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

Disease burden of food-related pathogens in the Netherlands, 2012

RIVM Letter Report 330331004/2012
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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, 2010

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 increased from 13,500 DALY in 2009 to 14,400 DALY in 2010. The share of foodborne transmission in this burden increased from 6,020 to 6,440 DALY.

The increase in disease burden was a result of an increase in the incidence of disease by *Campylobacter* spp., *Salmonella* spp., norovirus, rotavirus and hepatitis A virus. Furthermore, more persons died from an infection with *Listeria monocytogenes*. Most observed increases are within the range of observed disease incidence in the previous decennium. However, the incidence of campylobacteriosis was approximately 25% higher than in previous years. No explanation for this increase 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 in not reported.

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

Rapport in het kort

Ziektelast van via voedsel overdraagbare pathogenen in Nederland in 2010

Op verzoek van het ministerie van VWS onderzoekt het RIVM jaarlijks hoeveel mensen ziek worden van 14 darminfecties. 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 steeg van 13.500 DALY in 2009 naar 14.400 DALY in 2010. Het deel van deze ziektelast dat alleen via voedsel werd overgedragen, steeg van 6.020 tot 6.440 DALY.

De stijging in de ziektelast via voedsel komt doordat er ten opzichte van 2009 meer mensen ziek zijn geworden van een infectie met de *Campylobacter* spp., *Salmonella* spp., het norovirus, het rotavirus en het hepatitis A-virus. Daarnaast zijn er meer mensen overleden als gevolg van een infectie met *Listeria monocytogenes*. De meeste van deze stijgingen vallen binnen de marges voor de mate waarin deze infecties voorkomen ten opzichte van het voorgaande decennium. Dit geldt niet voor het aantal infecties met de Campylobacter-bacterie. Deze veroorzaakte in 2010 ongeveer 25 procent vaker een infectie dan in voorgaande jaren. Een verklaring hiervoor 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 2010. Compared to 2009, the incidence of campylobacteriosis increased by 14% and the incidence of salmonellosis by 19%. The incidence of gastroenteritis by rotavirus increased by 14% and by norovirus with 25% (based on all hospitalisations for viral gastroenteritis). The incidence of perinatal and acquired listeriosis was similar to 2009 with 4 and 73 cases, respectively. There were 13 fatal cases of acquired listeriosis, considerably more than in 2009. The incidence of STEC O157 was similar to 2009. The incidence of hepatitis A increased by 49%. 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 higher incidence, there was also an increase in the burden of campylobacteriosis, salmonellosis, norovirus, and rotavirus. Due to the high number of fatal cases, the burden of listeriosis also increased considerably. Perinatal listeriosis was the disease outcome with the highest individual burden among all pathogens. The total burden of the 14 pathogens increased with 10% from 13,500 to 14,900 DALY. The burden of foodborne disease increased with 7% from 6,020 to 6,440 DALY. A particularly high increase was estimated in human-human transmitted disease, with 18% from 2,370 to 2,800 DALY (related to strong increases in virus incidence). Among food pathways, the highest burden was attributed to poultry, beef/mutton and transmission by humans or animals (mainly infected food handlers). Foods from animal origin caused 50% of all cases but 72% 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 increases in 2010 compared to 2009 are within the range of observed disease incidence in the previous decennium, except for the incidence of campylobacteriosis that was approximately 25% higher than in previous years. No explanation for this increase 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 presented information includes estimates of the disease burden, expressed in Disability Adjusted Life Years. The methodology is described in detail in a peer-reviewed paper (Havelaar et al., Submitted for publication). Data in that paper referred to the year 2009. In this report, trend information from epidemiological surveillance and demographic information is used to update the information to the year 2010. For comparison, data for 2009 are also presented.

[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 by pathogen in the general population and consulting the general practitioner was obtained from the following sources (partly also presented in Aalten et al., 2011):

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.

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, both 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.

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.

