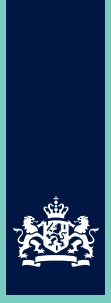

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Disease burden of food-related pathogens in the Netherlands, 2011

RIVM Letter Report 330331006/2013
M. Bouwknegt et al.

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This investigation has been performed by order and for the account of Ministery of Public Health, welfare and Sports, within the framework of Programma 5

Abstract

Disease burden of food-related pathogens in the Netherlands, 2011

The Ministry of VWS has requested RIVM to present an annual update on the number of illnesses caused by 14 enteric pathogens. These pathogens can be transmitted by food, the environment, animals and humans. The number of persons who are ill and who die from the infections is expressed in DALYs (Disability Adjusted Life Years), a measure of the disease burden in the population. The total disease burden caused by the 14 pathogens decreased from 14,900 DALY in 2010 to 13,900 DALY in 2011. The share of foodborne transmission in this burden decreased from 6,440 to 6,230 DALY.

The decrease in disease burden was a result of a decrease in the incidence of disease by *Salmonella* spp., rotavirus, norovirus and hepatitis A virus. Furthermore, fewer persons died from an infection with *Listeria monocytogenes* compared to 2010. The number of perinatal listeriosis cases has doubled, increasing the burden of perinatal listeriosis by 50% compared to 2010 to 156 DALY per year in 2011. The incidence of campylobacteriosis continued to increase in 2011. Furthermore, an overall increasing trend in norovirus incidence was observed in the period 2001-2011, despite the decrease in 2011 compared to 2010. No explanation for the trends is available.

This research results in more insight in the true incidence of foodborne diseases and the associated disease burden. The Dutch Food and Consumer Product Safety Authority (NVWA) and Regional Health Services register and investigate outbreaks of foodborne disease in the Netherlands. However, the majority of foodborne diseases is not reported.

Keywords:
food-related disease, disease burden, DALY, trend

Rapport in het kort

Ziektelast van via voedsel overdraagbare pathogenen in Nederland in 2011

Op verzoek van het ministerie van VWS onderzoekt het RIVM jaarlijks hoeveel mensen ziek worden van 14 darmpathogenen. Deze infecties kunnen worden overgedragen via voedsel, het milieu, dieren en de mens. Het aantal mensen dat ziek wordt van een infectie of eraan overlijdt, wordt uitgedrukt in DALY's (Disability Adjusted Life Year); een maat voor gezondheidsverlies onder de bevolking. De ziektelast die door de 14 darminfecties in totaal werd veroorzaakt daalde van 14.900 DALY in 2010 naar 13.900 DALY in 2011. Het deel van deze ziektelast dat alleen via voedsel werd overgedragen, daalde van 6.440 tot 6.230 DALY.

De daling in de ziektelast via voedsel komt doordat er ten opzichte van 2010 minder mensen ziek zijn geworden van een infectie met de *Salmonella* spp., het rotavirus, het norovirus en het hepatitis A-virus. Daarnaast zijn er minder mensen overleden als gevolg van een infectie met *Listeria monocytogenes*. Het aantal baby's met een Listeria infectie is wel gestegen in 2011, waardoor de bijbehorende ziektelast met 50% steeg tot 156 DALY. Het aantal infecties met de Campylobacter-bacterie bleef ook in 2011 stijgen. Daarnaast is over de periode 2001-2011 een toenemende trend gezien in het aantal mensen dat ziek wordt van het norovirus, ondanks de daling in 2011 ten opzichte van 2010. Een verklaring voor de trends is niet voorhanden.

De resultaten van dit onderzoek bieden handvaten om meer zicht te krijgen op het daadwerkelijke aantal voedselinfecties dat mensen jaarlijks oplopen en de ziektelast die daardoor wordt veroorzaakt. De Nederlandse Voedsel- en Warenautoriteit (NVWA) en GGD'en registeren en onderzoeken in Nederland uitbraken van voedselinfecties en -vergiftigingen. Het merendeel van de infecties wordt echter niet gemeld.

Trefwoorden:
voedsel-gerelateerde ziekte, ziektelast, DALY, trend

Contents

Summary

Since 2008, RIVM regularly publishes estimates of the incidence, burden and costs of 14 enteric pathogens on its web pages. In this report, trend information from epidemiological surveillance and demographic information is used to update the information to the year 2011. Compared to 2010, the incidence of campylobacteriosis increased by 2% and the incidence of salmonellosis decreased by 13%. The incidence of gastroenteritis by rotavirus decreased by 49% and by norovirus with 12% (based on all hospitalisations for viral gastroenteritis). For norovirus a generally increasing trend in incidence was nevertheless observed in the period 2001-2011. The incidence of acquired listeriosis was similar to 2010 with 79 cases. The incidence of perinatel listeriosis increased from 4 to 9 cases. There were 4 fatal cases of acquired listeriosis, considerably less than in 2010 (13). The incidence of STEC O157 increased by 25% compared to 2010. The incidence of hepatitis A decreased by 52% to a comparable level as in 2009. Trends in cryptosporidiosis and giardiasis were extrapolated from surveillance data up to 2007. No trend information was available for bacterial toxins and toxoplasmosis.

