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Disease burden of food- related pathogens in the Netherlands, 2023

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Colophon

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Synopsis

Disease burden of food-related pathogens in the Netherlands, 2023

Each year, RIVM examines how many people become ill or die from gastrointestinal infections in the Netherlands. The study focuses on 14 pathogens known to cause these infections, which can be transmitted through food, human-to-human contact, animals or environmental sources.

The disease burden associated with these 14 pathogens in 2023 was higher than in 2022, 2021, and 2020, reaching levels comparable to 2019, the last pre-COVID-19 year.

The disease burden is expressed in Disability Adjusted Life Years (DALYs), an international metric used to quantify the number of healthy years of life lost due to disability or premature death. In 2023, the total number of DALYs resulting from these 14 pathogens was 11,000 DALYs, an increase from 10,000 DALYs in 2022, 9,100 DALYs in 2021, and 7,300 DALYs in 2020. The number of DALYs in 2023 was the same as in 2019 (11,000 DALYs). The fraction of the 2023 disease burden attributable to foodborne transmission was estimated at 4,700 DALYs. This was higher than in 2022 (4,300 DALYs), 2021 (4,200 DALYs), and 2020 (3,600 DALYs), and slightly higher than in 2019 (4,600 DALYs).

The total costs associated with the disease burden from the 14 pathogens in 2023 have been estimated at 538 million euros. This was higher than the costs for 2022 (496 million euros), 2021 (411 million euros), 2020 (328 million euros) and 2019 (497 million euros). The estimated costs include direct medical costs, such as hospitalizations, as well as indirect costs incurred by patients and families, such as travel expenses. Additionally, the costs include the losses incurred in other sectors, such as those from absenteeism. The costs due to gastrointestinal infections caused by foodborne transmission in 2023 (217 million euros) were also higher than in 2022 (209 million euros), 2021 (197 million euros) and 2020 (179 million euros) and slightly higher than in 2019 (214 million euros).

This study was commissioned by the Ministry of Health, Welfare and Sport. The results provide policy-makers with insights into the burden of disease of food-related pathogens. This study also allows monitoring of possible trends in time of the burden of disease caused by foodborne infections, as well as of the associated costs.

Keywords: food-related disease, burden of disease, DALY, costs of illness

Publiekssamenvatting

Ziektelast van voedseloverdraagbare ziekteverwekkers in Nederland in 2023

Het RIVM brengt elk jaar in kaart hoeveel jaren mensen een slechte gezondheid hebben of eerder overlijden (ziektelast) in Nederland door een infectie van de maag of darm. Het heeft hiervoor naar 14 ziekteverwekkers gekeken die deze infecties kunnen veroorzaken. Mensen kunnen hiermee besmet worden via voedsel, dieren, andere mensen of het milieu. In 2023 was de ziektelast van deze 14 ziekteverwekkers hoger dan in de drie jaren ervoor en hetzelfde als in 2019, het laatste jaar voor de coronapandemie.

De ziektelast wordt met een internationale maat aangegeven: DALY's (Disability Adjusted Life Years). Het verschilt per ziekteverwekker in welke mate ze via de verschillende routes mensen besmetten. In 2023 was het totale aantal DALY's voor de Nederlandse bevolking als gevolg van deze 14 ziekteverwekkers 11.000 DALY's. Dat was hoger dan in 2022 (10.000 DALY's), 2021 (9.100 DALY's) en 2020 (7.300 DALY's). Het deel van de ziektelast dat via voeding is veroorzaakt, is in 2023 geschat op 4.700 DALY's. Dit was iets hoger dan in 2022 (4.300 DALY's), 2021 (4.200 DALY's) en 2020 (3.600 DALY's) en zelfs iets hoger dan in 2019 (4.600 DALY's).

De totale kosten van de ziektelast van de ziekteverwekkers zijn geschat op 538 miljoen euro in 2023. Dat is veel hoger dan in 2022 (496 miljoen euro), 2021 (411 miljoen euro) en 2020 (328 miljoen euro), en zelfs hoger dan in 2019 (497 miljoen euro). De geschatte kosten gaan over de directe medische kosten, zoals in ziekenhuizen, en de kosten die de patiënten en families maken, zoals reiskosten. Hieronder vallen ook de kosten die in andere sectoren worden gemaakt, bijvoorbeeld door ziekteverzuim. De kosten als gevolg van maag-darminfecties door deze ziekteverwekkers via voeding waren in 2023 met 217 miljoen euro hoger dan in 2022 (209 miljoen euro). Ook waren ze hoger dan in 2021 (197 miljoen euro) en 2020 (179 miljoen euro), en zelfs iets hoger dan in 2019 (214 miljoen euro).

Het ministerie van VWS heeft de opdracht voor dit onderzoek gegeven. De resultaten geven beleidsmakers handvatten om meer zicht te krijgen op de ziektelast en de manieren waarop mensen met de ziekteverwekkers in contact komen. Ook geeft het een beeld hoe de ziektelast van voedselinfecties en de kosten ervan zich door de jaren heen ontwikkelen.

Kernwoorden: DALY, ziektelast, ziektekosten, ziekteverwekkers, voedseloverdraagbaar

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Introduction

Enteric infections encompass acute and chronic syndromes with varying duration and severity, as well as mortality. Although these infections have multiple sources of transmission (incl. food, other humans, animals and the environment) most of these are usually referred to as “food-related” infections. Risk-based food safety management (i.e. decisions on control, prevention and surveillance) requires a consistent, quantitative assessment of the relative public health importance of foodborne diseases [1]. As such, we express the public health impact of foodborne pathogens in burden of disease (BoD) and cost-of-illness (CoI). The methodology that is used to estimate the burden of disease (in terms of Disability Adjusted Life Years (DALY)) is described in detail in another study [1], and in the disease burden report of food-related pathogens over the year 2015 [2].

Since 2008, the RIVM regularly publishes estimates of the number of incident cases, burden of disease, and costs of food-related infectious disease on its webpages¹, and since 2010 in publicly available reports (e.g. [3, 4]). In the current report, trend information on disease incidence, demographics, and consumer price index (a measure for changes in price levels of consumer goods and services) were used to update the information to the year 2023. From 2019 onwards, the annual trends in BoD and CoI for toxin-producing bacteria *Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus* are no longer estimated due to the absence of recent national surveillance data for these pathogens. However, these three pathogens are still included in tables and figures presenting the overall estimates (based on data from previous years [4]), to maintain comparability of the total burden and costs with those from previous years.

1 Methods

1.1 Trend information

Data on the size and age distribution of the Dutch population (Table 1), as well as mortality risks and the number of live births (Table 2) and stillbirths, were obtained from Statistics Netherlands¹.

Table 1 Population in the Netherlands by age group, 2019-2023.

Age group	2019	2020	2021	2022	2023
0	168,443	169,497	168,270	179,133	167,629
1-4	697,619	691,975	689,356	685,520	700,526
5-11	1,294,145	1,293,205	1,281,948	1,288,551	1,273,615
12-17	1,197,548	1,182,568	1,171,648	1,184,960	1,171,332
18-64	10,610,404	10,677,785	10,706,658	10,764,428	10,680,182
65+	3,314,004	3,392,555	3,457,535	3,313,251	3,601,167
Total	17,282,163	17,407,585	17,475,415	17,415,843	17,594,451

Table 2 Live births by age of mothers in the Netherlands, 2019-2023.

Age of mother	2019	2020	2021	2022	2023*
-19	915	876	715	771	682
20-24	10,685	10,015	9,899	10,021	9,984
25-29	45,300	43,666	45,289	41,719	41,611
30-34	69,205	70,258	75,904	70,129	71,968
35-39	35,732	35,868	39,153	36,725	38,106
40-44	7,356	7,571	8007	7,684	7,867
45+	487	427	474	455	480
Total	169,680	168,681	179,441	167,504	170,698

* Estimates based on observed trend data from 2020-2022

Trend information on the incidence of gastro-enteritis (GE) by pathogen in the general population and among those consulting a general practitioner was obtained from the following sources:

- *Campylobacter* spp.: RIVM ISIS-AR laboratory surveillance.
- Non-typhoidal *Salmonella* spp.: RIVM laboratory surveillance. Starting this year, we present all laboratory-confirmed human salmonellosis cases reported to the RIVM in 2023. In previous years, only cases reported by public health laboratories (*streeklaboratoria*) were included in the DALY calculations. To allow for comparison with previous years, we also provide the calculations based solely on the data from the *streeklaboratoria*.
- Shiga-toxin producing *Escherichia coli* O157 (STEC O157): mandatory notification and laboratory surveillance.
- Perinatal and acquired listeriosis: mandatory notification and laboratory surveillance.
- Norovirus: estimated norovirus-associated hospitalized cases derived from RIVM laboratory surveillance.
- Rotavirus: RIVM laboratory surveillance.

