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# The Norwegian Zoonoses Report 2023

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# Content

# Summary

The occurrence of most zoonotic pathogens in animals was stable in 2023 compared to previous years. In humans the incidence of several zoonotic infectious diseases has increased after the decline seen during the COVID-19 pandemic. There was a notable increase of STEC cases reported in humans in 2023, compared to previous years. Campylobacteriosis still has the highest number of reported cases, followed by salmonellosis. The situation regarding antimicrobial resistance in bacteria from animals and food in Norway is still good, however carbapenem-resistant *Enterobacterales* was detected for the first time in food producing animals in 2023.

# Introduction

The Zoonoses Report is published annually in Norway in accordance with the requirements of the EU Council Directive 2003/99/EC. In addition, data on specified zoonoses in feed, animals and food are reported to the European Food Safety Authority (EFSA). Corresponding data from humans are reported to the European Centre for Disease Prevention and Control (ECDC). These two European institutions compile an annual European zoonosis report based on the received data: https://www.efsa.europa.eu/en/publications?sub_subject=61616

The Norwegian Veterinary Institute (NVI) is responsible for reporting of Norwegian data to EFSA, while the Norwegian Institute of Public Health (NIPH) reports Norwegian data to ECDC. The Zoonoses Report is written by the NVI in collaboration with the Norwegian Food Safety Authority (NFSA) and NIPH.

## Origin of data

*Humans*

"The Norwegian Surveillance System for Communicable Diseases" (MSIS) was implemented nationally in Norway in 1975, and the NIPH is responsible for managing the system. The main purpose of MSIS is surveillance to describe trends and detect outbreaks of communicable diseases.

According to the Infectious Disease Control Act, all clinicians and laboratories that analyse samples from humans must report all cases of specified communicable diseases (at present 73 different diseases). All zoonoses described in this report, with the exception of toxoplasmosis, are notifiable.

Patients who have not travelled abroad during the incubation period for the diagnosed infection are classified as "infected in Norway". Patients who develop the diagnosed infection abroad or shortly after returning home to Norway are classified as travel associated and "infected abroad". Patients for whom information regarding travel is not available are classified as «unknown place of infection» with respect to where the infection was contracted.

The District Medical Officer must notify the NFSA in cases where humans are believed to be infected from animals or food.

*Feed, animals and food*
The data presented in this report are obtained through national surveillance programmes, projects, diagnostic investigations and various inspections performed by public authorities and private companies. Two types of data are reported:

- Data on detected notifiable diseases and data from public surveillance. The NFSA decides which infectious agents are notifiable and which surveillance programmes should be carried out. The NVI assists with planning and laboratory analyses, data processing and reporting. Testing of animals and food for various zoonotic agents is also in association with import and export. In addition, surveillance in association with commercial slaughter through pre- and post-mortem inspections are carried out by the NFSA.
- Data from diagnostic investigations and data from internal control systems of food-, and feed-producing companies are also included in the Zoonoses Report. All laboratories are obliged to report any detection of notifiable diseases in animals to the NFSA. A large proportion of the laboratory diagnostics (including pathology) performed on animals in Norway is performed by the NVI. In cases where laboratories abroad are used, the responsible veterinarian is obliged to report any detection of notifiable disease in animals. Data from internal control of companies are not always available. One exception is Salmonella control in feed producing companies, where data from most of the performed internal control is made available and is presented in this report.

Notifiable diseases/agents in animal and humans are presented in Table 1.

## Preventive and protective measures

Norway has strict regulations to prevent introduction and spread of certain infections in animals and humans.

*Humans*
When clusters of notifiable zoonoses are detected in humans, investigations are performed to trace the source of infection and measures to prevent new cases are implemented. In cases where food or animals are suspected to be the source, NFSA is notified and an outbreak investigation team consisting of NFSA, NVI, relevant municipal doctors and NIPH is established.

People employed in the food industry or health personnel working with patients should not work while symptomatic with infections that may be transmitted through food. After clinical improvement and before returning to work, they should have two negative faecal samples (*Salmonella* spp (other than S. Typhi and S. Paratyphi), *Shigella* spp. (other than S. dysenteriae 1), *Vibrio cholera, Campylobacter* spp. *Yersinia enterocolitica* and EIEC. For high virulent or suspected high virulent enterohaemorrhagic *Escherichia col*i (EHEC/STEC), Salmonella Typhi, S. Paratyphi and *Shigella dysenteriae* 1 the number of negative faecal samples should be three.

*Feed, animals and food*
According to the Food Act, https://lovdata.no/dokument/NL/lov/2003-12-19-124 Food Business Operators are responsible for implementing appropriate measures to prevent the occurrence or spread of contagious disease in animals, and to notify the NFSA about any suspicion of contagious disease in animals that has potential to cause significant negative consequences for society.

The Regulation on Notification of Diseases in Animals Forskrift om dyrehelse (dyrehelseforskriften) - Kapittel V. Utfyllende nasjonale bestemmelser for landdyr, reptiler, amfibier og sjøpattedyr – li... - Lovdata states that veterinarians and laboratories must notify the NFSA about specified animal diseases categorized as list 1-, 2-, and 3-diseases. This list includes, but is not limited to, the notifiable diseases in EU EUR-Lex, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02016R0429-20191214 and

includes zoonotic diseases listed in the EU Council Directive 2003/99/EC. In addition, there is a general duty to notify diseases in animals that:

- could cause death or serious disease in humans.
- could result in high numbers of animals becoming diseased or exposed to infection.
- could result in substantial economic losses for society.
- could cause other substantial consequences for society.
- are presumed not to exist in Norway or have an unexpected distribution.
- compromise animal health in an unexpected manner or in an unexpected fashion.

Suspicion or diagnosis of list 1 and 2 diseases in animals must be notified immediately to the NFSA. Diagnosis of list 3 disease in animals shall be reported to the NFSA as soon as possible.

If a list 1- or 2-disease is detected in animals in Norway, restrictions will be imposed on the infected animal or animal holding, and efforts will be made to eradicate the infective agent. The measures depend on EU's categorisation of the disease animal species, management system, and the infective agent. When a zoonosis is detected or suspected, the NFSA must notify the District Medical Officer if the infection has transmitted, or may transmit, to humans.

Companies that produce or sell food are responsible for ensuring that the products they produce are safe to consume. The NFSA follows up and inspects food industry facilities to ensure that they exercise their responsibility. Food producers must also consider zoonoses in their internal control systems. In addition to the national surveillance programmes and various short-term projects initiated by the head office of the NFSA, regional NFSA offices perform some sampling. However, the data from regional offices are not included in this report.

Feed business operators are obliged to apply an internal control system to secure the hygienic quality of the feed, the absence of *Salmonella* in particular, to prevent zoonotic infections in animals. In total, 14 border inspection posts and 7 associated control centres in Norway perform control of foods and foodstuffs of animal origin that are imported from non-EU and non-EEA countries.

If a zoonotic agent is detected in a food or foodstuff, measures are carried out to prevent spread and to identify the source. The District Medical Officer must be notified, and if there is a risk that animals have been infected or may become infected, the NFSA must perform further investigations.

***Table 1**. Disease/agents included in the zoonoses report in 2023 and their status with respect to notifiability and existing surveillance programmes.*

| Disease/agent | Notifiability | | | Feed, animals and food |
|---|---|---|---|---|
| | Humans | Feed and food | Animals | Surveillance programme |
| Salmonellosis | Yes | Yes | Yes (2-disease) | Yes |
| Campylobacteriosis | Yes | No* | No** | Yes |
| Yersiniosis | Yes | No* | No | No (occasionally) |
| Listeriosis | Yes | No* | No | No (occasionally) |
| Pathogenic *E. coli* | Yes | Yes* | No | No (occasionally) |
| Tuberculosis | Yes | Yes | Yes (2-disease) | Yes |
| Brucellosis | Yes | Yes | Yes (1-disease) | Yes |
| Trichinellosis | Yes | Yes | Yes (2-disease) | Yes |
| Echinococcosis | Yes | Yes | Yes (2-disease) | Yes |
| Toxoplasmosis | No | No | No | No |
| Rabies | Yes | - | Yes (1-disease) | No |
| Q-fever | Yes | - | Yes (2-disease) | No (occasionally) |
| BSE og vCJD | Yes | - | Yes (2-disease) | Yes |
| MRSA | Yes | - | Yes (2-disease) | Yes |

* Some conditions are notifiable according to national regulation within specific areas. Otherwise, the food law contains a general obligation to immediately inform the competent authorities if there exists a risk or potential risk (to human, animal and plant health) of significant consequences to the society.
** The exception is broiler chickens slaughtered before 51 days of age between May and October, because these are included in the surveillance programme, and measures are implemented if samples are positive.

## Acknowledgements

Institute of Marine Research, Geno, Norsvin and the feed industry are acknowledged for providing data for this report.

# Salmonellosis

**The disease and its transmission routes**
There are more than two thousand variants of *Salmonella* bacteria. The most common symptom of infection is diarrhoea, both in humans and in animals, but healthy carriage is not uncommon. *Salmonella* are shed in faeces and the most important sources of infection are contaminated food, feed or water. *Salmonella* can also spread through direct contact with infected individuals.

**Surveillance and control**
Salmonellosis in humans is notifiable in Norway. From 2017, both *Salmonella* infections verified by PCR and/or by culture are registered in MSIS. *Salmonella*-infection in animals is notifiable (group 2-disease in Norway). Detection of *Salmonella* in feed or food must also be reported to the NFSA.

Surveillance of *Salmonella* in feed, cattle, swine and poultry (live animals and animal products) started in 1995. Testing is performed in cases of disease, live animal import and as part of *Salmonella* control systems in feed production. Vaccination of animals against *Salmonella* is forbidden in Norway.

## Results 2023

A total number of 757 cases of salmonellosis in humans was reported to MSIS in 2023, of which 243 contracted the infection in Norway and 410 cases were travel associated. For 104 cases, place of infection was unknown. The number of reported cases of Salmonellosis in humans has increased slightly compared 2022 (712 cases), but the number of cases is still lower than before the pandemic. This is mainly due to a decrease in the number of travel-associated cases. In 2023, there were three outbreaks of salmonellosis in the human population with two to seven cases included in each outbreak. Information on the most frequently detected serotypes is presented in the Appendix.