Because of the generally lower incidence, there was also a decrease in the burden of all pathogens except for campylobacteriosis and perinatal listeriosis. Perinatal listeriosis was the disease outcome with the highest individual burden among all pathogens. The total burden of the 14 pathogens decreased with 7% from 14,900 to 13,900 DALY. The burden of foodborne disease decreased with 3% from 6,440 to 6,230 DALY. The largest decrease (12%) in the attribution of DALYs was estimated for human-human transmitted and travel related disease (related to strong decreases in virus incidences). Among food pathways, all estimated DALYs decreased compared to 2010, with the largest decrease (7%) for dairy, for (shell-)fish and for other foods. The highest burden was attributed to pork followed by poultry and beef/mutton. Foods of animal origin caused 43% of all cases, but 66% of the burden due to food, indicating that the pathogens associated with these foods tend to cause more severe infections than pathogens associated with other foods.

The changes in incidence and burden as presented in this report need to be interpreted with care due to limitations in the available trend information for specific pathogens. The observed decreases in 2011 compared to 2010 are within the range of observed disease incidence in the previous decennium except for campylobacteriosis and norovirus cases. No explanation for the increasing trends for *Campylobacter* and norovirus is available.

1 Introduction

Since 2008, RIVM regularly publishes estimates of the incidence, burden and costs of food-related disease on its web pages in the "Nationaal Kompas Volksgezondheid"[1]. The estimates of the disease burden are expressed in Disability Adjusted Life Years. The methodology for these estimates is described in detail in peer-reviewed paper (1). Data in that paper referred to the year 2009, and an update based on data for the year 2010 has been presented (2). In this report, trend information from epidemiological surveillance and demographic information was used to update the information to the year 2011.

[1] http://www.nationaalkompas.nl/gezondheidsdeterminanten/omgeving/milieu/voedselveiligheid/microbiologisch/

2 Methods

2.1 Trend information

Data on the size and age distribution of the Dutch population, as well as mortality risks and the number of live births and stillbirths were obtained from Statistics Netherlands[2].

Trend information on the incidence of gastro-enteritis (GE) by pathogen in the general population and consulting the general practitioner was obtained from the following sources (partly also presented in (3)):

Thermophilic *Campylobacter* spp.: laboratory surveillance;
Shiga-toxin producing *Escherichia coli* O157 (STEC O157): active surveillance;
Non-typhoidal *Salmonella* spp.: laboratory surveillance;
Norovirus: hospitalisation for viral gastro-enteritis (ICD code 86);
Rotavirus: laboratory surveillance;
Perinatal and acquired listeriosis: active surveillance;
Hepatitis-A: OSIRIS (mandatory notifications);
Cryptosporidium spp.: a stable incidence since 2003 was assumed, based on laboratory surveillance data from 2001 to 2007;
Giardia spp.: a continuing decrease with the rate observed between 2001 and 2007 was assumed;
No trend information was available for the GE toxin-producing bacteria (*Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus*), hepatitis-E and toxoplasmosis.

Trends in hospitalizations for gastro-enteritis as primary cause (ICD codes 20-93; 558.9) were obtained from the National Medical Register up until 2010. For 2011 these data were obtained from Dutch Hospital Data (DHD). Data for 2006-2010 were extracted from the DHD database to ascertain that the change in data source did not affect the estimated number of hospitalizations. Estimates were indeed similar (data not shown).

Age-specific excess mortality risks from campylobacteriosis and salmonellosis were assumed constant. Fatalities due to STEC O157 were from active surveillance. 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.

2.2 Model corrections

Three coding errors in the 2009 model were corrected, all three relating to acquired listeriosis. The probability of meningitis for 2009 was corrected from 39% to 30%. Including 2010 data did not change this estimate. A correction for comorbidity in fatal cases of acquired listeriosis by reducing the statistical life expectancy by 50% had not been implemented and is now included in the model. The proportion of children under 18 years among cases hospitalised for gastroenteritis was changed from 18 to 38% in 2009, this was 35% in 2010. Furthermore, the percentages of attribution of cases and DALYs to pathways and foods were more refined by including one more decimal.

[2] http://statline.cbs.nl/statweb/, accessed 28 September 2012

2.3 Disease burden

Disease burden calculations were not changed; hence all differences in results will reflect the impact of trends in the underlying information on demographics and pathogen incidence.

3 Results

3.1 Trend information

The number of inhabitants in the Netherlands slightly increased from 16.6 million in 2010 to 16.7 million in 2011 (Table 1). There was a slight decrease in the number of persons below 18 years of age. Survival tables for 2010 were not available from Statline at the time of finalizing the model calculations for this report (01 November 2012). The number of live births decreased from 184,400 in 2009 to 180,060 in 2011 (Table 2). The age of mothers was fairly similar in the two years with a decrease in the number of births from mothers in all age classes. The number of stillbirths (24 weeks or more gestational age) in 2011 was 620, somewhat lower than 648 in 2010. The number of hospitalizations for gastroenteritis decreased with 6% from 23,871 to 22,500.

