Estimating the burden of foodborne diseases in Japan

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Objective To assess the burden posed by foodborne diseases in Japan using methods developed by the World Health Organization's Foodborne Disease Burden Epidemiology Reference Group (FERG).

Methods Expert consultation and statistics on food poisoning during 2011 were used to identify three common causes of foodborne disease in Japan: *Campylobacter* and *Salmonella* species and enterohaemorrhagic *Escherichia coli* (EHEC). We conducted systematic reviews of English and Japanese literature on the complications caused by these pathogens, by searching Embase, the Japan medical society abstract database and Medline. We estimated the annual incidence of acute gastroenteritis from reported surveillance data, based on estimated probabilities that an affected person would visit a physician and have gastroenteritis confirmed. We then calculated disability-adjusted life-years (DALYs) lost in 2011, using the incidence estimates along with disability weights derived from published studies.

Findings In 2011, foodborne disease caused by *Campylobacter* species, *Salmonella* species and EHEC led to an estimated loss of 6099, 3145 and 463 DALYs in Japan, respectively. These estimated burdens are based on the pyramid reconstruction method; are largely due to morbidity rather than mortality; and are much higher than those indicated by routine surveillance data.

Conclusion Routine surveillance data may indicate foodborne disease burdens that are much lower than the true values. Most of the burden posed by foodborne disease in Japan comes from secondary complications. The tools developed by FERG appear useful in estimating disease burdens and setting priorities in the field of food safety.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

There have been few attempts to provide comprehensive, consistent and comparable estimates of the burden of acute foodborne diseases.[1] In 2006, however, the World Health Organization (WHO) set up the Foodborne Disease Burden Epidemiology Reference Group (FERG) specifically to produce such estimates.[2] FERG aims to provide the data and tools needed to set appropriate, evidence-informed priorities for food safety at country level. Since its launch, FERG has established several task forces that focus on parasitic and enteric diseases, chemicals and natural toxins, source attribution, computational modelling and country studies. The members of the country studies task force were asked to develop methods for estimating the burden posed by foodborne disease at national level. These methods were intended to facilitate the collection of national data on foodborne disease burdens and support the use of such data for policy-making and practice in food safety.[3] FERG selected Albania, Japan, Thailand and Uganda as the locations for initial pilot studies estimating disability-adjusted life-years (DALYs) lost as a result of foodborne disease.[4,5]

In Japan, priorities for foodborne disease prevention are primarily based on the apparent public health significance of each disease, although impact on the food market, consumers' risk perceptions and public opinion are also taken into consideration.[6] The Japanese Food Sanitation Act and Infectious Disease Control Act require collection of data on the incidence of food poisoning and infectious diseases, respectively. However, as there has never been a comprehensive, internally consistent and robust assessment of the burden posed by foodborne disease in Japan, robust and objective standards for ranking priorities are lacking. Surveillance data are not as useful as formal estimates when identifying and ranking diseases in terms of their contributions to the country's overall burden. Our objective is to assess the burden posed by common foodborne diseases in Japan, using the methods recommended by FERG and expressing the main findings in terms of DALYs.

Methods

Disease selection

After analysis of food poisoning statistics and consultation with experts, we identified *Campylobacter* species, *Salmonella* species and enterohaemorrhagic *Escherichia coli* (EHEC) as the first, second and third most common causes of foodborne disease in Japan in 2011.[7] This ranking was entirely based on clinical cases in health facilities. To estimate the relative burden posed by each of these three causes of foodborne disease, we used a pyramid reconstruction method and supplemented routine surveillance and reporting data with information from telephone and patient surveys.

Data sources

We used data from four sources to estimate the annual incidence of acute gastroenteritis caused by *Campylobacter*, *Salmonella* and EHEC and to estimate associated mortality rates. The four data sources were: (i) food poisoning statistics that had been compiled using information collected by local governments on outbreaks of food poisoning; (ii) surveillance data on EHEC (routine collection of data on EHEC cases in Japan was not

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made a legal requirement until 1999; disease caused by *Salmonella* or *Campylobacter* species was not recorded);[8,9] (iii) national patient surveys for 1996, 1999, 2002, 2005, 2008 and 2011. (These surveys record patients in hospitals and clinics on a single day in October, coded according to the International Classification of Diseases [ICD-10]);[10] and (iv) vital registration records assimilated by the Japan Ministry of Health, Labour and Welfare.[11]

Incidence estimation

Because of the limitations of the reported statistics, the annual numbers of cases of acute gastroenteritis attributable to foodborne disease caused by *Campylobacter* (Y_1), *Salmonella* (Y_2) and EHEC (Y_3) were estimated using the formulae:

$$Y_1 = \frac{31A_1W_1}{B_1CD} \tag{1}$$

$$Y_2 = \frac{31A_2W_2}{B_2CD} \tag{2}$$

$$Y_3 = \frac{31A_3W_3}{B_3CD} \tag{3}$$

where 31 represents the number of days in October. A_i represents the corresponding reported incidence – A_1 and A_2 estimated from the patient survey data and disease durations[12] and A_3 derived from the data collected from infectious disease surveillance. W_i represents the proportions of infection attributable to foodborne disease. B_i represents seasonality – calculated as the number of cases of acute gastroenteritis caused by *Campylobacter* or *Salmonella* on survey days divided by the corresponding daily mean numbers of cases of acute gastroenteritis caused by *Campylobacter* and *Salmonella* recorded in the survey years. C represents the proportion of incident cases confirmed by stool examination. D represents the proportion of incident cases who visited a physician. Data for the estimation of C and D were derived from population-based telephone surveys.[13,14]

We used a Bayesian method to estimate the probability distributions of B_i, C and D. We assumed that C and D followed binomial probability distributions with a beta

prior distribution for the binomial probability parameter. Because the beta prior is the conjugate distribution of the binomial likelihood, the posterior distribution is also beta-distributed.[15] We assumed a uniform prior distribution – i.e. a special case of the beta distribution in which the probability parameter lies between 0 and 1.[14] Once we had obtained three beta distributions, we assumed that the parameters underlying them were mutually independent and used Mathematica version 8 (Wolfram Research, Hanborough, United Kingdom of Great Britain and Northern Ireland) to calculate the distribution as the product of the three independent distributions.

Finally, the proportions (W_i) of Y_1, Y_2 and Y_3 attributable to foodborne disease were estimated using an expert elicitation process similar to that done in the Netherlands.[16] We invited contributions to this estimation from experts from different scientific backgrounds – microbiology, epidemiology and food science. We invited 88 experts and thirty (34.1%) agreed to participate. We asked the experts to provide their best estimate of the percentages of individuals with gastroenteritis caused by *Campylobacter*, *Salmonella* or EHEC that had become infected by each of five pathways: food, environment, animal–human, human–human and travel. We also asked the experts to estimate the 90% confidence limits around their best estimates. Individual expert opinions were represented in terms of a Dirichlet distribution. Where more than one expert provided an opinion on the same pathway we combined the estimates using a Bayesian update method with equal weighting (details available from the corresponding author).

