Disease burden of food-related pathogens in the Netherlands, 2013

RIVM Letter report 2014-0115
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Colophon

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M. Bouwknecht (author), RIVM
M.J. Mangen (author), Julius Centrum, UMCU
I.H.M. Friesema (author), RIVM
W. van Pelt (author), RIVM
A.H. Havelaar (author), RIVM

Contact:
Martijn Bouwknecht
Centre for Zoonoses and Environmental Microbiology, Centre for Infectious Disease Control Netherlands, RIVM
martijn.bouwknecht@rivm.nl

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

This is a publication of:
National Institute for Public Health and the Environment
P.O. Box 1 | 3720 BA Bilthoven
The Netherlands
www.rivm.nl/en
Synopsis

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. Furthermore, the cost-of-illness (COI) related to the 14 food-related pathogens were estimated and expressed in euros. The total disease burden caused by the 14 pathogens decreased from 14,500 DALY in 2012 to 13,200 DALY in 2013. The share of foodborne transmission in this burden decreased from 6,600 to 5,800 DALY, reaching the lowest estimated level since 2009. The COI increased by 6 M€ compared to 2012, reaching a total of 424 million euro. The share of foodborne transmission was 172 million euro. The decrease in disease burden was a result of decreased incidences for most pathogens, except for rotavirus. The latter incidence increased by 16% compared to 2012, reaching a comparable level to 2011 and a ~30% lower level compared to 2009 and 2010.

The research presented in this report results in more insight in the true incidence of foodborne diseases and the associated disease burden and costs and enables to monitor trend in time for these public health indicators.

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

Ziektelast van via voedsel overdraagbare ziekteverwekkers in Nederland in 2013

Het RIVM onderzoekt jaarlijks hoeveel mensen ziek worden van 14 ziekteverwekkers die via voedsel in het menselijk lichaam terechtkomen (darmpathogenen). Deze ziektelast wordt uitgedrukt in DALY's (Disability Adjusted Life Year), een internationaal gehanteerde maat voor het aantal gezonde levensjaren die verloren gaan aan ziekte of overlijden. Het aantal DALY's als gevolg van de 14 ziekteverwekkers daalde van ongeveer 6.600 in 2012 tot 5.800 DALY's in 2013.

Daarnaast wordt geschat welke kosten hieraan verbonden zijn (cost of illness). Deze omvatten directe medische kosten, maar ook de kosten voor de patiënt en/of zijn familie, zoals reiskosten, als ook de kosten binnen andere sectoren, bijvoorbeeld door werkverzuim. De gerelateerde kosten van de 14 ziekteverwekkers die mensen via voedsel opliepen bedroegen in 2013 172 miljoen euro.


VWS is opdrachtgever van dit onderzoek. De resultaten bieden handvaten om meer zicht te krijgen op het daadwerkelijke aantal voedselinfecties dat mensen jaarlijks oplopen en de bijbehorende ziektelast.

Kernwoorden: voedsel-gerelateerde ziekte, ziektelast, DALY, kosten, trend
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Introduction

Since 2008, RIVM regularly publishes estimates of the incidence, disease burden and costs of food-related disease on its web pages in the “Nationaal Kompas Volksgezondheid”. The epidemiological estimates of the disease burden are expressed in Disability Adjusted Life Years (DALY). The methodology for these estimates is described in detail in a peer-reviewed paper [1]. Data in the latter paper referred to represent estimates for the year 2009, and updates based on data for the years 2010 up until 2012 have followed [2-4]. In this report, trend information from surveillance and demographic information was used to update the information to the year 2013.

The economical estimates of the disease burden, the cost-of-illness (COI) expressed in euros, were finalized for all 14 food-related pathogens for the year 2011 [5]. The economic models were added to the existing disease burden model. The estimates for 2011 [6] were updated to 2012 in a previous report [3], and the results for 2013 are integrated in this report.

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 Netherlands².

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:

- Thermophilic *Campylobacter* spp.: laboratory surveillance
- Non-typhoidal *Salmonella* spp.: laboratory surveillance
- Norovirus: hospitalisation for viral gastro-enteritis (ICD code 86)
- Rotavirus: laboratory surveillance
- Hepatitis A, and perinatal and acquired listeriosis: mandatory notification and active surveillance
- *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 of -1.03% per year 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*), Shiga-toxin producing *Escherichia coli* O157 (STEC O157), 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. From 2011 onwards these data were obtained from Dutch Hospital Data (DHD). Data for 2013 were not available in time due to changes in procedures at DHD and change in coding from ICD9 to ICD10. Therefore estimates for the number of hospitalized patients were obtained by extrapolation, using the 10-year relationship of the number of hospitalized patients and time series from the laboratory surveillance (primarily tested faeces, but in part (<18 years) rotavirus). Using this method on data for earlier years showed similar estimates for the number and age-distribution of hospitalized GE-patients.

Excess mortality risks from campylobacteriosis and salmonellosis were assumed constant. Fatalities due to listeriosis and STEC O157 were obtained 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 updates

The estimation of excess mortality due to *Campylobacter* spp. and *Salmonella* spp. was updated. The initial model was based on a fixed

number of reported cases, which was not updated annually. The updated model attributes the actual number of reported cases in the updating year over 5-year age classes. The proportions for attribution are estimates as five-year averages (2009-2013) from the age distribution in the surveillance data.

The effects of the updates on the burden estimation are shown by re-estimating the relevant results for all years from 2009-2012, as reported in Table 7. The interpretation of trends in this report are based on the results from the updated model.

2.3 Disease burden
The DALY calculations were not changed compared to previous years; hence all differences in the results for 2013 compared to 2011 and 2012 will reflect the impact of trends in the underlying information on demographics and pathogen incidence, and the aforementioned model updates. As described above, the impact of the latter is shown in Table 7.