Trend information for specific pathogens is presented in Table 3. A summary of trends (in comparison with 2010) is discussed below:

- The incidence of **campylobacteriosis** (laboratory confirmed cases) **increased by 2%** from 50.2 to 51.3 cases per 100,000 inhabitants; there is **a significantly increasing 5-year trend** ($p=0.02$) since 2007 with an annual increase of 5%.
- The incidence of **salmonellosis** (laboratory confirmed cases) **decreased by 13%** from 13.8 to 12.2 per 100,000 inhabitants; nevertheless there is **no significant 5-year trend** ($p=0.84$) since 2007.
- The incidence of gastroenteritis by **rotavirus** (laboratory confirmed cases) **decreased by 49%** from 35.2 to 23.7 cases per 100,000 inhabitants; there is **no significant trend** ($p=0.50$) since 2007.
- The incidence of **hospitalizations** for viral gastroenteritis (a proxy for the incidence of gastroenteritis by norovirus) **decreased by 12%** from 22.2 to 19.4 cases per 100,000 inhabitants; however, there is **an increasing trend** ($p<0.001$) **since 2001** with an average increase of 0.97 cases per 100,000 inhabitants per year or 6% per year.
- The incidence of **acquired listeriosis** (active surveillance) was 79 cases, **similar to previous years**. There were 4 **fatalities**, **considerably less** than the exceptionally high number of 13 fatal cases in 2010. The statistical life expectancy of fatal cases was 13.8 years; in the DALY model half of this life expectancy is used for calculating years of life lost to correct for comorbidity. Including new data from 2011, the probability of developing **meningitis** as a consequence of acquired listeriosis was updated to **28%** (95% confidence interval 25-36%).
- The incidence of **perinatal listeriosis** (active surveillance) was 9 cases with 1 fatality. There were also 2 abortions before gestational age of 24 weeks. These are not included in the DALY estimations. The number of perinatal cases was **higher than in previous years,** while the mortality was **the same**.
- The incidence of diseases caused by **STEC O157** (active surveillance) was 65 with 18 hospitalizations. The number of STEC cases was **higher than in most previous years,** but the number of hospitalised cases was **similar**. There were no fatal cases (2 in 2010).
- The incidence of **hepatitis A** (notified cases) **decreased** to 125, with 25 hospitalizations; both lower than in the years 2006-2010.

3.2 Disease incidence

The incidence of gastroenteritis by pathogen, of non-gastrointestinal pathogens and sequelae by pathogen in 2011 is presented in Tables 4-6, and Figure 1. There were increases in the incidence of campylobacteriosis, listeriosis and STEC

O157 at all levels of the surveillance pyramid while the incidence of salmonellosis, giardiasis, and viral infections except of hepatitis E-virus decreased in comparison to 2010. The estimated incidence for the latter viral infection and the remaining pathogens was unchanged as no trend information was available. The estimated total number of cases by the 14 pathogens decreased from 1,990,000 to 1,750,000 and was comparable to the estimate for 2009. In comparison with 2010, there were considerably more sequelae due to listeriosis (12 in 2011 vs. 4 in 2010).

3.3 Disease burden by pathogen

The burden by pathogen is presented in Table 7 and Figures 1-2. In general, estimates for 2011 were lower than for 2010, except for campylobacteriosis, acquired toxoplasmosis and perinatal listeriosis. The largest relative difference with 2010 was observed for acquired listeriosis and hepatitis A-virus, the latter with about 50% decrease in burden. Due to the high number of perinatal listeriosis cases, its burden increased considerably (from 108 to 156 DALY), resulting in a corresponding increase in the burden per 1,000 cases. Perinatal listeriosis was the disease outcome with the highest individual burden among all pathogens (27.2 DALY per case). The total burden of the 14 pathogens decreased with 7% from 14,900 to 13,900 DALY. The standardized burden (per 100,000) decreased in parallel with the total burden. Overall there were small changes in the individual burden with the exception of listeriosis, which decreased from 28,680 to 17,760 DALY per 1,000 cases, mainly due to fewer fatal cases.

3.4 Attribution

Attribution results are presented in Tables 8-9. The burden of foodborne disease decreased with 3% from 6,440 to 6,230 DALY. The largest decrease was estimated for human-human transmitted and travel related disease, decreasing with about 12% to 2,400 and 1,300 DALY, respectively (related to the strong decreases in virus incidence). Among food pathways, all estimated DALYs decreased compared to 2010, with the largest decrease (7%) for dairy, for (shell-)fish and for other foods. The highest burden was attributed to pork (21%) followed by poultry (18%) and beef/mutton (15%). Foods from animal origin caused 43% of all cases but 66% of the burden due to food, indicating that the pathogens associated with these foods tend to cause more severe infections than pathogens associated with other foods.

4 Discussion

The disease burden of 14 enteric pathogens decreased by 1,000 DALY from 14,900 DALY in 2010 to 13,900 DALY in 2011. The share of foodborne transmission in this burden decreased from 6,440 to 6,230 DALY. The decrease was a result of a decrease in the incidence of cases by *Salmonella* spp., norovirus, rotavirus and hepatitis A virus and an decrease in fatal cases by *Listeria monocytogenes*. Of two of these (*Salmonella* spp., and rotavirus), trend data are based on laboratory surveillance, for hepatitis A virus on disease notification. The observed decreases in these disease incidences in 2011 compared to 2010 are within the range of those in the previous decennium. The incidence of campylobacteriosis continued to increase in 2011 and was approximately 25% higher than in the previous decennium (see Table 3). No explanation for this increase is available. For norovirus, no direct trend information is available, and therefore this is estimated from trends in hospitalisation for viral gastroenteritis, which includes also rotaviruses. Hence the trend in norovirus incidence may be overestimated. The incidence of listeriosis was lower than in 2010, and similar to levels before 2010. The total listeriosis burden decreased in comparison to 2010, with a 50% increase in the burden for perinatal listeriosis and a 56% decrease in acquired listeriosis due to fewer fatalities. There is no trend information available on bacterial toxins and toxoplasmosis while trends for *Cryptosporidium* spp. and *Giardia* spp. are extrapolated from trends until 2007, when systematic surveillance was discontinued. Attribution data used in this report are based on an expert elicitation study, conducted in 2006 (Havelaar et al., 2008). No time-trends in the expert estimates are available. As a consequence, the changes in incidence and burden as presented in this report need to be interpreted with care.