Complications

In our investigation of the burden caused by complications of gastroenteritis, we used outcome trees based on a European study.[17] The complications resulting from *Campylobacter* included Guillain-Barré syndrome, inflammatory bowel disease and reactive arthritis; from *Salmonella*, inflammatory bowel disease and reactive arthritis and from EHEC, haemorrhagic colitis and haemolytic-uraemic syndrome.[17,18]

We used systematic reviews of prospective cohort studies to estimate the proportions of these complications that could be attributed to gastroenteritis caused by each infectious agent. We searched the Japan medical abstract society database and Embase for relevant articles published between 1 January

1983 and 29 February 2012 and Medline for relevant articles published between 1 January 1946 and 29 February 2012.[19] The search terms were designed by an information specialist using the appropriate medical subheadings (available from the corresponding author). We included prospective cohort studies that described, in English or Japanese, the proportions of laboratory-confirmed sequelae that resulted from gastroenteritis caused by *Campylobacter*, *Salmonella* or EHEC. We only used published data and made no attempt to obtain any further data from the authors of relevant articles. We excluded case reports, review papers, letters, comments, conference proceedings, studies with insufficient information on criteria, studies that only provided aggregated data for multiple conditions and unpublished studies (Fig. 1).

The title, abstract and, if appropriate, the full text of each eligible article of potential interest were screened by two authors independently. Discrepancies were resolved by discussion and consensus. We collected information on the year of publication, study duration, country and area, data source or sources, follow-up period, sample size, serotype, age group, sex, case definition and the incidence of sequelae and their associated standard errors. We assessed the quality of each included study using the Newcastle-Ottawa scale.[20]

Data analysis

Meta-analyses of the proportions of sequelae attributable to gastroenteritis caused by *Campylobacter*, *Salmonella* or EHEC were done to generate pooled values of prevalence with 95% uncertainty intervals. Heterogeneity among studies was estimated using Cochran's Q and the I^2 statistic. Either the Freeman-Tukey double arcsine transformation or log–normal random-effects were used to stabilize model variances.[21–69] Potential sources of heterogeneity were investigated further by analysis of subgroups by age and methods of laboratory confirmation. We used random-effects models[70] in Stata version 13 (StataCorp. LP, College Station, United States of America).

Estimation of mortality

Data on gastroenteritis-related deaths caused by *Campylobacter*, *Salmonella* or EHEC – (ICD-10 codes A045, A02 and A043 respectively) and sequelae such as Guillain-Barré syndrome, inflammatory bowel disease or haemolytic-uraemic

Fig. 1. **Flowchart for the selection of studies included in the systematic review on the disability associated with foodborne disease**
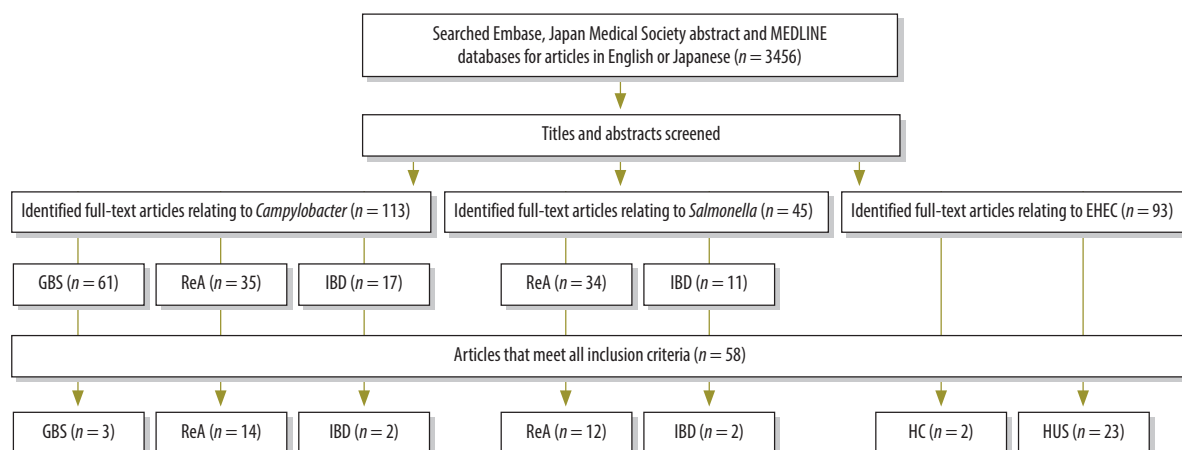
EHEC: enterohaemorrhagic *Escherichia coli*; GBS: Guillain-Barré syndrome; HC: haemorrhagic colitis; HUS: haemolytic uraemic syndrome; IBD: inflammatory bowel disease; ReA: reactive arthritis.

syndrome (ICD-10 codes G610, K50/K51 and D59.3 respectively) were obtained from the Japan vital registration system.[11] These mortality estimates were adjusted based on the proportions estimated to be attributable to foodborne disease. We did not adjust for possible misclassification.

Estimation of burden

We used DALYs to assess the burden of foodborne disease caused by *Campylobacter*, *Salmonella* or EHEC in Japan in 2011. DALYs combine the years of potential life lost due to premature death with the years lived with disabilities.[71] We estimated years of potential life lost by multiplying the number of deaths due to a particular form of foodborne disease by the number of potential life-years lost due to premature death from that disease. The latter was based on standard life expectancies from the Global Burden of Disease (GBD) 2010 study.[72] The corresponding years lived with disabilities were calculated as the product of the number of incident cases of a particular form of foodborne disease, the mean duration of that disease and the disability weight for that disease. Age-specific disease incidences were estimated from the age distributions recorded in food poisoning and infectious diseases statistics for Japan. Whenever possible, we used disease durations and disability weights from studies conducted in Europe.[17,18] To be consistent with the assumptions made in the GBD 2010 study, we did not apply any discounting or non-uniform age-weighting. DALY components were calculated separately for each sex and age group and then summed to obtain estimates of the total burdens.

Uncertainty analysis

Uncertainty intervals were derived by Monte-Carlo simulation within the R statistical package (R Foundation for Statistical Computing, Vienna, Austria). Appropriate probability distributions were specified for parameters that, based on the published literature, were considered to be important sources of uncertainty. Estimates were repeatedly calculated from randomly drawn sets of input values, and 95% uncertainty intervals were derived from the 2.5th and 97.5th percentiles of the output values. The process was continued until the difference between the means of the incremental iterations satisfied the stopping criterion of less than 1 unit difference in the mean of the outcome estimates. The number of draws ranged from 22, for acute gastroenteritis caused by *Campylobacter*, to 52951, for inflammatory bowel disease caused by *Salmonella*.

Results

Incidences of acute gastroenteritis

Table 1 shows the incidence of gastroenteritis caused by foodborne *Campylobacter*, *Salmonella* or EHEC reported in the routine surveillance data, and the corresponding – much higher – adjusted incidences that we estimated using the pyramid reconstruction method. Fig. 2 shows the estimated annual incidence of acute gastroenteritis caused by foodborne *Campylobacter*, *Salmonella* or EHEC between 1996 or 1999 and 2011. Over this period, there was no clear trend in the incidence of acute gastroenteritis caused by foodborne *Campylobacter* or EHEC but the incidence of gastroenteritis caused by foodborne *Salmonella* appeared to fall substantially after 2002.