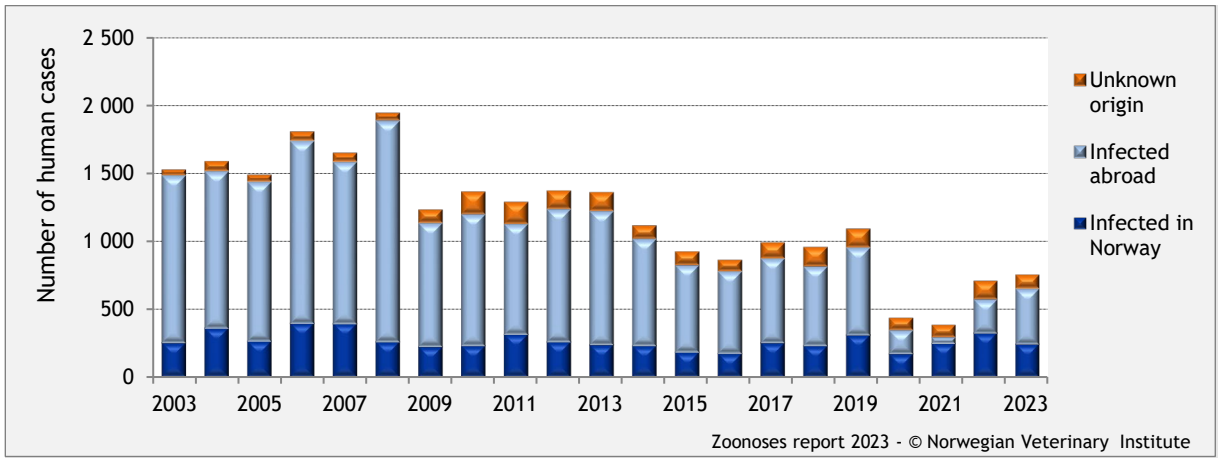



***Figure 1**. Reported cases of salmonellosis in humans. Data from MSIS*

The surveillance programmes for *Salmonella* covering animals, meat and eggs, include testing of live animals (pigs, poultry and cattle) and fresh meat (pigs and cattle). Altogether 9,160 faecal samples from 1,312 poultry holdings were investigated, and samples from two layer flocks were positive for *Salmonella*. *Salmonella* was not detected in 1,349 faecal samples from 69 elite and multiplier breeding swine herds, but one of 3,002 lymph node samples from pigs were positive for *Salmonella* giving an estimated *Salmonella* prevalence of 0.03% at the individual carcass level. Three out of 3,172 lymph

node samples from cattle were positive for *Salmonella* giving an estimated *Salmonella* prevalence of 0.09% at the individual carcass level. None of the 6,036 swab samples of cattle and swine carcasses examined were positive for *Salmonella*. A total of 3,098 samples of crushed meat were examined, and one sample was positive for *Salmonella*, giving an estimated *Salmonella* prevalence of 0, 03% at sample level.

In the diagnostic services at the NVI, *Salmonella* was detected in faecal samples from one swine herd, three sheep flocks, two horse stables, five dogs, thirteen cats, two reptiles, eight wild boars and three wild birds.

## Evaluation of the current situation

The number of salmonellosis cases in humans has decreased over the past 10 years. The incidence of cases infected in Norway has varied from 3.2 to 6.1 in the period 2014-2023, with the lowest incidence during the COVID-19 pandemic. This was probably due to measurements against COVID-19 in Norway and reduced travel. The reduced prevalence of *Salmonella* in European poultry is presumed to contribute to the observed reduction, with less people infected abroad. Data from outbreaks of salmonellosis indicate that a great variety of foods can be implicated. When infection is contracted in Norway, imported foods are more often implicated than foods produced in Norway.

In Norway, food-producing animals are very rarely infected with *Salmonella*. This is well documented in the surveillance programme (Figure 2). *Salmonella enterica* subspecies *diarizonae* is occasionally detected in Norwegian sheep and was detected in 3 sheep flocks in 2023. This variant is only rarely associated with disease in animals and is not considered a public health threat.

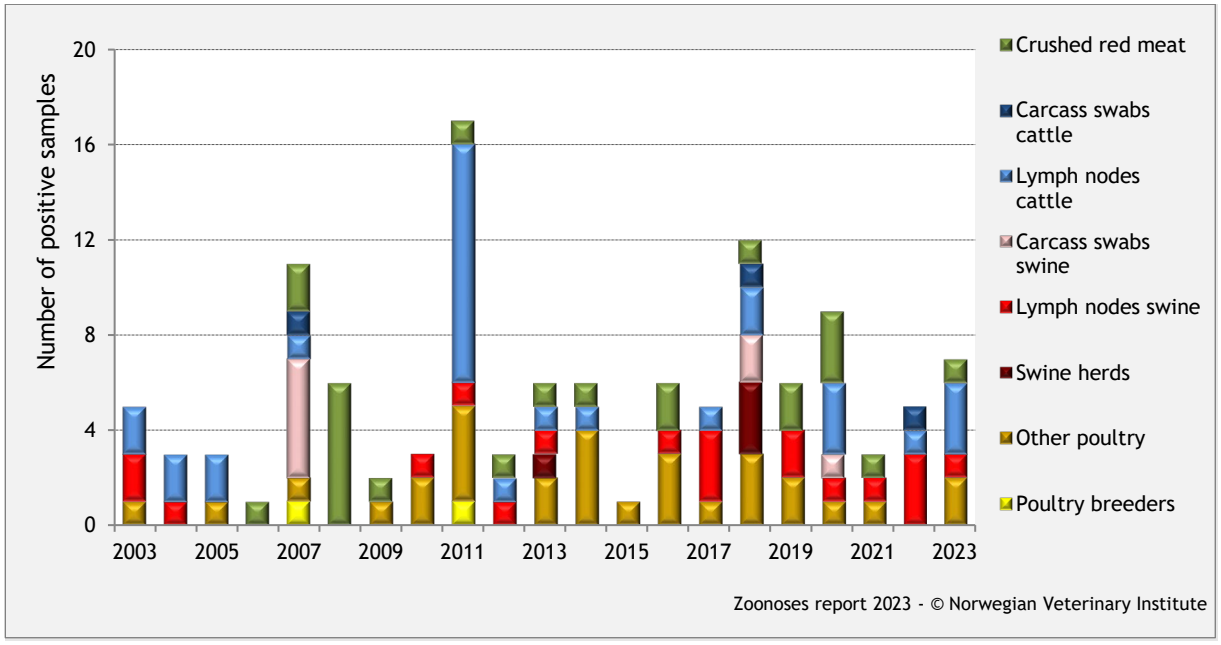



***Figure 2**. The number of positive samples in the Salmonella surveillance programme.*

*Salmonella* is occasionally detected in dogs and cats and in reptiles in Norway. In 2020, an increase in salmonellosis was evident particularly in cats. This coincided with an outbreak of salmonellosis in wild birds and a winter with less snow than usual, which is likely to have enabled cats to hunt more easily. The same trend was not observed in 2021, but in 2022 the number of detected cases was again quite high (n=32) compared to previous years. In 2023 the number of detected cases was lower, with thirteen reported cases.

*Salmonella* spp. is also sporadically detected in wild boar in Norway. During 2023, *Salmonella* was detected in samples from 8 of 366 hunted wild boar from which fecal samples were submitted for laboratory analysis. The most commonly detected serotype during 2023 was *S. enterica* subsp. d*iarizonae,* with four cases. Other serotypes detected were *S.* Abony (two cases), and single cases of *S.* Typhimurium and *S.* Hessarek. In the autumn of 2020, *Salmonella* Choleraesuis was detected in a domestic pig herd in southern Sweden for the first time in more than 40 years, and since then *S.* Choleraesuis has also been detected in Swedish wild boar. *Salmonella* Choleraesuis has not been detected in samples from wild boars in Norway.

In 2017, an exemption was made for 19 species on the general ban on import and marketing of reptiles in Norway. Reptiles frequently carry *Salmonella* and may pose a source of infection to humans.

*Salmonella* Typhimurium can sometimes be detected from wild birds and hedgehogs in Norway. Contamination of food and water by these animals may lead to infection of humans.

Feed given to domestic animals in Norway is generally free from *Salmonella*, but *Salmonella* is sometimes detected in feed factories, especially those producing fish feed. Continued surveillance of *Salmonella* in animals, feed and food is necessary for early detection, to facilitate control and to sustain the beneficial situation with respect to *Salmonella* in Norway.

# Campylobacteriosis

**The disease and its transmission routes**
There are many *Campylobacter* variants, but *C. jejuni* and *C. coli* are the most important zoonoses. These are commonly found in the guts of healthy birds, and humans may contract the infection through contaminated food or water or by direct contact. Diarrhoea is the most common symptom of campylobacteriosis, but more severe disease may also occur.

**Surveillance and control**
Campylobacteriosis is notifiable in humans in Norway, but not in animals (except *C. fetus* in cattle). In humans, both campylobacter infections verified by PCR and/or culture are registered in MSIS.

Norway has a surveillance programme for *Campylobacter* in broiler chickens. All flocks slaughtered before 51 days of age between the 1st May and 31st October are tested prior to slaughter. Carcasses from positive flocks are heat treated or frozen prior to sale in order to reduce the potential for transmission to humans. Pasteurisation of milk and disinfection of water are other measures that prevent transmission of *Campylobacter* to humans.

## Results 2023

In MSIS, 3,034 human cases of campylobacteriosis were reported in 2023, of which 1,216 contracted the infection in Norway, and 1,221 cases were travel associated. For 597 of the cases, place of infection was unknown (Figure 3). There were no outbreaks of campylobacteriosis reported in 2023.

Surveillance in 2023 showed that a total of 128 flocks (6.1%) tested positive for *Campylobacter spp.* when all broiler flocks slaughtered before 51 days of age during the period 1st of May – 31st of October were tested. In total 2,100 flocks from 505 farms were sampled. Of all farms sampled, 83 (16.4%) had positive flocks, and of these, 28 (5.5% of all farms) had two or more positive flocks. The majority of the positive flocks comes from farms having more than one positive flock and even though these farms only represent 5.5% (28/505) of all farms tested, they contributed with 57.0% (73/128) of all positive flocks tested in 2023. The carcasses from the positive flocks were either heat treated or frozen for a minimum of three weeks before being marketed. This year's result is within the range from 2020 - 2022 with 6.1%, 5.8% and 4.8% positive flocks, respectively. The prevalence is still very low, compared to most other European countries.

During 2023, caecal samples from 277 cattle and 333 fattening pigs were examined for *Campylobacter* spp. in the national antimicrobial resistance monitoring programme (NORM-VET). *C. jejuni* was detected from 128 (98.5%) cattle and 14 (4.7%) pig samples. *C. coli* isolates were obtained from 296 (99.3%) of the pig samples and none of the samples from cattle.

In the diagnostic services at the NVI, *Campylobacter* was detected in samples from 21 cattle, seven sheep, 41 dogs and one cat. For details see the Appendix.