Acknowledgement

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Table 1. Population in the Netherlands by age group, 2009-11

Age group	2011	2010	2009
0	184,007	184,586	184,408
1-4	739,099	740,295	747,148
5-11	1,394,007	1,405,533	1,405,232
12-17	1,184,970	1,184,064	1,191,453
18-64	10,558,770	10,522,183	10,485,731
65+	2,594,946	2,538,328	2,471,815
Total	16,655,799	16,574,989	16,485,787

Table 2. Live births by age of mothers in the Netherlands, 2009-11

Age of mother	2011	2010	2009
-19	1,717	1,884	1,953
20-24	15,782	16,417	16,499
25-29	50,295	51,570	51,459
30-34	69,174	69,420	68,828
35-39	35,340	37,213	38,637
40-44	7,393	7,565	7,252
45+	359	328	287
Total	180,060	184,397	184,915

Table 3. Trends in incidence of food-related pathogens, 1999-2011

Year	Ca*	Sa	RV	NV	aLm	aLm †	pLm	pLm†	O157	O157 hosp	HAV	HAV hosp
	(a)	(a)	(a)	(a)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
1999	38.7	21.1	19.2	14.2					36			
2000	42.1	20.3	15.7	12.8					43			
2001	44.3	20.4	17.5	11.2					41			
2002	40.8	15.4	16.5	11.8					49			
2003	33.3	20.7	17.5	12.6					57			
2004	40.0	15.6	15.4	13.2					37			
2005	43.8	12.9	21.4	15.6	85	15	6		53			
2006	40.0	16.0	25.5	17.3	59	17	5	1	40		258	39
2007	40.7	11.9	20.1	14.5	60	12	6	1	83		168	27
2008	39.2	15.7	27.1	18.1	51	6	1	1	45		183	35
2009	44.1	11.6	30.9	17.7	76	4	3	1	57	21	176	29
2010	50.2	13.8	35.2	22.2	73	13	4	1	52	21	262	52
2011	51.3	12.2	23.7	19.4	79	4	9	1	65	18	125	25

Data sources: see text

* Ca: Campylobacter spp.; Sa: Salmonella spp., RV: rotavirus, NV: norovirus; aLm: acquired listeriosis, pLm: perinatal listeriosis, †: fatal cases; O157: STEC O157; HAV: hepatitis A-virus; hosp: hospitalized.

(a) per 100,000 inhabitants

(b) reported cases

Table 4. Incidence of gastroenteritis by pathogen in the Netherlands, 2011 (population 16.7 million)

Pathogen	General population (x 1,000)	GP visit (x 1,000)	Hospitalised (x 1,000)	Fatal cases
All causes	4,810[†]	221	22.5	NA[#]
	3,995-5,705[‡]	73-511		
Bacteria – infectious				
Campylobacter spp.	108	26	1.1	34
	33-271	13-47	0.4-2.2	21-51
STEC O157	2.1	0.3	0.02	1
	0.22-8.8	0.01-0.9	-	0-3
Salmonella spp.	37	5.6	1.1	35
	6.5-107	3.0-9.3	0.5-2.2	30-39
Bacteria – toxin producing				
Bacillus cereus	51	7.0	0.2	0
	19-111	1.7-18	0.07-0.5	
Clostridium perfringens	171	31	0.3	5
	63-357	7.4-81	0.1-0.6	0-19
Staphylococcus aureus	292	41	1.5	7
	135-531	12-95	0.6-2.9	0-30
Viruses				
Norovirus	694	17	2.0	65
	481-988	9.6-27	1.1-3.3	29-121
Rotavirus	301	19	5.9	45
	157-528	12-28	4.4-7.8	15-97
Protozoa				
Cryptosporidium spp.	28	1.7	0.6	2
	10-67	0.8-3.1	0.2-1.2	0-8
Giardia spp.	64	5.7	0.4	2
	36-118	2.9-10	0.04-1.4	0-7

[†] mean
[‡] 2.5-97.5 percentile
[#] not available

Table 5. Incidence of non-gastrointestinal pathogens in the Netherlands, 2011

Pathogen	Incidence	Fatal cases
Listeria monocytogenes		
Perinatal	9*	1
Acquired	79	4
Hepatitis A virus	612†	2
	391-989‡	1-3
Hepatitis E virus	53	1
	31-81	0-1
Toxoplasma gondii		
Perinatal	364	13
	189-637	7-22
Acquired^	426	0
	203-727	

* No uncertainty because *Listeria* cases were acquired through active surveillance
† mean
‡ 2.5-97.5 percentile
^ Chorioretinitis only

Table 6. Incidence of sequelae by pathogen in the Netherlands, 2011

Pathogen and sequelae	Incidence	Fatal cases
Campylobacter spp.		
Guillain-Barré Syndrome	79[†] (0-149) [‡]	2 (0-5)
Reactive arthritis	1,935 (829-3,919)	0
Irritable Bowel Syndrome	9,350 (2,668-24,150)	0
Inflammatory Bowel Disease	23 (16-31)	0
STEC O157		
Hameolytic Uraemic Syndrome	22 (15-30)	2 (1-5)
End-Stage Renal Disease	3 (1-5)	1 (1-1)
Salmonella spp.		
Reactive arthritis	458 (163-954)	0
Irritable Bowel Syndrome	3,125 (468-9,440)	0
Inflammatory Bowel Disease	8 (6-11)	0
Listeria monocytogenes (perinatal)		
Meningitis	8[*]	NA
Neurological sequelae of meningitis	4 (2-5)	0
Listeria monocytogenes (acquired)		
Meningitis	22 (18-26)	NA
Neurological sequelae of meningitis	3 (2-5)	0
Toxoplasma gondii (perinatal)		
Chorioretinitis 1st year of life	49 (25-87)	NA
Chorioretinitis later years of life	59 (31-103)	NA
Intracranial calcifications	38 (19-69)	NA
Hydrocephalus	7 (3-14)	NA
Central Nervous System Abnormalities	10 (2-29)	NA
Toxoplasma gondii (acquired)		
Chorioretinitis	426 (203-727)	0