Table 1. **Estimated incidences of acute gastroenteritis, Japan, 2011**

Data source	Causative agent	Estimated no. of cases	Estimated incidence, cases per 100 000 population (95% UI)
Food poisoning statistics	*Campylobacter* spp.	2341	1.8 (1.1–2.8)
	Salmonella sp.	3068	2.4 (1.5–3.6)
	EHEC	714	0.6 (0.2–1.3)
Pyramid reconstruction	*Campylobacter* spp.	118 502	92.5 (55.2–154.5)
	Salmonella sp.	40 571	31.7 (19.2–51.8)
	EHEC	103 338	80.7 (49.5–133.1)

EHEC: enterohaemorrhagic *Escherichia coli*; UI: uncertainty interval.

Fig. 2. **Estimates of the incidence of foodborne disease caused by *Campylobacter,*
Salmonella or enterohaemorrhagic *Escherichia coli*, Japan, 2011**
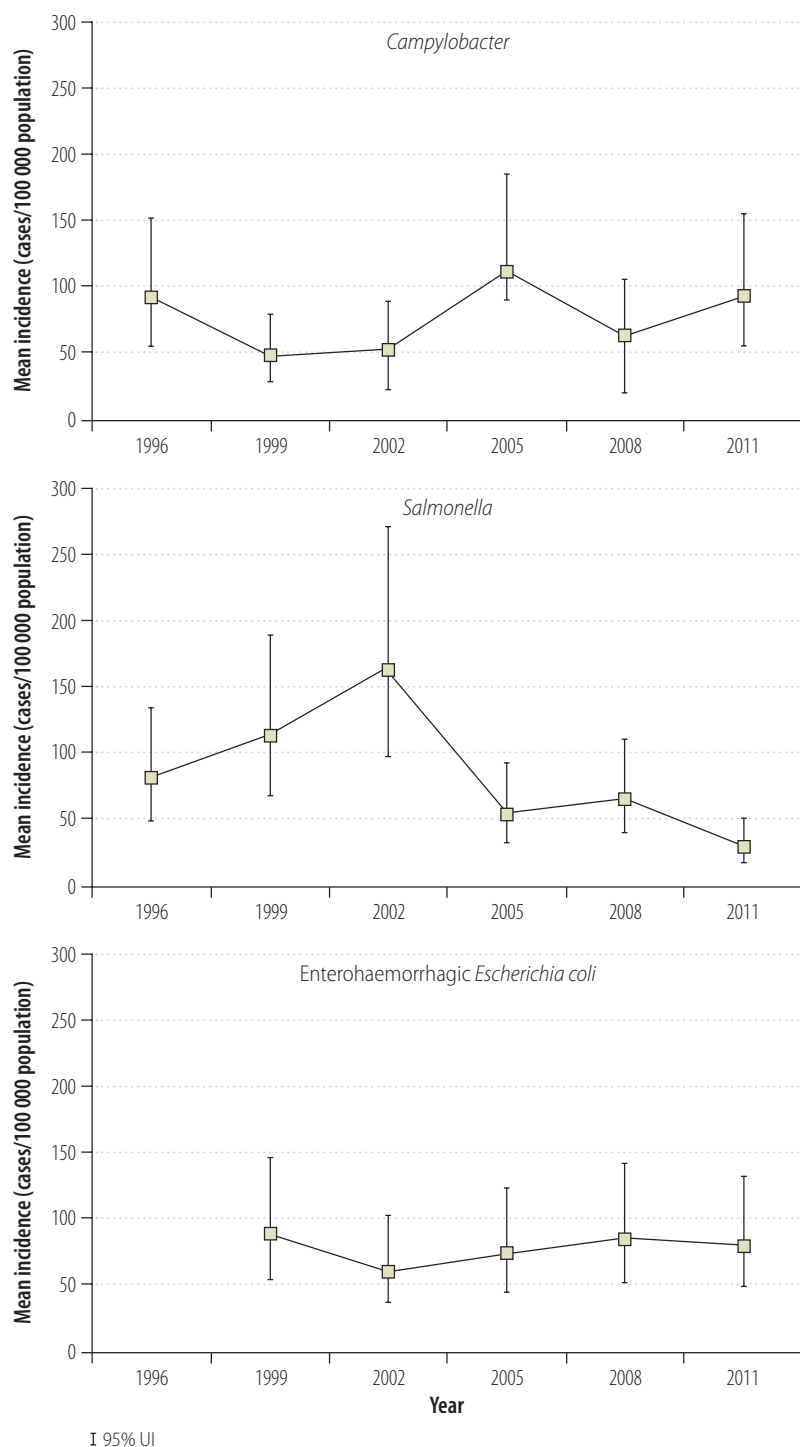
I 95% UI

UI: uncertainty intervals.

Disease burdens

Table 2 summarizes the experts' esti-
mates of the proportions of the acute
gastroenteritis incidence that can be at-
tributed to foodborne transmission and
other pathways. Table 2 also shows the
corresponding Bayesian factors used to

adjust for seasonality, physician visits and
stool examination – i.e. the denominators
of Equation 1, Equation 2 and Equation 3.
Table 3 shows the results of our
systematic review and meta-analysis of
the prevalence of various complications
that may occur after infection with *Cam-
pylobacter*, *Salmonella* or EHEC (Fig. 3,

Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8 and
Fig. 9; all available at: http://www.who.
int/bulletin/volumes/93/08-/14-148056).
The attributable proportions – i.e. the
percentages of the cases of the sequelae
that could be attributed to one of our
pathogens of interest – varied from
0.03%, for Guillain-Barré syndrome and
Campylobacter, to 9.14%, for haemor-
rhagic colitis and EHEC.
Table 4 summarizes the numbers
of deaths recorded in Japan in 2011 that
were attributed to gastroenteritis caused
by foodborne *Campylobacter*, *Salmonella*
or EHEC or to the related complications.
No deaths were attributed to gastroen-
teritis caused by *Campylobacter*, reactive
arthritis or haemorrhagic colitis.
Table 4 also presents disability
weights, disease durations, estimated in-
cidences and disease burdens in terms of
DALYs. Most of the overall disease bur-
den posed by foodborne *Campylobacter*,
Salmonella or EHEC was the result of a
relatively small number of complications.

Discussion

Our study provides national estimates
of incidence, deaths and disease burden
in DALYs, caused by *Campylobacter*,
Salmonella and EHEC in Japan in 2011.
Estimates of annual incidence were
approximately 92.5, 31.7 and 80.7 cases
per 100 000 population for gastroenteri-
tis caused by foodborne *Campylobacter*,
Salmonella and EHEC, respectively. These
estimates were many-fold higher than the
values indicated by the results of routine
surveillance, which ranged from 0.6 to
2.4 cases per 100 000 population. In 2011
at least, Japan's routine surveillance sys-
tem for foodborne diseases appeared to
grossly underreport the incidence of acute
gastroenteritis caused by our pathogens
of interest. One probable cause of such
underreporting is that the surveillance
system focuses on clusters, outbreaks and
other large public health events and usu-
ally ignores individual sporadic cases.[73]
Our estimate of the annual incidence
of gastroenteritis caused by foodborne
Campylobacter appears relatively low for
a high-income country. Previous estimates
of such incidence in a high-income coun-
try have ranged from 440 per 100 000,
in the United States in 2006, to 930 per
100 000, in the United Kingdom in 2008–
2009.[74] Apparent geographical variation in
the incidence of such disease may partly
reflect between-country and between-
study differences in the surveillance

Table 2. **Estimated proportions of gastroenteritis cases resulting from foodborne transmission and other pathways, Japan, 2011**