¹ [Birth; key figures](#); accessed in February 2024

- Hepatitis A virus: mandatory notification and laboratory surveillance.
- Hepatitis E virus: RIVM laboratory surveillance.
- *Cryptosporidium* spp.: RIVM laboratory surveillance data since 2013 until 2018. The incidence in 2020 is based on observed (2017-2018) and estimated (2019) trend data from 2017-2019. The incidence in 2021 is based on observed (2018) and estimated (2019-2020) trend data from 2018-2020. The incidence in 2022 is based on estimated trend data from 2019-2021. The incidence in 2023 is based on estimated trend data from 2020-2022. Although nationally representative data are not available, incidence data for *Cryptosporidium* spp. from three diagnostic laboratories in the Netherlands was available and showed a strong increase in 2023 compared to previous years. We therefore used this rate of increase to rescale the estimated 2023 incidence.
- *Giardia* spp.: a stable incidence was assumed since 2007 (i.e. the last year of RIVM laboratory surveillance data for *Giardia* spp.). Because the incidence of *Giardia* spp. followed similar trends as the incidence of *Cryptosporidium* spp., we assumed for the incidence *Giardia* spp. in 2020, 2021 and 2022 (the years with the COVID-19 pandemic) the same trend as the one observed for *Cryptosporidium* spp. in 2020, 2021 and in 2022. In 2023 the three diagnostic laboratories show a very high incidence of *Cryptosporidium* spp., even higher than in the pre-COVID-19 years. As there is no evidence of a similar increase for *Giardia* spp., we assumed that the incidence of *Giardia* spp. remained stable at pre-COVID-19 levels.
- No trend information was available for GE toxin-producing bacteria (*Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus*), and *Toxoplasma gondii*. For the latter, trends in reported fatalities are included.

Trends in hospitalizations for gastro-enteritis as primary cause (ICD codes 20-93; 558.9) were obtained from the Dutch Hospital Data (DHD) for 2011-2014. Since 2015 the number of hospitalized patients is indirectly estimated from the observed time series of RIVM laboratory surveillance data on rotavirus, norovirus, campylobacteriosis, and salmonellosis.

Excess mortality risks from campylobacteriosis and salmonellosis were assumed constant across the years. Fatalities due to listeriosis and STEC O157 were obtained from surveillance data based on mandatory notification to RIVM. Age-specific case fatality ratios for norovirus and rotavirus, originally obtained from German surveillance data, and for protozoan pathogens, originally obtained from the international literature, were assumed constant throughout the years (changes in years of life lost therefore reflect changes in incidence on which mortality is based).

1.2 Burden of disease

The method for the burden of disease calculations, in terms of Disability Adjusted Life Years (DALYs), was not changed since 2018 (i.e. reporting on 2017) [3].

1.3 Cost of illness

The method for CoI estimates was not changed since the 2019 report [5-8]. The cost prices used for the different resources were updated to 2023 euros using consumer price indexes as provided by Statistics Netherlands².

1.4 Attribution

The fraction of human cases of enterically transmitted illness by five major pathways (food, environment, direct animal contact, human-human transmission, and travel) and by 11 groups within the food pathway was estimated using structured expert elicitation and is described in detail in Havelaar et al. [9]. For four pathogens (i.e. *Salmonella* spp., *Listeria monocytogenes*, *Campylobacter* spp. and STEC O157) we did not use the estimates from the aforementioned expert elicitation, but we used the average attributable fractions estimated by a Bayesian statistical model that integrates the attribution estimates from the expert elicitation with attribution estimates based on empirical data from microbial subtyping and case-control studies [10]. To allow for comparison with earlier results, we also updated the attribution estimates of previous years for the four aforementioned pathogens by applying the same Bayesian statistical model.

² [Consumer prices](#); accessed in February 2024

2 Results

2.1 Trend information

Trend information for the last five years for specific pathogens is presented in Table 3. For trend information since 1999 for the 14 pathogens, see Annex - Table A.1.

A summary of trends is discussed below:

- The incidence of campylobacteriosis (laboratory confirmed cases) in 2023, with 27 cases per 100,000 inhabitants, was the same as in 2022. This incidence was slightly higher than in 2021 (24 cases per 100,000 inhabitants) and 2020 (23 cases per 100,000 inhabitants).
- The incidence of salmonellosis (laboratory confirmed cases) in 2023, with 13 cases per 100,000 inhabitants, was higher than in 2022 (7 cases per 100,000 inhabitants) and 2021 (6 cases per 100,000 inhabitants) and higher than in the pre-COVID-19 years (8 cases per 100,000 inhabitants in 2019). This increase does not reflect a true rise in the number of salmonellosis cases, but rather the effect of changes in the surveillance data used. Since 2023, we consider all laboratory-confirmed human salmonellosis cases reported to the RIVM. If we consider only the cases reported by public health laboratories (*streeklaboratoria*), as in previous years, the incidence was 9 cases per 100,000 inhabitants, which is consistent with the incidence observed in the pre-COVID years.
- The estimated incidence of *Cryptosporidium* spp. in 2023 was 14 cases per 100,000 inhabitants, which was higher than in 2022 (6 cases per 100,000 inhabitants), and higher than in the pre-COVID year 2019 (8 cases per 100,000). The incidence of *Cryptosporidium* spp. has been obtained by rescaling the incidence by the rate of increase observed in three diagnostic laboratories in 2023.
- The incidence of gastroenteritis by rotavirus (laboratory confirmed cases) in 2023 (14 per 100,000 inhabitants) was lower than in 2022 (21 per 100,000 inhabitants) and slightly higher than in 2021 (13 per 100,000 inhabitants).
- The incidence of gastroenteritis by norovirus in 2023 (laboratory confirmed cases), with 31 cases per 100,000 inhabitants was higher than in 2022 (27 cases per 100,000 inhabitants) and 2021 (19 cases per 100,000 inhabitants).
- The incidence of acquired listeriosis (laboratory confirmed cases), with 89 cases in 2023, was lower than in 2022 (94 cases) but higher than in 2021 (82 cases). The recorded fatalities increased from 12 in 2022 to 14 in 2023, and were higher than in 2021 (11 fatalities), but still lower than in 2020 (18 fatalities).
- The incidence of perinatal listeriosis (laboratory confirmed cases) decreased from 8 cases in 2022 to 6 cases in 2023, and it represented half of the incidence of 2021 (12 cases). The number of fatalities in 2023 was the same as in 2022 (2 cases), but was lower than in 2021 (4 cases).
- The incidence of STEC O157 (laboratory confirmed cases) in 2023 was 69 cases, of which 18 were hospitalized, and was slightly lower than in 2022 (71 cases, 17 hospitalized), but higher than in 2021 (55 cases, 22 hospitalized). The number of patients with HUS was

with 3 cases in 2023 the same as in 2022 but lower than in 2021 (4 cases).

- The incidence of hepatitis A virus (notified cases) was 153 reported cases and 34 hospitalized cases in 2023. This was higher than in 2022 (93 reported cases and 30 hospitalized cases) and in 2021 (78 reported cases and 23 hospitalized).
- With 2 cases per 100,000 inhabitants, the incidence of hepatitis E virus (laboratory confirmed cases) in 2023 was higher than the incidence of 2022 and 2021 (1 case per 100,000 inhabitants).
- The number of patients that were admitted to the hospital due to GE was estimated to be 21.608 which was slightly higher than the 21.224 estimated in 2022 and higher than the 15.824 estimated in 2021.

Table 3 Trends in incidence per 100,000 inhabitants and reported cases, of food-related pathogens, 2019-2023.

Pathogen		2019	2020	2021	2022	2023
<i>Campylobacter</i> spp. ^a (x 100,000 inhabitants)		35	23	24	27	27
<i>Salmonella</i> spp. ^a (x 100,000 inhabitants)		9**	5**	6**	7**	13* (9**)
<i>Cryptosporidium</i> spp. ^a (x 100,000 inhabitants)		8	2	4	6	14
Rotavirus ^a (x 100,000 inhabitants)		16	5	13	21	14
Norovirus ^a (x 100,000 inhabitants)		25	11	19	27	31
Acquired listeriosis ^b (Total reported cases)		113	94	82	94	89
	Fatal	16	18	11	12	14
Perinatal Listeriosis ^b (Total reported cases)		4	2 ^c	12	8	6
	Fatal	0	0	4	2	2
STEC O157 ^b (Total reported cases)		35	36	55	71	69
	Hospitalized	13	13	22	17	18
Hepatitis A virus ^b (Total reported cases)		166	50	78	93	153
	Hospitalized	135 ^d	12 ^e	23 ^f	30 ^g	34 ^h
Hepatitis E virus ^a (x 100,000 inhabitants)		2	2	1	1	2

Notes: a) Incidences per 100,000 inhabitants are presented in italics and the presented numbers are rounded: ≥ 10 to two significant figures (e.g. 12.5 = 12) and < 10 to 1 significant figure (e.g. 0.89=0.9); b) reported cases; c) one twin; d) known for 159/166 cases; e) known for 47/50 cases; f) known for 76/78 cases; g) known for 86/93 cases; h) known for 153/153 cases.

* Incidence based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Incidence based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

2.2 Number of incident cases

Ten of the selected pathogens (i.e. *Campylobacter* spp.; STEC O157; *Salmonella* spp.; all three toxin-producing bacteria; norovirus; rotavirus; *Cryptosporidium* spp.; *Giardia* spp.) cause mainly acute gastroenteritis. The other four pathogens (i.e. *Listeria monocytogenes*; *Toxoplasma gondii*; hepatitis A virus; hepatitis E virus) also cause other diseases (e.g. meningitis, sepsis, hepatitis). The estimated number of

incident cases of (acute) gastroenteritis by pathogen in 2023 is presented in Table 4. The estimated number of incident cases of diseases by non-gastrointestinal pathogens in 2023 is presented in Table 5. The number of incident cases by the 14 pathogens for the years 2019-2023 is presented in Figure 1 and in Table A.2 in Annex I.