2.4 Cost of illness
Cost-of-illness calculations were not changed compared to previous years (i.e. 2012 and 2011), only the cost prices used for the different resources had to be updated to 2013 euros by multiplying all prices with the consumer price index for 2013 provided by Statistics Netherlands. In order to allow comparison with earlier results we also updated the earlier cost-of-illness estimates (i.e. 2011 and 2012) to 2013 euros; hence all differences in the results for the year 2013 compared to 2011 and 2012 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 with 50,000 inhabitants in 2013 (Table 1). There was a decrease in all age classes except the ages 12-17 and 65+. The number of live births decreased by approximately 4,500 to 171,000 in 2013 (Table 2). A decrease was observed in all age classes (of mothers) except for mothers aged up to 19 years and aged between 35-39; both categories showed a slight increase. The number of stillbirths (24 weeks or more gestational age) in 2013 was 510, lower than the 594 cases reported for 2012. The number of hospitalizations for gastroenteritis remained fairly stable at 22,000.

Trend information for specific pathogens is presented in Table 3. A summary of trends (in comparison with 2012) is discussed below:

- The incidence of campylobacteriosis (laboratory confirmed cases) decreased by 1% from 48.8 to 48.0 cases per 100,000 inhabitants.
- The incidence of salmonellosis (laboratory confirmed cases) decreased by 55% from 20.7 to 9.3 per 100,000 inhabitants, reaching the lowest reported incidence rate since 1999 (the former lowest reported incidence rate was 11.6 per 100,000 in 2009).
- The incidence of gastroenteritis by rotavirus (laboratory confirmed cases) increased further by 16% from 20.1 to 23.3 cases per 100,000 inhabitants, reaching a comparable level to 2011 and a ~30% lower level compared to 2009 and 2010.
- The incidence of hospitalizations for viral gastroenteritis (a proxy for the incidence of gastroenteritis by norovirus) decreased from 19.7 to 18.6 cases per 100,000 inhabitants; the apparent increasing trend from 2001 onwards has levelled off in 2013.
- The incidence of acquired listeriosis (active surveillance) increased from 71 cases in 2012 to 76 cases in 2013. There were 7 fatalities, similar to the 8 fatalities in 2012, but considerably more than the 4 fatalities in 2011. 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 2013, the probability of developing meningitis as a consequence of acquired listeriosis was updated from 25% to 23% (95% confidence interval 20-27%).
- The incidence of perinatal listeriosis (active surveillance) was 3 cases with no fatalities. The number of perinatal cases and mortality were similar to previous years.
- The incidence of diseases caused by STEC O157 (active surveillance) was 90 with 36 hospitalizations (of 84 cases for which this information is known). The number of STEC O157 cases, including the number of hospitalized cases, was higher than in previous years. There were no fatal cases recorded.
The incidence of HUS cases was 7, the highest reported number since 2009.

- The incidence of **hepatitis A** (notified cases) **decreased** compared to the previous two years; the incidence was the lowest among the recorded incidences for the years 2006-2013. The number of **hospitalizations**, however, **increased**, with the proportion of hospitalized patients showing a continuous increase from 16.5% in 2009 to 27.5% in 2013. We have currently no explanation for this finding.

### 3.2 Disease incidence

The incidence of gastroenteritis by pathogen, disease by non-gastrointestinal pathogens and of sequelae by pathogen in 2013 is presented in Tables 4-7, and Figure 1. There were increases in the incidence of *E. coli* O157, acquired listeriosis and rotavirus in the general population while the incidence of campylobacteriosis, salmonellosis, perinatal listeriosis, giardiasis, rotavirus and HAV decreased in comparison to 2012. The estimated incidence of the remaining pathogens was unchanged, mostly because no trend information was available. The estimated total number of foodborne cases due to the 14 pathogens decreased by approximately 40,000 to 1,680,000 in 2013 compared to 2012 and was at the lowest level since 2009. The total number of deaths for 2013 was 236 (in 2012 this was 265 as estimated with the updated model). Compared to 2012, the incidence of sequelae was similar (Table 6).

### 3.3 Disease burden by pathogen

The burden by pathogen is presented in Table 8 and Figure 2. The total burden of the 14 pathogens decreased by 800 DALY: from 14,000 DALY in 2012 to 13,200 DALY in 2013. The largest burden at population level was caused by *Toxoplasma gondii* and *Campylobacter* (both ~3,400 DALY), followed by norovirus and rotavirus (both ~1,600 DALY). *Salmonella* spp. ranked 5th with approximately 1,100 DALY. In general, estimates for 2013 were similar to the estimates for 2012, except for salmonellosis and listeriosis (both were lower in 2013). Perinatal listeriosis was the disease outcome with the highest individual burden among all pathogens (9.2 DALY per case), followed by congenital toxoplasmosis (6.3 DALY per case).

### 3.4 Cost of illness by pathogen

The total COI decreased with 10 M€ compared to 2012 and was estimated at 428 M€ (discounted at 4%) (Table 9). The three pathogens causing the largest discounted COI are norovirus (110 M€), rotavirus (78 M€) and *Campylobacter* spp. (76 M€). The lowest contribution to the COI was by hepatitis E-virus (0.2 M€). The average cost per case were largest for perinatal *Listeria* (0.3 M€, discounted), followed by congenital *Toxoplasma gondii* infections (0.05 M€, discounted). The trends in COI compared to 2012 followed the trends in DALYs.

### 3.5 Attribution

The attribution results for DALYS and COI are presented in Tables 10 and 11. The foodborne disease burden decreased by 11% from 6,600 DALY to 5,900 DALY. All non-food routes decreased by 3-4% in DALYS.
compared to 2012. Among the food pathway, all estimated DALYs decreased with 2-4% compared to 2012. Fifty-five percent of the foodborne burden was associated with meat (pork 21%, poultry 18% and beef & lamb 16%). These foods caused 30% of all food-related cases, indicating that the pathogens associated with these foods tend to cause more severe infections than pathogens associated with other foods.

The total food-related COI decreased by 4% from 181 M€ to 174 M€. Approximately 40% of the COI was associated with meat and 50% with foods of animal origin. The COI for the other pathways similarly decreased except for the transmission among humans. The latter increased due to the increased rotavirus incidence.

### 3.6 Model update effects

Table 7 shows the effects of the model updates on the estimates for 2009-2012. The number of excess deaths due to campylobacteriosis increased by about 20 cases annually. The number of deaths due to salmonellosis fluctuated more compared to campylobacteriosis, with a peak in 2012 due to the *Salmonella* Thompson outbreak.