Causative agent	No. of experts[a]	Transmission pathway, % (95% UI)					Bayesian adjustment factor (95% UI)
		Food	Environment	Animal–human	Human–human	Travel	
Campylobacter spp.	15	82.0 (78.5–85.5)	8.3 (6.7–10.1)	3.1 (2.1–4.3)	0.2 (0.0–0.5)	6.4 (5.0–8.0)	0.17 (0.08–0.32)
Salmonella sp.	14	79.3 (74.7–84.0)	2.7 (1.7–3.8)	10.1 (8.4–12.0)	3.4 (2.4–4.7)	4.5 (3.2–5.9)	0.26 (0.12–0.47)
EHEC	20	77.6 (73.4–81.8)	4.0 (2.8–5.3)	8.5 (6.9–10.4)	6.0 (4.6–7.6)	3.9 (2.8–5.29)	2.23 (0.97–4.00)

EHEC: enterohaemorrhagic *Escherichia coli*; UI: uncertainty interval.
[a] These experts were asked to estimate the proportions of gastroenteritis cases resulting from each transmission pathway.

methods employed. In some countries, population-based cohort studies – e.g. the Sensor study in the Netherlands and two Infectious Intestinal Disease studies in the United Kingdom[75–77] – are being used. In Australia, Canada and the United States, a surveillance pyramid method that included information on hospital visits and laboratory-confirmed cases is being employed.[78–82] Harmonization of methods will be necessary if we are to make meaningful comparisons of incidence estimates between countries and over time. The results of this pilot study will hopefully help FERG to improve its recommendations and the production of comparable, consistent estimates of the incidences of foodborne diseases.

In our study, to address the potential bias resulting from the one-day hospital reporting period and the inclusion only of laboratory-confirmed cases, we applied a pyramid reconstruction technique similar to that used in previous research.[78–82] Although this technique allows some adjustment for seasonality, care-seeking and diagnostic factors, it has several limitations. First, we estimated the age-specific incidence of gastroenteritis based on food poisoning statistics from a passive surveillance system, that tends to miss sporadically occurring cases.[83] To make the estimation of the number of cases occurring annually in each age group more accurate, active surveillance – via national surveys or a population-based surveillance network – would be needed.

Second, we restricted the sequelae we investigated to those previously identified in a European study. In Japan, there may be different or more complications than observed in Europe.

Third, we based some of our estimation process on a systematic review of sequelae from other countries, where the epidemiology of foodborne disease may differ from that in Japan – e.g. because of the geographical variation in dietary habits.

Fourth, the validity and comparability of the disability weights that we used may be limited. In the field of foodborne disease, information on disability weights for specific complications is scarce. Hopefully, relevant data will soon be provided by FERG.[72]

Finally, our estimates of the proportion of gastroenteritis resulting from foodborne transmission were based on expert opinion instead of empirical data. The size of the so-called foodborne fraction appears to vary markedly depending on the country involved. Such a large variation may be due to differences in dietary habit, consumer tastes, food processing and food safety – but may also reflect differences in the methods used to investigate transmission pathways.

The approach recommended by FERG appears useful for understanding the magnitude of foodborne diseases, prioritizing food safety interventions and policies and harmonizing methods for the estimation of the foodborne disease burden. ■

Table 3. **Proportions of cases of sequelae attributable to *Campylobacter* spp., *Salmonella* sp. or enterohaemorrhagic *Escherichia coli***

Pathogen, sequelae	Attributable proportion, % of cases of sequelae, (95% UI)	No. of studies	Country
***Campylobacter* spp.**			
Guillain-Barré syndrome	0.03 (0.02–0.06)	3	Netherlands, Sweden
Inflammatory bowel disease	0.30 (0.27–0.34)	2	Denmark, Sweden
Reactive arthritis	5.01 (2.60–8.08)	14	Denmark, Finland, Netherlands, Norway, United Kingdom, USA
***Salmonella* sp.**			
Inflammatory bowel disease	0.43 (0.38–0.48)	2	Denmark, Sweden
Reactive arthritis	6.09 (2.81–10.47)	12	Australia, Denmark, Finland, Netherlands, Switzerland, United Kingdom, USA
EHEC			
Haemorrhagic colitis	9.14 (4.17–15.51)	2	Germany, United Kingdom
Haemolytic uraemic syndrome	6.13 (4.61–7.82)	23	Austria, Belgium, Canada, Denmark, Finland, Germany, Hungary, Slovakia, United Kingdom, USA

EHEC: enterohaemorrhagic *Escherichia coli*; UI: uncertainty interval; USA: United States of America.
Sources: Data drawn from the results of identified studies.[21–69]

Yuko Kumagai et al.

Table 4. Burdens posed by foodborne diseases caused by *Campylobacter* spp., *Salmonella* sp. or enterohaemorrhagic *Escherichia coli*, Japan, 2011

Causative agent, condition	Incidence, cases (95% UI)	Fatal cases	Years of illness	Disability weight	Burden metrics			YLD/DALY (%)
					YLD (95% UI)	YLL (95% UI)	DALY (95% UI)	
***Campylobacter* spp.**								
Gastroenteritis	118 502 (70 654–197 823)	–	–	–	122	0	122	100.0
Visiting a general practitioner	4 833 (3 439–7 156)	0	0.03	0.39	50 (42–66)	0	50 (42–66)	100.0
Not visiting a general practitioner	114 219 (67 864–190 644)	0	0.01	0.07	72 (42–122)	0	72 (42–122)	100.0
Mild Guillain-Barré syndrome	30 (14–60)	0	1.00	0.25	7 (5–12)	0	7 (5–12)	100.0
Severe Guillain-Barré syndrome	5 (3–11)	1	29.26	0.16	29 (13–57)	12 (6–21)	42 (24–69)	69.0
Reactive arthritis	6 087 (2 956–11 156)	0	0.61	0.14	520 (257–952)	0	520 (257–952)	100.0
Inflammatory bowel disease	452 (93–1 051)	4	44.36	0.26	5 261 (1 095–12 393)	83 (31–150)	5 344 (1 173–12 475)	98.4
Total	–	–	–	–	6003 (1 651–13 687)	96 (42–160)	6 099 (1 745–13 778)	98.4
***Salmonella* sp.**								
Gastroenteritis	40 571 (24 607–66 382)	–	–	–	70	122	192	
Visiting a general practitioner	3 866 (3 411–4 658)	3	0.03	0.39	47 (42–56)	122 (8–292)	169 (52–338)	27.8
Not visiting a general practitioner	36 667 (21 237–62 597)	0	0.02	0.07	23 (13–37)	0	23 (13–37)	100.0
Reactive arthritis	2 556 (1 190–4 774)	0	0.61	0.15	227 (119–390)	0	227 (119–390)	100.0
Inflammatory bowel disease	202 (36–481)	2	50.52	0.26	2652 (492–6 211)	38 (13–69)	2 690 (522–6 236)	98.6
Total	–	–	–	–	2979 (753–6 795)	166 (49–350)	3 145 (906–6 950)	94.7
EHEC								
Gastroenteritis	103 338 (63 419–170 419)	–	–	–	75	130	205	
Visiting a general practitioner	2 064 (1 955–2 175)	10	0.02	0.39	12 (11–13)	130 (53–232)	142 (65–244)	8.5
Not visiting a general practitioner	101 982 (60 428–169 268)	0	0.01	0.07	63 (38–96)	0	63 (38–96)	100.0
Haemorrhagic colitis	229 (115–361)	0	0.02	0.39	1 (1–2)	0	1 (1–2)	100.0
Haemolytic uraemic syndrome[a]	132 (108–155)	3	NA	NA	133 (109–159)	108 (42–196)	240 (169–326)	55.4
Total	–	–	–	–	211 (171–266)	252 (129–395)	463 (325–606)	45.6