The total number of cases caused by the 14 food-related pathogens in 2023 (1,772,000 cases) was higher than in 2022 (1,599,000 cases) and 2021 (1,287,000 cases). The total number of estimated cases was also higher than the number of cases estimated in 2019 (1,570,000), the year preceding the COVID-19 pandemic.

Table 4 Mean estimated number of incident cases and 95% uncertainty interval (between brackets) of gastroenteritis by pathogen in the Netherlands, 2023.

Pathogen	Number of incident cases [#]			Fatal cases [#]
	General population (x 1,000)	GP visit (x 1,000)	Hospitalised (x 1,000)	
All causes	4900 (4100-5900)	100 (19-420)	22	NA [#]
Bacteria – infectious				
<i>Campylobacter</i> spp.	56 (9-170)	14 (7-26)	1 (0.4-2)	37 (25-52)
STEC O157	2 (0.23-9)	0 (0-0)	0.05 (0.04-0.06)	4 (2-7)
<i>Salmonella</i> spp.* (all laboratories)	41 (4-140)	6 (3-11)	1 (0.47-2)	47 (41-54)
<i>Salmonella</i> spp.** (selected laboratories)	27 (3-89)	4 (2-7)	1 (0.46-2)	32 (28-36)
Bacteria – toxin producing				
<i>Bacillus cereus</i>	55 (18-140)	8 (2-22)	0.23 (0.07-0.55)	0 (0-0)
<i>Clostridium perfringens</i>	170 (57-380)	32 (8-85)	0.31 (0.11-0.65)	5 (0.1-20)
<i>Staphylococcus aureus</i>	290 (130-560)	41 (12-99)	1 (0.64-3)	7 (0.16-29)
Viruses				
Norovirus	740 (500-1100)	17 (10-28)	2 (0.96-3)	89 (36-170)
Rotavirus	190 (93-340)	11 (7-17)	6 (4-7)	35 (11-77)
Protozoa				
<i>Cryptosporidium</i> spp.	130 (42-340)	8 (4-14)	1 (0.41-2)	8 (0.16-36)
<i>Giardia</i> spp.	83 (41-160)	8 (4-14)	0.45 (0.04-1)	2 (0.06-10)

[#]Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Number of incident and fatal cases on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Number of incident and fatal cases based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

Table 5 Mean estimated number of incident cases and 95% uncertainty interval (between brackets) of non-gastrointestinal pathogens in the Netherlands, 2023.

Pathogen	Number of incident cases mean (95% CI)		Fatal cases mean (95% CI)	
<i>Listeria monocytogenes</i> *				
Perinatal	6		2	
Acquired	89		14	
Hepatitis A virus [#]	740	(480-1200)	2	(1-4)
Hepatitis E virus [#]	990	(580-1500)	11	(4-24)
<i>Toxoplasma gondii</i> [#]				
Congenital	350	(180-610)	12	(8-19)
Acquired**	430	(200-740)	0	

*No uncertainty because *Listeria* cases were acquired through surveillance. The reported number of cases of listeriosis includes only cases with systemic symptoms. Mild cases of listeriosis are not monitored and the number is thus unknown. ; ** chorioretinitis only.

[#]The presented numbers are rounded: ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

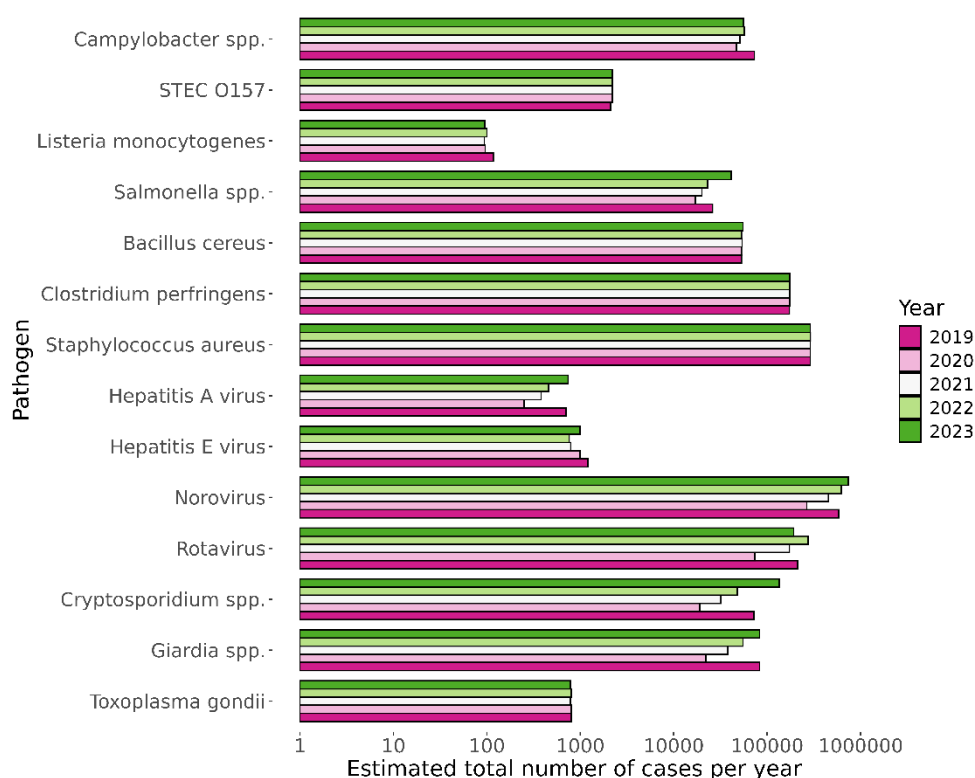


Figure 1 Comparison of mean estimated number of incident cases of food-related pathogens, 2019-2023.

The total number of estimated fatal cases due to foodborne diseases in 2023 was higher than in 2022 and in 2021 (280 fatal cases in 2023 compared to 230 fatal cases in 2022 and to 200 fatal cases in 2021) (see Table A.3 in Annex).

2.3 Disease burden by pathogen

Table 6 presents the estimated burden of disease by pathogen for the total Dutch population in 2023, expressed as DALY per 100,000 inhabitants and DALY per case, both undiscounted and discounted with 1.5% rate.

The total disease burden of the 14 pathogens in 2023 is estimated at 11,000 DALYs, which is higher than in 2022 (10,000 DALYs) and 2021 (9,100 DALYs), but is similar to 2019, the year preceding the COVID-19 pandemic (Table A.4 in Annex). Compared to 2022, an increase in disease burden was found for norovirus (+400 DALYs), hepatitis A virus (+32 DALYs), hepatitis E virus (+90 DALYs), *Cryptosporidium* spp. (+146 DALYs) and *Giardia* spp. (+70 DALYs). *Salmonella* spp. also increased compared to the year before (+ 840), but this increase is reflecting a change in the surveillance data used rather than an increase in incidence.

In Figure 2, the contributions to total DALYs of the years lived with disability (YLD) associated with acute infections are shown per pathogen, as well as YLD associated with sequelae and years of life lost (YLL) due to premature mortality. YLD associated with acute infections contributed 14% to the total disease burden; YLD associated with sequelae/residuals contributed 36% and YLL 50% of the total disease burden. The distribution between the different categories varied between pathogens (see Figure 2 for details).

Table 6 Mean total DALY per year, DALY per 100,000 inhabitants and DALY per case of illness in the Netherlands, 2023.

Pathogen	DALY/year		DALY per 100,000/year		DALY per case	
	0%	1.5%	0%	1.5%	0%	1.5%
Bacteria – infectious						
<i>Campylobacter</i> spp.	2,500	2,200	14	13	0.04	0.04
STEC O157	150	120	0.86	0.67	0.07	0.05
<i>Salmonella</i> spp.*	1,800	1,600	10	9	0.04	0.04
<i>Salmonella</i> spp.**	1,200	1,000	7	6	0.04	0.04
<i>L. monocytogenes</i> (perinatal)	210	120	1	0.68	35	20
<i>L. monocytogenes</i> (acquired)	120	110	0.66	0.63	1	1
<i>L. monocytogenes</i> (total)	330	230	2	1	3	2
Bacteria – toxin producing						
<i>Bacillus cereus</i>	34	34	0.19	0.19	0.001	0.001
<i>Clostridium perfringens</i>	200	200	1	1	0.001	0.001
<i>Staphylococcus aureus</i>	220	210	1	1	0.001	0.001
Viruses						
Norovirus	2,400	2,200	14	12	0.003	0.003
Rotavirus	1,000	910	6	5	0.005	0.005
Hepatitis A virus	82	66	0.47	0.37	0.11	0.09
Hepatitis E virus	390	310	2	2	0.39	0.31
Protozoa						
<i>Cryptosporidium</i> spp.	230	220	1	1	0.002	0.002
<i>Giardia</i> spp.	220	220	1	1	0.003	0.003
<i>Toxoplasma gondii</i> (congenital)	1,600	930	9	5	5	3
<i>Toxoplasma gondii</i> (acquired)	290	210	2	1	0.66	0.49
<i>Toxoplasma gondii</i> (total)	1,900	1,100	11	6	2	1

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023 = 0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Mean total DALY per year, DALY per 100,000 inhabitants and DALY per case of illness based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Mean total DALY per year, DALY per 100,000 inhabitants and DALY per case of illness based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

