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Supplementary material: Supporting tables and figures

Table 1. Main features of studies of foodborne illness in the UK, Australia, Canada and USA

Feature	UK	Australia	Canada	USA
Year to which outputs relate	2009 & 2018	2010	2006	2006
Data sources on which estimates of overall burden of illness are based.	Infectious Intestinal Disease (IID) estimates based on nationally representative, population-based prospective cohort study in 2009. Nationally representative, cross-sectional telephone surveys with 7-day and 28-day recall in 2009.	National Gastroenteritis Survey II – a nationally representative, retrospective cross-sectional telephone survey conducted in 2008–2009 with 4-week recall.	National Studies on Acute Gastrointestinal Illness (NSAGI) population surveys conducted in Ontario and British Columbia via retrospective, cross-sectional telephone surveys with 28-day recall.	Cross-sectional, retrospective telephone survey of self-reported acute diarrheal illness with 28-day recall in Foodborne Diseases Active Surveillance Network (FoodNet) at 10 US sites extrapolated to the whole of the US.
Case definitions.	IIID defined as loose stools or clinically significant vomiting lasting less than 2 weeks, in the absence of a known non-infectious cause, preceded by a symptom-free period of 3 weeks. Vomiting was clinically significant if it occurred more than once in a 24 h period, and if it incapacitated the patient or was accompanied by other symptoms such as cramps or fever.	Gastroenteritis defined as 3 or more episodes of diarrhoea or 2 or more episodes of vomiting within a 24-h period during the preceding 4 weeks in the absence of a non-infectious cause for illness.	Acute diarrheal defined as ≥3 loose stools in 24 h with duration lasting >1 day not resulting from pregnancy, medication, food allergy, and/or medical conditions previously diagnosed by a doctor (e.g. colitis, diverticulitis, Crohn's disease, irritable bowel syndrome).	Acute diarrheal illness defined as 3 or more loose stools in 24 hours lasting more than 1 day or resulting in restricted daily activities.
Adjustment for under-diagnosis?	Estimates for 2009 did not need adjustments as they were measured as part of the IID2 study.[10] 2018 updates used adjustments based on this study and the change in confirmed laboratory for *Campylobacter*, *E. coli* O157, *Salmonella, Shigella, Cryptosporidium, Giardia* and rotavirus. For 2018, *C. Perfringens*, adenovirus, astrovirus, norovirus,	Yes	Yes	Yes

	and sapovirus were scaled up based on population from the IID2 study, so were not adjusted for under-diagnosis. *E. coli* O157 and *Listeria monocytogenes* were assumed to have no under-diagnosis			
Estimating proportion of illnesses that are foodborne	Using outbreak surveillance data (excluding norovirus). For norovirus estimate based on Foodborne Disease Estimates for the United Kingdom in 2018 (Food Standards Agency, 2020a)	Expert elicitation.	Expert elicitation and literature review.	Using data from surveillance, risk factor studies, and a literature review.
Number of foodborne pathogens included	13	18 (IID only)	30	31
Unknown agents	Included	Included	Included	Included

Table 2: Methodology to produce estimates by country

Estimate	UK	Australia	Canada	USA
Total IID (1)	Cohort Study	Telephone survey with 28 day recall	Telephone survey with 28 day recall	Telephone survey with 28 day recall
Total cases for individual pathogens (2)	Estimates based largely on cohort study. Of the 13 pathogens covered in detail in this paper, *Campylobacter*, *Salmonella non-typhoidal*, *Shigella*, *Cryptosporidium*, *Giardia*, norovirus and rotavirus were scaled up based on confirmed laboratory reports and underreporting rates from the cohort study. For *C. perfringens*, adenovirus, astrovirus, norovirus and sapovirus cases	Of the 12 pathogens covered in detail in this paper *C. perfringens*, *Campylobacter*, *Listeria monocytogenes*, *Salmonella non-typhoidal*, *Shigella*, *Cryptosporidium* and *Giardia* scaled up from surveillance data. Adenovirus, astrovirus, norovirus, rotavirus and sapovirus scaled down from Total IID (1)	Of the 13 pathogens covered in detail in this paper *Campylobacter*, *E. coli* O157, *Listeria monocytogenes*, *Salmonella non-typhoidal*, *Shigella*, *Cryptosporidium* and *Giardia* scaled up from surveillance data. *C. perfringens*, adenovirus, astrovirus, norovirus, rotavirus and sapovirus scaled down from Total IID (1)	Of the 12 pathogens covered in detail in this paper *C. perfringens*, *Campylobacter*, *E. coli* O157, *Listeria monocytogenes*, *Salmonella non-typhoidal*, *Shigella*, *Cryptosporidium* and *Giardia* scaled up from surveillance data. Astrovirus, norovirus, rotavirus and sapovirus scaled down from Total IID (1)