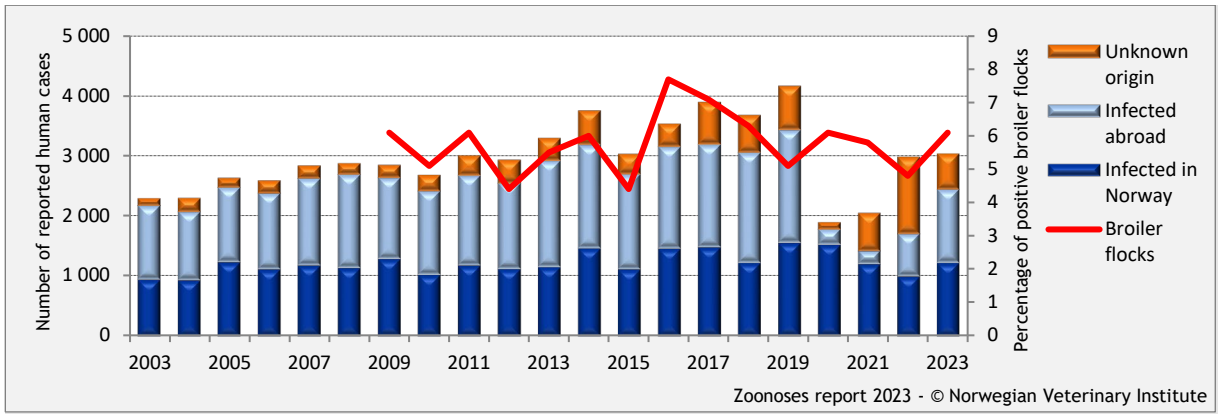



***Figure 2**. The number of reported cases of campylobacteriosis in humans (data from MSIS) and the percentage of positive broiler flocks (sampled between 1st May and 31st October).*

## Evaluation of the current situation

Campylobacteriosis is the most commonly reported zoonosis in humans in Norway. The number of human cases varies somewhat from year to year. The total number of cases in 2023 is comparable to 2022 but still lower than before the covid-19 pandemic. The number of travel-associated cases has returned to the same level as before the pandemic.

Case-control studies have shown that the most common source of campylobacteriosis in Norway is drinking untreated water at home, at holiday homes or in nature. Eating or preparing poultry and barbeque meals have also been identified as risk factors for infection (McDonald et al, 2015). Studies have also shown that contact with livestock is associated with an increased risk of campylobacteriosis in humans (McDonald et al 2015, Kapperud et al, 2003).

The prevalence of *Campylobacter* in broilers is low in Norway (3.3-7.7% of sampled flocks from 2002-2023) compared to other countries. A limited number of farms seem to deliver a high proportion of the positive flocks. The measures implemented in Norway to reduce *Campylobacter* in chicken meat are considered to have had a positive effect on public health.

# Yersiniosis

**The disease and its transmission routes**
Certain serogroups of the bacteria *Yersinia enterocolitica* can cause disease in humans, for which the most common symptom is diarrhoea. Swine are considered to be the main source of these disease-causing variants. The most common sources of human infection are contaminated food and water.

*Yersinia pseudotuberculosis*, which belongs to the same genus as *Y. enterocolitica*, may also cause disease in humans and animals.

**Surveillance and control**
Yersiniosis in humans is notifiable, while detection of *Y. enterocolitica* and *Y. pseudotuberculosis* in animals are not. There is no surveillance for this bacterium in animals or food in Norway. Because healthy swine can be carriers, contamination of carcasses may occur at slaughter. Good hygiene at slaughter reduces this risk.

## Results 2023

A total number of 86 cases of yersiniosis in humans was reported to MSIS in 2023, of which 53 contracted the infection in Norway and 17 cases were travel associated. For 16 cases, place of infection was unknown (Figure 4). The reported cases in 2023 were caused by *Y. enterocolitica* (85 cases) and *Y. pseudotuberculosis* (1 case).

In animals, *Y. enterocolitica* was detected in one dog, one deer and one white eared marmoset in 2023. *Y. intermedia* was detected in one dog in 2023. In 2022 The Norwegian Food Safety Authority initiated a survey on the occurrence of pathogenic *Y. enterocolitica* ready-to-eat (RTE) foods and whole RTE vegetables which was completed in 2023. In total 266 samples were analysed. The occurrence of pathogenic *Y. enterocolitica* in such products is low, as *ail*-positive *Y. enterocolitica* biotype 1A was only isolated from one sample. The significance of this finding from a food safety perspective is unclear as *Y. enterocolitica* biotype 1A has traditionally not been considered pathogenic for humans.

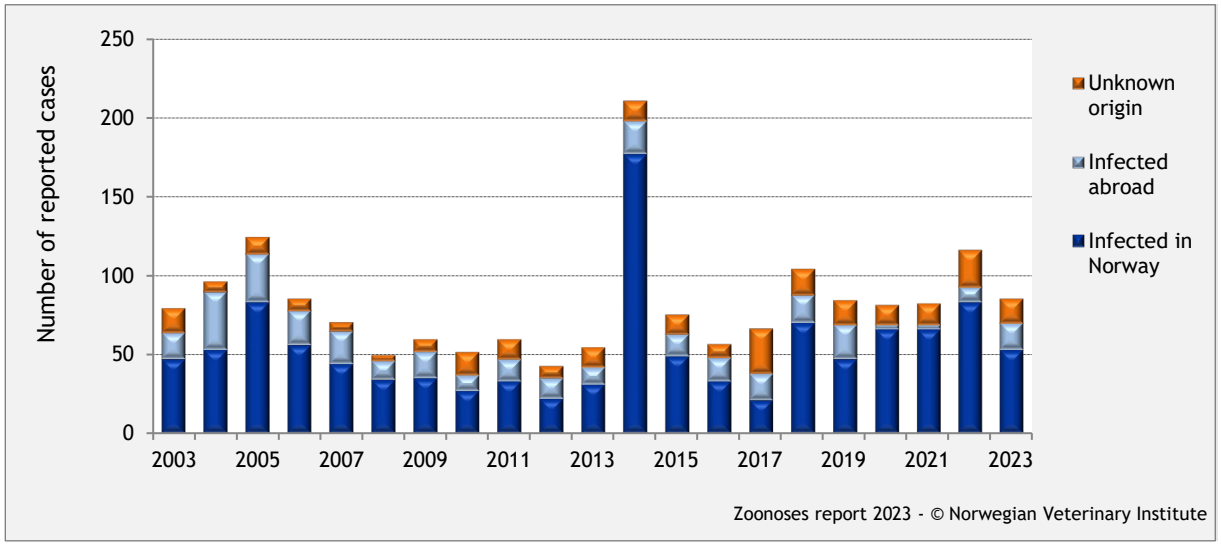



***Figure 4**. The number of reported cases of yersiniosis in humans. Data from MSIS.*

## Evaluation of the current situation

Most yersiniosis cases in humans in Norway are sporadic and have been acquired domestically. The number of reported human cases of yersiniosis in 2023 was on the same level as in 2019-2020. In 2022 the numbers were higher due to two national outbreaks with a total of 46 cases. Also, in 2014 and 2018 the increase in the number of reported cases were due to outbreaks.

*Y. enterocolitica* is presumed to be prevalent in swine and the bacteria cannot be eliminated from swine herds. During the 1990s routines for improved slaughter hygiene were implemented and this has contributed to reducing the number of human cases of yersiniosis. In a survey of pathogenic *Y. enterocolitica* in minced pork carried out in 2019, pathogenic *Y, enterocolitica* was isolated from 5.9% (9/152) samples. Eight of the isolates belonged to serogroup O:3, while the last one was of unknown serogroup.

# Listeriosis

**The disease and its transmission routes**
*Listeria monocytogenes* occurs naturally in the environment and is mainly pathogenic for pregnant women, the elderly and people with a compromised immune system. The main route of infection in is contaminated food or water, and listeriosis can cause fever, abortion, meningitis and septicaemia. In animals, listeriosis also causes meningitis and abortion, and feed is the main source of infection.

**Surveillance and control**
Listeriosis in humans is notifiable. In animals, it is categorised as a group C-disease and detection in animals usually does not result in any measures.

Detection of *L. monocytogenes* is part of the control system in the manufacture of certain food products. The upper limit in ready-to-eat foods is 100 cfu/g during the entire shelf life period, and 0 cfu/ml in products intended for small children or other vulnerable persons. If the upper limit is exceeded, the food should be withdrawn from market and corrective actions be taken in order to avoid concentrations above the legal limit in the products and minimise further contamination. Dietary advice is available; www.mattilsynet.no/mat-og-drikke/forbrukere and www.fhi.no

## Results 2023

A total number of 39 cases of listeriosis in humans was reported to MSIS in 2023, of which 32 contracted the infection in Norway and four cases were travel associated. For three cases, place of infection was unknown (Figure 5). One outbreak, with a total of seven cases was reported in 2023.

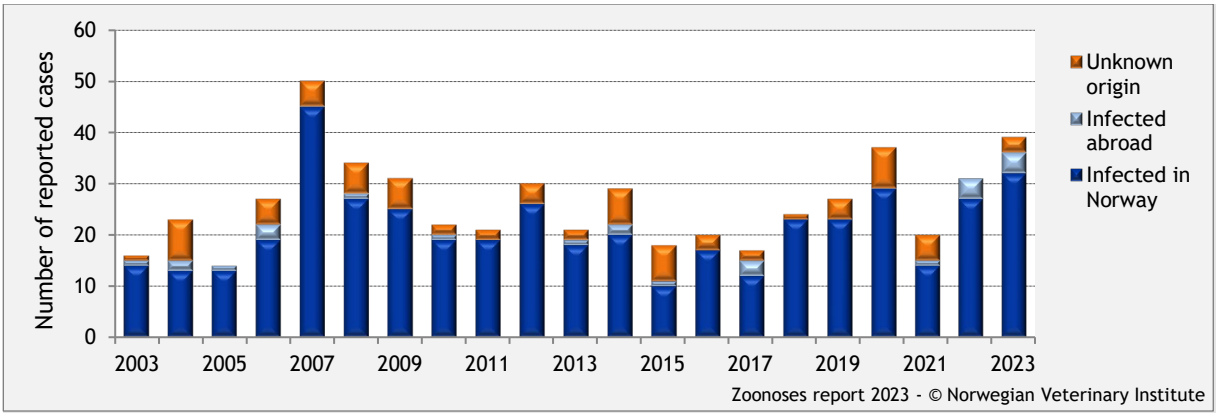



***Figure 5**. The number of cases of listeriosis in humans. Data from MSIS.*

In the diagnostic services at the NVI, *L. monocytogenes* was detected in seven sheep and four goats in 2023. There was no surveillance programme for *Listeria monocytogenes* in ready to eat foods in 2023.

The Institute of Marine Research (Havforskningsinstituttet) examined 49 samples of imported fish products, and *L. monocytogenes* was not detected in any of them.