[†] mean
[‡] 2.5-97.5 percentile
[*] No uncertainty because cases were acquired through active surveillance
NA: Not applicable (fatal cases reported in Table 2)

Table 7. Overall disease burden, disease burden per 100.000 inhabitants and mean disease burden per case of illness in the Netherlands, 2011

Pathogen	DALY per year		DALY per 100,000		DALY per 1,000 cases	
Discount rate	0%	1.5%	0%	1.5%	0%	1.5%
Bacteria-infectious						
Campylobacter spp.	3,633	3,250	21.8	19.5	39	34
STEC O157	138	109	0.8	0.7	158	125
Salmonella spp.	1,294	1,109	7.7	6.7	46	38
Listeria monocytogenes (perinatal)	156	91	0.93	0.54	17,160	10,070
Listeria monocytogenes (acquired)	47	45	0.28	0.27	600	570
Listeria monocytogenes (total)	203	136	1.2	0.82	17,760	10,650
Bacteria-toxin-producing						
Bacillus cereus	113	113	0.7	0.7	2.6	2.3
Clostridium perfringens	543	535	3.2	3.2	3.2	3.2
Staphylococcus aureus	766	760	4.6	4.6	2.6	2.6
Viruses						
Norovirus	1,754	1,547	10.5	9.3	2.5	2.3
Rotavirus	1,603	1,437	9.6	8.6	5.6	5.0
Hepatitis A virus	98	88	1.30	1.1	167	145
Hepatitis E virus	23	20	0.15	0.12	460	380
Protozoa						
Cryptosporidium spp.	72	72	0.4	0.4	3.1	3.0
Giardia spp.	127	125	0.8	0.7	2.1	2.1
Toxoplasma gondii (perinatal)	2,210	1,300	13.7	8.0	6,350	3,730
Toxoplasma gondii (acquired)	1,350	1,020	8.1	6.2	3,170	2,400
Toxoplasma gondii (total)	3,570	2,320	21.4	14.0	9,520	6,130

Table 8. Attribution of the incidence, fatalities and disease burden to the major transmission pathways in the Netherlands, 2011

Transmission pathway	Food	Environment	Human	Animal	Travel	Total*
Incidence	689†	215	612	89	143	1,750
(x 1000)	315-1,325‡	120-380	377-964	45-169	79-261	936-3,100
Fatal cases	74	36	70	17	23	219
	42-138	19-63	30-136	10-27	13-40	114-404
Disease burden (DALY per year, not discounted)	6,230	2,870	2,430	1,130	1,280	13,940
	3, 400-11,300	1,730-4,770	1,320-4,240	650-2,080	740-2,330	7,840-24,700
Disease burden (DALY per year, discounted)	5,150	2,260	2,140	990	1,110	12,650
	2,650-9,770	1,320-3,86	1,180-3,740	540-1,870	610-2,050	6,300-21,300

† mean
‡ 2.5-97.5 percentile
* due to 14 pathogens included in this study

Table 9. Attribution of the incidence, fatalities and disease burden of foodborne disease to food groups in the Netherlands, 2011

Food group	Beef/ mutton	Pork	Poultry	Eggs	Dairy	Fish/ shellfish	Fruit/ veg.	Bever- ages	Cereals	Other foods	Human/an imal	Total
Incidence	107[†]	46	63	23	56	57	42	16	42	122	116	689
(x 1000)	41-223[‡]	19-89	24-138	9-48	25-110	30-103	20-78	8-30	19-77	55-239	67-193	316-1,330
Fatal cases	8.6	8.9	12	5.4	5.3	6.3	5.5	1.8	3.0	5.0	12	74
	4.5-19	5.7-15	8.3-19	4.2-7.3	3.3-10	3.4-12	2.9-10	1.1-3.3	1.5-5.8	2.0-13	5.4-23	42-138
Disease burden	956	1320	1,130	256	449	401	386	99	186	464	586	6,230
(DALY per year, not discounted)	503-1,770	804-2,050	637-2,130	133-512	249-853	223-732	215-680	52-200	81-364	190-970	319-1,060	3,410-11,320
Disease burden	768	927	999	224	392	343	314	90	162	426	505	5,140
(DALY per year, discounted)	370-1,500	564-1,540	548-1,510	108-475	199-757	181-641	169-580	44-186	72-343	168-923	265-924	2,650-9,780