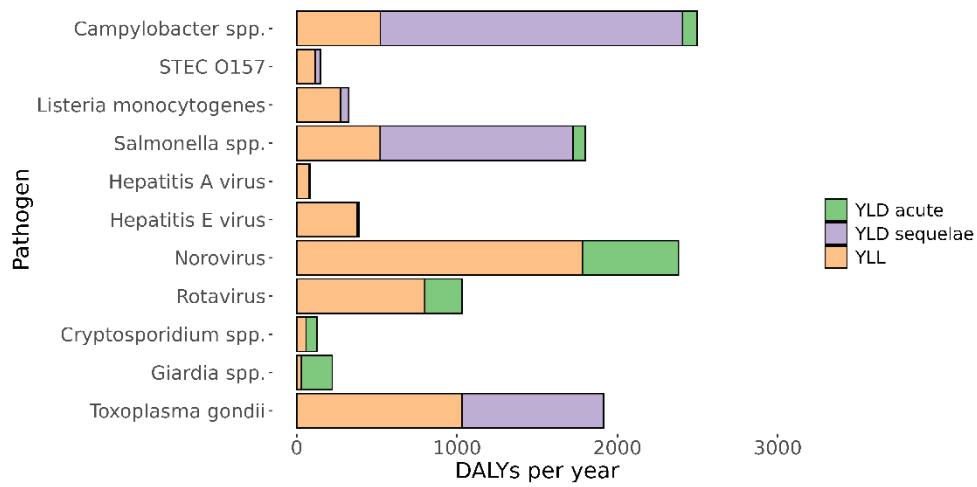


Figure 2 Mean DALY per year of food-related pathogens in 2023, split up into YLD associated with acute infections; YLD associated with sequelae and YLL.

The mean disease burden by the 14 pathogens for the years 2019-2023 is presented in Figure 3 and in Table A.4 in Annex.

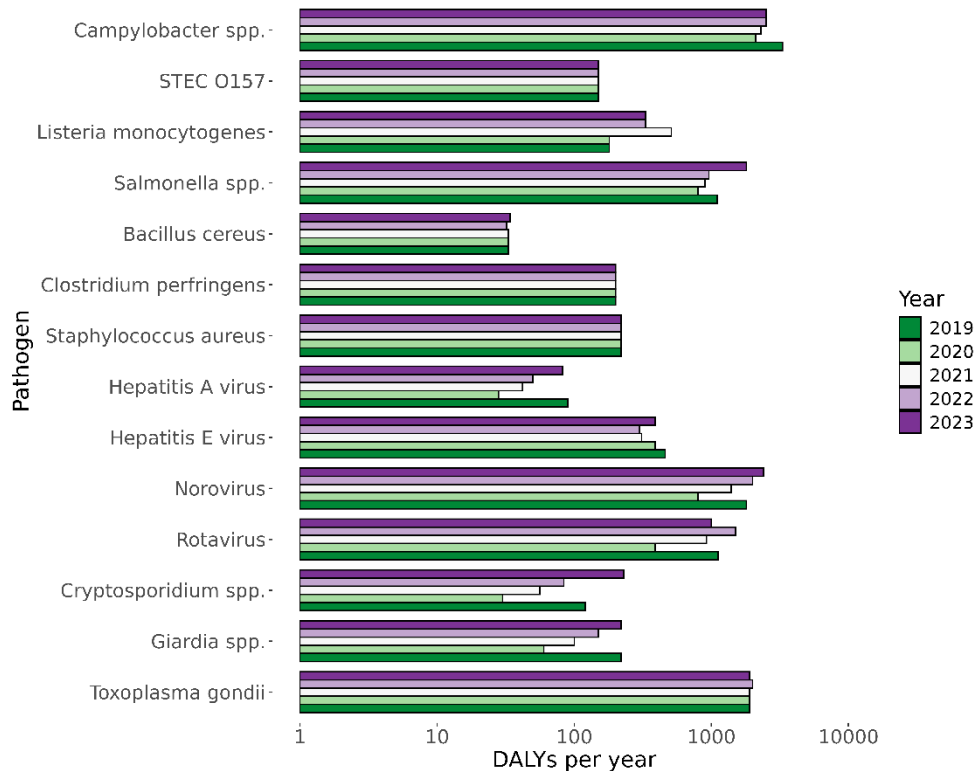


Figure 3 Comparison of disease burden (undiscounted DALYs) of food-related pathogens in 2019-2023.

2.4 Cost-of-illness by pathogen

The total CoI in 2023 (538 M€; discounted at 4%) was higher than in 2022 (496 M€; discounted at 4%) and in 2021 (411 M€; discounted at 4%) (Table 7, Figures 4-5, and Annex Table A.5). The four pathogens causing the largest CoI were norovirus (157 M€), rotavirus (70 M€),

Staphylococcus aureus toxin (74 M€) and *Campylobacter* (57 M€). The lowest contribution to the CoI was by hepatitis A virus (1 M€). The largest changes in CoI compared to 2022 were for norovirus (+24 M€), rotavirus (-24 M€) and *Cryptosporidium spp.* (+26 M€). The average cost per case was largest for perinatal *Listeria monocytogenes* infections (243,000 €/case).

Table 7 Estimated mean total costs of illness (COI), mean COI per 100,000 inhabitants and mean COI per case of illness in the Netherlands, 2023.

Pathogen	COI/year (M€)#		COI per 100,000 (k€)#		COI per case (€)#	
	0%	4%	0%	4%	0%	4%
Bacteria – infectious						
<i>Campylobacter spp.</i>	62	57	350	330	1,100	1,000
STEC O157	13	7	75	39	6,100	3,100
<i>Salmonella spp.*</i>	36	33	200	190	860	800
<i>Salmonella spp.**</i>	25	23	140	130	930	870
<i>L. monocytogenes</i> (perinatal)	4	1	23	8	683,000	243,000
<i>L. monocytogenes</i> (acquired)	3	3	17	17	35,000	33,000
<i>L. monocytogenes</i> (total)	7	4	41	25	76,000	46,000
Bacteria – toxin producing						
<i>Bacillus cereus</i>	14	14	79	79	250	250
<i>Clostridium perfringens</i>	36	36	200	200	210	210
<i>Staphylococcus aureus</i>	74	74	420	420	260	260
Viruses						
Norovirus	157	157	890	890	210	210
Rotavirus	70	70	400	400	370	370
Hepatitis A virus	1	1	8	8	1,900	1,900
Hepatitis E virus	5	5	31	31	5,600	5,600
Protozoa						
<i>Cryptosporidium spp.</i>	41	41	230	230	310	310
<i>Giardia spp.</i>	20	20	110	110	240	240
<i>Toxoplasma gondii</i> (congenital)	54	17	300	97	155,000	49,000
<i>Toxoplasma gondii</i> (acquired)	1	1	8	8	3,300	3,300
<i>Toxoplasma gondii</i> (total)	55	19	310	110	71,000	24,000

Used abbreviations: million € (M€); 1000 € (k€). #Total COI per year are presented in million € (M€) and if less than 1 million rounded to 1 significant figure (e.g. 0.0023 million = 0.002). COI per 100,000 and COI per case are rounded: ≥ 100,000 to three significant figures (e.g. 123,256 = 123,000 or 123 k€); between <100,000 and ≥10 to two significant figures (e.g. 1,325 = 1,300 or 1.3 k€). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Estimated mean total costs of illness (COI), mean COI per 100,000 inhabitants and mean COI per case of illness based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Estimated mean total costs of illness (COI), mean COI per 100,000 inhabitants and mean COI per case of illness based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

In Figure 4, the mean CoI per year was split up in healthcare costs, patient/family costs and costs in other sectors. Costs in other sectors were mostly productivity losses of patients and caregivers being absent

from work. Healthcare costs accounted for 21% of the total costs for the 14 pathogens, patient/family costs for 2% and costs in other sectors accounted for 77%. The distribution between the different cost categories varied between pathogens.

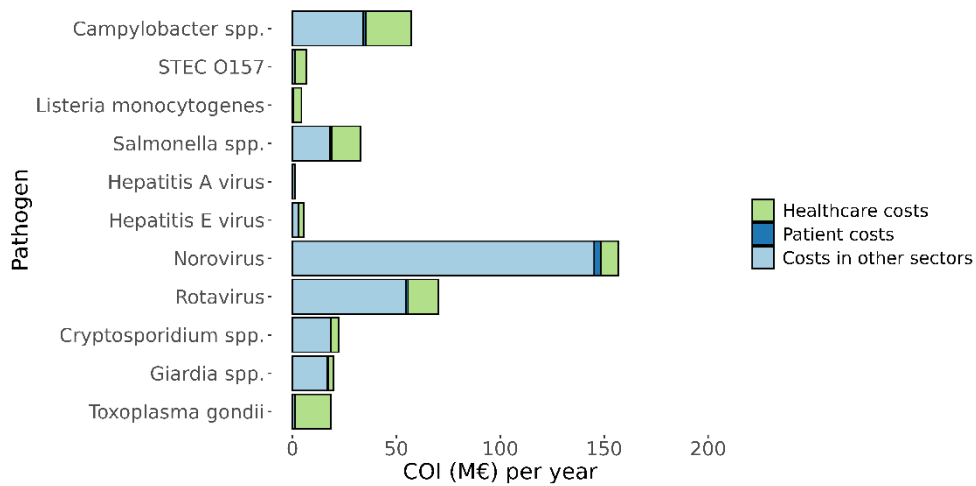


Figure 4 Mean cost-of-illness (discounted) per year of food-related pathogens in 2023, split up into healthcare costs, patient costs and costs in other sectors.