NVI examined samples during the investigation of the outbreak linked to smoked salmon.

## Evaluation of the current situation

In Norway, the number of reported cases of listeriosis in 2023 increased compared to 2022, and it is the highest number of cases reported since 2014 (Figure 19). There was one outbreak of listeriosis in 2023, which included seven cases. The outbreak was caused by the same strain of *Listeria monocytogenes* as a previous outbreak in 2022. Both outbreaks were linked to smoked salmon from a specific producer. More information about the outbreak can be found in the report Utbrudd av smittsomme sykdommer i Norge i 2023. Vevbasert system for utbruddsvarsling (Vesuv) - FHI.

The number of cases of listeriosis is increasing both in Norway and in the rest of Europe. A possible explanation is more elderly people and thus a larger vulnerable group. The number of listeriosis cases in both humans and animals in Norway is low, but the infection can have severe consequences. Therefore, it is important that manufacturers of ready-to-eat foods have proper routines in place for preventing *Listeria* in their products, and systems for traceability and withdrawal of products from the market in cases where *L. monocytogenes* are detected. Until 2022 the surveillance programme for ready-to-eat foods had 1-5 positive samples per year, with concentrations in the range <10 cfu/g to more than 10 000 cfu/g. The positive samples have been from vegetables, meat and seafood products. Farmers, especially sheep farmers, must ensure that feed has good quality in order to reduce the risk of listeriosis in animals.

Until a few years ago, it was considered that most illness cases of listeriosis were sporadic. After the implementation of WGS, it has been found that apparently sporadic cases can be linked to each other via the DNA sequence, indicating that the cases are parts of outbreaks that may last for years. The outbreak in Norway in 2023, which had the same sequence as the outbreak in 2022, is an example of this. The implementation of whole genome sequencing (WGS) has transformed outbreak tracing by enabling detailed comparisons of sequences with patient isolates. Unlike traditional methods relying on patient interviews to identify food sources, WGS allows a more comprehensive approach. In 2023, international investigations found matches between patient isolates and fish farming isolates from Norway, despite processing in other countries.

Authorities like EFSA have contacted Norway about these cases, even though matching sequences from food samples may date back years. The persistence of virulent strains in raw materials like fresh salmon highlights Listeria's genetic stability and ability to survive in environments and production facilities for extended periods. Thus, epidemiology and traceability studies remain crucial to verify WGS findings.

Additionally, the detection of matching genetic profiles in unexpected food sources emphasizes the need for increased awareness. WGS data stress the importance of proper traceability and product withdrawal routines for producers of ready-to-eat products and raw material suppliers.

As important, the bioinformatic methods applied for comparison of DNA sequences from different isolates of *L. monocytogenes* need to be sufficiently sensitive to detect differences between apparently matching strains, in order to avoid misinterpretations.

# Shiga toxin-producing *E. coli* (STEC)

**The disease and its transmission routes**
*Escherichia coli* are normal inhabitants of the intestines of humans and animals. Some *E. coli* can produce Shiga toxin (also known as verotoxin). These variants are called shigatoxin producing *E.coli* (STEC) and can cause serious disease and bloody diarrhoea in humans. Transmission occurs via food, water or by animal contact.

**Surveillance and control**
STEC and diarrhoea-associated haemolytic uremic syndrome (HUS) are notifiable in humans. Detection of STEC in animals is not notifiable but the NFSA should be informed so that measures can be considered. There is no routine surveillance of STEC in animals or food, but several screening studies have been performed.

STEC should not be found in ready-to-eat foods and detection of these bacteria in such foods would lead to withdrawal of the product from the market. Good hygiene and proper routines at slaughter reduces the risk of contamination of meat with STEC.

## Results 2023

A total number of 663 cases of reported STEC cases in humans was reported to MSIS in 2023, of which 373 contracted the infection in Norway and 132 cases were travel associated. For 158 cases, place of infection was unknown. Among the reported cases in 2023, 17 developed HUS and 15 of these were children 0-9 years (Figure 6). Of the total number of STEC cases in 2023, 18% and 25% were classified as highly virulent or suspected highly virulent STEC, while 57% were classified as low virulent STEC. There were two outbreaks reported in 2023 caused by STEC O157 and STEC O26, with 12 and 24 cases respectively. In the STEC O26 outbreak nine cases developed HUS. More information about the outbreak can be found in the report Utbrudd av smittsomme sykdommer i Norge i 2023. Vevbasert system for utbruddsvarsling (Vesuv) - FHI.

In connection with two separate outbreaks of STEC O157 and STEC O26 infections in 2023, the Norwegian Veterinary Institute analysed around 10 and 95 samples, respectively. The STEC O26 outbreak strain was isolated from four samples of hamburgers. Although hamburgers were also suspected in the STEC O157 outbreak, STEC O157 was not isolated from any of the samples analysed.

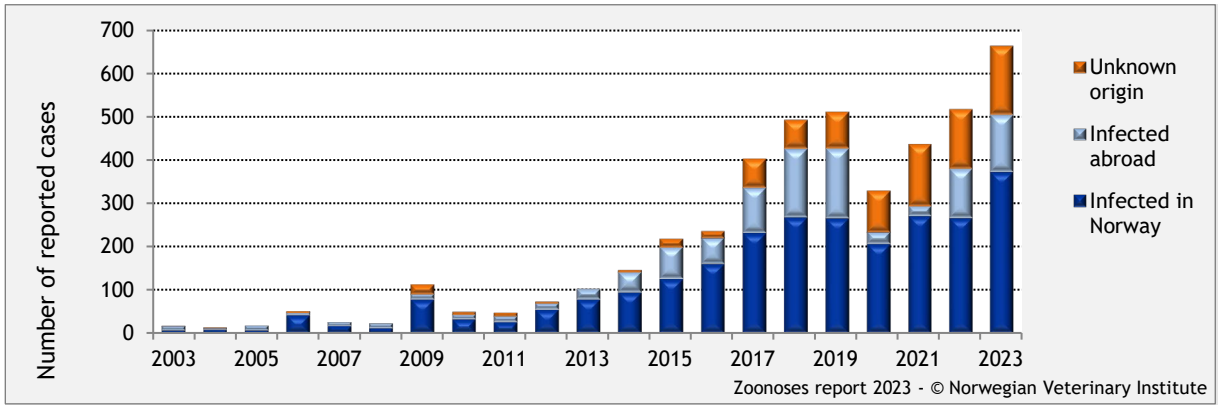



***Figure 6**. The number of reported cases of STEC (Shiga toxin-producing E. coli) in humans. Data from MSIS.*

## Evaluation of the current situation

The number of STEC cases reported in 2023 (663) was the highest number reported to MSIS ever. This is most likely associated with changed diagnostics and the introduction of multiplex PCR in more and more primary laboratories, but we cannot rule out a real increase. The number of domestically infected cases appears to be relatively stable, and for many years more than half of the STEC cases have been infected in Norway. However, in the past four years an increasing proportion of cases have been reported with unknown place of infection and this makes the trend difficult to interpret.

In a survey of zoonotic *E. coli* in Norwegian cattle, conducted in 2014, the Norwegian Veterinary Institute (NVI) found a low occurrence of STEC, with 15.6% of 179 herds positive for at least one STEC belonging to six serogroups (O26, O91, O103, O121, O145 and O157). Surveys of different food products performed by NVI have indicated a low occurrence, with STEC of serogroups O26 and O91 isolated from two of 308 samples of minced beef (2018). STEC was isolated from one of 137 samples of domestically produced fermented sausage (2020) and three of 151 samples of wheat flour (2021).

# Tuberculosis

**The disease and its transmission routes**
Tuberculosis is caused by species in the *Mycobacterium tuberculosis*-complex. As a zoonosis, *Mycobacterium tuberculosis* subsp. *bovis* (*M. bovis*), which causes bovine tuberculosis, is the most important. This bacterium is mostly found in cattle. Humans are usually infected by drinking unpasteurised milk. Tuberculosis in humans is usually caused by *M. tuberculosis subsp. tuberculosis* (*M. tuberculosis*) which is transmitted between humans in microscopic airborne droplets. Humans may also transmit tuberculosis to animals. Tuberculosis can cause an array of symptoms depending on the affected organ system, but symptoms from the respiratory system are most common. Tuberculosis is a chronic infection in both animals and humans.

**Surveillance and control**
Tuberculosis in humans is notifiable in Norway. Persons in higher-risk groups are offered BCG vaccination. Tuberculosis caused by *M. bovis* and *M. tuberculosis* in animals is categorised as a group 2 disease in Norway and a category B disease in EU, while detection of other non-tuberculous mycobacteria are group C.

Norway is free of bovine tuberculosis, and this is acknowledged in the EEA agreement where Norway is declared as officially free. Vaccination of animals against tuberculosis is forbidden in Norway. All animals, except poultry, are inspected for tuberculosis at commercial slaughter. Any suspicious findings will be examined further. Tuberculin testing is performed on all breeding bulls and breeding boars at semen collection facilities, imported animals, and in cases where tuberculosis is suspected or must be excluded. Animals with a positive tuberculin test will be euthanized and further examined. The NFSA have a surveillance programme for *M. tuberculosis* in cattle, camelids and farmed deer.

## Results 2023

In total, 152 cases of tuberculosis in humans were reported in 2023. One of these was caused by *M. bovis,* and most of the infections were contracted abroad.

As part of the surveillance programme for tuberculosis all cattle, sheep, goats, swine, horses and reindeer commercially slaughtered were examined *post mortem,* and any suspicious lesions are submitted for testing. Defined risk animals (imported animals and fallen stock) are also examined and tested, and so are any suspicious lesions found in fallen or suspected ill and culled animals, or hunted animals.

As part of the surveillance programs, the NFSA submit samples from suspicious lesions for testing. A total of 67 cattle from 56 herds, four camelids and one wild red deer were examined. Infection due to Mycobacterium tuberculosis complex (*M. bovis, M. caprae, M. tuberculosis*) was not detected in any of the samples.

In addition, 204 breeding boar studs and 411 breeding bulls were tuberculin tested, and all were negative. As part of diagnostic testing, samples from 20 swine were tested for *Mycobacterium* spp, but *Mycobacterium bovis* was not detected in any of the samples.

## Evaluation of the current situation

Since the mid-1990s, the number of tuberculosis cases caused by *M. tuberculosis* increased in Norway due to immigration, but since 2013 the number has decreased. The number of patients reported in 2023 is the lowest since the National Tuberculosis Registry (later MSIS) was established in 1962. *M. bovis*

infection in humans is rarely reported in Norway. Less than 1% of the reported human tuberculosis cases in the last 10 years were caused by *M. bovis*, and these patients were either infected abroad or many decades ago in Norway.