The overall DALY estimates increased by 300-500 DALY per year and the portion attributed to food by about 100-300 DALY per year. The estimated COI increased marginally by 1 M€ in 2011 and 5 M€ in 2012.
Discussion

The disease burden of 14 enteric pathogens decreased in 2013 by 1,300 DALY from 14,500 DALY in 2012 to 13,200 DALY. The share of foodborne transmission in this burden decreased by 700 DALY from 6,600 to 5,900 DALY. These estimates are the lowest since 2009, the first year in which the burden for all 14 pathogens was estimated. The overall COI estimates decreased by 10 M€ to 428 (discounted at 4%), and the foodborne COI decreased by approximately 6 M€ to ~174 M€ compared to 2012. The decrease was a result of lower incidences for Campylobacter spp., Salmonella spp. and norovirus in 2013 compared to 2012.

The incidence of campylobacteriosis decreased in 2012 compared to 2011, after a continuously increasing trend from 2003 onwards, leading to a trend break. In 2013, the incidence decreased further. This trend break is possibly associated with the use of proton-pump-inhibitors [7, 8]. The refund policies of healthcare insurance companies for proton-pump inhibitors changed in 2012, possibly leading to lower intake and a lower proportion of individuals with an increased risk for campylobacteriosis in the population.

From August 2012 onwards, an increase in Cryptosporidium infections was observed in several EU countries, including the Netherlands, without a clear cause [9]. This increase in Cryptosporidium was not taken into account in the current disease burden estimates, as a constant incidence of cryptosporidiosis in the Netherlands is assumed for the model (based on laboratory surveillance data from 2001-2007). A rough estimate suggests that the disease burden for Cryptosporidium might have increased by a factor of 1.2, because a five-fold increase in cases was observed in 12 of 52 weeks (thus: 524/104×12/52=1.2). The data from the eight medical microbiological laboratories (available from at least 2010) might be useful for the annual trend update for Cryptosporidium and will be further examined for usability in future updates.

Other important aspects for interpreting results include the absence of trend information for bacterial toxins, toxoplasmosis and STEC O157, while trends for Cryptosporidium spp. and Giardia spp. are extrapolated from trends until 2007, when systematic surveillance was discontinued. Furthermore, attribution data used in this report are based on an expert elicitation study, conducted in 2006 [10]. No time-trends in the expert estimates are available. As a consequence, the changes in incidence and burden as presented in this report for these pathogens need to be interpreted with appropriate care. For 2013 and 2014, laboratory surveillance data on Cryptosporidium have been collected by RIVM. The use of these data for trend updating will be explored further, and if appropriate, applied to the updated estimates over subsequent years. Initial explorations suggest that the incidence estimates based on laboratory surveillance are twice as high as extrapolated from surveillance data until 2007.
References


### Table 1. Population in the Netherlands by age group, 2009-13

<table>
<thead>
<tr>
<th>Age group</th>
<th>2013</th>
<th>2012</th>
<th>2011</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
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<td>0</td>
<td>175,587</td>
<td>179,653</td>
<td>184,007</td>
<td>184,586</td>
<td>184,408</td>
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<tr>
<td>1-4</td>
<td>736,615</td>
<td>739,083</td>
<td>739,099</td>
<td>740,295</td>
<td>747,148</td>
</tr>
<tr>
<td>5-11</td>
<td>1,354,657</td>
<td>1,378,914</td>
<td>1,394,007</td>
<td>1,405,533</td>
<td>1,405,232</td>
</tr>
<tr>
<td>12-17</td>
<td>1,196,634</td>
<td>1,189,120</td>
<td>1,184,970</td>
<td>1,184,064</td>
<td>1,191,453</td>
</tr>
<tr>
<td>18-64</td>
<td>10,491,737</td>
<td>10,527,210</td>
<td>10,558,770</td>
<td>10,522,183</td>
<td>10,485,731</td>
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<tr>
<td>65+</td>
<td>2,824,345</td>
<td>2,716,368</td>
<td>2,594,946</td>
<td>2,538,328</td>
<td>2,471,815</td>
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<tr>
<td>Total</td>
<td>16,779,575</td>
<td>16,730,348</td>
<td>16,655,799</td>
<td>16,574,989</td>
<td>16,485,787</td>
</tr>
</tbody>
</table>

### Table 2. Live births by age of mothers in the Netherlands, 2009-13

<table>
<thead>
<tr>
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</tr>
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<td>-19</td>
<td>1,750</td>
<td>1,592</td>
<td>1,717</td>
<td>1,884</td>
<td>1,953</td>
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<td>20-24</td>
<td>15,190</td>
<td>15,206</td>
<td>15,782</td>
<td>16,417</td>
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<tr>
<td>25-29</td>
<td>46,616</td>
<td>50,371</td>
<td>50,295</td>
<td>51,570</td>
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<tr>
<td>30-34</td>
<td>65,651</td>
<td>67,489</td>
<td>69,174</td>
<td>69,420</td>
<td>68,828</td>
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<tr>
<td>35-39</td>
<td>35,489</td>
<td>33,725</td>
<td>35,340</td>
<td>37,213</td>
<td>38,637</td>
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<tr>
<td>40-44</td>
<td>6,378</td>
<td>7,212</td>
<td>7,393</td>
<td>7,565</td>
<td>7,252</td>
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<tr>
<td>45+</td>
<td>267</td>
<td>364</td>
<td>359</td>
<td>328</td>
<td>287</td>
</tr>
<tr>
<td>Total</td>
<td>171,341</td>
<td>175,959</td>
<td>180,060</td>
<td>184,397</td>
<td>184,915</td>
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### Table 3. Trends in incidence of food-related pathogens, 1999–2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Ca</th>
<th>Sa</th>
<th>RV</th>
<th>NV</th>
<th>aLm fatal</th>
<th>aLm</th>
<th>pLm fatal</th>
<th>pLm</th>
<th>O157 hosp</th>
<th>O157</th>
<th>HAV hosp</th>
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<tr>
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<td>20.3</td>
<td>15.7</td>
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<td></td>
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<td>2001</td>
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<td>17.5</td>
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<td></td>
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<td>2005</td>
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<td>12.9</td>
<td>21.4</td>
<td>15.6</td>
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<td>15</td>
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<td>2013</td>
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<td>23.3</td>
<td>18.6</td>
<td>76</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>90</td>
<td>36**</td>
<td>109</td>
</tr>
</tbody>
</table>