The mean CoI estimates per pathogen for the years 2019-2023 is presented in Figure 5 and in Table A.5 in Annex.

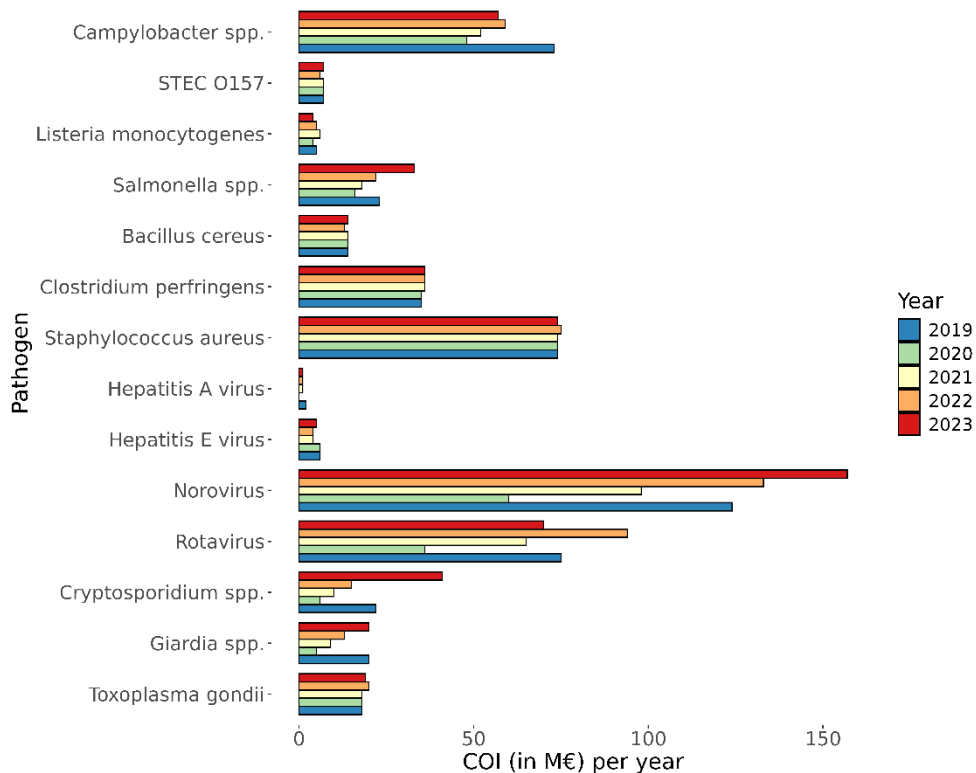


Figure 5 Comparison of cost-of-illness (M€, discounted at 4% and expressed in 2023 euros) of food-related pathogens in 2019-2023.

Attribution

The attribution results for the DALYs and CoI in 2023 are presented in Table 8 for the main pathways and in Table 9 for the different food groups. More details can be found in the Tables A.6–A.13 of the Annex. The disease burden due to foodborne transmission accounted for 42% of the total burden (i.e. 4,700 DALYs of the total burden of 11,000 DALYs per year), and 40% of the total CoI (i.e. 217 M€ of the 538 M€). About 54% of the foodborne burden was associated with meat (i.e. poultry, pork, beef & lamb). These foods were also estimated to cause 41% of all food-related fatal cases, indicating that the pathogens associated with these foods are considered to cause more severe infections than pathogens associated with other foods. The attributions are estimated using the proportions from the expert elicitation of Havelaar et al. [9]. For four pathogens (i.e. *Salmonella* spp., *Listeria monocytogenes*, *Campylobacter* spp. and STEC O157), however, we did not use the estimates from the aforementioned expert elicitation, but we used the average attributable fractions estimated by a Bayesian statistical model that integrates the attribution estimates from the expert elicitation with attribution estimates based on empirical data from microbial subtyping and case-control studies [10].

The attribution results for incidence, number of fatal cases, DALYs and CoI estimates of foodborne diseases for the years 2019-2023 are presented in Tables 10-13. The foodborne disease burden increased by 400 DALYs from 4,300 DALYs in 2022 to 4,700 DALYs in 2023. The CoI increased by 8 M€ from 209 M€ in 2022 to 217 M€ in 2023.

Table 8 Attribution of the mean estimated number of incident cases, fatalities, disease burden and cost-of-illness of foodborne disease^a to the major transmission pathways in the Netherlands, 2023.

Main pathway	Food	Environment	Human	Animal	Travel	Total
Number of incident cases (per year) ^b	686,000	221,000	609,000	90,000	165,000	1,772,000
Number of fatal cases (per year) ^b	97	39	82	18	42	280
Disease burden (DALY, undiscounted) ^b	4,700	1,900	2,400	760	1,700	11,000
Disease burden (DALY, discounted (1.5%)) ^b	3,800	1,500	2,200	650	1,400	9,600
Cost of illness (M€, undiscounted) ^c	246	89	158	34	65	592
Cost of illness (M€, discounted (4%)) ^c	217	74	156	31	61	538

a) Due to the 14 pathogens included in this study.

b) Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

c) Costs are expressed in million € (M€).

Table 9 Attribution of the mean incidence, fatalities, disease burden and cost-of-illness of foodborne disease^a to food group in the Netherlands, 2023.

Food groups	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
Number of incident cases (per year)^b	114,000	46,000	54,000	21,000	54,000	56,000	39,000	16,000	41,000	122,000	115,000	686,000
Number of fatal cases (per year)^b	12	12	16	5	8	7	9	2	3	5	15	97
Disease burden (DALY, undiscounted)^b	760	870	910	190	290	310	330	88	120	220	570	4,700
Disease burden (DALY, discounted (1.5%))^b	600	610	790	170	230	260	260	78	110	200	490	3,800
Cost of illness (M€, undiscounted)^c	42	31	30	8	18	18	15	5	11	33	33	246
Cost of illness (M€, discounted (4%))^c	35	20	27	7	17	16	13	5	11	32	31	217

a) Due to the 14 pathogens included in this study

b) Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $< 100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

c) Costs are expressed in million € (M€)

Table 10 Attribution of mean incidence to food in the Netherlands for 2019-2023, total and by pathogen.

Pathogen	Incidence/year				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	41,000	28,000	30,000	32,000	31,000
STEC O157	770	850	870	800	800
<i>Salmonella</i> spp.	12,000**	8,700**	10,000**	11,000**	19,000* 12,000**
<i>Listeria monocytogenes</i>	92	77	76	82	76
<i>Bacillus cereus</i>	48,000	48,000	48,000	47,000	49,000
<i>Clostridium perfringens</i>	157,000	157,000	157,000	157,000	158,000
<i>Staphylococcus aureus</i>	252,000	252,000	252,000	253,000	252,000
Norovirus	98,000	44,000	76,000	103,000	124,000
Rotavirus	27,000	10,000	22,000	36,000	25,000
Hepatitis A virus	75	62	89	52	85
Hepatitis E virus	160	140	110	100	140
<i>Cryptosporidium</i> spp.	8,600	2,200	3,900	5,800	16,000
<i>Giardia</i> spp.	11,000	2,800	4,900	7,200	11,000
<i>Toxoplasma gondii</i>	430	430	430	450	430
Total	655,000	553,000	606,000	654,000	686,000

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean incidence to food based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Attribution of mean incidence to food based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

Table 11 Attribution of mean number of fatal cases to food in the Netherlands for 2019-2023, total and by pathogen.

Pathogen	Number of fatal cases/year				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	30	21	22	22	21
STEC O157	1	2	2	1	1
<i>Salmonella</i> spp.	11**	12**	15**	9**	22* 15**
<i>Listeria monocytogenes</i>	13	15	12	11	13
<i>Bacillus cereus</i>	0	0	0	0	0
<i>Clostridium perfringens</i>	4	4	4	4	4
<i>Staphylococcus aureus</i>	6	6	6	6	6
Norovirus	11	5	9	12	15
Rotavirus	5	2	4	6	5
Hepatitis A virus	0.3	0.2	0.3	0.2	0.3
Hepatitis E virus	2	2	1	1	2

Pathogen	Number of fatal cases/year				
	2019	2020	2021	2022	2023
<i>Cryptosporidium</i> spp.	1	0	0.2	0.4	1
<i>Giardia</i> spp.	0.3	0.1	0.1	0.2	0.3
<i>Toxoplasma gondii</i>	7	7	7	7	7
Total	90	76	82	81	97

* Attribution of mean number of fatal cases to food based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Attribution of mean number of fatal cases to food based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

Table 12 Attribution of mean disease burden (DALY per year, undiscounted) to food in the Netherlands for 2019-2023, total and by pathogen.