[2] http://statline.cbs.nl/statweb/, accessed 8 August 2011

3 Results

3.1 Trend information

The number of inhabitants in the Netherlands slightly increased from 16.5 million in 2009 to 16.6 million in 2010 (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 2011). Therefore, the survival table for 2009 was used. The number of live births decreased slightly from 184,900 in 2009 to 184,400 in 2010 (Table 2). The age of mothers was fairly similar in the two years, although a decrease in the number of births from mothers between 35 and 39 years was observed, with a concomitant increase in the 30-34 years age group. The number of stillbirths (24 weeks or more gestational age) in 2010 was 648, the same as in 2009. The number of hospitalizations for gastroenteritis increased with 9% from 21,932 to 23,871.

Trend information for specific pathogens is presented in Table 3. A summary of trends (in comparison with 2009) is discussed below:

- The incidence of **campylobacteriosis** (laboratory confirmed cases) **increased by 14%** from 44.1 to 50.2 cases per 100,000 inhabitants; there is **no significant trend** (p=0.19) since 1999.
- The incidence of **salmonellosis** (laboratory confirmed cases) **increased by 19%** from 11.6 to 13.8 per 100,000 inhabitants; nevertheless there is a **significantly decreasing trend** (p=0.001) since 1999.
- The incidence of gastroenteritis by **rotavirus** (laboratory confirmed cases) **increased by 14%** from 30.9 to 35.2 cases per 100,000 inhabitants; there is a **significantly increasing trend** (p<0.001) since 1999.
- The incidence of hospitalizations for viral gastroenteritis (a proxy for the incidence of gastroenteritis by norovirus) increased by 25% from 17.7 to 22.2 cases per 100,000 inhabitants; there is a **significantly increasing trend** (p<0.001) since 1999.
- The incidence of **acquired listeriosis** (active surveillance) was 73 cases, **similar to 2009**. There were 13 **fatalities**, **considerably more** than the 4 fatal cases in 2009. The statistical life expectancy of fatal cases was 13.7 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 2010, the probability of developing **meningitis** as a consequence of acquired listeriosis was updated to **30%** (95% confidence interval 25-36%).
- The incidence of **perinatal listeriosis** (active surveillance) was 4 cases with 1 fatality, **similar to 2009**.
- The incidence of diseases caused by **STEC O157** (active surveillance) was 52 with 21 hospitalizations, **similar to 2009**. There were 2 fatal cases.
- The incidence of **hepatitis A** (notified cases) **increased by 49%** from 176 to 262 with 52 hospitalizations; there is **no significant trend** (p= 0.93 for incidence and p=0.45 for hospitalizations) since 2006.

3.2 Disease incidence

The incidence of gastroenteritis by pathogen, of non-gastrointestinal pathogens and sequelae by pathogen in 2010 is presented in Tables 4-6, and Figure 1. There were increases in the incidence of campylobacteriosis, salmonellosis, norovirus, and rotavirus at all levels of the surveillance pyramid while the incidence of listeriosis and giardiasis decreased slightly. For other pathogens, no trend information was available. The total number of cases by the 14 pathogens increased from 1,770,000 to 1,990,000. In comparison with 2009, there were

considerably more fatal cases of listeriosis (14 vs. 4). Table 3 suggests that the incidence of fatal cases varies considerably over the years, with relatively low numbers in 2008 and 2009.

3.3 Disease burden by pathogen

The burden by pathogen is presented in Table 7 and Figures 2-3. Because of the higher incidence, there was also an increase in the burden of campylobacteriosis, salmonellosis, norovirus, and rotavirus. Due to the high number of fatal cases, the burden of listeriosis also increased considerably (from 114 to 217 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 increased with 10% from 13,500 to 14,900 DALY. The standardized burden (per 100,000) increased in parallel with the total burden. There were few changes in the individual burden with the exception of listeriosis, which increased from 1,450 to 2,820 DALY per 1,000 cases due to more fatal cases.