Data sources: see text; * Ca: Campylobacter spp.; Sa: Salmonella spp.; RV: rotavirus; NV: norovirus; aLm: acquired listeriosis; pLm: perinatal listeriosis; O157: STEC O157; HAV: hepatitis A-virus; hosp: hospitalized; † known for 57 of the 65 cases; ‡ known for 77 of the 85 cases; ** known for 84 of the 90 cases; (a) per 100,000 inhabitants; (b) reported cases
Table 4. Incidence of gastroenteritis by pathogen in the Netherlands, 2013
(population 16.8 million)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>General population (x 1,000)</th>
<th>GP visit (x 1,000)</th>
<th>Hospitalised (x 1,000)</th>
<th>Fatal cases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All causes</strong></td>
<td>4,809¹</td>
<td>222</td>
<td>22.0</td>
<td>NA‡</td>
</tr>
<tr>
<td></td>
<td>3,988 - 5,716</td>
<td>72 - 513</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bacteria – infectious</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>100</td>
<td>24</td>
<td>1.1</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>14 - 272</td>
<td>12 - 44</td>
<td>0.4 - 2.1</td>
<td>21 - 51</td>
</tr>
<tr>
<td>STEC O157</td>
<td>2.1</td>
<td>0.8</td>
<td>0.03</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.2 - 8.8</td>
<td>0.02 - 3.1</td>
<td>-</td>
<td>0 - 1.2</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>28</td>
<td>4.2</td>
<td>1.1</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>2.4 - 85</td>
<td>2.3 - 7.1</td>
<td>0.5 - 2.1</td>
<td>30 - 39</td>
</tr>
<tr>
<td><strong>Bacteria – toxin producing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>51</td>
<td>7.0</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>18 - 124</td>
<td>1.7 - 20</td>
<td>0.07 - 0.5</td>
<td>-</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>169</td>
<td>31</td>
<td>0.3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>56 - 375</td>
<td>7.4 - 81</td>
<td>0.01 - 0.6</td>
<td>0 - 19</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>291</td>
<td>40</td>
<td>1.5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>124 - 548</td>
<td>11 - 96</td>
<td>0.6 - 2.8</td>
<td>0 - 28</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norovirus</td>
<td>663</td>
<td>16</td>
<td>1.9</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>452 - 967</td>
<td>9.0 - 25</td>
<td>1.0 - 3.2</td>
<td>28 - 124</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>298</td>
<td>18</td>
<td>5.8</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>145 - 532</td>
<td>11.8 - 27.1</td>
<td>4.3 - 7.7</td>
<td>15 - 104</td>
</tr>
<tr>
<td><strong>Protozoa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidium spp.</td>
<td>28</td>
<td>1.7</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>8.7 - 69.7</td>
<td>0.8 - 3.1</td>
<td>0.2 - 1.2</td>
<td>0 - 7.4</td>
</tr>
<tr>
<td>Giardia spp.</td>
<td>49</td>
<td>4.3</td>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>24.7 - 94.9</td>
<td>2.2 - 7.6</td>
<td>0.04 - 1.4</td>
<td>0 - 5.4</td>
</tr>
</tbody>
</table>

¹ mean; ² 2.5-97.5 percentile; ‡ not available
**Table 5. Incidence of non-gastrointestinal pathogens in the Netherlands, 2013**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Incidence</th>
<th>Fatal cases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Listeria monocytogenes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perinatal</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Acquired</td>
<td>76</td>
<td>7</td>
</tr>
<tr>
<td>Hepatitis A virus</td>
<td>535†</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(290 – 661)†</td>
<td>(1 – 3)</td>
</tr>
<tr>
<td>Hepatitis E virus</td>
<td>53</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(8 – 33)</td>
<td>(0 – 1)</td>
</tr>
<tr>
<td><strong>Toxoplasma gondii</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congenital</td>
<td>349</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(179 – 610)</td>
<td>(7 – 21)</td>
</tr>
<tr>
<td>Acquired**</td>
<td>430</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(197 – 726)</td>
<td></td>
</tr>
</tbody>
</table>

* 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, 2013

<table>
<thead>
<tr>
<th>Pathogen and sequelae</th>
<th>Incidence</th>
<th>Fatal cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guillain-Barré Syndrome</td>
<td>148 (5 – 258)</td>
<td>1 (0 – 5)</td>
</tr>
<tr>
<td>Reactive arthritis</td>
<td>1,800 (768 - 3,667)</td>
<td>0</td>
</tr>
<tr>
<td>Irritable Bowel Syndrome</td>
<td>8,553 (2,466 - 22,317)</td>
<td>0</td>
</tr>
<tr>
<td>Inflammatory Bowel Disease</td>
<td>23 (16 – 31)</td>
<td>0</td>
</tr>
<tr>
<td>STEC O157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemolytic Uremic Syndrome</td>
<td>22 (15 – 30)</td>
<td>2 (1 – 5)</td>
</tr>
<tr>
<td>End-Stage Renal Disease</td>
<td>3 (1 – 5)</td>
<td>1 (1 – 1)</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive arthritis</td>
<td>349 (123 – 728)</td>
<td>0</td>
</tr>
<tr>
<td>Irritable Bowel Syndrome</td>
<td>2,371 (349 - 7,162)</td>
<td>0</td>
</tr>
<tr>
<td>Inflammatory Bowel Disease</td>
<td>8 (6 – 11)</td>
<td>0</td>
</tr>
<tr>
<td>Listeria monocytogenes (perinatal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meningitis</td>
<td>3*</td>
<td>NA</td>
</tr>
<tr>
<td>Neurological sequelae of meningitis</td>
<td>1 (1 – 2)</td>
<td>0</td>
</tr>
<tr>
<td>Listeria monocytogenes (acquired)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meningitis</td>
<td>18 (15 – 21)</td>
<td>NA</td>
</tr>
<tr>
<td>Neurological sequelae of meningitis</td>
<td>3 (1 – 4)</td>
<td>0</td>
</tr>
<tr>
<td>Toxoplasma gondii (congenital)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chorioretinitis 1st year of life</td>
<td>47 (24 – 84)</td>
<td>NA</td>
</tr>
<tr>
<td>Chorioretinitis later years of life</td>
<td>56 (29 – 99)</td>
<td>NA</td>
</tr>
<tr>
<td>Intracranial calcifications</td>
<td>37 (18 – 66)</td>
<td>NA</td>
</tr>
<tr>
<td>Hydrocephalus</td>
<td>7 (3 – 13)</td>
<td>NA</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>10 (2 – 28)</td>
<td>NA</td>
</tr>
<tr>
<td>Abnormalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxoplasma gondii (acquired)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chorioretinitis</td>
<td>426 (197 – 724)</td>
<td>0</td>
</tr>
</tbody>
</table>

*mean; ‡ 2.5-97.5 percentile; * no uncertainty because cases were acquired through active surveillance; NA: not applicable (fatal cases are reported in Table 2)
Table 7. Comparison of results from the original and updated model.

