308,678	2,800
Sheep & lambs	6,167	141,825	76,100
Goats	2,893	18,569	-
Horses	-	-	1,200

Source: Statistics Denmark and Danish Veterinary and Food Administration, May 2019

Table A39. Number of holdings, houses/flocks and livestock capacity in the broiler production, 2018

	No. of holdings	No. of houses/flocks	Livestock (capacity)
Rearing period (grandparent)	2	10	50,000
Adult period (grandparent)	3	9	82,500
Rearing period (parent)	19	109	745,940
Adult period (parent)	42	141	1,116,900
Hatcheries	5	-	-
Broilers	259	631	18,267,017

Source: Danish Veterinary and Food Administration, March 2019

Table A40. Number of holdings, houses/flocks and livestock capacity in the table egg production, 2018

	No. of holdings	No. of houses/flocks	Livestock (capacity)
Rearing period (grandparent)	2	2	47,500
Adult period (grandparent)	2	7	75,000
Rearing period (parent)	7	7	37,500
Adult period (parent)	7	8	40,556
Hatcheries	7	-	-
Pullet-rearing	42	63	1,078,289
Layers (excl. barnyard)	184	294	4,882,254

Source: Danish Veterinary and Food Administration, March 2019

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Contributing institutions:

National Food Institute
Technical University of Denmark
Kemitorvet
Building 202
DK - 2800 Kgs. Lyngby
Tel: +45 3588 7000
E-mail: food@food.dtu.dk
www.food.dtu.dk

National Veterinary Institute
Technical University of Denmark
Kemitorvet
Building 202
DK - 2800 Kgs. Lyngby
Tel: +45 3588 6000
E-mail: vet@vet.dtu.dk
www.vet.dtu.dk

Statens Serum Institut
Artillerivej 5
DK - 2300 København S
Tel: +45 3268 3268
E-mail: serum@ssi.dk
www.ssi.dk

Danish Agriculture and Food Council
Axelborg, Axeltorv 3
DK - 1609 Copenhagen V
Tel: +45 3339 4000
E-mail: info@lf.dk
www.lf.dk

The Danish Veterinary and Food Administration
Stationsparken 31-33
DK - 2600 Glostrup
Tel: +45 7227 6900
E-mail: fvst@fvst.dk
www.fvst.dk

National Food Institute
Technical University of Denmark
Kemitorvet, Building 202
DK - 2800 Kgs. Lyngby

T: 35 88 70 00
F: 35 88 70 01
www.food.dtu.dk

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