Pathogen	DALY (undiscounted)/year				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	1,800	1,300	1,400	1,400	1,400
STEC O157	56	59	61	56	56
<i>Salmonella</i> spp.	510**	400**	470**	440**	830* 540**
<i>Listeria monocytogenes</i>	140	140	410	270	260
<i>Bacillus cereus</i>	29	29	29	29	30
<i>Clostridium perfringens</i>	180	180	180	180	180
<i>Staphylococcus aureus</i>	190	190	190	190	190
Norovirus	310	140	240	330	400
Rotavirus	150	50	120	190	130
Hepatitis A virus	8	6	10	6	9
Hepatitis E virus	63	54	43	41	53
<i>Cryptosporidium</i> spp.	15	4	7	10	28
<i>Giardia</i> spp.	29	7	13	19	29
<i>Toxoplasma gondii</i>	1,000	1,100	1,100	1,100	1,100
Total	4,600	3,600	4,200	4,300	4,700

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean disease burden to food based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Attribution of mean disease burden to food based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

Table 13 Attribution of mean COI (M€/year discounted at 4%) to food in the Netherlands for 2019-2023, total and by pathogen

Pathogen	COI per year (4%)/year (Million €, expressed in 2023 euros)				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	41	28	31	33	32
<i>STEC O157</i>	3	3	3	2	3
<i>Salmonella</i> spp.	11**	8**	9**	10**	15* 11**
<i>Listeria monocytogenes</i>	4	3	5	4	3
<i>Bacillus cereus</i>	13	13	13	12	13
<i>Clostridium perfringens</i>	32	32	33	33	33
<i>Staphylococcus aureus</i>	64	64	64	65	64
Norovirus	21	10	17	23	27
Rotavirus	10	5	8	12	9
Hepatitis A virus	0	0	1	0	0
Hepatitis E virus	1	1	1	1	1
<i>Cryptosporidium</i> spp.	3	1	1	2	5
<i>Giardia</i> spp.	3	1	1	2	3
<i>Toxoplasma gondii</i>	10	10	10	11	11
Total	214	179	197	209	217

Total COI per year are presented in million € (M€) and if less than 1 million rounded to 1 significant figure (e.g. 0.0023 million =0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean COI to food based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023.

** Attribution of mean COI to food based only on human salmonellosis cases reported by public health laboratories (*streeklaboratoria*).

3 Overall conclusions

This report provides a public health perspective on the burden of 14 enteric pathogens, commonly referred to as "foodborne pathogens", in the Netherlands. The ranking of these pathogens based on the burden of disease metrics differs from the ranking based solely on disease incidence. In 2023, we observed an increase in the number of incident cases for some of the pathogens, especially for norovirus, *Cryptosporidium* spp., hepatitis A virus, hepatitis E virus, and *Salmonella* spp. compared to the year 2022. In contrast, the number of incident cases of rotavirus decreased compared to the year 2022.

The total BoD of the 14 food-related pathogens in 2023 (11,000 DALYs) was slightly higher than in 2022 (10,000 DALYs, +10%) and 2020 (9,100 DALYs, +21%), but was the same as in the pre-COVID-19 pandemic year 2019 (11,000 DALYs). The burden attributable to foodborne transmission in 2023 slightly increased compared to 2022 (from 4,300 DALYs to 4,700 DALYs; +9%) and in 2021 (4,200 DALYs, +12%), and it was slightly higher than in 2019 (4,600 DALYs, +2%). Overall, in 2023, we observed an increase in disease burden compared to the year 2022 for norovirus, *Cryptosporidium* spp., hepatitis A virus, hepatitis E virus and *Salmonella* spp. For norovirus, *Cryptosporidium* spp. and *Salmonella* spp., the disease burden in 2023 was higher than in the pre-COVID-19 pandemic year 2019. The disease burden of *Campylobacter* spp. was the same as in 2022, but lower than in 2019.

The total CoI of the 14 food-related pathogens in 2023 was estimated at 538 million euros, which was higher than in 2022 (496 million euros, +8%) and 2021 (411 million euros, +31%). The highest costs were accounted for by norovirus. The costs resulting from infections transmitted via food in 2023 (217 million euros) were higher than in 2022 (209 million euros, +4%). The total COI of norovirus, *Cryptosporidium* spp. and *Salmonella* spp. in 2023 were higher than in 2022, and higher in the pre-COVID-19 year 2019.

The increase in the incidence, BoD and CoI for salmonellosis observed in 2023 reflects the change in the surveillance data used rather than a true increase in the number and/or type of cases. Using the same surveillance data as in previous years, we found that the incidence, BoD and CoI for salmonellosis were slightly higher than in 2022, but remained at the same level as in the pre-COVID year of 2019.

Overall, the disease burden and associated costs caused by the 14 food-related pathogens in the Netherlands slightly increased in 2023 compared to 2022, reaching levels similar to those in 2019. This indicates that the burden caused by these pathogens has returned to pre-COVID-19 levels.

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Annex Detailed results

Table A.1 Trends in incidence per 100,000 inhabitants and reported cases, respectively, of food-related pathogens, 1999-2023.

Year	Ca ^a	Sa ^a		Cryp ^a	RV ^a	NV ^a	aLm ^b	aLm fatal _b	pLm _b	pLm fatal _b	O157 ^b	O157 hosp _b	HAV _b	HAV hosp _b	HEV ^a
1999	39	21			19	14					32				
2000	42	20			16	13					43				
2001	44	20			18	11					41				
2002	41	15			17	12					49				
2003	33	21			18	13					57				
2004	40	16			15	13					37				
2005	44	13			21	16	85	15	6		53				
2006	40	16			26	17	59	17	5	1	40		258	39	
2007	41	12			20	15	60	12	6	1	83		168	27	
2008	39	16			27	18	51	6	1	1	45		183	35	
2009	44	12			31	18	76	4	3	1	57	21	176	29	
2010	50	14			35	23	73	13	4	1	51	21	262	52	0.8
2011	51	12			24	21	79	4	9	1	65	18 ^d	125	25	0.9
2012	49	21			20	26 ^c	71	8	6	0	85	31 ^e	121	28	1
2013	48	9		6	23	26 ^c	76	7	3	0	90	36 ^f	109	30	0.9
2014	48	9		6	9	25 ^c	92	9	4	2	79	31 ^g	105	23	2
2015	43	9		10	20	27 ^c	69	15	3	1	76	27 ^h	80	23	3
2016	38	11		12	10	33 ^c	89	8	7	4	64	21 ⁱ	81	22	3
2017	33	9		8	16	23 ^c	112	10	3	2	58	23	374 ^k	90 ^m	2
2018	35	9		10	17	27 ^c	71	4	7	2	59	23 ^j	188 ^l	57 ⁿ	2
2019	35	9		8	16	25 ^c	113	16	4	0	35	13	166	135 ^o	2
2020	23	5		2	5	11 ^c	94	18	2	0	36	13	50	12 ^p	2
2021	24	6		4	13	19 ^c	82	11	12	4	55	23	78	23 ^q	1
2022	27	7		6	21	27 ^c	94	12	8	2	71	17	93	30 ^r	1
2023	27	13*(9**)		14	14	31^c	89	14	6	2	69	18	153	34^s	2

Used abbreviations: Ca: *Campylobacter* spp. ; Sa: *Salmonella* spp.; Cryp: *Cryptosporidium* spp.; RV: rotavirus; NV: norovirus; aLm: acquired listeriosis; pLm: perinatal listeriosis; O157: STEC o157; HAV: hepatitis A virus; hosp: hospitalized; HEV: hepatitis E virus.

Notes: a).per 100,000 inhabitants whereby presented numbers are rounded: ≥ 10 to two significant numbers (e.g. 12.5 = 12) and < 10 to 1 significant number (e.g. 0.89=0.9); b) reported cases; c) estimated norovirus-associated hospitalized cases derived from RIVM laboratory surveillance data and therefore not directly comparable to numbers from before 2012; d) known for 57/65 cases; e) known for 77/85 cases; f) known for 84/90 cases; g) known for 71/79 cases; h) known for 68/76 cases; i) known for 60/64 cases; j) known for 58 out of 59 cases; k) ~ 275 cases are (in)directly linked to an international outbreak in men-having sex with men (MSM); l) 65 cases are (in)directly linked to an international outbreak of MSM m) known for 368/374. cases; n) known for 187/188 cases; o) known for 159/166 cases; p) known for 47/50 cases; q) known for 76/78 cases; r) known for 86/93 cases; s) known for 153/153 cases.

* Incidence on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Incidence based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.2 Mean number of incident cases by pathogen in the Netherlands, 2019-2023

Pathogen	Estimated mean number of incident cases/year				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	73,000	47,000	51,000	57,000	56,000
<i>STEC O157</i>	2,100	2,200	2,200	2,200	2,200
<i>Salmonella</i> spp. *	26,000	17,000	20,000	23,000	41,000
<i>Salmonella</i> spp. **					27,000
<i>Listeria monocytogenes</i>	120	96	94	100	95
<i>B. cereus</i> toxin	53,000	53,000	54,000	53,000	55,000
<i>C. perfringens</i> toxin	173,000	174,000	174,000	174,000	175,000
<i>S. aureus</i> toxin	289,000	289,000	289,000	290,000	289,000
Norovirus	585,000	265,000	453,000	619,000	742,000
Rotavirus	211,000	74,000	173,000	275,000	192,000
Hepatitis A virus	700	200	380	460	740
Hepatitis E virus	1,200	1,000	790	760	990
<i>Cryptosporidium</i> spp.	72,000	19,000	32,000	48,000	134,000
<i>Giardia</i> spp.	83,000	22,000	38,000	55,000	83,000
<i>Toxoplasma gondii</i>	760	770	780	800	780
Total	1,570,000	963,000	1,287,000	1,599,000	1,772,000

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figures (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help). There is one exception, *Listeria monocytogenes* which are acquired through surveillance.