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deaths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>Original</td>
<td>38</td>
<td>39</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>56</td>
<td>64</td>
<td>57</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>Original</td>
<td>40</td>
<td>40</td>
<td>35</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>38</td>
<td>45</td>
<td>35</td>
<td>59</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total number</strong></td>
<td>Original</td>
<td>233</td>
<td>269</td>
<td>219</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>250</td>
<td>300</td>
<td>240</td>
<td>270</td>
<td>240</td>
</tr>
<tr>
<td><strong>DALYs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>3,434</td>
<td>3,926</td>
<td>3,922</td>
<td>3,720</td>
<td>3,408</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>Original</td>
<td>1,270</td>
<td>1,410</td>
<td>1,294</td>
<td>1,796</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>1,203</td>
<td>1,423</td>
<td>1,226</td>
<td>2,040</td>
<td>1,101</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Original</td>
<td>13,500</td>
<td>14,900</td>
<td>13,900</td>
<td>14,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>13,900</td>
<td>15,400</td>
<td>14,200</td>
<td>14,500</td>
<td>13,300</td>
</tr>
<tr>
<td><strong>Food</strong></td>
<td>Original</td>
<td>5,800</td>
<td>6,400</td>
<td>6,200</td>
<td>6,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>6,100</td>
<td>6,600</td>
<td>6,300</td>
<td>6,600</td>
<td>5,900</td>
</tr>
<tr>
<td><strong>COI (MC discounted at 4%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>Original</td>
<td>n.a.</td>
<td>n.a.</td>
<td>76</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>n.a.</td>
<td>n.a.</td>
<td>77</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>Original</td>
<td>n.a.</td>
<td>n.a.</td>
<td>22</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>n.a.</td>
<td>n.a.</td>
<td>22</td>
<td>34</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Original</td>
<td>n.a.</td>
<td>n.a.</td>
<td>416</td>
<td>412</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>n.a.</td>
<td>n.a.</td>
<td>417</td>
<td>417</td>
<td>424</td>
</tr>
<tr>
<td><strong>Food</strong></td>
<td>Original</td>
<td>n.a.</td>
<td>n.a.</td>
<td>168</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>n.a.</td>
<td>n.a.</td>
<td>169</td>
<td>180</td>
<td>172</td>
</tr>
</tbody>
</table>
Table 8. Estimated total DALY, DALY per 100,000 inhabitants and mean DALY per case of illness in the Netherlands, 2013

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Discount rate 0%</th>
<th>DALY per year</th>
<th>DALY per 100,000</th>
<th>DALY per 1,000 cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DALY</td>
<td>per year</td>
<td>0%</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>DALY</td>
<td></td>
<td>0%</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>DALY</td>
<td></td>
<td>0%</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Bacteria – infectious</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>3,408</td>
<td>3,041</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>STEC O157</td>
<td>138</td>
<td>109</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>1,101</td>
<td>925</td>
<td>6.6</td>
<td>5.5</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>28</td>
<td>16</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>L. monocytogenes (perinatal)</td>
<td>64</td>
<td>61</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>L. monocytogenes (acquired)</td>
<td>92</td>
<td>77</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>L. monocytogenes (total)</td>
<td>3,452</td>
<td>2,256</td>
<td>21</td>
<td>13</td>
</tr>
<tr>
<td><strong>Bacteria – toxin producing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>116</td>
<td>116</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>541</td>
<td>534</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>767</td>
<td>760</td>
<td>4.6</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norovirus</td>
<td>1,698</td>
<td>1,508</td>
<td>10</td>
<td>9.0</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>1,605</td>
<td>1,440</td>
<td>10</td>
<td>8.6</td>
</tr>
<tr>
<td>Hepatitis A virus</td>
<td>86</td>
<td>74</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Hepatitis E virus</td>
<td>23</td>
<td>20</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Protozoa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryptosporidium spp.</td>
<td>67</td>
<td>70</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Giardia spp.</td>
<td>89</td>
<td>100</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Toxoplasma gondii (congenital)</td>
<td>2,104</td>
<td>1,235</td>
<td>13</td>
<td>7.3</td>
</tr>
<tr>
<td>Toxoplasma gondii (acquired)</td>
<td>1,348</td>
<td>1,021</td>
<td>8.0</td>
<td>6.1</td>
</tr>
<tr>
<td>Toxoplasma gondii (total)</td>
<td>3,452</td>
<td>2,256</td>
<td>21</td>
<td>13</td>
</tr>
</tbody>
</table>
Table 9. Estimated total costs of illness (COI), COI per 100,000 inhabitants and mean COI per case of illness in the Netherlands, 2013