[†] mean
[‡] 2.5-97.5 percentile

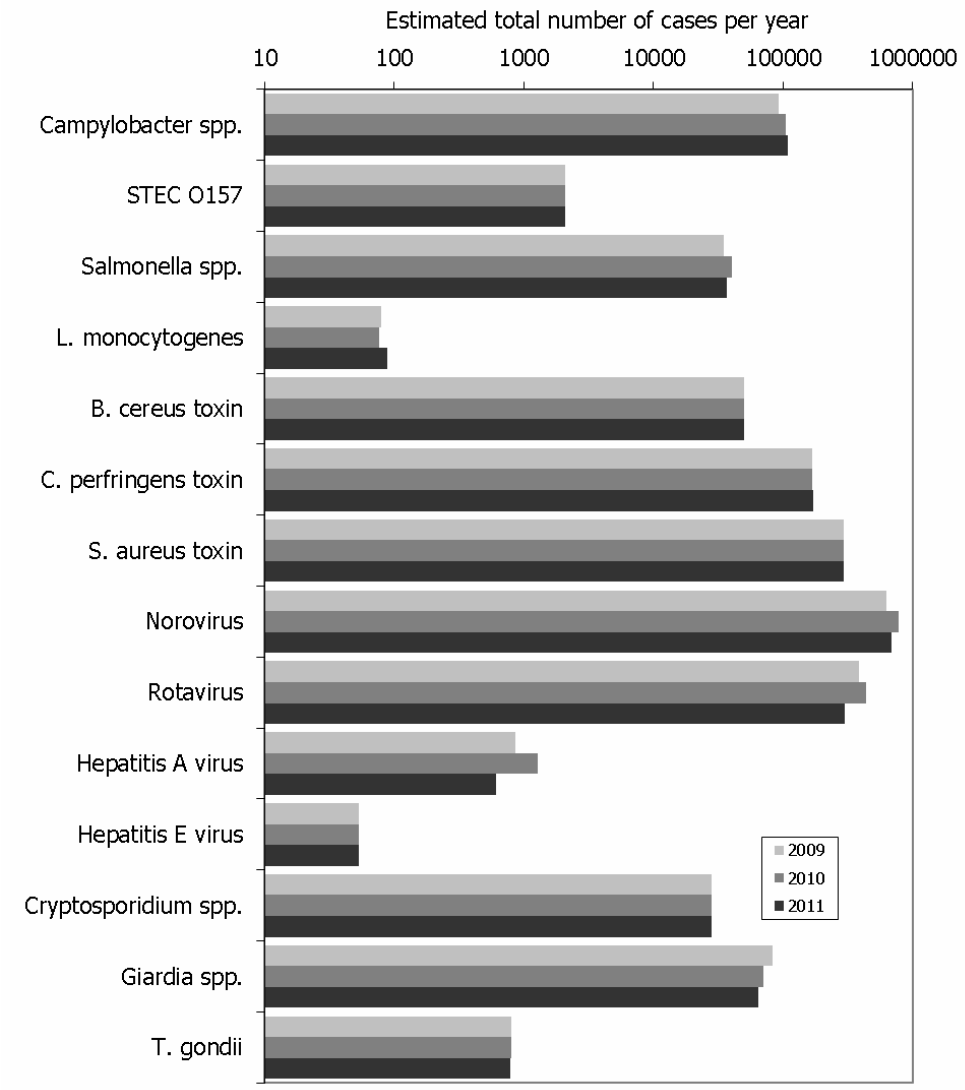

Figure 1. Comparison of incidence of food-related pathogens in 2009 through 2011

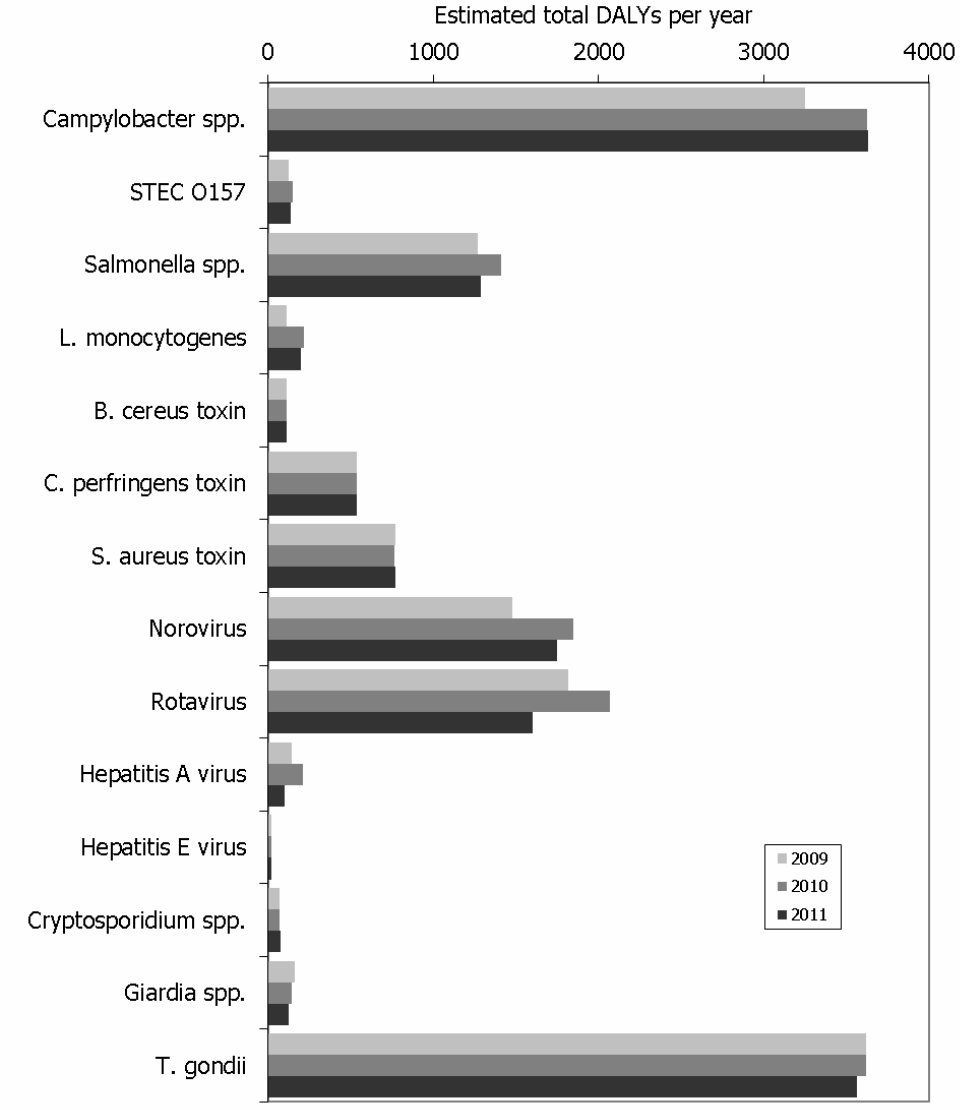

Figure 2. Comparison of disease burden of food-related pathogens in 2009 through 2011

Annex. Detailed results

Summary of results

Pathogen	**Incidence (per year)**	**Deaths (per year)**	**Disease burden (DALY)**
Campylobacter spp.	107,670	34.4	3,633
STEC O157	2,128	4.0	138
L. monocytogenes	88	5.0	203
Salmonella spp.	37,055	34.7	1,294
B. cereus toxin	50,554	0.0	113
C. perfringens toxin	170,587	4.6	543
S. aureus toxin	291,919	7.2	766
Hepatitis-A virus	609	1.9	98
Hepatitis-E virus	53	0.6	23
Norovirus	694,383	65.4	1,754
Rotavirus	300,902	45.1	1,603
Cryptosporidium spp.	28,216	1.7	72
Giardia spp.	64,284	1.8	127
Toxoplasma gondii	790	12.8	3,573
Totaal	1,749,238	219	13,940

Attribution to main pathways, all pathogens

Main pathway	Food	Environment	Human	Animal	Travel	Total
Incidence (per year)	689,447	215,121	612,474	89,273	142,923	1,749,238
Deaths (per year)	74	36	70	17	23	219
Disease burden (DALY)	6,231	2,871	2,427	1,131	1,280	13,940
Disease burden (DALY, discounted)	5,155	2,262	2,137	990	1,112	11,656

Attribution of incidence by pathogen to main pathways

Pathogen	Food	Environment	Human	Animal	Travel	Total
Campylobacter	45,222	22,180	6,783	20,565	12,920	107,670
STEC O157	855	367	218	438	250	2,128
L. monocytogenes	60	6	5	5	12	88
Salmonella	20,279	4,756	3,429	3,392	5,199	37,055
B. cereus toxine	45,183	552	602	552	3,665	50,554
C. perfringens toxine	154,309	3,730	3,561	3,561	5,426	170,587
S. aureus toxine	254,479	10,530	9,360	6,435	11,115	291,919
Hepatitis-A virus	67	68	111	-	363	609