3.4 Attribution

Attribution results are presented in Tables 8-9. The burden of foodborne disease increased with 7% from 6,020 to 6,440 DALY. A particularly high increase was estimated in human-human transmitted disease, with 18% from 2,370 to 2,800 DALY (related to strong increases in virus incidence). Among food pathways, the highest burden was attributed to poultry (up 10% from 1,050 to 1,150 DALYs), followed by beef/mutton (up 3% from 951 to 981 DALY) and transmission by humans or animals (mainly infected food handlers, up 12% from 573 to 642 DALY). Foods from animal origin caused 50% of all cases but 72% 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 increased from 13,500 DALY in 2009 to 14,400 DALY in 2010. The share of foodborne transmission in this burden increased from 6,020 to 6,440 DALY. The increase was a result of an increase in the incidence of cases by *Campylobacter* spp., *Salmonella* spp., norovirus, rotavirus and hepatitis A virus and an increase in fatal cases by *Listeria monocytogenes*. Of three of these (*Campylobacter* spp., *Salmonella* spp., and rotavirus), trend data are based on laboratory surveillance, for hepatitis A virus on disease notification. The observed increases in disease incidence in 2010 compared to 2009 are within the range of those in the previous decennium, except for the incidence of campylobacteriosis that was approximately 25% higher than in previous years (see Table 3). No explanation for this increase is available. For norovirus, no direct trend information is available, but is estimated from trends in hospitalisation for viral gastroenteritis, which includes also rotaviruses. Hence the trend in norovirus incidence may be overestimated. Even though the incidence of listeriosis was similar to previous years, the burden increased due to a higher incidence of fatal cases. The 2010 data were more similar to the long-term average; hence the burden of listeriosis in 2010 is a more accurate reflection of the public health impact of listeriosis in the Netherlands than the burden in 2009. 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

The authors thank Margaret Wilson (Risk Science International, Ottawa, Canada) for support in developing the stochastic simulation model.

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Table 1. Population in the Netherlands by age group, 2009-10

Age group	2010	2009
0	184,586	184,408
1-4	740,295	747,148
5-11	1,405,533	1,405,232
12-17	1,184,064	1,191,453
18-64	10,522,183	10,485,731
65+	2,538,328	2,471,815
Total	16,574,989	16,485,787

Table 2. Live births by age of mothers in the Netherlands, 2009-10

Age of mother	2010	2009
-19	1,884	1,953
20-24	16,417	16,499
25-29	51,570	51,459
30-34	69,420	68,828
35-39	37,213	38,637
40-44	7,565	7,252
45+	328	287
Total	184,397	184,915

Table 3. Trends in incidence of food-related pathogens, 1999-2010

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

Data sources: see text

* Ca: Campylobacter spp.; Sa: Salmonella spp., RV: rotavirus, NV:

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, 2010 (population 16.5 million)

Pathogen	General population (x 1,000)	GP visit (x 1,000)	Hospitalised (x 1,000)	Fatal cases
All causes	4,800[†]	221	24	NA[#]
	3,990-5,690[‡]	73-512		
Bacteria – infectious				
Campylobacter spp.	104	25	1.1	39
	13-285	12-46	0.4-2.3	26-55
STEC O157	2.1	0.3	0.02	1
	0.22-8.8	0.01-0.9	-	0-3
Salmonella spp.	40	6.2	1.2	40
	2.8-122	3.3-10.3	0.6-2.3	34-45
Bacteria – toxin producing				
Bacillus cereus	50	6.9	0.2	0
	18-116	1.7-19	0.1-0.5	
Clostridium perfringens	169	31	0.3	4
	56-371	7.4-82	0.1-0.6	0-20
Staphylococcus aureus	292	41	1.5	7
	127-549	11-96	0.7-2.8	0-29
Viruses				
Norovirus	785	19	2.1	73
	540-1,140	11.9-30	1.1-3.4	32-136
Rotavirus	437	28	6.4	66
	212-791	18-41	4.9-8.4	22-139
Protozoa				
Cryptosporidium spp.	28	1.8	0.7	2
	8-68	0.9-3.1	0.3-1.3	0-7
Giardia spp.	71	6.3	0.5	2
	31-137	3.3-11	0.04-1.4	0-8

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

Table 5. Incidence of non-gastrointestinal pathogens in the Netherlands, 2010

Pathogen	Incidence	Fatal cases
Listeria monocytogenes		
Perinatal	4*	1
Acquired	73	13
Hepatitis A virus	1,280†	4
	690-2,260‡	3-7
Hepatitis E virus	53	1
	22-94	0-1
Toxoplasma gondii		
Perinatal	372	13
	191-652	8-21
Acquired^	425	0
	196-730	