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Discount rate</th>
<th>COI(^a) per year (M€)</th>
<th>COI(^a) per 100,000 (k€)</th>
<th>COI(^a) per 1,000 cases (k€)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria – infectious</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Campylobacter</em> spp.</td>
<td>0%</td>
<td>82</td>
<td>76</td>
<td>489</td>
</tr>
<tr>
<td>STEC O157</td>
<td>4%</td>
<td>5</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td><em>Salmonella</em> spp.</td>
<td>0%</td>
<td>21</td>
<td>20</td>
<td>127</td>
</tr>
<tr>
<td><em>L. monocytogenes</em> (perinatal)</td>
<td>4%</td>
<td>2.8</td>
<td>1.0</td>
<td>17</td>
</tr>
<tr>
<td><em>L. monocytogenes</em> (acquired)</td>
<td>0%</td>
<td>2.4</td>
<td>2.2</td>
<td>14</td>
</tr>
<tr>
<td><em>L. monocytogenes</em> (total)</td>
<td>4%</td>
<td>5.2</td>
<td>3.2</td>
<td>31</td>
</tr>
<tr>
<td><strong>Bacteria – toxin producing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>0%</td>
<td>10</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>4%</td>
<td>28</td>
<td>28</td>
<td>167</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>0%</td>
<td>58</td>
<td>58</td>
<td>345</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Norovirus</em></td>
<td>0%</td>
<td>110</td>
<td>110</td>
<td>653</td>
</tr>
<tr>
<td><em>Rotavirus</em></td>
<td>4%</td>
<td>78</td>
<td>78</td>
<td>467</td>
</tr>
<tr>
<td><em>Hepatitis A virus</em></td>
<td>0%</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><em>Hepatitis E virus</em></td>
<td>4%</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Protozoa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cryptosporidium</em> spp.</td>
<td>0%</td>
<td>9</td>
<td>9</td>
<td>52</td>
</tr>
<tr>
<td><em>Giardia</em> spp.</td>
<td>4%</td>
<td>10</td>
<td>10</td>
<td>58</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em> (congenital)</td>
<td>0%</td>
<td>53</td>
<td>17</td>
<td>314</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em> (acquired)</td>
<td>4%</td>
<td>3.0</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em> (total)</td>
<td>0%</td>
<td>56</td>
<td>20</td>
<td>332</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>472</td>
<td>424</td>
<td>2,814</td>
</tr>
</tbody>
</table>

\(^a\) costs are expressed in 2013 euros
Table 10. Attribution of the incidence, fatalities, disease burden and Cost-of-Illness* to the major transmission pathways in the Netherlands, 2013

<table>
<thead>
<tr>
<th>Main pathway</th>
<th>Food</th>
<th>Environment</th>
<th>Human</th>
<th>Animal</th>
<th>Travel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence (per year)</td>
<td>669,579</td>
<td>203,682</td>
<td>587,588</td>
<td>83,578</td>
<td>134,974</td>
<td>1,679,402</td>
</tr>
<tr>
<td>Deaths (per year)</td>
<td>79</td>
<td>39</td>
<td>73</td>
<td>20</td>
<td>25</td>
<td>236</td>
</tr>
<tr>
<td>Disease burden (DALY)</td>
<td>5,847</td>
<td>2,739</td>
<td>2,349</td>
<td>1,057</td>
<td>1,191</td>
<td>13,183</td>
</tr>
<tr>
<td>Disease burden (DALY, discounted)</td>
<td>4,857</td>
<td>2,142</td>
<td>2,092</td>
<td>917</td>
<td>1,022</td>
<td>11,030</td>
</tr>
<tr>
<td>Cost of illness (M€, undiscounted)*</td>
<td>198</td>
<td>78</td>
<td>123</td>
<td>32</td>
<td>41</td>
<td>472</td>
</tr>
<tr>
<td>Cost of illness (M€, discounted at 4%)*</td>
<td>172</td>
<td>63</td>
<td>122</td>
<td>29</td>
<td>38</td>
<td>424</td>
</tr>
</tbody>
</table>

* due to the 14 pathogens included in this study
* costs are expressed in 2013 euros
Table 11. Attribution of the incidence, fatalities, disease burden and Cost-of-Illness of foodborne disease* to food groups in the Netherlands, 2013

<table>
<thead>
<tr>
<th>Food group</th>
<th>Beef &amp; Lamb</th>
<th>Pork</th>
<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods</th>
<th>Humans &amp; animals</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence (per year)</td>
<td>105,015</td>
<td>44,532</td>
<td>59,697</td>
<td>21,193</td>
<td>54,711</td>
<td>55,351</td>
<td>39,850</td>
<td>15,812</td>
<td>41,048</td>
<td>121,225</td>
<td>111,144</td>
<td>669,579</td>
</tr>
<tr>
<td>Deaths (per year)</td>
<td>8.4</td>
<td>8.7</td>
<td>16</td>
<td>4.7</td>
<td>6.1</td>
<td>7.0</td>
<td>5.8</td>
<td>1.9</td>
<td>3.1</td>
<td>5.1</td>
<td>12</td>
<td>79</td>
</tr>
<tr>
<td>Disease burden (DALY)</td>
<td>907</td>
<td>1,252</td>
<td>1,056</td>
<td>225</td>
<td>410</td>
<td>368</td>
<td>358</td>
<td>91</td>
<td>177</td>
<td>447</td>
<td>557</td>
<td>5,847</td>
</tr>
<tr>
<td>Disease burden (DALY, discounted)</td>
<td>729</td>
<td>892</td>
<td>923</td>
<td>200</td>
<td>354</td>
<td>319</td>
<td>298</td>
<td>83</td>
<td>163</td>
<td>415</td>
<td>480</td>
<td>4,857</td>
</tr>
<tr>
<td>Cost of illness (M€, undiscounted)</td>
<td>29</td>
<td>27</td>
<td>29</td>
<td>6.8</td>
<td>16</td>
<td>15</td>
<td>12</td>
<td>3.9</td>
<td>9.2</td>
<td>26</td>
<td>25</td>
<td>198</td>
</tr>
<tr>
<td>Cost of illness (M€, discounted at 4%)</td>
<td>23</td>
<td>17</td>
<td>26</td>
<td>6.4</td>
<td>14</td>
<td>13</td>
<td>11</td>
<td>3.7</td>
<td>9.0</td>
<td>25</td>
<td>24</td>
<td>172</td>
</tr>
</tbody>
</table>

* due to the 14 pathogens included in this study

a costs are expressed in 2013 euros
Figure 1. Comparison of incidence of food-related pathogens in 2009 through 2013.
Figure 2. Comparison of disease burden of food-related pathogens in 2009 through 2013.
Annex. Detailed results