Bovine tuberculosis, *M. bovis* infection in cattle, was eradicated in Norway in 1963, but was detected in two areas in the 1980s. The source of *M. bovis* in these cases is unknown but may have been transmitted from an infected human. Tuberculosis in animals caused by *M. tuberculosis* is rare in Norway and was last reported in a dog in 1989.

In 2022 *M. bovis* was detected in one cow during slaughter. Further testing revealed that multiple cattle in the same herd were infected with *M. bovis*. Further contact tracing and testing revealed animals with positive immunological tests in two receiving contact herds in 2022 and 2023 respectively. The source of the infection in the herd has not been identified. Contact tracing among slaughterhouse workers involved in the slaughter of the index cow, identified an unexpected high proportion of Interferon-gamma release assay (IGRA) positives. Investigations revealed a probable causal relation between aerosol generating procedures during the slaughtering process and IGRA-positivity in workers, highlighting the importance of using respiratory protection during slaughtering of infected animals. Norway still has official free status from bovine tuberculosis.

Import of live animals to Norway, especially camelids like llama and alpaca, is associated with a risk of introducing *M. bovis* to the Norwegian animal population. Therefore, camelids are tested upon import to Norway. Infected humans are considered to represent a potential, but very low risk of introducing *M. bovis* and *M. tuberculosis* to Norwegian animals.

# Brucellosis

**The disease and its transmission routes**
Brucellosis is caused by *Brucella* bacteria, of which *B. abortus* (cattle), *B. melitensis* (sheep and goats), and *B. suis* (pigs) are the most important zoonotic species. *B. canis,* which causes disease in dogs, is less pathogenic for humans.

Brucellosis may cause sterility and abortion in animals. In humans, fever is the most common symptom. The bacteria are shed in milk, and humans are usually infected through consumption of unpasteurised milk and products made from unpasteurised milk.

**Surveillance and control**
Brucellosis in humans is notifiable and brucellosis in animals is a notifiable as a list 1-disease.

The surveillance programme for *Brucella* includes blood tests from cattle that have aborted and annual blood testing of a sample of the sheep and goat population. In addition, breeding bulls and boars and imported animals are tested. Vaccination of animals against brucellosis is forbidden in Norway. According to the EEA agreement, Norway is officially free of *B. abortus, B. melitensis* and *B. suis* in the bovine animals populations, and of *B. melitensis* in the ovine and caprine animal population.

## Results 2023

One case of brucellosis in humans was reported in 2023, and the person was infected abroad.

As part of the surveillance programmes, 110 cattle from 37 herds, bulk milk samples from 202 cattle herds, 9,628 sheep from 3,239 flocks, 1,675 goats from 57 herds and bulk milk samples from 169 dairy goat herds were tested. Antibodies against *Brucella* spp. were not detected. In addition, 462 breeding cattle and 2,571 breeding pigs were tested and were negative for antibodies against *Brucella* spp. No alpacas were tested. Two dogs tested negative for *B. canis* antibodies and/or by culture.

## Evaluation of the current situation

In humans, brucellosis is rare with only 1-4 reported cases per year, most of which have been infected abroad. The last case infected in Norway was in 2016.

Bovine brucellosis was eradicated from Norway in 1953 and brucellosis in sheep, goats and pigs has never been detected in Norway. In April 2021, ESA granted Norway status as officially free from *Brucella melitensis* in sheep and goats. *B. canis* has been detected in Sweden, but not in Norway.

# Trichinellosis

**The disease and its transmission routes**
Trichinellosis is caused by the group of parasitic nematodes called *Trichinella*. Animals and humans are infected upon the consumption of raw or undercooked meat containing *Thrichinella* larvae. These larvae develop into adults and reproduce in the small intestine of the host. The female nematodes produce larvae which penetrate the intestinal wall and then migrate through the host to muscle tissue. Trichinellosis symptoms and severity varies depending on *Thrichinella* species and infectious dose. The symptoms can range from mild flu-like symptoms to more severe muscle pain and mortalities.

**Surveillance and control**
Trichinellosis is a notifiable disease in humans, and a list 2 disease in animals. Commercially slaughtered pigs and horses have mandatory *Trichinella* testing carried out in accordance with EU legislation. Game meat from omnivorous wildlife like bears and wild boar must also be tested for *Trichinella* unless for own consumption. Even though not mandatory, it is advisable to test game meat from these species for the parasite.

## Results 2023

No cases of trichinellosis were reported in humans in 2023.

All commercially slaughtered pigs, 1,600 000 in 2023, and horses, 39 in 2023 (table 2), were tested for *Trichinella*, and none were positive. The NVI also recommend that all hunted wild boar are tested for *Trichinella* before consumption. A health surveillance programme for wild boar was started in 2018, and in 2023 samples from 366 wild boar harvested through hunting were tested for *Trichinella*, all negative.

## Evaluation of the current situation

Trichinellosis in humans is very rare in Norway. The last case, due to infection from abroad, was reported in 1996, and the last case infected in Norway was reported in 1980.

*Trichinella* in domestic animals in Norway was last reported in two pig herds in 1994, and before that in 1981. *Trichinella* may be found in wild animals, and the parasite may transmit to domestic animals kept outside such as swine and horses. To date only two species of *Trichinella* have been confirmed in animals in Norway: *Trichinella nativa* and *T. britovi*.

Since September 2018, hunters have had the opportunity to submit muscle tissue samples from wild boar hunted in Norway for free of charge *Trichinella* analysis when blood, feces and nasal swab samples are also submitted. The number hunted wild boar samples tested for *Trichinella* has increased significantly since 2018, and no samples have been positive.

Muscle samples from selected wild predators were collected in 2020-2021 for *Trichinella* analysis and analysed in 2022. *Trichinella larvae* were detected in two of the 62 lynx analysed, in one of 16 wolves and in six of 79 wolverine. Species identification of these larvae is ongoing.

In 2022, 200 arctic foxes and one polar bear from the high Arctic archipelago of Svalbard were also analysed for *Trichinella*. Four of the foxes in addition to the polar bear were positive, and *Trichinella nativa* identified. With the exception of the wild boar, there were no other wildlife examined for *Trichinella* in 2023.

# Echinococcosis

**The disease and its transmission routes**
*Echinococcus granulosus sensu lato* and *E. multilocularis* are small tapeworms that can cause serious disease in humans. The parasites have their adult stage in the intestines of predators (eg. dog and fox), and parasite eggs are shed in faeces of these hosts (definitive host). Other animals (intermediate host) are infected through ingestion of the eggs. In the intermediate host the eggs hatch to larvae that migrate and encapsulate in cysts in various organs. The intermediate host must be eaten by a definitive host for the parasite to develop further into adult stages. It is the larval cysts in the intermediate host, e.g. in humans, that cause disease. Humans may be infected through eating fruit and berries contaminated with eggs or through direct contact with infective definitive hosts (e.g. dogs).

**Surveillance and control**
Echinococcosis in humans is notifiable in Norway and in animals it is a group 2 disease. Intermediate hosts for *E. granulosus sensu lato* (eg. reindeer and cattle), are examined at slaughter. Since 2006, hunted red foxes have also been examined for *E. multilocularis*. This surveillance was intensified in 2011 when the parasite was detected in Sweden.

## Results 2023

Thirteen cases of echinococcosis in humans were reported in 2023, 12 were infected abroad while one had unknown place of infection. Reporting of echinococcosis in MSIS does not differentiate between alveolar echinococcosis/hydatidosis (caused by *Echinococcus multilocularis*) and cystic echinococcosis/hydatidosis (*Echinococcus granulosus sensu lato*).

The annual surveillance programme for *E. multilocularis* examined faecal samples from 512 red foxes, one arctic fox and twelve wolves on mainland Norway using molecular methods. *E. multilocularis* was not detected. All commercially slaughtered cattle, sheep and pigs were examined during meat inspection for gross-pathological changes suggestive of echinococcosis. No suspicious cases were identified. For details see the Appendix.

The prevalence and abundance of *E. multilocularis* prevalence was investigated in 2023 in the high Arctic archipelago of Svalbard as part of a small project. A total of 36 arctic foxes were examined and four positive animals found.

In 2023, cystic hydatidosis, *Echinococcus canadensis* genotype 10, was diagnosed in four moose (*Alces alces*) in Åmot and Røros counties shot during the autumn hunt. These findings corroborated the first detection of this parasite in moose in Stor-Elvdal county during the previous hunting season (2022). Changes suggestive of cystic hydatidosis found in the lungs and/or liver of hunted moose during meat inspection were submitted for further molecular analysis and confirmation. The molecular method used in the *E. multilocularis* surveillance program is specific for *E. multilocularis* and not able to detect *E. canadensis*.

## Evaluation of the current situation

Echinococcosis is not a current public health problem in Norway. During the years 2013-2023 between 0 and 13 cases have been reported annually of which almost all cases have been infected abroad. For the few remaining cases the place of infection was unknown.

*E. granulosus s.l.* was common in reindeer and reindeer herders in northern Norway in the 1950s. A concerted effort by public authorities to inform the public, anthelmintic treatment of herding dogs and preventing dogs getting access to raw meat and offal was enacted and saw parasite prevalence plummet.

*E. granulosus s.l. w*as last detected in reindeer in 1990 and 2003 in Norway. Further molecular identification of the genotype involved has not been possible, but *E. canadensis* has been reported in reindeer in Sweden. In cattle, *E. granulosus s.l.* was last reported in 1987. The detection of *E. canadensis* in a moose in the autumn of 2022 was not surprising given a known wolf-wild cervid cycle in neighbouring regions in Sweden and a shared wolf population. Advice has been provided to hunters in Norway to increase awareness of this parasite. This includes ensuring the proper disposal of slaughter waste, preventing hunting dogs from getting access to raw offal and, where this is not possible, giving the dogs appropriate anthelmintic treatment during the period with high infection risk (autumn hunt). The use of anthelmintics for dogs requires a prescription and should be done in dialogue with a veterinarian.

*E. multilocularis* has never been detected in mainland Norway. However, it is detected in Sweden, and surveillance of red foxes has been intensified in Norway in order to rapidly detect the parasite should it be introduced to Norway. Since 2002, 6,563 red foxes have been tested, and all have tested negative.

*E. multilocularis* is endemic in Svalbard in sibling voles (*Microtus levis*) and the Arctic foxes (*Vulpes lagopus*). Dogs and people in Svalbard are therefore at risk. *E. multilocularis* has not yet been detected in dogs in Svalbard.

Dog owners must ensure that dogs entering Norway from other countries are given anthelmintic treatment in accordance with national regulations, https://lovdata.no/dokument/SF/forskrift/2016-05-19-542. *Echinococcus* is endemic in many European countries, including Denmark, Sweden, the Baltics and central Europe. Infection may be introduced to Norwegian via untreated, imported dogs or dogs returning with their owners after holidays abroad. Recent research has also highlighted a risk of infection from unwashed lettuce and berries from endemic countries.