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

Table 6. Incidence of sequelae by pathogen in the Netherlands, 2010

Pathogen and sequelae	Incidence	Fatal cases
Campylobacter spp.		
Guillain-Barré Syndrome	77[†] (0-145) [‡]	1 (0-5)
Reactive arthritis	1,890 (792-3,790)	0
Irritable Bowel Syndrome	9,150 (2,620-23,400)	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	511 (185-1,060)	0
Irritable Bowel Syndrome	3,150 (520-10,700)	0
Inflammatory Bowel Disease	8 (6-11)	0
Listeria monocytogenes (perinatal)		
Meningitis	3[*]	NA
Neurological sequelae of meningitis	1 (1-2)	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	50 (26-88)	NA
Chorioretinitis later years of life	60 (31-105)	NA
Intracranial calcifications	39 (20-70)	NA
Hydrocephalus	7 (3-14)	NA
Central Nervous System Abnormalities	11 (2-30)	NA
Toxoplasma gondii (acquired)		
Chorioretinitis	425 (196-730)	0

[†] mean
[‡] 2.5-97.5 percentile
[*] No uncertainty because cases were acquired through active surveillance
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, 2010

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.	3,620	3,230	21.8	19.5	40	35
STEC O157	149	115	0.9	0.7	170	132
Salmonella spp.	1,410	1,240	8.5	7.5	45	38
Listeria monocytogenes (perinatal)	109	63	0.65	0.38	27,200	15,900
Listeria monocytogenes (acquired)	108	104	0.65	0.62	1,480	1,420
Listeria monocytogenes (total)	217	167	1.3	1.00	2,820	2,170
Bacteria-toxin-producing						
Bacillus cereus	114	113	0.7	0.7	2.3	2.3
Clostridium perfringens	537	532	3.2	3.2	3.2	3.2
Staphylococcus aureus	768	760	4.6	4.6	2.6	2.6
Viruses						
Norovirus	1,860	1,650	11.2	9.4	2.4	2.1
Rotavirus	2,120	1,910	12.8	11.5	5.0	4.5
Hepatitis A virus	212	184	1.30	1.1	167	145
Hepatitis E virus	24	20	0.15	0.12	460	380
Protozoa						
Cryptosporidium spp.	76	74	0.5	0.4	3.2	3.1
Giardia spp.	140	137	0.8	0.8	2.1	2.1
Toxoplasma gondii (perinatal)	2,270	1,330	13.7	8.0	6,360	3,730
Toxoplasma gondii (acquired)	1,350	1,020	8.1	6.2	3,170	2,400
Toxoplasma gondii (total)	3,620	2,350	21.8	14.2	4,610	2,990

Table 8. Attribution of the incidence, fatalities and disease burden to the major transmission pathways in the Netherlands, 2010

Transmission pathway	Food	Environment	Human	Animal	Travel	Total*
Incidence	725†	255	745	98	169	1,990
(x 1000)	339-1,390‡	142-446	459-1,190	51-186	93-300	1,080-3,510
Fatal cases	89	43	88	19	29	269
	54-159	23-76	37-171	12-31	17-51	143-489
Disease burden (DALY per year, not discounted)	6,440	3,030	2,800	1,180	1,450	14,900
	3, 160-11,500	1,900-4,830	1,860-4,260	690-2,090	880-2,470	8,950-25,100
Disease burden (DALY per year, discounted)	5,350	2,400	2,500	1200	1,250	12,500
	2,840-9,990	1,460-3,850	1,630-3,850	580-1,880	740-2,090	7,240-21,800

† 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, 2010

Food group	Beef/ mutton	Pork	Poultry	Eggs	Dairy	Fish/ shellfish	Fruit/ veg.	Bever- ages	Cereals	Other foods	Human/an imal	Total
Incidence	109[†]	46	63	23	57	64	47	17	42	125	131	728
(x 1000)	43-225[‡]	20-91	24-138	9-50	26-111	33-113	23-89	8-33	20-81	56-242	76-218	340-1,390
Fatal cases	9.9	10	15	6.3	7.5	8.5	7.0	2.3	3.6	5.9	14	89
	5.6-21	6.7-16	9.8-22	5.7-8.3	5.2-12	5.4-15	3.6-15	1.4-5.4	2.1-6.9	2.7-14	6.6-27	54-159
Disease burden (DALY per year, not discounted)	981	1330	1,150	269	474	429	409	108	187	470	642	6,450
	516-1,800	822-2,080	644-2,140	143-546	260-866	254-737	242-700	59-206	92-373	199-992	388-1,060	3,620-11,500
Disease burden (DALY per year, discounted)	786	949	1,010	240	405	367	337	98	173	433	557	5,350
	384-1,520	564-1,540	537-1,950	118-510	210-772	208-653	192-602	50-192	81-354	175-944	321-935	2,840-9,980