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Incidence (per year)</th>
<th>Deaths (per year)</th>
<th>DALY (undisc.)</th>
<th>Costs (M€ per year)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter spp.</td>
<td>99,501</td>
<td>55</td>
<td>3,408</td>
<td>83</td>
</tr>
<tr>
<td>STEC O157</td>
<td>2,141</td>
<td>4</td>
<td>138</td>
<td>5</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>79</td>
<td>7</td>
<td>92</td>
<td>5</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>28,019</td>
<td>27</td>
<td>1,101</td>
<td>20</td>
</tr>
<tr>
<td>B. cereus toxine</td>
<td>51,329</td>
<td>0</td>
<td>116</td>
<td>10</td>
</tr>
<tr>
<td>C. perfringens toxine</td>
<td>168,703</td>
<td>5</td>
<td>541</td>
<td>28</td>
</tr>
<tr>
<td>S. aureus toxine</td>
<td>291,077</td>
<td>7</td>
<td>767</td>
<td>58</td>
</tr>
<tr>
<td>Hepatitis-A virus</td>
<td>534</td>
<td>2</td>
<td>86</td>
<td>1</td>
</tr>
<tr>
<td>Hepatitis-E virus</td>
<td>53</td>
<td>1</td>
<td>23</td>
<td>0.2</td>
</tr>
<tr>
<td>Norovirus</td>
<td>663,274</td>
<td>66</td>
<td>1,698</td>
<td>110</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>297,538</td>
<td>47</td>
<td>1,605</td>
<td>78</td>
</tr>
<tr>
<td>C. parvum</td>
<td>27,689</td>
<td>2</td>
<td>67</td>
<td>9</td>
</tr>
<tr>
<td>G. lamblia</td>
<td>48,695</td>
<td>1</td>
<td>89</td>
<td>10</td>
</tr>
<tr>
<td>T. gondii</td>
<td>770</td>
<td>12</td>
<td>3,452</td>
<td>56</td>
</tr>
<tr>
<td><strong>Totaal</strong></td>
<td><strong>1,679,402</strong></td>
<td><strong>236</strong></td>
<td><strong>13,183</strong></td>
<td><strong>472</strong></td>
</tr>
</tbody>
</table>

*Note: Costs are expressed in 2013 euros.
### Attribution of incidence by pathogen to main pathways

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Food</th>
<th>Environment</th>
<th>Human</th>
<th>Animal</th>
<th>Travel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Campylobacter</em> spp.</td>
<td>41,789</td>
<td>20,498</td>
<td>6,269</td>
<td>19,005</td>
<td>11,940</td>
<td>99,501</td>
</tr>
<tr>
<td>STEC O157</td>
<td>865</td>
<td>368</td>
<td>218</td>
<td>439</td>
<td>250</td>
<td>2,141</td>
</tr>
<tr>
<td><em>L. monocytogenes</em></td>
<td>55</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>11</td>
<td>79</td>
</tr>
<tr>
<td><em>Salmonella</em> spp.</td>
<td>15,270</td>
<td>3,614</td>
<td>2,606</td>
<td>2,578</td>
<td>3,951</td>
<td>28,019</td>
</tr>
<tr>
<td><em>B. cereus</em> toxine</td>
<td>45,836</td>
<td>565</td>
<td>616</td>
<td>565</td>
<td>3,747</td>
<td>51,329</td>
</tr>
<tr>
<td><em>C. perfringens</em> toxine</td>
<td>152,508</td>
<td>3,711</td>
<td>3,543</td>
<td>3,543</td>
<td>5,398</td>
<td>168,703</td>
</tr>
<tr>
<td><em>S. aureus</em> toxine</td>
<td>253,819</td>
<td>10,479</td>
<td>9,314</td>
<td>6,404</td>
<td>11,061</td>
<td>291,077</td>
</tr>
<tr>
<td>Hepatitis-A virus</td>
<td>62</td>
<td>59</td>
<td>97</td>
<td>0</td>
<td>316</td>
<td>534</td>
</tr>
<tr>
<td>Hepatitis-E virus</td>
<td>7</td>
<td>13</td>
<td>4</td>
<td>6</td>
<td>23</td>
<td>53</td>
</tr>
<tr>
<td>Norovirus</td>
<td>110,595</td>
<td>94,214</td>
<td>367,568</td>
<td>33,174</td>
<td>57,723</td>
<td>663,274</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>38,681</td>
<td>50,581</td>
<td>172,869</td>
<td>8,926</td>
<td>26,481</td>
<td>297,538</td>
</tr>
<tr>
<td><em>C. parvum</em></td>
<td>3,330</td>
<td>7,659</td>
<td>7,576</td>
<td>3,705</td>
<td>5,419</td>
<td>27,689</td>
</tr>
<tr>
<td><em>G. lamblia</em></td>
<td>6,331</td>
<td>11,638</td>
<td>16,897</td>
<td>5,210</td>
<td>8,619</td>
<td>48,695</td>
</tr>
<tr>
<td><em>T. gondii</em></td>
<td>431</td>
<td>278</td>
<td>7</td>
<td>19</td>
<td>35</td>
<td>770</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>669,579</td>
<td>203,682</td>
<td>587,588</td>
<td>83,578</td>
<td>134,974</td>
<td>1,679,402</td>
</tr>
</tbody>
</table>