# Toxoplasmosis

**The disease and its transmission routes**
*Toxoplasma gondii* is a single celled parasite that has its adult stage in the cat (definitive host). The parasite is shed in faeces and intermediate hosts (e.g. sheep, human, rodents) are infected through contaminated food or water or by direct contact with contagious cats. Humans can also be infected through consumption of inadequately heat treated meat. Healthy adults will usually not become sick from toxoplasmosis. However, if women contract the infection for the first time during pregnancy, it may result in abortion or harm the foetus.

**Surveillance and control**
Toxoplasmosis is not notifiable in humans or animals in Norway.

The NFSA provides dietary advice to persons in risk groups (http://www.matportalen.no). Every year some animals are tested for *T. gondii* due to disease, abortion or in association with import/export. Testing of cats for *T. gondii* is not considered necessary.

## Results 2023

As part of the diagnostic work at the NVI, 5 sheep were tested serologically for *T. gondii* and two were positive.

## Evaluation of the current situation

*T. gondii* is prevalent in Norway, but less prevalent than in southern Europe. It has been estimated that 90% of Norwegian women are susceptible to infection, and that 2 in 1,000 pregnant women contract the infection for the first-time during pregnancy. The parasite is estimated to transmit to the foetus in approximately 50% of these cases.

*T. gondii* is prevalent in several mammals in Norway, in particularly cats and sheep. In an investigation of lambs in the 1990s, 18% of the tested lambs had antibodies against *Toxoplasma,* and positive animals were found in 44% of the tested flocks. Similarly, in a study performed between 2002 and 2008, 17% of tested goats were antibody-positive, and positive animals were found in 75% of the tested herds. In another study, performed in the 1990s, 2.6% of pigs for slaughter were antibody positive. In a serological survey of Norwegian cats, 41% of 478 cats were seropositive for *Toxoplasma*, and the risk of positivity increased with age (Sævik *et a*l, 2015). Wild deer may be infected with *T. gondii*. In a serological study of 4,300 deer hunted between 1992 and 2000, 34% roe deer, 13% elk, 5% hart deer and 1% reindeer were antibody positive.

# Rabies

**The disease and its transmission routes**
Rabies is caused by a lyssavirus, and the infection manifests itself as a neurological disease. The virus transmits through bites, or from exposure of open wounds to saliva from rabid animals. The incubation period is usually 1-3 months but may vary greatly, depending on the entrance site of the virus. Untreated rabies is always fatal. There are currently 17 species of lyssavirus. Bats are the reservoir hosts for all lyssaviruses, however, the main reservoir host for classical rabies virus (RABV) are carnivores. Carnivores, particularly stray dogs, constitute the main source of rabies infection leading to death in humans. Classic rabies is attributed to RABV, and bat rabies is caused by different viruses. In Europe, several different bat lyssaviruses have been detected. European bat lyssavirus 2 is detected in Norway and several neighbouring countries.

**Surveillance and control**
Rabies is notifiable both in humans and in animals (group 1 disease). A vaccine is available for people who are traveling to high-risk areas for extended periods. The vaccine is also used in combination with anti-serum to treat people who may have been exposed to rabies.

Animals showing clinical signs of rabies will be euthanized, and measures will be implemented to stop further spread. From the 1st January 2012, dogs and cats imported from EU and EEA countries are required to be vaccinated against rabies. Previously, a blood test to prove sufficient antibody titres was also mandatory. For dogs and cats imported from non-EU non-EEA countries, both a rabies blood test and proof of antibody titre is required.

## Results 2023

No cases of rabies were reported in humans in 2023.

Samples from one reindeer from Svalbard was tested for rabies at the NVI. Rabies was not detected.

## Evaluation of the current situation

In rare cases, bat rabies may transmit from bats to other warm-blooded animals, including humans. Therefore, care is advised when handling bats, and any bite in humans from a bat should be consulted with a doctor. It is not considered necessary to rabies vaccinate animals in Norway due to the detection of bat rabies in 2015.

Classical rabies has never been detected in animals in mainland Norway, but it has been detected in arctic fox, reindeer and a ringed seal in Svalbard. The last detection was in 2018 and before that 2012. Hence, outbreaks of rabies occur sporadically in Svalbard, most probably due to migrating arctic foxes during winter. It is important that persons living in or traveling to Svalbard are aware that rabies may occur among wild animals and take necessary precautions.

Dogs imported to Norway without vaccination may confer a risk of introducing rabies to mainland Norway. In a study performed at the NVI in 2012, serological results indicated that approximately 50% of dogs imported from Eastern Europe were improperly vaccinated or not vaccinated at all. Illegal import of dogs to Norway poses a threat to human and animal health due to the risk of introducing rabies to the country.

# Q-fever

**The disease and its transmission routes**
Q-fever is caused by the bacteria *Coxiella burnetii*, and is mainly associated with ruminants. However, humans and other animals may also become infected and sick. The bacteria are shed in urine, faeces, foetal fluids, placenta and foetal membranes, and can survive for extended periods in the environment. Transmission is airborne via aerosols. In animals, infection results in weak offspring, abortions, infections of the placenta and uterus. In humans *C. burnetii* may cause influenza-like symptoms and rarely more serious disease.

**Surveillance and control**
Q-fever in humans has been notifiable in Norway since 2012, and is a group 2-disease in animals. Animals with clinical signs of Q-fever must not have contact with animals from other herds/farms and the NFSA may impose restrictions on animal holdings where infection is confirmed or suspected.

From 2012, samples collected in the surveillance programme for *Brucella abortus* in cattle have also been tested serologically for *C. burnetii*. The programme involves passive clinical surveillance, and blood samples from cattle with an abortion in the second half of the pregnancy are analysed.

## Results 2023

Three cases of q-fever in humans were reported to MSIS in 2023, of which two cases were travel associated. For one case, place of infection was unknown.

At the NVI, blood samples from a total of 110 cattle were tested serologically for *C. burnetii* in the surveillance programme and 24 cattle were tested before export. In addition, seven alpacas were tested after import. Antibodies were not detected in any samples. For further information see the Appendix.

## Evaluation of the current situation

Q-fever is currently not a problem for human or animal health in Norway. The infection became notifiable in humans in 2012, and for the years 2014-2023, 37 cases have been reported in total. Of these, 31 cases were infected abroad and six cases had an unknown place of infection.

Q-fever has not been detected in Norwegian animals. Screening studies were performed in 2008 (460 bovine dairy herds and 55 bovine meat herds), in 2009 (349 goat herds and 45 bovine herds) and in 2010 (3,289 bovine dairy herds). Testing is regularly performed on imported animals and as part of diagnostic testing of sick animals and from 2012, serological testing for Q-fever has also been included on samples from cattle collected in the surveillance programme for *Brucella*.

# BSE and vCJD

**The disease and its transmission routes**
Bovine spongiform encephalopathy (BSE, mad cow disease) in cattle and Creutzfeldt-Jacob disease (CJD) in humans are transmissible spongiform encephalopathies (TSE). These fatal diseases cause spongy degeneration of the brain and spinal cord. The infective agents are prions, protein structures without DNA. A form of CJD, variant CJD (vCJD) was first described as the cause of death in a person in the UK In 1995. The disease was suspected to be caused by consumption of beef containing the prion associated with classic BSE.

Other TSE-diseases that do not transmit between animals and humans have also been described, such as atypical BSE in cattle, scrapie in sheep, sporadic CJD in humans and chronic wasting disease (CWD) in deer.

**Surveillance and control**
Surveillance for BSE started in Norway in 1998, and includes testing of imported animals and their offspring, emergency slaughtered cattle, cattle with defined clinical signs at slaughter and a sample of routinely slaughtered cattle. All small ruminants with scrapie are tested to rule out BSE.

At slaughter, specified risk material (SRM) is removed from cattle and small ruminants. It is forbidden to use protein from animal (including fish protein) in feed for ruminants. Norway banned the use of bone meal in ruminant feed in 1990.

## Results 2023

No cases of vCJD were reported in humans in 2023.

In total, 5,898 cattle were tested, and all were negative for BSE.

# Antimicrobial resistance

Antimicrobial resistant bacteria may be zoonotic and transmit through direct or indirect contact, including through food. One example is methicillin resistant *Staphylococcus aureus* (MRSA), which may transmit between animals and humans.

**Surveillance and control**
Infection and carriage of some types of antimicrobial resistant bacteria such as MRSA is notifiable in humans (www.fhi.no) and in animals (NFSA) in Norway. In addition, selected microbes from certain infections, and their resistance profiles, are reported annually to the NORM surveillance programme for antimicrobial resistance in human pathogens. Correspondingly, antimicrobial resistance in bacteria from animals, feed and food are reported through the NORM-VET surveillance programme. There is a separate surveillance programme for MRSA in swine, aimed at identifying MRSA positive herds as Norway has chosen a strategy to eradicate MRSA from swine.

The 2023 data confirm that the situation regarding antimicrobial resistance in bacteria from animals and food in Norway is good. The occurrence of multi-drug resistance (MDR), i.e. resistance to three or more antimicrobial classes, and specific emerging resistant bacteria/mechanisms such as resistance to extended-spectrum cephalosporins (ESC), are low. Carbapenem-resistant *Enterobacterales* (CRE) was for the first time detected from food-producing animals in 2023. The sample was from a healthy cow and taken at slaughter.

A total of 124 *Campylobacter jejuni* isolates from cattle were susceptibility tested in 2023. Of these, 79.8% were fully susceptible to all antimicrobial agents included in the test panel. MDR was detected in 2.4% of the isolates. In addition, 281 *Campylobacter coli* isolates from pigs were susceptibility tested. In total, 79.0% of these were fully susceptible to all antimicrobial agents included in the test panel, while 0.4% were MDR.

The MRSA surveillance programme in pigs did not detect any pig herds with MRSA in 2023. In total, 541 herds were included in the survey, of which 70 were genetic nucleus or multiplier herds, 11 herds were central units of the sow pool herds, 14 were of the largest farrow to grower or farrow to finish herds, and the remaining 446 were herds with more than 10 sows.

## Evaluation of the current situation

Antimicrobial resistance in bacteria has become a serious threat to human and animal health globally. The prevalence of antimicrobial resistant bacteria is still low in both humans and animals in Norway compared to other European countries. However, the situation is threatened by the high use of antimicrobials globally.

Bacterial resistance to critically important antimicrobials, such as extended-spectrum cephalosporins and carbapenems, has received special attention over the last years. Carbapenems are defined by the WHO as critically important for antimicrobial treatment of human infections. Development of a reservoir of carbapenem resistant bacteria in food production animals and the food chain is of concern as they may have an impact on resistance development in human bacterial populations.