DALY: disability-adjusted life-years; EHEC: enterohaemorrhagic *Escherichia coli*; NA: not available; UI: uncertainty interval; YLD: years lived with disability; YLL: years of life lost.
a Every case was estimated to correspond to 1.05 years lived with disability.[17]
Sources: years of illness and disability weights were based on values provided by Van Lier and Havelaar[77] and Kemmeren et al.[18]

ملخص

تقدير عبء الأمراض المنقولة عن طريق الغذاء في اليابان

الغرض تقييم العبء الذي يفرضه المرض المنقول عن طريق الغذاء في اليابان باستخدام الطرائق التي وضعها الفريق المرجعي المعني بالوبائيات المتعلقة بعبء الأمراض المنقولة عن طريق الغذاء (FERG) التابع لمنظمة الصحة العالمية.

الطريقة تمت الاستعانة بمشورة الخبراء والإحصائيات المتعلقة بالتسمم الغذائي خلال عام 2011 لتحديد ثلاثة أسباب شائعة للإصابة بالمرض المنقول عن طريق الغذاء في اليابان: أنواع بكتريا الكامبيلوباكتر والسالمونيلا والإشريكية القولونية المعوية النزفية (EHEC). وأجرينا مراجعات منهجية للكتابات الصادرة باللغتين الإنجليزية واليابانية التي تتناول المضاعفات الناتجة عن مسببات الأمراض المذكورة، وذلك عن طريق البحث في قاعدة معطيات Embase، وقاعدة معطيات ملخصات المنشورات التابعة للجمعية الطبية اليابانية، وقاعدة معطيات Medline. وأجرينا تقديرًا لنسبة حالات الإصابة بالتهاب المعدة والأمعاء الحاد سنويًا من خلال بيانات الرصد التي تم الإبلاغ عنها، وذلك بناءً على الاحتمالات التقديرية التي تفترض زيارة الشخص المصاب للطبيب والتأكد من إصابته بالتهاب المعدة والأمعاء.

ومن ثم احتسبنا الخسارة التي تشير إليها سنوات العمر المصححة باحتساب مدد العجز (DALYs) في عام 2011، وذلك باستخدام تقديرات حالات الإصابة بالإضافة إلى نتائج مقياس العجز المستمدة من الدراسات المنشورة.

النتائج أدت الإصابة بالمرض المنقول عن طريق الغذاء والناتج عن وجود أنواع بكتريا الكامبيلوباكتر والسالمونيلا وEHEC إلى خسارة 6099، و3145، و463 عامًا بالرجوع إلى DALYs على التوالي. وتعتمد الأعباء المقدَّرة على طريقة إعادة الهيكلة الهرمية للرصد، وتعود إلى حد كبير إلى الاعتلال بدلاً من الوفيات، كما ترتفع نسبتها إلى حد بعيد عن تلك التي أشارت إليها بيانات الرصد الروتيني.

الاستنتاج قد تشير بيانات الرصد الروتيني إلى الانخفاض الشديد في معدلات الإصابة بالمرض المنقول عن طريق الغذاء مقارنة بالقيم الحقيقية. وينشأ الجزء الأعظم من العبء الذي يفرضه المرض المنقول عن طريق الغذاء في اليابان عن مضاعفات ثانوية. وتبدو الأدوات التي وضعها FERG مفيدة لتقدير أعباء المرض ووضع أولويات في مجال سلامة الأغذية.

摘要

估算日本食源性疾病负担

目的 旨在使用世界卫生组织食源性疾病负担流行病学参考组 (FERG) 制定的方法，评估日本食源性疾病所带来的负担。

方法 利用 2011 年有关食品中毒的专家会诊和统计数据，确定日本食源性疾病的三种常见致因：弯曲杆菌和沙门氏病菌和肠出血性大肠杆菌 (EHEC)。我们通过搜索 Embase、日本医学社会摘要数据库和 Medline，系统查看了有关这些病原体所导致的并发症的英文和日文文献。我们依据估计感染者前去就诊并确诊患有肠胃炎的概率，利用报告的监测数据估算出每年急性肠胃炎的发病率。然后，我们基于来自公布数据的发病率估测值以及伤残权重，计算出 2011 年损失的伤残调整寿命年 (DALY)。

结果 2011 年，因弯曲杆菌和沙门氏病菌和 EHEC 引发的食源性疾病导致分别估计损失 6099、3145 和 463 DALY。依据金字塔重构方法，大多基于发病率而非死亡率估算出负担，其远远超出常规监测数据指示的数值。

结论 常规监测数据指示的食源性疾病负担可能远远低于真实数值。日本食源性疾病带来的大多数负担源于继发性并发症。FERG 开发的工具有助于估算疾病负担及确定食品安全领域的优先事项。

Résumé

Estimation de la charge des maladies d'origine alimentaire au Japon

Objectif Évaluer la charge des maladies d'origine alimentaire au Japon, à l'aide de méthodes développées par le Groupe de travail de référence de l'OMS sur l'épidémiologie des maladies d'origine alimentaire (FERG).

Méthodes Des avis d'experts et des statistiques sur les intoxications alimentaires pour l'année 2011 ont été utilisés pour identifier les trois principales causes des maladies d'origine alimentaire au Japon : à savoir les espèces *Campylobacter*, *Salmonella* et *Escherichia coli* entérohémorragique (ECEH). Nous avons procédé à des revues systématiques de la littérature anglaise et japonaise sur les complications causées par ces agents pathogènes, en faisant des recherches dans Embase (base de données bibliographiques de la société médicale du Japon) et Medline. Nous avons évalué l'incidence annuelle de la gastro-entérite aiguë à partir des données de surveillance disponibles, sur la base des probabilités estimées qu'une personne affectée ira consulter un médecin et sera diagnostiquée comme souffrant de gastro-entérite. Nous avons ensuite calculé les AVCI (années de vie corrigées du facteur incapacité) perdues en 2011, en utilisant les évaluations d'incidence ainsi que les coefficients de pondération de l'incapacité tirés des études publiées.

Résultats En 2011, au Japon, les maladies d'origine alimentaire causées par les espèces *Campylobacter*, *Salmonella* et ECEH ont respectivement entraîné une perte estimée à 6 099, 3 145 et 463 AVCI. Ces charges estimées sont fondées sur la méthode de reconstruction de la pyramide de surveillance. Elles sont largement liées à la morbidité -plutôt qu'à la mortalité- et sont très supérieures à celles indiquées par les données de surveillance de routine.

Conclusion Il est possible que les données de surveillance de routine reflètent des chiffres largement inférieurs à la réalité. La charge des maladies d'origine alimentaire au Japon est principalement liée à leurs complications secondaires. Les outils développés par le FERG semblent être utiles pour évaluer les charges des maladies et définir les priorités en matière de sécurité sanitaire des aliments.

Резюме

Оценка бремени болезней пищевого происхождения в Японии

Цель Оценка бремени болезней пищевого происхождения в Японии с применением методов, разработанных Справочной группой Всемирной организации здравоохранения по эпидемиологии бремени болезней пищевого происхождения (FERG).