Hepatitis-E virus	7	13	4	6	23	53
Norovirus	117,692	98,307	383,538	34,615	60,231	694,383
Rotavirus	39,117	51,153	174,825	9,027	26,780	300,902
C. parvum	3,380	7,809	7,724	3,778	5,525	28,216
G. lamblia	8,356	15,364	22,307	6,879	11,378	64,284
T. gondii	441	286	7	20	36	790
Total	689,447	215,121	612,474	89,273	142,923	1,749,238

Attribution of deaths by pathogen to main pathways

Pathogen	Food	Environment	Human	Animal	Travel	Totaal
Campylobacter	14.4	7.1	2.2	6.6	4.1	34.4
STEC O157	1.6	0.7	0.4	0.8	0.5	4.0
L. monocytogenes	3.4	0.3	0.3	0.3	0.7	5.0
Salmonella	19.0	4.5	3.2	3.2	4.9	34.7
B. cereus toxine	0.0	0.0	0.0	0.0	0.0	0.0
C. perfringens toxine	4.1	0.1	0.1	0.1	0.1	4.6
S. aureus toxine	6.3	0.3	0.2	0.2	0.3	7.2
Hepatitis-A virus	0.2	0.2	0.4	0.0	1.1	1.9
Hepatitis-E virus	0.1	0.2	0.0	0.1	0.3	0.6
Norovirus	11.1	9.3	36.1	3.3	5.7	65.4
Rotavirus	5.9	7.7	26.2	1.4	4.0	45.1
C. parvum	0.2	0.5	0.5	0.2	0.3	1.7
G. lamblia	0.2	0.4	0.6	0.2	0.3	1.8
T. gondii	7.2	4.6	0.1	0.3	0.6	12.8
Total	73.7	35.7	70.3	16.5	22.9	219.1

Attribution of disease burden (DALY per year, undiscounted) to main pathways

Pathogen	Food	Environment	Human	Animal	Travel	Total
Campylobacter	1,526	748	229	694	436	3,633
STEC O157	56	24	14	28	16	138
L. monocytogenes	140	14	11	11	27	203
Salmonella	708	166	120	118	182	1,294
B. cereus toxine	102	1	1	1	8	113
C. perfringens toxine	492	12	11	11	17	543
S. aureus toxine	667	28	25	17	29	766
Hepatitis-A virus	9	11	18	0	60	98
Hepatitis-E virus	2	6	2	3	10	23
Norovirus	298	248	969	87	152	1,754
Rotavirus	209	272	931	48	143	1,603
C. parvum	8	20	20	10	14	72
G. lamblia	17	30	44	14	22	127
T. gondii	1,997	1,291	32	89	164	3,573
Total	6,231	2,871	2,427	1,131	1,280	13,940