	rates per 1,000 person-years as given in the cohort study were used. For *E. coli* O157 and *Listeria monocytogenes* confirmed laboratory numbers were used as there was assumed to be no underreporting			
FBI for individual pathogens (3)	Estimates of total cases for each pathogen (2) multiplied by proportion attributed to food. Exception is norovirus which is based on a Quantitative Microbial Risk Assessment model.	Estimates of IID for each pathogen (2) multiplied by proportion attributed to food		
Total FBI (4)	Total of FBI for all individual pathogens (3) plus foodborne estimate for unattributed cases. IID estimate for unattributed cases is Total IID (1) minus sum of IID for individual IID pathogens (2). Foodborne proportion for unattributed cases is based on weighted foodborne proportions for individual IID pathogens.			

Table 3: Infectious Intestinal Disease per 1 million population per annum

Country and approach	Annual rate per 1 million population		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
Australia - telephone survey 28 day recall	746,479	643,192	845,070
Canada - telephone survey 28 day recall	630,500	594,973	666,432
USA - telephone survey 28 day recall	612,000	581,786	642,214
UK - cohort study	274,512	257,230	292,506
UK - telephone survey 7 day recall	1,548,929	1,178,609	1,985,067
UK - telephone survey 28 day recall	542,370	393,532	722,424
Sweden - cohort study	360,000	326,000	395,000
Netherlands - cohort study	283,000	252,000	315,000

Table 4: Foodborne Illness per 1 million population per annum

Country and approach	Annual rate per 1 million population		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
Australia - telephone survey 28 day recall	193,005	109,390	300,000
Canada - telephone survey 28 day recall	123,077	95,385	153,846
USA - telephone survey 28 day recall	159,802	95,849	237,906
UK - cohort study	35,979	28,224	45,215
UK - telephone survey 7 day recall	202,985	140,823	281,015
UK - telephone survey 28 day recall	71,079	47,415	101,176

Figure S1: FBI rates per 1 million population per annum – sensitivity analysis (90% credible intervals shown with the mean)
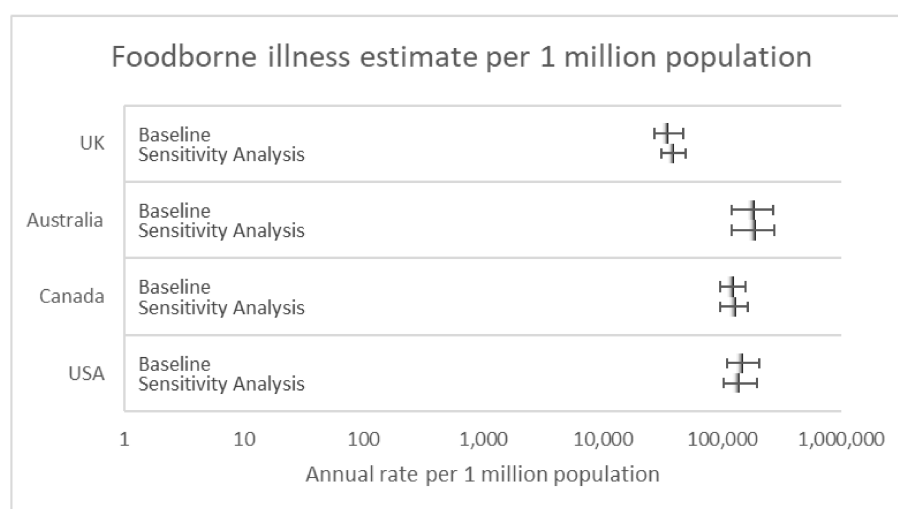
The baseline is based on the models as described in the published papers. As the models have been re-run there are slight differences to previously published figures. Sensitivity analysis is based on using just the 10 IID pathogens common to all four studies.