Методы С помощью экспертных консультаций и статистических данных по пищевым отравлениям за 2011 год были определены три основные причины болезней пищевого происхождения в Японии: бактерии *Campylobacter* и *Salmonella*, а также энтерогеморрагический штамм кишечной палочки *Escherichia coli* (EHEC). Был проведен систематический обзор английской и японской литературы по осложнениям, вызванным данными патогенными микроорганизмами, которая была найдена в базах данных Embase, Medline и реферативной базе данных публикаций медицинского сообщества Японии. Оценивался уровень ежегодной заболеваемости острым гастроэнтеритом по данным эпиднадзора. Для его оценки использовалась расчетная вероятность того, что заболевшие придут к врачу и врач поставит диагноз «гастроэнтерит». Затем рассчитывалось количество лет

жизни, утраченных в связи с болезнью (DALY) в 2011 году. Для этого использовалась оценка количества случаев заболевания и весовые коэффициенты для нетрудоспособности, полученные из опубликованных исследований.

Результаты В 2011 году болезни пищевого происхождения, вызванные бактериями *Campylobacter*, *Salmonella* и EHEC, привели к потере 6099, 3145 и 463 лет жизни, утраченных в связи с болезнью, соответственно. Выявленное бремя болезней, рассчитанное путем реконструкции пирамиды наблюдений, в большей степени связано с заболеваемостью, а не со смертностью. Оно оказалось намного выше показателей, полученных в результате обычного эпиднадзора.

Вывод Данные обычного эпиднадзора могут свидетельствовать о бремени болезней пищевого происхождения, которое намного ниже его истинных значений. Большая часть бремени болезней пищевого происхождения в Японии приходится на вторичные осложнения. Методы, разработанные FERG, оказались эффективными для оценки бремени болезней и определения приоритетов в сфере безопасности пищевых продуктов.

Resumen

Estimación de la carga de enfermedades de transmisión alimentaria en Japón

Objetivo Evaluar la carga que plantean las enfermedades de transmisión alimentaria en Japón mediante la utilización de métodos desarrollados por el Grupo de Referencia sobre Epidemiología de la Carga de Enfermedades de Transmisión Alimentaria (FERG) de la Organización Mundial de la Salud.

Métodos Se utilizaron consultas de expertos y estadísticas en intoxicación alimentaria durante 2011 para identificar tres causas comunes en las enfermedades de transmisión alimentaria en Japón: las bacterias *Campylobacter*, *Salmonella* y *E. coli* enterohemorrágica (EHEC). Se llevaron a cabo revisiones sistemáticas de bibliografía inglesa y japonesa sobre las complicaciones causadas por estos patógenos buscando en Embase, la base de datos de la sociedad médica japonesa, y Medline. Se estimó la incidencia anual de gastroenteritis aguda de los datos de vigilancia informados, en base a probabilidades estimadas de que una persona afectada acudiría a un médico y se le confirmaría la gastroenteritis. Entonces se calcularon los años de vida ajustados en función de la discapacidad (AVAD) perdidos en 2011, utilizando los

cálculos de incidencia junto con los pesos de la discapacidad derivados de estudios publicados.

Resultados En 2011, las enfermedades de transmisión alimentaria causadas por las bacterias *Campylobacter*, *Salmonella* y EHEC condujeron a una pérdida de 6.099, 3.145 y 363 AVAD, respectivamente. Estas cargas estimadas están basadas en el método de reconstrucción de la pirámide de vigilancia, se deben en gran parte a la morbilidad más que a la mortalidad y son mucho más altas que aquellas indicadas por los datos obtenidos a partir de la vigilancia rutinaria.

Conclusión Los datos de la vigilancia rutinaria pueden indicar que las cargas de enfermedades de transmisión alimentaria son mucho más bajas que los valores reales. La mayoría de la carga que plantean las enfermedades de transmisión alimentaria en Japón proviene de complicaciones secundarias. Las herramientas desarrolladas por el FERG parecen útiles a la hora de estimar las cargas de enfermedades y de configurar prioridades en el área de la seguridad alimentaria.
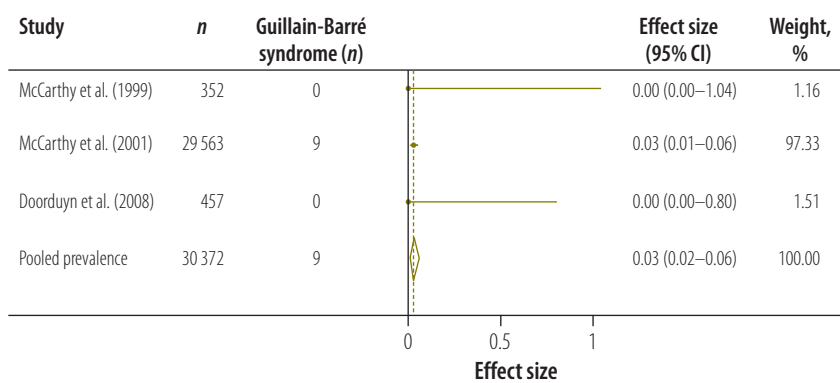
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Fig. 3. **Campylobacter spp. associated cases of Guillain-Barré syndrome, 1999–2008**

Study	n	Guillain-Barré syndrome (n)		Effect size (95% CI)	Weight, %
McCarthy et al. (1999)	352	0		0.00 (0.00–1.04)	1.16
McCarthy et al. (2001)	29 563	9		0.03 (0.01–0.06)	97.33
Doorduyn et al. (2008)	457	0		0.00 (0.00–0.80)	1.51
Pooled prevalence	30 372	9		0.03 (0.02–0.06)	100.00

Effect size axis: 0   0.5   1

Effect size

CI: confidence interval.
Notes: Heterogeneity, I^2: 0.0%. Logistic normal random-effects model was used to test effect size $z = -24.37$; $P = 0.000$.

Fig. 4. **Campylobacter spp. associated cases of reactive arthritis, 1981–2010**

Study	n	No. of reactive arthritis cases		Effect size (95% CI)	Weight, %
Gumpel et al. (1981)	42	8		19.05 (9.98–33.30)	5.43
Kosunen et al. (1981)	342	8		2.34 (1.19–4.55)	7.66
Pitkanen et al. (1981)	55	3		5.45 (1.87–14.85)	5.89
Johnsen et al. (1983)	37	1		2.70 (0.48–13.82)	5.20
Pitkanen et al. (1983)	188	9		4.79 (2.54–8.85)	7.31
Ponka et al. (1984)	283	6		2.12 (0.98–4.55)	7.57
San Joaquin et al. (1984)	135	1		0.74 (0.13–4.08)	7.04
Hannu et al. (2002)	609	45		7.39 (5.57–9.74)	7.86
Locht H et al. (2002)	173	27		15.61 (10.95–21.75)	7.25
Rees et al. (2004)	324	9		2.78 (1.47–5.19)	7.64
Doorduyn et al. (2008)	434	20		4.61 (3.00–7.01)	7.76
Schiellerup et al. (2008)	1003	131		13.06 (11.12–15.29)	7.97
Townes et al. (2008)	2384	33		1.38 (0.99–1.94)	8.07
Schonberg-Norio et al. (2010)	199	8		4.02 (2.05–7.73)	7.36
Pooled prevalence	6208	309		5.01 (2.60–8.08)	100.00

Effect size axis: 0   5   10   15   20   25   30   35

Effect size

CI: confidence interval.
Notes: Heterogeneity, I^2: 94.7%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 6.13$; $P = 0.000$.