MRSA was most likely first introduced to Norwegian swine production through labourers carrying the bacteria, and subsequently spread further through movement of live animals. From swine, MRSA may transmit back to humans through direct or indirect contact. This form of transmission is difficult to control and is a modern biosecurity challenge in Norwegian food production.

# Foodborne outbreaks

An outbreak is either defined as more cases than expected of a specific disease within a defined geographical area and time period, or as two or more cases of a disease with a common source of infection. In 2005, the NIPH and the NFSA introduced a web-based system for reporting outbreaks, Vesuv. The system is used by specialist- and municipal health services and the NFSA to notify outbreaks. The following types of outbreaks are notifiable through Vesuv: outbreaks of conditions that are notifiable in MSIS; outbreaks associated with food or water; outbreaks caused by particularly serious infections; very large outbreaks; and outbreaks in healthcare institutions. The four last categories also include outbreaks of conditions that are not notifiable in MSIS.

The purpose of investigating foodborne outbreaks is to stop the outbreak, implement control measures and prevent future outbreaks. The District Medical Officer is responsible for coordinating investigation and response to outbreaks in his/her municipality. Proper outbreak investigation requires cooperation between local and central health authorities, the NFSA and other relevant authorities.

## Results 2023

In 2023, the NIPH received 25 notifications through Vesuv of possible or confirmed foodborne outbreaks outside health institutions. In total, 518 persons were reported to have become sick in these outbreaks. The number of affected persons in each of the outbreaks varied between two and 140 (median 14). Norovirus caused five outbreaks, *Salmonella* three, *Cryptosporidium* two and *Escherichia coli* (STEC) two. In eight of the outbreaks, the causative agent was not identified (Figure 7). More information about the outbreaks can be found in the report Utbrudd av smittsomme sykdommer i Norge i 2023. Vevbasert system for utbruddsvarsling (Vesuv) - FHI.

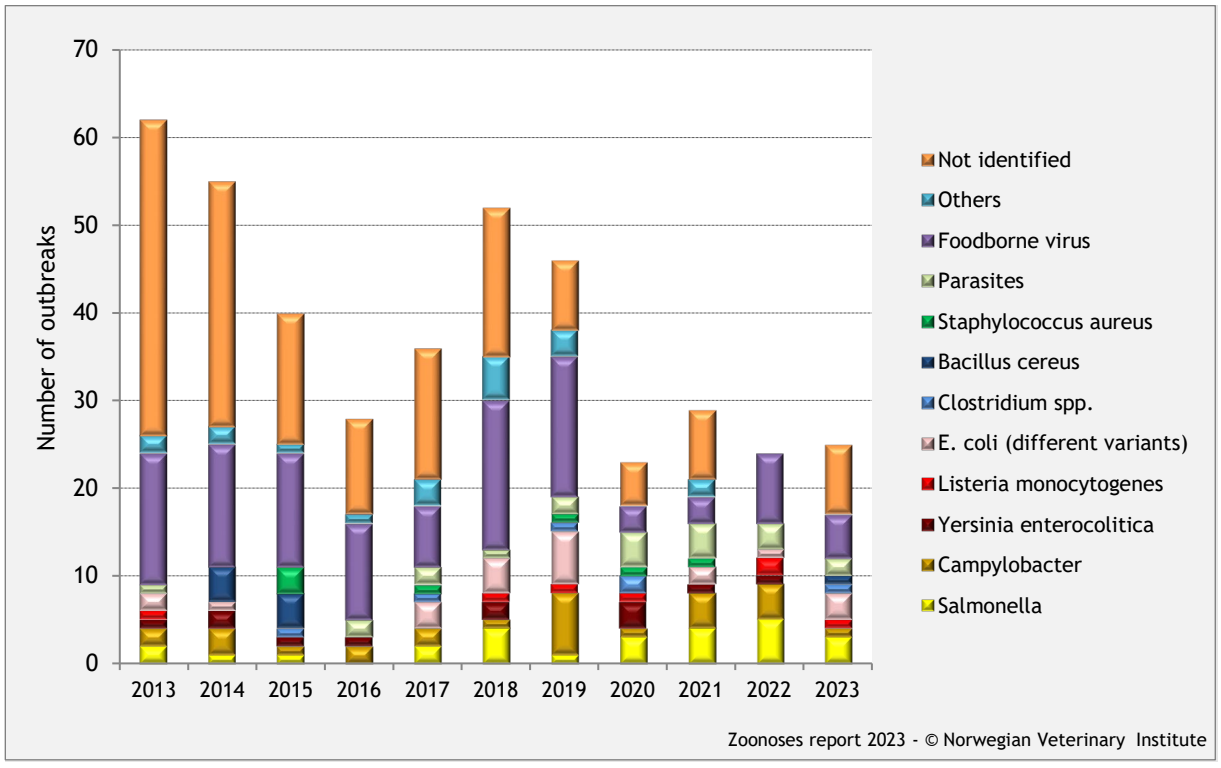



***Figure 7**. The number of reported foodborne outbreaks where an agent was verified or strongly suspected.*

# Appendix Tables

***Table 1.*** *Human population of Norway per 1st January 2023 (from statistics Norway).*

| Age group | Female | Male | Total |
|---|---|---|---|
| 0 - 9 | 300 016 | 284 377 | 584 393 |
| 10 - 19 | 337 329 | 319 705 | 657 034 |
| 20 - 29 | 360 711 | 341 453 | 702 164 |
| 30 - 39 | 390 755 | 374 563 | 765 318 |
| 40 - 49 | 365 881 | 349 948 | 715 829 |
| 50 - 59 | 375 771 | 360 920 | 736 691 |
| 60 - 69 | 303 141 | 301 619 | 604 760 |
| 70 - 79 | 231 641 | 244 794 | 476 435 |
| 80 - 89 | 85 866 | 114 511 | 200 377 |
| 90 - | 14 359 | 31 624 | 45 983 |
| **Total** | **2 765 470** | **2 723 514** | **5 488 984** |

***Table 2.*** *Animal population of Norway in 2023.*

| **Animal species - category** | **Number*** | | |
|---|---|---|---|
| | **Herds /flocks** | **Animals** | **Slaughtered animals** |
| Cattle - total | 12 300 [a] | 886 000 [a] | 302 000 [c] |
| Dairy production | 6 500 [a] | 203 000 [a] | |
| Meat production | 6 000 [a] | 109 000 [a] | |
| Combined production | 1 100 [a] | | |
| Sheep - total | | | 1 100 000 [c] |
| Sheep >1 year | 13 200 [a] | 915 000 [a] | |
| Goats - total | 1 600 [a] | 76 300 [a] | 26 000 [c] |
| Dairy goats | 260 [a] | 34 600 [a] | |
| Swine - total | 2 400 [a] | 709 000 [a] | 1 600 000 [c] |
| Breeding pigs | 850 [a] | 38 800 [a] | |
| Slaughter pigs | 800 [a] | 406 000 [a] | |
| Chickens (*Gallus gallus*) | | | |
| Grandparent stock – egg producers | 2 (2)[b] | | |
| Parent stock – egg producers | 7 (15)[b] | | |
| Parent stock – broiler | 93 (235)[b] | | |
| Laying hens | 581 (863)[b] | | |
| Broilers | 556 (4 576[1])[b] | | 75 000 000 [c] |
| Turkey, goose and duck | | | |
| Parent stock | 6 (23)[b] | | |
| Meat production | 55 (457[1])[b] | | 950 000 [c] |
| Farmed deer | 100[a] | 6 400[a] | |
| Horses | | | 39 [c] |

[a] Figures from the registry of production subsidy per 31.3.2023.
[b] Figures from the surveillance programme for *Salmonella* in 2023
[c] Figures from the Norwegian Agriculture Agency (based on delivery for slaughter)
[1] Slaughter batches

***Table 3**. The most common Salmonella serovars found in humans in Norway in 2023.*

| Serovar | Place of infection | | | Total |
|---|---|---|---|---|
| | Norway | Abroad | Unknown | |
| S. Enteritidis | 43 | 25 | 172 | 240 |
| S. Typhimurium | 35 | 14 | 28 | 77 |
| S. Typhimurium monofasisk variant | 18 | 1 | 18 | 37 |
| S. Stanley | 8 | 4 | 20 | 32 |
| S. Java | 2 | 2 | 17 | 21 |
| S. Newport | 7 | 0 | 11 | 18 |
| S. Chester | 3 | 4 | 10 | 17 |
| S. Agona | 13 | 2 | 1 | 16 |
| S. Infantis | 3 | 2 | 7 | 12 |
| S. Napoli | 10 | 1 | 0 | 11 |
| S. Saintpaul | 4 | 1 | 6 | 11 |
| S. Montevideo | 8 | 1 | 1 | 10 |
| Other | 89 | 47 | 119 | 255 |
| **Total** | **243** | **104** | **410** | **757** |

***Table 4**. Human cases of campylobacteriosis (infected in Norway) in 2023 distributed by county. From 2017 both cases verified by PCR and/or culturing are notifiable to MSIS and included in the table. PCR positive cases are also included for 2015 and 2016.*

| County | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Agder | 87 | 47 | 63 | 77 | 44 | 51 | 71 | 60 | 43 | 39 |
| Akershus | 175 | 136 | 156 | 141 | 103 | 131 | 156 | 136 | 99 | 121 |
| Buskerud | 60 | 62 | 63 | 80 | 55 | 84 | 81 | 95 | 35 | 47 |
| Finnmark | 19 | 12 | 21 | 19 | 20 | 18 | 6 | 11 | 10 | 16 |
| Innlandet | 120 | 89 | 118 | 143 | 111 | 111 | 137 | 131 | 94 | 116 |
| Møre og Romsdal | 71 | 34 | 35 | 66 | 59 | 47 | 62 | 43 | 40 | 51 |
| Nordland | 59 | 47 | 42 | 44 | 58 | 45 | 66 | 47 | 37 | 65 |
| Oslo | 154 | 120 | 110 | 109 | 145 | 126 | 165 | 132 | 103 | 107 |
| Rogaland | 130 | 124 | 166 | 205 | 130 | 118 | 150 | 106 | 95 | 128 |
| Telemark | 50 | 35 | 55 | 46 | 33 | 46 | 38 | 38 | 29 | 54 |
| Troms | 56 | 43 | 57 | 52 | 36 | 47 | 60 | 39 | 35 | 56 |
| Trøndelag | 153 | 121 | 140 | 154 | 118 | 130 | 145 | 96 | 109 | 123 |
| Vestfold | 77 | 46 | 183 | 99 | 74 | 192 | 83 | 47 | 39 | 82 |
| Vestland | 183 | 148 | 168 | 216 | 189 | 350 | 234 | 159 | 189 | 175 |
| Østfold | 70 | 44 | 73 | 61 | 50 | 54 | 61 | 63 | 31 | 32 |
| Ukjent fylke | | | | | | 1 | | | 1 | 4 |
| **Total** | **1 464** | **1 108** | **1 450** | **1 512** | **1 225** | **1 551** | **1 515** | **1 203** | **989** | **1 216** |