[†] mean
[‡] 2.5-97.5 percentile

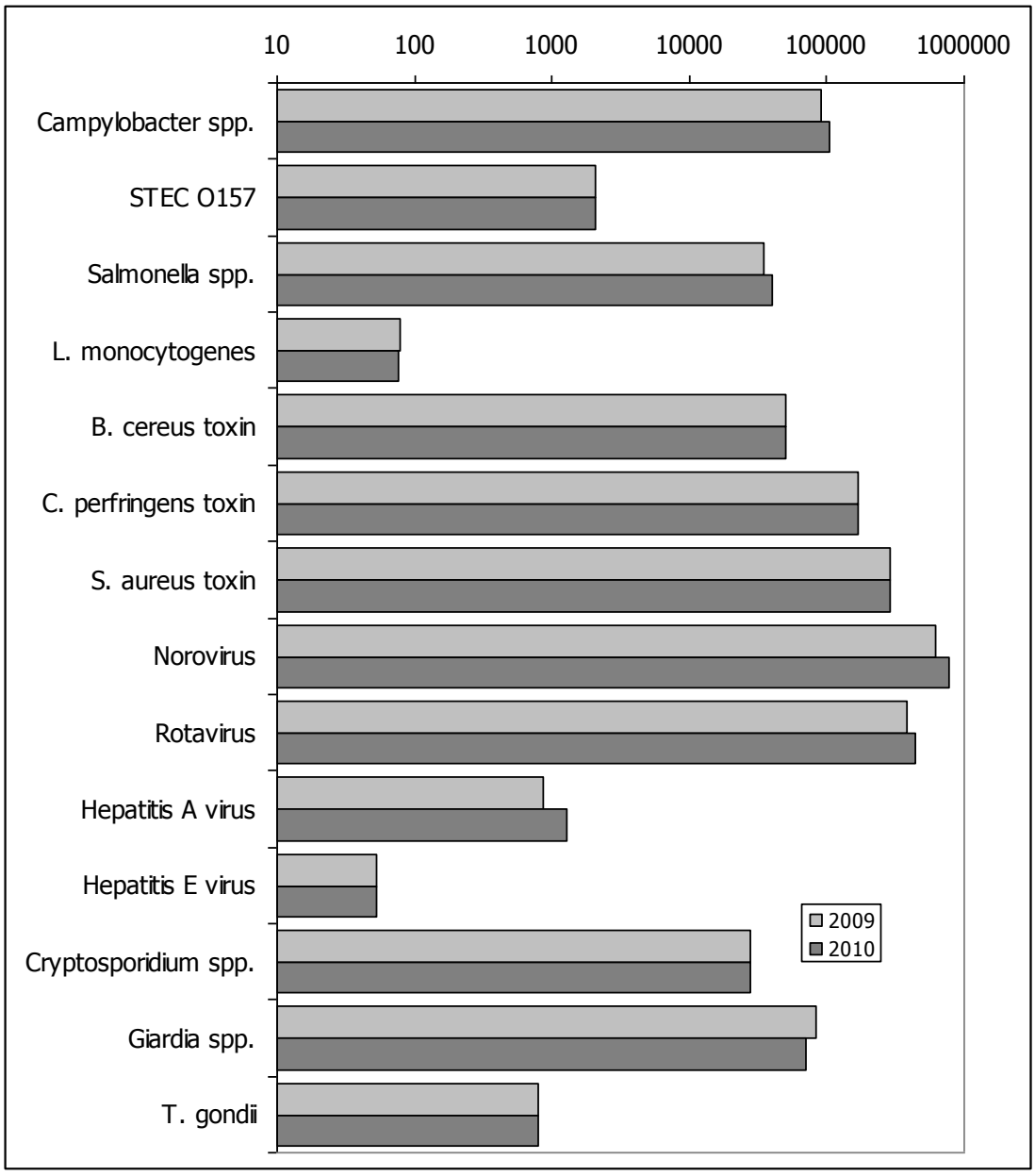

Figure 1. Comparison of incidence of food-related pathogens in 2009 and 2010