Fig. 5. *Campylobacter* spp. associated cases of inflammatory bowel disease, 2008–2011
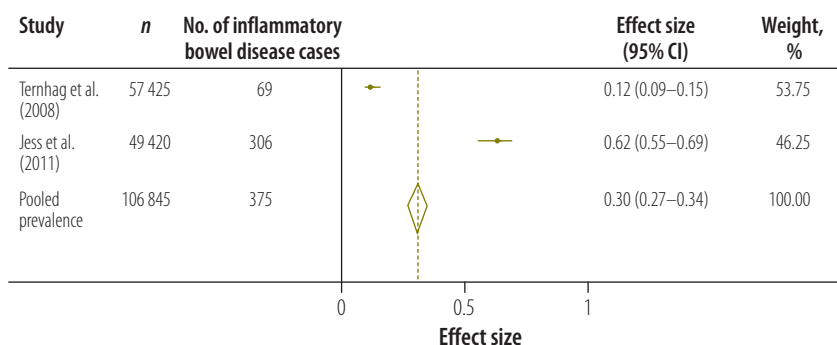
Study	n	No. of inflammatory bowel disease cases		Effect size (95% CI)	Weight, %
Ternhag et al. (2008)	57 425	69		0.12 (0.09–0.15)	53.75
Jess et al. (2011)	49 420	306		0.62 (0.55–0.69)	46.25
Pooled prevalence	106 845	375		0.30 (0.27–0.34)	100.00

Effect size scale: 0, 0.5, 1

Effect size

CI: confidence interval.
Notes: Heterogeneity, I^2: 0%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 34.65; P = 0.013.$

Fig. 6. *Salmonella* sp. associated cases of reactive arthritis, 1986–2008

Study	n	No. of reactive arthritis cases		Effect size (95% CI)	Weight, %
Trull et al. (1986)	448	6		1.34 (0.62–2.89)	8.64
Mattila et al. (1994)	246	16		6.50 (4.04–10.30)	8.44
Samuel et al. (1995)	495	6		1.21 (0.56–2.62)	8.67
Mattila et al. (1998)	191	22		11.52 (7.73–16.82)	8.31
Ekman et al. (2000)	198	8		4.04 (2.06–7.77)	8.33
Urfer et al. (2000)	156	1		0.64 (0.11–3.54)	8.19
Hannu et al. (2002)	63	5		7.94 (3.44–17.27)	7.32
Ress et al. (2004)	100	2		2.00 (0.55–7.00)	7.83
Lee et al. (2005)	261	38		14.56 (10.79–19.35)	8.46
Schiellerup et al. (2008)	619	104		16.80 (14.06–19.95)	8.72
Townes et al. (2008)	1356	204		15.04 (13.24–17.05)	8.82
Doorduyn et al. (2008)	181	8		4.42 (2.26–8.48)	8.28
Pooled prevalence	4314	420		6.09 (2.81–10.47)	100.00

Effect size scale: 0, 5, 10, 15, 20, 25

Effect size

CI: confidence interval.
Notes: Heterogeneity, I^2: 96.0%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 5.43; P = 0.000.$

Fig. 7. *Salmonella* sp. associated cases of inflammatory bowel disease, 2008–2011

Study	n	No. of inflammatory bowel disease cases		Effect size (95% CI)	Weight, %
Ternhag et al. (2008)	34 664	43		0.12 (0.09–0.17)	45.44
Jess et al. (2011)	41 628	342		0.82 (0.74–0.91)	54.56
Pooled prevalence	76 292	385		0.43 (0.38–0.48)	100.00

Effect size scale: 0, 0.5, 1

Effect size

CI: confidence interval.
Notes: Heterogeneity, I^2: 0%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 34.9; P = 0.029.$

Fig. 8. **Enterohaemorrhagic *Escherichia coli*-associated cases of haemorrhagic colitis, 1997–1998**

Study	n	No. of haemorrhagic colitis cases		Effect size (95% CI)	Weight, %
McDonell et al. (1997)	23	4		17.39 (6.98–37.14)	20.80
Beutin et al. (1998)	89	7		7.87 (3.86–15.36)	79.20
Pooled prevalence	112	11		9.14 (4.17–15.51)	100.00

CI: confidence interval.

Notes: Heterogeneity, I^2: 43.8%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 3.60$; $P = 0.000$.
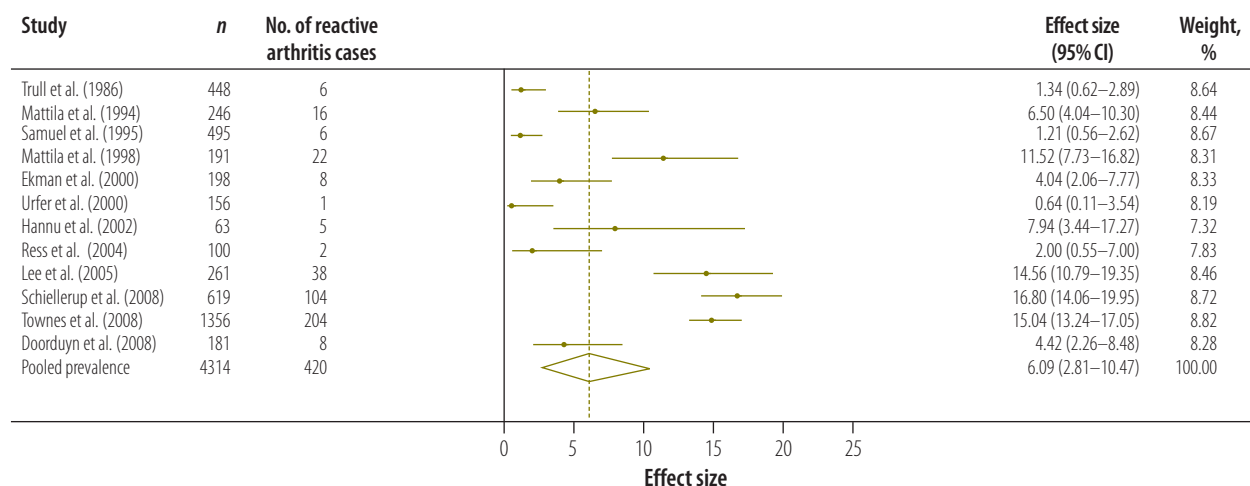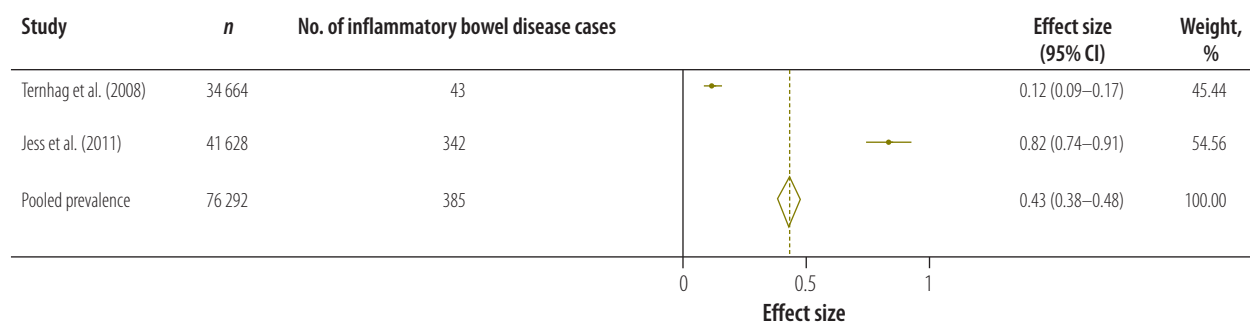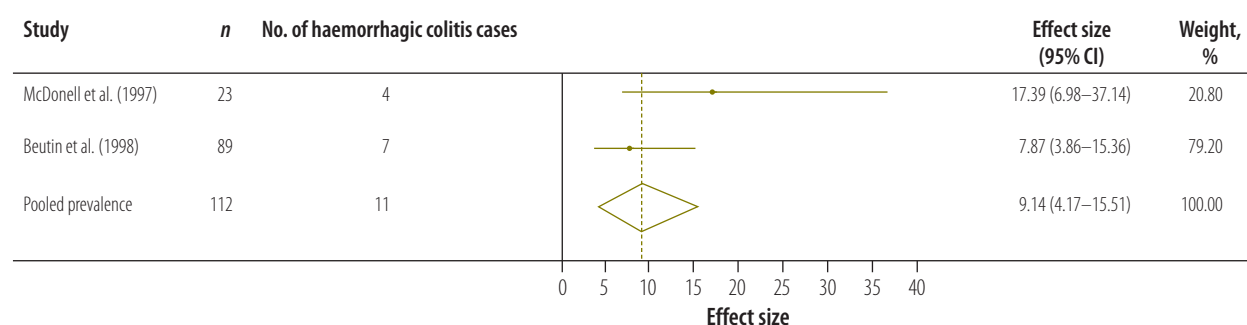
Fig. 9. **Enterohaemorrhagic *Escherichia coli*-associated cases of haemolytic-uraemic syndrome, 1984–2012**