Attribution to food groups, all pathogens

Food group	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
Incidence (per year)	107,290	45,943	62,724	22,597	55,790	57,397	41,778	16,378	41,732	122,065	115,755	689,447
Deaths (per year)	9	9	12	5	5	6	6	2	3	5	12	74
Disease burden (DALY)	956	1,315	1,133	256	449	401	386	99	186	464	586	6,231
Disease burden (DALY, discounted)	768	927	999	224	392	343	314	90	162	426	505	5,140

Attribution of incidence by pathogen to food groups

Pathogen	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
Campylobacter	1,854	2,306	24,374	1,402	4,025	3,166	2,397	769	1,040	1,492	2,397	45,221
STEC O157	377	55	26	18	63	25	61	31	25	30	144	855
L. monocytogenes	7	6	4	2	15	11	5	2	4	3	3	62
Salmonella	2,555	2,900	3,001	4,502	1,338	831	1,278	629	872	1,217	1,156	20,279
B. cereus toxine	3,253	1,581	723	1,627	2,621	904	904	768	7,636	24,082	1,084	45,183
C. perfringens toxine	73,759	12,962	10,956	4,321	6,327	10,030	10,647	3,858	4,012	11,882	5,555	154,309
S. aureus toxine	19,086	20,613	19,849	8,398	37,408	14,760	5,090	4,581	19,086	75,325	30,283	254,478
Hepatitis-A virus	-	-	-	-	-	8	9	3	3	2	42	67
Hepatitis-E virus	-	5	-	-	-	-	1	-	-	-	1	7
Norovirus	3,766	3,648	3,413	2,236	2,354	18,242	8,592	3,648	6,120	5,885	59,788	117,692
Rotavirus	-	1,095	-	-	665	7,589	9,310	1,721	2,934	1,760	14,043	39,117
C. parvum	886	149	98	91	311	737	700	101	-	101	206	3,380
G. lamblia	1,646	401	259	-	643	1,078	2,758	267	-	276	1,028	8,356
T. gondii	101	222	21	-	20	16	26	-	-	10	25	441
Total	107,290	45,943	62,724	22,597	55,790	57,397	41,778	16,378	41,732	122,065	115,755	689,447

Attribution of deaths by pathogen to food groups

Pathogen	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
Campylobacter	0.6	0.7	7.8	0.4	1.3	1.0	0.8	0.2	0.3	0.5	0.8	14.4
STEC O157	0.7	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.3	1.6
L. monocytogenes	0.4	0.3	0.2	0.1	0.9	0.6	0.3	0.1	0.2	0.2	0.2	3.4
Salmonella	2.4	2.7	2.8	4.2	1.3	0.8	1.2	0.6	0.8	1.1	1.1	19.0
B. cereus toxine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. perfringens toxine	2.0	0.3	0.3	0.1	0.2	0.3	0.3	0.1	0.1	0.3	0.1	4.1
S. aureus toxine	0.5	0.5	0.5	0.2	0.9	0.4	0.1	0.1	0.5	1.9	0.7	6.3
Hepatitis-A virus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Hepatitis-E virus	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Norovirus	0.4	0.3	0.3	0.2	0.2	1.7	0.8	0.3	0.6	0.6	5.6	11.1
Rotavirus	0.0	0.2	0.0	0.0	0.1	1.1	1.4	0.3	0.4	0.3	2.1	5.9
C. parvum	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
G. lamblia	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2
T. gondii	1.6	3.6	0.3	0.0	0.3	0.3	0.4	0.0	0.0	0.2	0.4	7.2
Total	8.6	8.9	12.3	5.4	5.3	6.3	5.5	1.8	3.0	5.0	11.5	73.7

Attribution of disease burden (DALY per year, undiscounted) to food groups

Pathogen	Beef & Lamb	Pork	Poultry	Eggs	Dairy	Fish & shellfish	Produce	Beverages	Grains	Other foods	Humans & animals	Total
Campylobacter	63	78	822	47	136	107	81	26	35	50	81	1,526
STEC O157	24	4	2	1	4	2	4	2	2	2	9	56
L. monocytogenes	16	13	9	5	34	25	11	4	8	8	7	140
Salmonella	89	101	105	157	47	29	45	22	30	43	40	708
B. cereus toxine	7	4	2	4	6	2	2	2	17	54	2	102
C. perfringens toxine	235	41	35	14	20	32	34	12	13	38	18	492
S. aureus toxine	50	54	52	22	98	39	13	12	50	198	79	667
Hepatitis-A virus	-	-	-	-	-	1	1	-	-	-	7	9
Hepatitis-E virus	-	2	-	-	-	-	-	-	-	-	-	2
Norovirus	10	9	9	6	6	46	22	9	15	15	151	298
Rotavirus	-	6	-	-	4	40	50	9	16	9	75	209
C. parvum	2	-	-	-	1	2	2	-	-	-	1	8
G. lamblia	3	1	1	-	1	2	5	1	-	1	2	17
T. gondii	457	1,002	96	-	92	74	116	-	-	46	114	1,997
Total	956	1,315	1,133	256	449	401	386	99	186	464	586	6,231

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