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Table 5: Proportion of estimated FBI from known pathogens by IID pathogens common to all 4 studies, other IID pathogens (those included in some studies) and non-IID pathogens

% FBI by pathogen category	UK	Australia	Canada	USA
% FBI from 10 common IID pathogens	98.4%	64.7%	91.0%	91.7%
% FBI from other IID pathogens	1.6%	35.3%	8.4%	7.2%
% FBI from non-IID pathogens	0.02%	NA	0.6%	1.1%

Table 6: Estimated proportion of cases attributable to food for unspecified agents

Proportions based on:	UK			Australia			Canada			USA		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
IID pathogens used in individual country's study	13.1%	10.4%	16.3%	25.5%	16.6%	35.9%	20.2%	15.4%	24.9%	25.8%	21.5%	30.2%
10 IID Pathogens common to all 4 studies	14.4%	11.4%	18.0%	26.3%	16.5%	37.0%	20.8%	15.6%	26.1%	24.4%	20.2%	29.0%

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Table 7: Infectious Intestinal Disease per 1 million population per annum for 11 pathogens where estimates are available for all four countries

Country	Annual rate per 1 million population		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
UK	94,855	84,808	105,689
Australia	100,860	82,505	121,332
Canada	220,306	201,342	240,021
USA	118,152	91,577	149,176

Figure S2: IID rates per 1 million population per annum for the 11 pathogens common to all 4 studies (90% credible intervals shown with the mean)
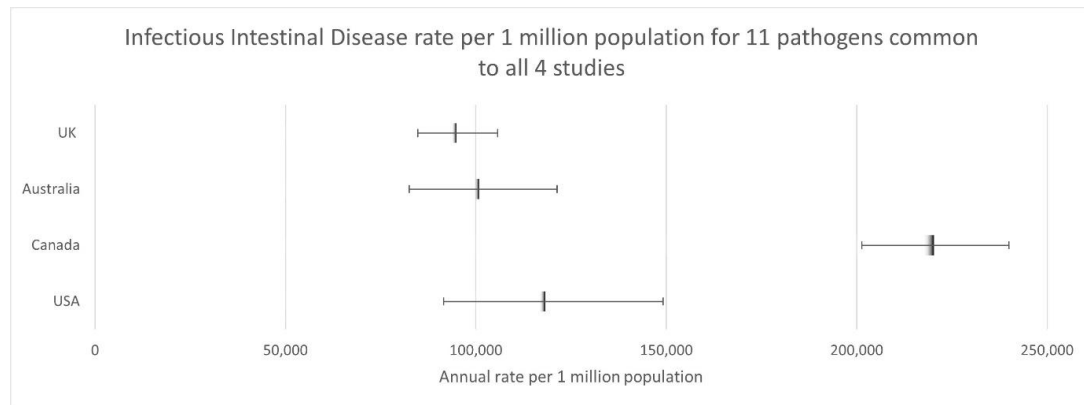
Note: Figures are based on the sum of the estimates for the 11 pathogens and do not use total IID estimates from either the telephone surveys or cohort studies.

Table 8: Foodborne Illness per 1 million population per year for 11 pathogens where estimates are available for all four countries

Country	Annual rate per 1 million population		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
UK	13,676	10,775	17,297
Australia	26,450	16,188	38,754
Canada	45,798	33,928	58,266
USA	28,752	20,152	39,104

Figure S3: FBI rates per 1 million population per annum for the 11 pathogens common to all 4 studies (90% credible intervals shown with the mean)
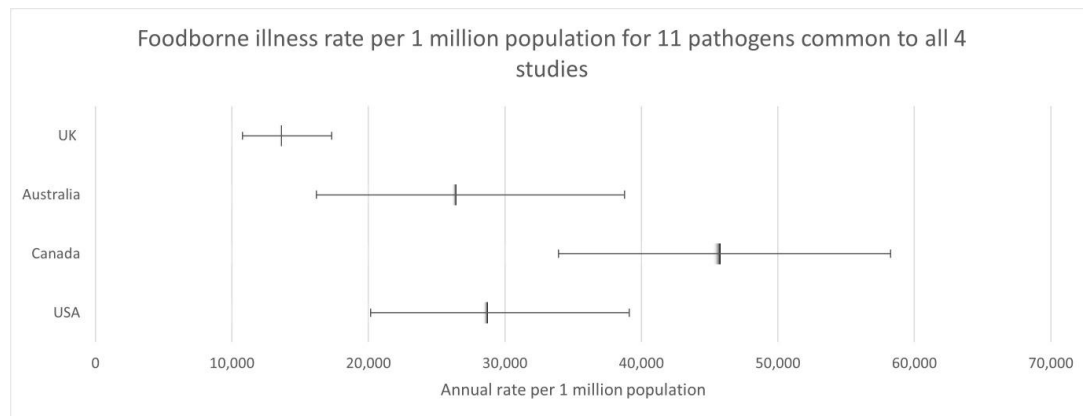

Note: Figures are based on the sum of the estimates for the 11 pathogens and do not use total IID estimates from either the telephone surveys or cohort studies.