* Mean number of incident cases based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Mean number of incident cases based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.3 Mean number of fatal cases by pathogen in the Netherlands, 2019-2023.

Pathogen	Estimated mean number of fatal cases/year				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	53	36	37	38	37
STEC O157	4	4	4	4	4
<i>Salmonella</i> spp.*	24	23	28	20	47
<i>Salmonella</i> spp. **					32
<i>Listeria monocytogenes</i>	16	19	15	14	16
<i>B. cereus</i> toxin	0	0	0	0	0
<i>C. perfringens</i> toxin	5	5	5	5	5
<i>S. aureus</i> toxin	7	7	7	7	7
Norovirus	66	30	52	70	89
Rotavirus	36	12	31	48	35
Hepatitis A virus	3	1	1	1	2
Hepatitis E virus	13	13	9	9	11
<i>Cryptosporidium</i> spp.	4	1	2	3	8
<i>Giardia</i> spp.	2	1	1	2	2
<i>Toxoplasma gondii</i>	12	12	12	13	12
Total	245	163	200	230	280

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help). There is one exception, *Listeria monocytogenes* which are acquired through surveillance.

* Mean number of fatal cases based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Mean number of fatal cases based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.4 Mean estimated disease burden (undiscounted DALY/year) in the Netherlands for the years 2019-2023, total and by pathogen.

Pathogen	2019	2020	2021	2022	2023
	<i>Campylobacter</i> spp.	3,300	2,100	2,300	2,500
STEC O157	150	150	150	150	150
<i>Salmonella</i> spp. *	1,100	800	900	960	1,800
<i>Salmonella</i> spp. **					1,200
<i>Listeria monocytogenes</i>	180	180	510	330	330
<i>B. cereus</i> toxin	33	33	33	32	34
<i>C. perfringens</i> toxin	200	200	200	200	200
<i>S. aureus</i> toxin	220	220	220	220	220
Norovirus	1,800	800	1,400	2,000	2,400
Rotavirus	1,100	390	920	1,500	1,000
Hepatitis A virus	90	28	42	50	82
Hepatitis E virus	460	390	310	300	390
<i>Cryptosporidium</i> spp.	120	30	56	84	230
<i>Giardia</i> spp.	220	60	100	150	220
<i>Toxoplasma gondii</i>	1,900	1,900	1,900	2,000	1,900
Total	11,000	7,300	9,100	10,000	11,000

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figures (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help). There is one exception, *Listeria monocytogenes* which are acquired through surveillance.

* Mean estimated disease burden based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Mean estimated disease burden based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.5 Mean discounted COI (4%) in million euros in the Netherlands for 2019-2023, total and by pathogen.

Pathogen	COI per year (4%)/year (Million €, expressed in 2023 euros)				
	2019	2020	2021	2022	2023
<i>Campylobacter</i> spp.	73	48	52	59	57
STEC O157	7	7	7	6	7
<i>Salmonella</i> spp.*	23	16	18	22	33
<i>Salmonella</i> spp.**					23
<i>Listeria monocytogenes</i>	5	4	6	5	4
<i>B. cereus</i> toxin	14	14	14	13	14
<i>C. perfringens</i> toxin	35	35	36	36	36
<i>S. aureus</i> toxin	74	74	74	75	74
Norovirus	124	60	98	133	157
Rotavirus	75	36	65	94	70
Hepatitis A virus	2	0	1	1	1
Hepatitis E virus	6	6	4	4	5
<i>Cryptosporidium</i> spp.	22	6	10	15	41
<i>Giardia</i> spp.	20	5	9	13	20
<i>Toxoplasma gondii</i>	18	18	18	20	19
Total	497	328	411	496	538

COI per year are presented in million € (M€) and if less than 1 million rounded to 1 significant figure (e.g. 0.0023 million =0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Mean discounted COI based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Mean discounted COI based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.6 Attribution of mean estimated number of incident cases by pathogen to main pathways in the Netherlands, 2023.

Main pathway	Food	Environment	Human	Animal	Travel	Total
<i>Campylobacter</i> spp.	31,000	8,300	1,700	6,100	8,300	56,000
STEC O157	800	320	210	400	440	2,200
<i>Salmonella</i> spp.*	19,000	2,100	4,600	3,100	12,000	41,000
<i>Salmonella</i> spp.**	12,000	1,400	3,000	2,000	8,000	27,000
<i>Listeria monocytogenes</i>	76	5	4	4	7	95
<i>B. cereus</i> toxin	49,000	600	660	600	4,000	55,000
<i>C. perfringens</i> toxin	158,000	3,800	3,700	3,700	5,600	175,000
<i>S. aureus</i> toxin	252,000	10,000	9,200	6,400	11,000	289,000
Norovirus	124,000	105,000	411,000	37,000	65,000	742,000
Rotavirus	25,000	33,000	111,000	5,800	17,000	192,000
Hepatitis A virus	85	83	140	0	440	740
Hepatitis E virus	140	250	75	110	420	990
<i>Cryptosporidium</i> spp.	16,000	37,000	37,000	18,000	26,000	134,000
<i>Giardia</i> spp.	11,000	20,000	29,000	8,900	15,000	83,000
<i>Toxoplasma gondii</i>	430	280	7	19	36	780
Total	686,000	221,000	609,000	90,000	165,000	1,772,000

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean estimated cases to main pathways based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean estimated cases to main pathways based only on cases reported from public health laboratories (*streeklaboratoria*).

Table A.7 Attribution of mean estimated number of fatal cases to main pathways in the Netherlands, 2023.

Main pathway	Food	Environment	Human	Animal	Travel	Total
<i>Campylobacter</i> spp.	21	6	1	4	6	37
STEC O157	1	0.6	0.4	0.7	0.8	4
<i>Salmonella</i> spp.*	22	2	5	4	14	47
<i>Salmonella</i> spp.**	15	2	4	2	9	32
<i>Listeria monocytogenes</i>	13	0.8	0.6	0.6	1	16
<i>B. cereus</i> toxin	0	0	0	0	0	0
<i>C. perfringens</i> toxin	4	0.1	0.1	0.1	0.2	5
<i>S. aureus</i> toxin	6	0.3	0.2	0.2	0.3	7
Norovirus	15	13	49	4	8	89
Rotavirus	5	6	20	1	3	35
Hepatitis A virus	0.3	0.3	0.4	0	1	2
Hepatitis E virus	2	3	0.9	1	5	11
<i>Cryptosporidium</i> spp.	1	2	2	1	2	8
<i>Giardia</i> spp.	0.3	0.6	0.8	0.3	0.4	2
<i>Toxoplasma gondii</i>	7	4	0.1	0.3	0.6	12
Total	97	39	82	18	42	280

Presented numbers are rounded: ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023 = 0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean estimated number of fatal cases to main pathways based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean estimated number of fatal cases to main pathways based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.8 Attribution of mean disease burden (DALY per year, undiscounted) to main pathways in the Netherlands, 2023.

Main pathway	Food	Environment	Human	Animal	Travel	Total
<i>Campylobacter</i> spp.	1,400	370	75	270	370	2,500
STEC O157	56	23	14	28	31	150
<i>Salmonella</i> spp.*	830	92	200	140	540	1,800
<i>Salmonella</i> spp.**	540	59	130	88	350	1,200
<i>Listeria monocytogenes</i>	260	16	13	13	23	330
<i>B. cereus</i> toxin	30	0.4	0.4	0.4	2	34
<i>C. perfringens</i> toxin	180	4	4	4	7	200
<i>S. aureus</i> toxin	190	8	7	5	8	220
Norovirus	400	340	1,300	120	210	2,400
Rotavirus	130	180	600	31	92	1,000
Hepatitis A virus	9	9	15	0	49	82
Hepatitis E virus	53	96	29	42	170	390
<i>Cryptosporidium</i> spp.	28	64	64	31	45	230
<i>Giardia</i> spp.	29	53	77	24	39	220
<i>Toxoplasma gondii</i>	1,100	690	17	48	88	1,900
Total	4,700	1,900	2,400	760	1,700	11,000

Presented numbers are rounded: ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023 = 0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean disease burden to main pathways based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean disease burden to main pathways based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.9 Attribution of mean cost-of-illness (M€ per year, C) to main pathways in the Netherlands, 2023.

Main pathway	Food	Environment	Human	Animal	Travel	Total
<i>Campylobacter</i> spp.	32	9	2	6	9	57
STEC O157	2	1	0.6	1	1	7
<i>Salmonella</i> spp.*	15	2	4	2	10	33
<i>Salmonella</i> spp.**	11	1	3	2	7	23
<i>Listeria monocytogenes</i>	3	0.2	0.2	0.2	0.3	4
<i>B. cereus</i> toxin	12	0.2	0.2	0.2	1	14
<i>C. perfringens</i> toxin	33	0.8	0.8	0.8	1	36
<i>S. aureus</i> toxin	64	3	2	2	3	74
Norovirus	26	22	87	8	14	157
Rotavirus	9	12	41	2	6	70
Hepatitis A virus	0.2	0.2	0.3	0	0.9	1
Hepatitis E virus	0.8	1	0.4	0.6	2	5
<i>Cryptosporidium</i> spp.	5	11	11	6	8	41
<i>Giardia</i> spp.	3	5	7	2	3	20
<i>Toxoplasma gondii</i>	10	7	0.2	0.5	0.9	19
Total	217	74	156	31	61	538

COI per year are presented in million € (M€) and if less than 1 million rounded to 1 significant figure (e.g. 0.0023 million =0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean cost-of-illness (discounted at 4%) to main pathways based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean cost-of-illness (discounted at 4%) to main pathways based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.10 Attribution of mean incidence by pathogen to food groups in the Netherlands, 2023.