Study	n	Haemolytic-uraemic syndrome (n)		Effect size (95% CI)	Weight, %
Pai et al. (1984)	20	3		15.00 (5.24–36.04)	1.60
Carter et al. (1987)	73	12		16.44 (9.66–26.57)	4.16
Salmon et al. (1989)	26	1		3.85 (0.68–18.89)	1.98
Pierard et al. (1990)	14	2		14.29 (4.01–39.94)	1.18
Simor et al. (1990)	31	1		3.23 (0.57–16.19)	2.27
Orr et al. (1994)	152	21		13.82 (9.22–20.20)	6.13
Sharp et al. (1994)	16	3		18.75 (6.59–43.01)	1.32
MacDonald et al. (1996)	83	8		9.64 (4.97–17.88)	4.49
McDonell et al. (1997)	23	2		8.70 (2.42–26.80)	1.79
Chalmers et al. (1999)	415	17		4.10 (2.57–6.46)	8.50
Fischer et al. (2001)	97	11		11.34 (6.45–19.17)	4.91
Beutin et al. (2002)	156	15		9.62 (5.91–15.26)	6.20
Beutin et al. (2004)	608	21		3.45 (2.27–5.22)	9.15
Ethelberg et al. (2004)	343	21		6.12 (4.04–9.18)	8.12
Liptakova et al. (2004)	9	3		33.33 (12.06–64.58)	0.80
Laine et al. (2005)	10	1		10.00 (1.79–40.42)	0.88
Afza et al. (2006)	20	1		5.00 (0.89–23.61)	1.60
Gould et al. (2009)	3464	218		6.29 (5.53–7.15)	10.59
Hedican et al. (2009)	206	7		3.40 (1.66–6.85)	6.93
Lathrop et al. (2009)	111	5		4.50 (1.94–10.11)	5.27
Mag et al. (2010)	33	2		6.06 (1.68–19.61)	2.39
Hadler et al. (2011)	663	46		6.94 (5.24–9.13)	9.28
Lienemann et al. (2012)	5	1		20.00 (3.62–62.45)	0.48
Pooled prevalence	6578	422		6.13 (4.61–7.82)	100.00

CI: confidence interval.

Notes: Heterogeneity, I^2: 63.4%. Freeman-Tukey double arcsine transformation was used to test effect size $z = 12.19$; $P = 0.000$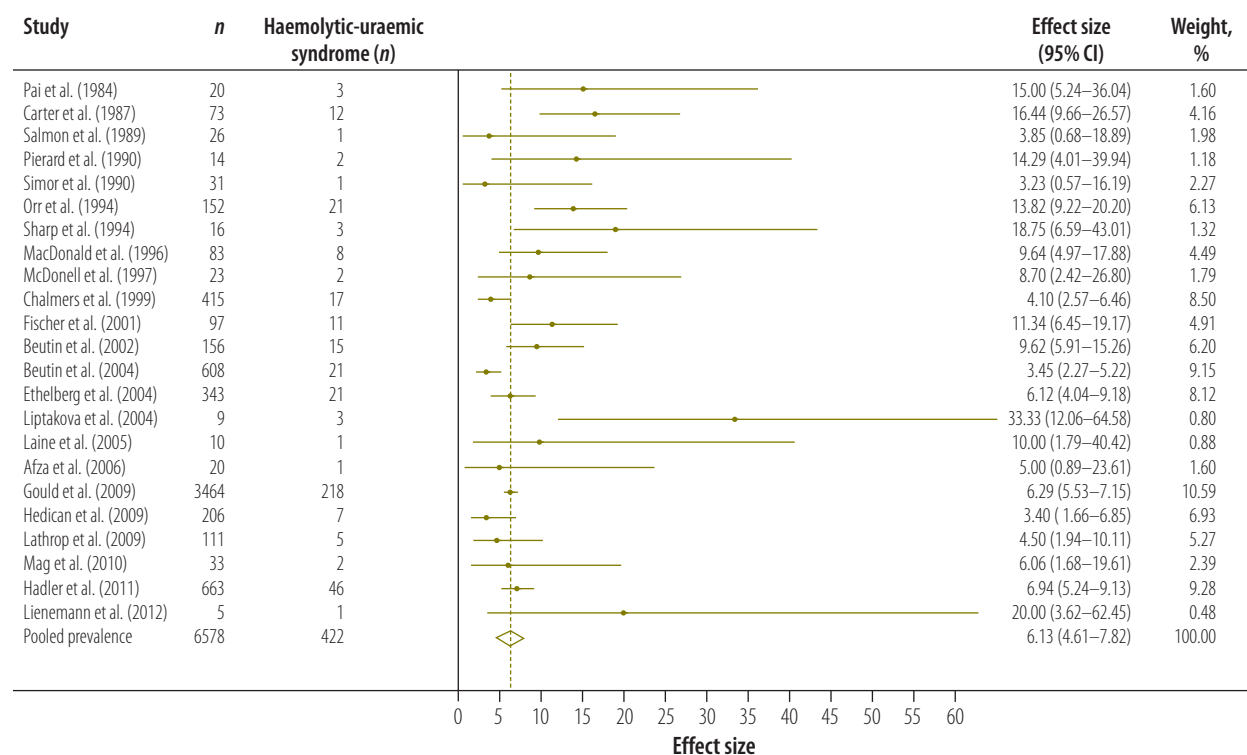.