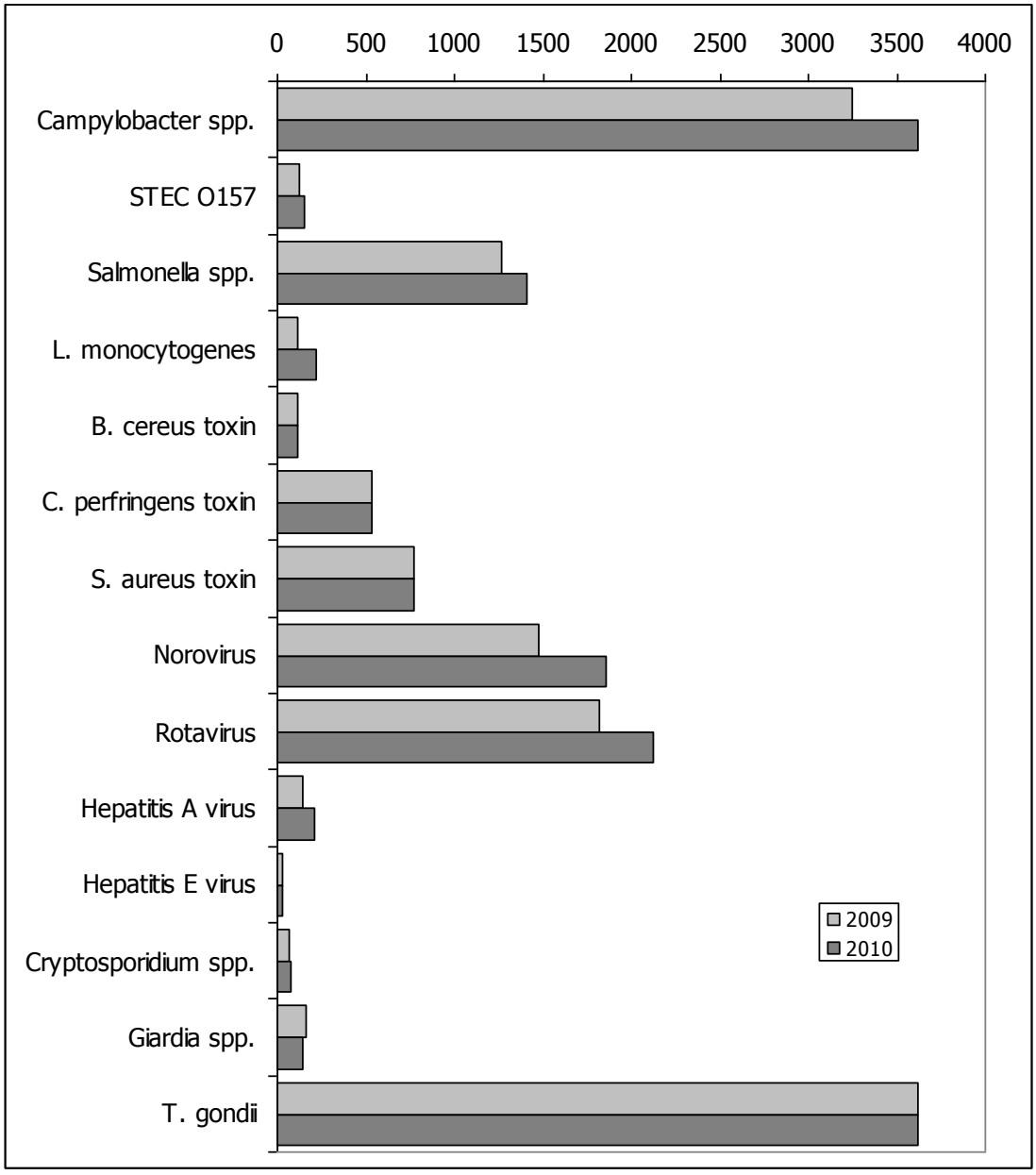

Figure 2. Comparison of disease burden of food-related pathogens in 2009 and 2010