Food groups	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
<i>Campylobacter</i> spp.	6,100	970	15,000	720	1,300	2,100	970	560	560	560	2,100	31,000
STEC O157	520	74	18	14	28	18	28	21	18	21	41	800
<i>Salmonella</i> spp.*	1,400	4,100	2,500	2,900	1,300	780	1,100	590	780	1,100	2,300	19,000
<i>Salmonella</i> spp.**	910	2,700	1,600	1,900	850	510	730	380	510	720	1,500	12,000
<i>Listeria monocytogenes</i>	5	4	9	2	22	4	22	2	2	2	2	76
<i>B. cereus</i> toxin	3,500	1,700	780	1,800	2,800	980	980	830	8,300	26,000	1,200	49,000
<i>C. perfringens</i> toxin	76,000	13,000	11,000	4,400	6,500	10,000	11,000	3,900	4,100	12,000	5,700	158,000
<i>S. aureus</i> toxin	19,000	20,000	20,000	8,300	37,000	15,000	5,000	4,500	19,000	75,000	30,000	252,000
Norovirus	4,000	3,800	3,600	2,400	2,500	19,000	9,000	3,800	6,400	6,200	63,000	124,000
Rotavirus	0	700	0	0	420	4,800	5,900	1,100	1,900	1,100	9,000	25,000
Hepatitis A virus	0	0	0	0	0	11	11	3	3	3	53	85
Hepatitis E virus	0	100	0	0	0	7	10	5	0	0	14	140
<i>Cryptosporidium</i> spp.	2,300	380	250	230	790	1,900	1,800	260	0	260	530	16,000
<i>Giardia</i> spp.	2,100	520	340	0	830	1,400	3,600	350	0	360	1,300	11,000
<i>Toxoplasma gondii</i>	99	220	21	0	20	16	25	0	0	10	25	430
Total	114,000	46,000	54,000	21,000	54,000	56,000	39,000	16,000	41,000	122,000	115,000	686,000

Presented numbers are rounded: $\geq 100,000$ to three significant figures (e.g. 123,256 = 123,000); between $<100,000$ and ≥ 10 to two significant figures (e.g. 1,325 = ,300) and <10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean incidence to food groups based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean incidence to food groups based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.11 Attribution of mean number of fatal cases by pathogen to food groups in the Netherlands, 2023.

Food groups	Beef & lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
<i>Campylobacter</i> spp.	4	0.6	10	0.5	0.9	1	0.6	0.4	0.4	0.4	1	21
STEC O157	1	0.1	0.03	0.03	0.05	0.03	0.05	0.04	0.03	0.04	0.08	1
<i>Salmonella</i> spp.*	2	5	3	3	2	0.9	1	0.7	0.9	1	3	22
<i>Salmonella</i> spp.**	1	3	2	2	1	0.6	0.9	0.5	0.6	0.8	2	15
<i>Listeria monocytogenes</i>	0.8	0.7	1	0.3	4	0.8	4	0.3	0.4	0.4	0.4	13
<i>B. cereus</i> toxin	0	0	0	0	0	0	0	0	0	0	0	0
<i>C. perfringens</i> toxin	2	0.4	0.3	0.1	0.2	0.3	0.3	0.1	0.1	0.3	0.2	4
<i>S. aureus</i> toxin	0.5	0.5	0.5	0.2	0.9	0.4	0.1	0.1	0.5	2	0.7	6
Norovirus	0.5	0.5	0.4	0.3	0.3	2	1	0.5	0.8	0.7	7	15
Rotavirus	0	0.1	0	0	0.08	0.9	1	0.2	0.3	0.2	2	5
Hepatitis A virus	0	0	0	0	0	0.03	0.03	0.01	0.01	0.008	0.2	0.3
Hepatitis E virus	0	1	0	0	0	0.08	0.1	0.05	0	0	0.2	2
<i>Cryptosporidium</i> spp.	0.1	0.02	0.02	0.01	0.05	0.1	0.1	0.02	0	0.02	0.03	1
<i>Giardia</i> spp.	0.06	0.01	0.009	0	0.02	0.04	0.1	0.01	0	0.01	0.04	0.3
<i>Toxoplasma gondii</i>	2	3	0.3	0	0.3	0.3	0.4	0	0	0.2	0.4	7
Total	12	12	16	5	8	7	9	2	3	5	15	97

Presented numbers are rounded: ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean number of fatal cases to food groups based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean number of fatal cases to food groups based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.12 Attribution of mean disease burden (DALY per year, undiscounted) by pathogen to food groups in the Netherlands, 2023

Food groups	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
<i>Campylobacter</i> spp.	270	43	680	32	57	96	43	25	25	25	96	1400
STEC O157	36	5	1	1	2	1	2	1	1	1	3	56
<i>Salmonella</i> spp.*	62	180	110	130	57	34	49	26	34	48	100	830
<i>Salmonella</i> spp.**	40	120	71	83	37	22	32	17	22	31	66	540
<i>Listeria monocytogenes</i>	16	15	29	7	75	15	74	6	8	8	8	260
<i>B. cereus</i> toxin	2	1	0.5	1	2	0.6	0.6	0.5	5	16	0.7	30
<i>C. perfringens</i> toxin	87	15	13	5	7	12	12	5	5	14	7	180
<i>S. aureus</i> toxin	14	15	15	6	28	11	4	3	14	56	23	190
Norovirus	13	12	12	8	8	62	29	12	21	20	200	400
Rotavirus	0	4	0	0	2	26	32	6	10	6	48	130
Hepatitis A virus	0	0	0	0	0	1	1	0.4	0.4	0.3	6	9
Hepatitis E virus	0	40	0	0	0	3	4	2	0	0	6	53
<i>Cryptosporidium</i> spp.	4	0.7	0.4	0.4	1	3	3	0.4	0	0.4	0.9	28
<i>Giardia</i> spp.	6	1	0.9	0	2	4	9	0.9	0	0.9	4	29
<i>Toxoplasma gondii</i>	240	540	51	0	49	40	62	0	0	25	61	1100
Total	760	870	910	190	290	310	330	88	120	220	570	4700

Presented numbers are rounded: ≥ 10 to two significant figures (e.g. 1,325 = 1,300) and < 10 to 1 significant figure (e.g. 0.0023=0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean disease burden to food groups based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean disease burden to food groups based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

Table A.13 Attribution of mean cost-of-illness (M€ per year, discounted at 4%) by pathogen to food groups in the Netherlands, 2023.

Food groups	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
<i>Campylobacter</i> spp.	6	1	16	0.7	1	2	1	0.6	0.6	0.6	2	32
STEC O157	2	0.2	0.06	0.04	0.09	0.06	0.09	0.06	0.06	0.06	0.1	2
<i>Salmonella</i> spp.*	1	3	2	2	1	0.6	0.9	0.5	0.6	0.9	2	15
<i>Salmonella</i> spp.**	0.8	2	1	2	0.7	0.4	0.6	0.3	0.4	0.6	1	11
<i>Listeria monocytogenes</i>	0.2	0.2	0.4	0.09	1	0.2	1	0.08	0.1	0.1	0.1	3
<i>B. cereus</i> toxin	0.9	0.4	0.2	0.4	0.7	0.2	0.2	0.2	2	7	0.3	12
<i>C. perfringens</i> toxin	16	3	2	0.9	1	2	2	0.8	0.8	3	1	33
<i>S. aureus</i> toxin	5	5	5	2	9	4	1	1	5	19	8	64
Norovirus	0.8	0.8	0.8	0.5	0.5	4	2	0.8	1	1	13	26
Rotavirus	0	0.3	0	0	0.2	2	2	0.4	0.7	0.4	3	9
Hepatitis A virus	0	0.0	0	0	0	0.02	0.02	0.01	0.01	0	0.1	0.2
Hepatitis E virus	0	0.6	0	0	0	0.04	0.06	0.03	0	0	0.08	0.8
<i>Cryptosporidium</i> spp.	0.7	0.1	0.08	0.07	0.2	0.6	0.5	0.08	0	0.08	0.2	5
<i>Giardia</i> spp.	0.5	0.1	0.08	0	0.2	0.3	0.8	0.08	0	0.09	0.3	3
<i>Toxoplasma gondii</i>	2	5	0.5	0	0.5	0.4	0.6	0	0	0.2	0.6	10
Total	35	20	27	7	17	16	13	5	11	32	31	217

COI per year are presented in million € (M€) and if less than 1 million rounded to 1 significant figure (e.g. 0.0023 million =0.002). The presented numbers are estimates that rely on annual surveillance data being corrected for: i) coverage (where applicable); ii) underdiagnosis and underreporting; and iii) under-ascertainment (i.e. being sick without requiring medical help).

* Attribution of mean cost-of-illness to food groups based on all lab-confirmed human salmonellosis cases reported to the RIVM in 2023

** Attribution of mean cost-of-illness to food groups based only on human salmonellosis cases reported from public health laboratories (*streeklaboratoria*).

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