### Attribution of deaths by pathogen to main pathways

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Food</th>
<th>Environment</th>
<th>Human</th>
<th>Animal</th>
<th>Travel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Campylobacter</em> spp.</td>
<td>23.2</td>
<td>11.4</td>
<td>3.5</td>
<td>10.5</td>
<td>6.6</td>
<td>55.2</td>
</tr>
<tr>
<td>STEC O157</td>
<td>1.6</td>
<td>0.7</td>
<td>0.4</td>
<td>0.8</td>
<td>0.5</td>
<td>4.0</td>
</tr>
<tr>
<td><em>L. monocytogenes</em></td>
<td>4.8</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.9</td>
<td>7.0</td>
</tr>
<tr>
<td><em>Salmonella</em> spp.</td>
<td>14.5</td>
<td>3.4</td>
<td>2.5</td>
<td>2.5</td>
<td>3.8</td>
<td>26.6</td>
</tr>
<tr>
<td><em>B. cereus</em> toxine</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><em>C. perfringens</em> toxine</td>
<td>4.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>4.5</td>
</tr>
<tr>
<td><em>S. aureus</em> toxine</td>
<td>6.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
<td>7.2</td>
</tr>
<tr>
<td>Hepatitis-A virus</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
<td>0.0</td>
<td>1.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Hepatitis-E virus</td>
<td>0.1</td>
<td>0.2</td>
<td>0.0</td>
<td>0.1</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Norovirus</td>
<td>11.1</td>
<td>9.4</td>
<td>36.9</td>
<td>3.3</td>
<td>5.8</td>
<td>66.5</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>6.1</td>
<td>8.0</td>
<td>27.4</td>
<td>1.4</td>
<td>4.2</td>
<td>47.1</td>
</tr>
<tr>
<td><em>C. parvum</em></td>
<td>0.2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.2</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td><em>G. lamblia</em></td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>0.1</td>
<td>0.2</td>
<td>1.4</td>
</tr>
<tr>
<td><em>T. gondii</em></td>
<td>6.8</td>
<td>4.4</td>
<td>0.1</td>
<td>0.3</td>
<td>0.6</td>
<td>12.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>79.1</td>
<td>39.3</td>
<td>72.7</td>
<td>19.9</td>
<td>24.6</td>
<td>235.6</td>
</tr>
</tbody>
</table>
### Attribution of disease burden (DALY per year, undiscounted) to main pathways

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Food</th>
<th>Environment</th>
<th>Human</th>
<th>Animal</th>
<th>Travel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Campylobacter spp.</strong></td>
<td>1,431</td>
<td>702</td>
<td>215</td>
<td>651</td>
<td>409</td>
<td>3,408</td>
</tr>
<tr>
<td>STEC O157</td>
<td>56</td>
<td>24</td>
<td>14</td>
<td>28</td>
<td>16</td>
<td>138</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>64</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>12</td>
<td>92</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>601</td>
<td>142</td>
<td>102</td>
<td>101</td>
<td>155</td>
<td>1,101</td>
</tr>
<tr>
<td>B. cereus toxine</td>
<td>104</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>116</td>
</tr>
<tr>
<td>C. perfringens toxine</td>
<td>490</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>17</td>
<td>541</td>
</tr>
<tr>
<td>S. aureus toxine</td>
<td>668</td>
<td>28</td>
<td>25</td>
<td>17</td>
<td>29</td>
<td>767</td>
</tr>
<tr>
<td>Hepatitis-A virus</td>
<td>8</td>
<td>10</td>
<td>16</td>
<td>0</td>
<td>52</td>
<td>86</td>
</tr>
<tr>
<td>Hepatitis-E virus</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Norovirus</td>
<td>284</td>
<td>241</td>
<td>940</td>
<td>85</td>
<td>148</td>
<td>1,698</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>209</td>
<td>273</td>
<td>932</td>
<td>48</td>
<td>143</td>
<td>1,605</td>
</tr>
<tr>
<td>C. parvum</td>
<td>3</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>14</td>
<td>67</td>
</tr>
<tr>
<td>G. lamblia</td>
<td>1</td>
<td>24</td>
<td>35</td>
<td>11</td>
<td>18</td>
<td>89</td>
</tr>
<tr>
<td>T. gondii</td>
<td>1,926</td>
<td>1,250</td>
<td>31</td>
<td>86</td>
<td>159</td>
<td>3,452</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,847</td>
<td>2,739</td>
<td>2,349</td>
<td>1,057</td>
<td>1,191</td>
<td>13,183</td>
</tr>
</tbody>
</table>

### Attribution of cost-of-illness (k€ per year, undiscounted and expressed in 2013 euros) to main pathways

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Food</th>
<th>Environment</th>
<th>Human</th>
<th>Animal</th>
<th>Travel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Campylobacter spp.</strong></td>
<td>34,662</td>
<td>17,001</td>
<td>5,199</td>
<td>15,763</td>
<td>9,903</td>
<td>82,528</td>
</tr>
<tr>
<td>STEC O157</td>
<td>2,118</td>
<td>902</td>
<td>535</td>
<td>1,075</td>
<td>613</td>
<td>5,243</td>
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<tr>
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<td>587</td>
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### Attribution of cost-of-illness (k€ per year, discounted at 4% and expressed in 2013 euros) to main pathways

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<th>Pathogen</th>
<th>Food</th>
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<th>Animal</th>
<th>Travel</th>
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<td>111</td>
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<td>10,129</td>
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<tr>
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<td>615</td>
<td>587</td>
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<td>27,976</td>
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<td>Hepatitis-A virus</td>
<td>93</td>
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<td>149</td>
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<td>Rotavirus</td>
<td>10,182</td>
<td>13,315</td>
<td>45,508</td>
<td>2,350</td>
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<td>78,326</td>
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<tr>
<td><em>C. parvum</em></td>
<td>1,040</td>
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<tr>
<td><em>G. lamblia</em></td>
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<td>3,358</td>
<td>1,035</td>
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<td>9,976</td>
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### Attribution of incidence by pathogen to food groups

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<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods</th>
<th>Humans &amp; animals</th>
<th>Total</th>
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## Attribution of deaths by pathogen to food groups

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<th>Pathogen</th>
<th>Beef &amp; Lamb</th>
<th>Pork</th>
<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods</th>
<th>Humans &amp; animals</th>
<th>Total</th>
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## Attribution of disease burden (DALY per year, undiscounted) to food groups

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<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods &amp; animals</th>
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DALY: Disability Adjusted Life Years
## Attribution of cost-of-illness (k€ per year, undiscounted and expressed in 2013 euros) to food groups

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Beef &amp; Lamb</th>
<th>Pork</th>
<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods</th>
<th>Humans &amp; animals</th>
<th>Total</th>
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<tbody>
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## Attribution of cost-of-illness (k€ per year, discounted at 4% and expressed in 2013 euros) to food groups

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<th>Pathogen</th>
<th>Beef &amp; Lamb</th>
<th>Pork</th>
<th>Poultry</th>
<th>Eggs</th>
<th>Dairy</th>
<th>Fish &amp; shellfish</th>
<th>Produce</th>
<th>Beverages</th>
<th>Grains</th>
<th>Other foods</th>
<th>Humans &amp; animals</th>
<th>Total</th>
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