Annex. Detailed results

Summary of results

Pathogen	Incidence (per year)	Deaths (per	Disease burden (DALY)
Campylobacter	105388	39.4	3621
STEC O157	2134	4.0	149
L. monocytogenes	77	13.9	217
Salmonella	41165	39.5	1414
B. cereus toxine	49883	0.0	113
C. perfringens toxine	169038	4.5	537
S. aureus toxine	291961	7.2	769
Hepatitis-A virus	1283	4.1	212
Hepatitis-E virus	53	0.6	24
Norovirus	786972	73.0	1862
Rotavirus	443561	66.1	2122
C. parvum	28189	1.7	76
G. lamblia	71673	2.0	139
T. gondii	797	13.2	3616
Totaal	1992173	269	14871

Attribution to main pathways, all pathogens

Main pathway	Food	Environment	Human	Animal	Travel	Total
Incidence (per year)	725279	254526	745924	98135	169036	1992900
Deaths (per year)	89	43	88	19	30	269
Disease burden (DALY)	6439	3034	2805	1177	1450	14905
Disease burden (DALY, discounted)	5345	2396	2502	1023	1248	12514

Attribution of incidence by pathogen to main pathways

Pathogen	Food	Environment	Human	Animal	Reizen	Total
Campylobacter	44263	22132	6323	20024	12647	105389
STEC O157	854	363	213	448	256	2134
L. monocytogenes	53	5	4	4	10	76
Salmonella	22640	5351	3705	3705	5763	41164
B. cereus toxine	44894	499	499	499	3492	49883
C. perfringens toxine	153825	3381	3381	3381	5071	169039
S. aureus toxine	254006	11678	8759	5839	11678	291960
Hepatitis-A virus	141	141	231	0	770	1283
Hepatitis-E virus	7	13	4	6	23	53
Norovirus	133785	110176	432835	39349	70827	786972
Rotavirus	57663	75405	257265	13307	39920	443560
C. parvum	3383	7893	7611	3665	5638	28190
G. lamblia	9318	17202	25086	7884	12901	72391
T. gondii	447	287	8	24	40	806
Total	725279	254526	745924	98135	169036	1992900

Attribution of deaths by pathogen to main pathways

Pathogen	Food	Environment	Human	Animal	Reizen	Totaal
Campylobacter	16.6	8.3	2.4	7.5	4.7	39.4
STEC O157	1.6	0.7	0.4	0.8	0.5	4.0
L. monocytogenes	9.7	1.0	0.7	0.7	1.8	13.9
Salmonella	21.7	5.1	3.6	3.6	5.5	39.5
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	4.5
S. aureus toxine	6.3	0.3	0.2	0.1	0.3	7.2
Hepatitis-A virus	0.4	0.4	0.7	0.0	2.4	4.1
Hepatitis-E virus	0.1	0.2	0.0	0.1	0.3	0.6
Norovirus	12.4	10.2	40.2	3.7	6.6	73.0
Rotavirus	8.6	11.2	38.3	2.0	5.9	66.1
C. parvum	0.2	0.5	0.4	0.2	0.3	1.7
G. lamblia	0.3	0.5	0.7	0.2	0.4	2.0
T. gondii	7.3	4.7	0.1	0.4	0.7	13.2
Total	89.3	43.2	87.9	19.3	29.5	269.2

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

Pathogen	Food	Environment	Human	Animal	Reizen	Total
Campylobacter	1521	760	217	688	434	3620
STEC O157	60	25	15	31	18	149
L. monocytogenes	150	15	11	11	28	215
Salmonella	778	184	127	127	198	1414
B. cereus toxine	102	1	1	1	8	113
C. perfringens toxine	489	11	11	11	16	538
S. aureus toxine	669	31	23	15	31	769
Hepatitis-A virus	23	23	38	0	127	211
Hepatitis-E virus	3	6	2	3	10	24
Norovirus	316	261	1024	93	168	1862
Rotavirus	276	361	1231	64	191	2123
C. parvum	9	21	20	10	15	75
G. lamblia	18	33	49	15	25	140
T. gondii	2025	1302	36	108	181	3652
Total	6439	3034	2805	1177	1450	14905