***Table 5**. Foodborne outbreaks 2023.*

| Agent | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Salmonella* sp. | 1 | 1 | | 2 | 4 | 1 | 3 | 4 | 5 | 3 |
| *Campylobacter* sp. | 3 | 1 | 2 | 3 | 1 | 7 | 1 | 4 | 1 | 1 |
| *Yersinia* sp. | 2 | 1 | 1 | 1 | 2 | | 3 | 1 | 3 | |
| *Listeria monocytogenes* | | | | | 1 | 1 | 1 | | 2 | 1 |
| *Escherichia coli (VTEC)* | 1 | | 1 | 3 | 4 | 6 | | 2 | | 2 |
| *Clostridium* spp. | | 1 | | 1 | | 1 | 2 | | | 1 |
| *Bacillus cereus* | 4 | 4 | | | | | | 1 | | 1 |
| *Staphylococcus* enterotoxin | | 3 | | 1 | | 1 | 1 | 1 | | |
| Parasites | | | 2 | 2 | 1 | 2 | 4 | | 3 | 2 |
| Virus | 14 | 13 | 11 | 7 | 17 | 16 | 3 | 4 | 8 | 5 |
| Other | 2 | 1 | 1 | 1 | 5 | 3 | | | 1 | 1 |
| Unknown | 28 | 15 | 11 | 15 | 17 | 8 | 5 | 8 | 11 | 8 |
| **Total** | **55** | **40** | **29** | **36** | **52** | **46** | **23** | **25** | **34** | **25** |

***Table 6**. Salmonella in feed and feedstuff 2023.*

| Category | Number tested* | Number positive | Comment |
|---|---|---|---|
| **Feedstuff** | | | |
| Cereal grain | 176 (2) | 0 | |
| Corn | 55 | 1 | S. Lexington |
| Rape | 48 (1) | 2 | S. Mbandaka |
| Soya | 2 342 (4) | 0 | |
| Sunflower | 24 | 0 | |
| Legume seeds etc. | 21 | 0 | |
| Tubers, roots etc. | 25 | 0 | |
| Other plant based feedstuffs | 121 (1) | 4 | S. Cubana, S. Give, S. Yoruba, S. Enterica serovar 47:z4z23 |
| Meat based feedstuff | 330 | 13 | S. Havana (12), S. Agona |
| Marine based feedstuff | 277 | 0 | |
| **Feed** | | | |
| Domestic animals (cattle, swine, poultry) | 239 (96) | 0 | |
| Fish | 2 152 (20) | 3 | S. Give (2), S. Lexington |
| **Environmental samples in factories producing feed and feedstuff** | 14 083 | 222 | 32 different serovars |

Total numbers are presented, in brackets the number of samples collected by Authorities.

***Table 7.*** *Salmonella in animals 2023.*

| Category | Number tested[1] | Number positive[1] | Comment |
|---|---|---|---|
| Chicken – surveillance - breeding flocks | 250 | 0 | |
| Chicken – surveillance – layer flocks | 863 | 2 | *S.* Typhimurium; *S.* ent. subsp. *diarizonae* serovar 61:k:1,5,7 |
| Chickens – surveillance – broiler flocks[2] | 4 576 | 0 | |
| Chicken flocks – other samples | 5 | 0 | |
| Turkey, ducks, geese – surveillance - breeding flocks | 23 | 0 | |
| Turkey, ducks, geese – surveillance – meat flocks[2] | 457 | 0 | |
| Turkey, ducks, geese – other samples | 7 | 0 | |
| Cattle – surveillance – animals (lymph nodes) | 3 172 | 3 | *S.* Hessarek |
| Cattle – diagnostics - herds | 38 | 0 | |
| Sheep – diagnostics - herds | 11 | 3 | *S.* ent. subsp. *diarizonae* serovar 61:k:1,5,7 |
| Goats- diagnostics - herds | 3 | 0 | |
| Swine – surveillance – slaughter pigs – animals (lymph nodes) | 1 673 | 0 | |
| Swine – surveillance – sows – animals (lymph nodes) | 1 329 | 1 | *S.* Saintpaul[3] |
| Swine – surveillance – breeding herds | 69 | 0 | |
| Swine – diagnostics - herds | 31 | 1 | *S.* Saintpaul[3] |
| Horse – diagnostics – stables | 77 | 2 | *S.* Typhimurium; *S.* ent. subsp. *diarizonae* serovar 61:k:1,5,7 |
| Dog - diagnostics | 132 | 5 | *S.* Typhimurium (2), *S.* Derby (2); *S.* Infantis |
| Cat - diagnostics | 49 | 13 | *S.* Typhimurium |
| Alpaca – herds - diagnostics | 0 | 0 | |
| Wild boar – surveillance - animals | 361 | 8 | *S.* Typhimurium, S. Abony (2), S. Hessarek, *S.* ent. subsp. *diarizonae* (4) |
| Animals/birds/zoo birds/zoos | 24 | 0 | |
| Reptiles | 5 | 2 | *S.* ent. subsp. *diarizonae* |
| Various wild animals | 17 | 0 | |
| Wild birds | 7 | 3 | *S.* Typhimurium |

[1] Units for numbers are given in the first column.
[2] Number of slaughter batches
[3] Samples from the same herd

***Table 8.*** *Salmonella in food 2023.*

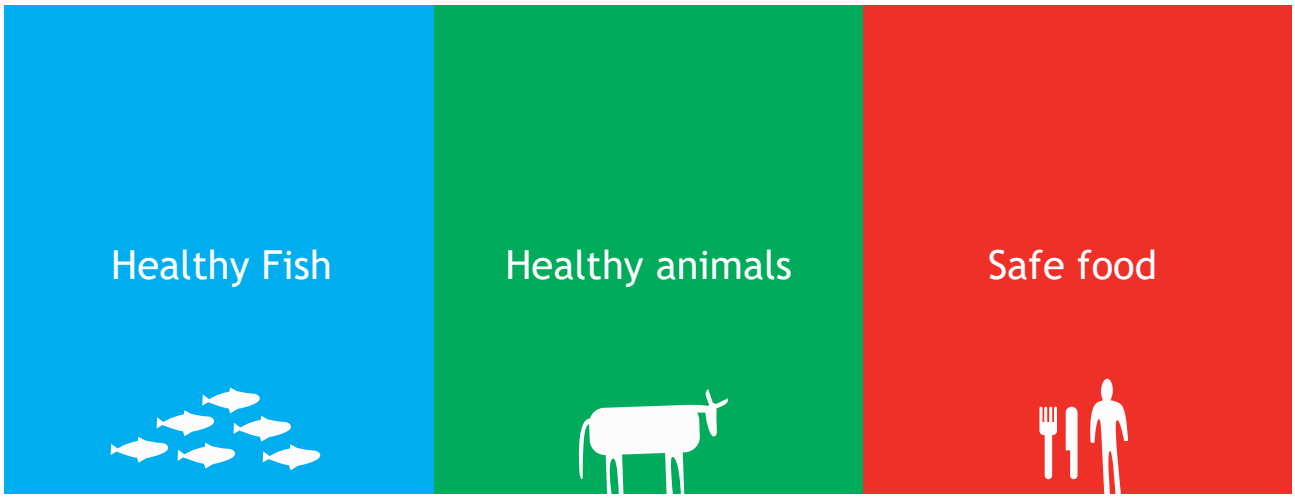
| Category | Number sampled | Number positive | Comment |
|---|---|---|---|
| Cattle – swab of carcass – surveillance | 3 067 | 0 | |
| Swine - swab of carcass – surveillance | 2 969 | 0 | |
| Meat scrapings (cattle, swine. sheep) - surveillance | 3 098 | 1 | *S.* ent. subsp. *diarizonae* 61:k:1,5,7 |
| Fishery products – imported – IMR* | 95 | 0 | |
| Fishery products - Norwegian – IMR* | 30 | 0 | |

* Data from Institute of Marine Research (Havforskningsinstituttet)

***Table 9**. Selected zoonoses in animals 2023. Salmonella is presented in separate tables.*

| Infection/agent | Category | Number tested | Number positive | Comment |
|---|---|---|---|---|
| Campylobacteriosis | Broiler chicken flocks – surveillance | 2 100 | 128 | May - October |
| | Cattle – diagnostics | 41 | 21 | *C. jejuni* |
| | Dog – diagnostics | 90 | 41 | *C. upsaliensis* (37), *C. jejuni* (2), C. lari (2) |
| | Sheep – diagnostics | 21 | 7 | *C. jejuni (5), C. coli (2)* |
| | Cat – diagnostics | 12 | 1 | *C. upsaliensis* |
| Tuberculosis | Cattle – surveillance - animals | 67 | 0 | |
| | Camelides – surveillance - animals | 4 | 0 | |
| | Red deer – surveillance - animals | 1 | 0 | |
| | Swine – diagnostic – herds | 20 | 17 | *M. avium* subsp. *hominissuis* |
| | Cattle – tuberculin testing – breeding animals | 411 | 0 | |
| | Swine – tuberculin testing – breeding animals | 204 | 0 | |
| Brucellosis | Cattle – surveillance | 110 | 0 | |
| | Cattle – breeding animals | 462 | 0 | |
| | Sheep – surveillance | 9 628 | 0 | |
| | Goat – surveillance | 1 675 | 0 | |
| | Swine – breeding stock | 2 571 | 0 | |
| | Dog | 2 | 0 | |
| Echinococcosis | Fox – surveillance | 512 | 0 | |
| | Wolf – surveillance | 12 | 0 | |
| | Moose – diagnostics | 9 | 4 | *E. canadensis* G10 |
| | Cattle, small ruminants, swine, horse | All slaughtered* | 0 | |
| Toxoplasmosis | Sheep – diagnostics | 5 | 2 | *T. gondii* |
| Rabies | Reindeer – diagnostics | 1 | 0 | |
| Trichinellosis | Pig and horse | All slaughtered* | 0 | |
| | Wild boar – surveillance | 366 | 0 | |
| | Arctic fox | 1 | 0 | |
| | Glutton | 1 | 0 | |
| Q-fever | Cattle – surveillance | 110 | 0 | |
| | Cattle – export | 24 | 0 | |
| | Alpaca – import | 7 | 0 | |
| BSE | Cattle – surveillance - animal | 5 898 | 0 | |
| MRSA | Swine – surveillance – herds | 541 | 0 | |

* Commercial slaughtered animals (for animal population see Table 2).

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