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)	109255	45985	63731	23136	57490	63760	47416	17362	42578	125440	131678	727683
Deaths (per year)	9.9	10.0	14.5	6.3	7.5	8.5	7.0	2.3	3.6	5.9	14.0	88.9
Disease burden (DALY)	980.0	1331.0	1150.0	269.0	473.0	428.0	409.0	106.0	187.0	472.0	642.0	6420.0
Disease burden (DALY, discounted)	785.0	948.0	1009.0	242.0	405.0	367.0	339.0	97.0	172.0	437.0	550.0	5327.0

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	1771	2213	23902	1328	3984	3098	2213	885	885	1328	2213	43820
STEC O157	376	51	26	17	60	26	60	34	26	34	145	855
L. monocytogenes	6	5	4	2	13	10	4	2	3	3	3	55
Salmonella	2943	3170	3396	4981	1585	906	1358	679	906	1358	1358	22640
B. cereus toxine	3143	1347	898	1796	2694	898	898	898	7632	24243	898	45345
C. perfringens toxine	73836	12306	10768	4615	6153	9229	10768	3076	4615	12306	6153	153825
S. aureus toxine	20320	20320	20320	7620	38101	15240	5080	5080	17780	76202	30481	256544
Hepatitis-A virus	0	0	0	0	0	18	18	6	6	4	89	
Hepatitis-E virus	0	5	0	0	0	0	1	0	0	0	1	
Norovirus	4014	4014	4014	2676	2676	21406	9365	4014	6689	6689	68230	133787
Rotavirus	0	1730	0	0	1153	10956	13839	2307	4036	2883	20759	57663
C. parvum	879	135	101	101	304	744	710	101	0	101	203	3379
G. lamblia	1864	466	280	0	745	1211	3075	280	0	280	1118	9319
T. gondii	103	223	22	0	22	18	27	0	0	9	27	451
Total	109255	45985	63731	23136	57490	63760	47416	17362	42578	125440	131678	727683

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	0.7	0.8	8.9	0.5	1.5	1.2	0.8	0.3	0.3	0.5	0.8	16.4
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	1.1	0.9	0.7	0.4	2.4	1.7	0.8	0.3	0.6	0.6	0.5	9.9
Salmonella	2.8	3.0	3.3	4.8	1.5	0.9	1.3	0.7	0.9	1.3	1.3	21.7
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	0.2	0.3	0.1	0.1	0.3	0.2	4.1
S. aureus toxine	0.5	0.5	0.5	0.2	0.9	0.4	0.1	0.1	0.4	1.9	0.8	6.3
Hepatitis-A virus	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.3	0.4
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	0.4	0.4	0.2	0.2	2.0	0.9	0.4	0.6	0.6	6.3	12.4
Rotavirus	0.0	0.3	0.0	0.0	0.2	1.6	2.1	0.3	0.6	0.4	3.1	8.6
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	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3
T. gondii	1.7	3.7	0.4	0.0	0.4	0.3	0.4	0.0	0.0	0.1	0.4	7.4
Total	9.9	10.0	14.5	6.3	7.5	8.5	7.0	2.3	3.6	5.9	14.0	89.4

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	61	76	821	46	137	106	76	30	30	46	76	1505
STEC O157	26	4	2	1	4	2	4	2	2	2	10	59
L. monocytogenes	16	13	10	6	37	27	12	4	9	9	7	150
Salmonella	101	109	117	171	54	31	47	23	31	47	47	778
B. cereus toxine	7	3	2	4	6	2	2	2	17	55	2	102
C. perfringens toxine	235	39	34	15	20	29	34	10	15	39	20	490
S. aureus toxine	53	53	53	20	100	40	13	13	47	201	80	673
Hepatitis-A virus	0	0	0	0	0	3	3	1	1	1	15	
Hepatitis-E virus	0	3	0	0	0	0	0	0	0	0	0	
Norovirus	9	9	9	6	6	51	22	9	16	16	161	314
Rotavirus	0	8	0	0	6	52	66	11	19	14	99	275
C. parvum	2	0	0	0	1	2	2	0	0	0	1	8
G. lamblia	4	1	1	0	1	2	6	1	0	1	2	19
T. gondii	466	1013	101	0	101	81	122	0	0	41	122	2047
Total	980	1331	1150	269	473	428	409	106	187	472	642	6420

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