Table 9: Infectious Intestinal Disease per 1 million population per year

Pathogen	UK			Australia			Canada			USA		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
Bacteria												
C. perfringens	1,695	671	3,366	785	35	2,465	5,446	2,930	8,314	3,221	642	8,306
Campylobacter	9,748	6,535	13,809	10,950	6,850	17,415	7,131	4,440	9,503	3,502	1,399	6,673
E. coli O157	13	13	13	NA	NA	NA	520	214	913	309	78	746
Listeria monocytogenes	3	3	3	7	3	10	7	5	10	5	2	11
Salmonella non typhoidal	716	145	1,914	2,650	1,515	4,650	3,366	2,293	4,769	3,633	2,266	5,903
Shigella	108	108	108	140	75	260	205	115	336	1,399	264	4,016
Parasites												
Cryptosporidium	745	151	1,990	850	365	1,860	779	441	1,414	2,248	487	6,482
Giardia	1,310	311	3,295	1,560	920	2,665	3,339	2,170	4,884	3,710	2,704	4,990
Viruses												
Adenovirus	10,379	7,187	14,342	4,150	1,300	9,675	23,009	17,750	28,604	NA	NA	NA
Astrovirus	5,528	3,290	8,540	3,150	1,000	7,250	11,768	8,023	15,895	10,340	7,859	12,822
Norovirus	47,078	40,436	54,369	72,500	57,100	90,550	104,000	92,398	116,260	69,414	44,228	99,402
Rotavirus	1,712	1,221	2,311	2,100	875	4,260	26,161	20,468	32,173	10,340	7,858	12,822
Sapovirus	26,212	20,987	32,188	3,800	3,000	4,800	61,217	49,826	67,545	10,340	7,858	12,822

Table 10: Estimates of Infectious Intestinal Disease for certain pathogens for Canada and UK per 1 million population per year. Based on using different estimates of overall IID for Canada.

Pathogen	UK			Canada based on UK Cohort study as in paper			Canada based on UK Cohort Study re-modelled			Canada based on UK Telephone Survey with 28 day recall		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
C. perfringens	1,695	671	3,366	5,446	2,647	8,784	4,439	1,861	7,661	2,353	933	4,142
Adenovirus	10,379	7,187	14,342	23,010	17,047	29,533	24,476	17,618	32,100	12,990	8,362	18,230
Astrovirus	5,528	3,290	8,540	11,768	7,573	16,558	13,237	8,317	18,874	7,018	4,041	10,487
Sapovirus	26,212	20,987	32,188	58,417	48,622	69,040	61,077	49,235	73,945	32,433	22,768	43,299

Note this table gives estimates for Canada based on the UK study as they appear in the published paper and the those re-created using the models. Both figures have been provided to illustrate that the models for Canada re-created for this study give similar but not identical to those published. Only the published figures are given in figure 6 in the main paper.

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Table 11: Foodborne Illness per 1 million population per year

Pathogen	UK			Australia			Canada			USA		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
Bacteria												
C. perfringens	1,443	562	2,885	765	130	2,350	5,445	2,930	8,313	3,231	643	8,238
Campylobacter	4,706	2,247	7,831	8,400	5,050	13,650	4,472	2,944	6,553	2,856	1,127	5,388
E. coli O157	7	5	9	NA	NA	NA	395	161	700	211	59	500
Listeria monocytogenes	2	2	3	7	3	10	5	4	9	5	2	11
Salmonella non typhoidal	647	131	1,731	1,850	1,000	3,350	2,693	1,810	3,862	3,437	2,223	5,618
Shigella	28	3	67	16	6	40	37	17	66	439	82	1,253
Parasites												
Cryptosporidium	47	7	139	80	57	320	71	31	139	193	40	558
Giardia	285	42	821	175	35	490	239	146	365	257	171	367
Viruses												
Adenovirus	213	60	450	80	25	215	115	42	197	NA	NA	NA
Astrovirus	45	11	101	60	20	160	59	21	105	52	19	89
Norovirus	5,768	5,768	5,768	12,920	3,620	26,300	32,238	20,910	44,125	18,267	10,793	27,791
Rotavirus	35	10	74	40	15	95	131	48	222	52	19	89
Sapovirus	669	466	915	700	350	1,150	292	109	483	52	19	89

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Table 12: Proportion of cases attributed to food by country by pathogen

Pathogen	UK			Australia			Canada			USA		
	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.	Mean	Lower 90% Cred. Int.	Upper 90% Cred. Int.
Bacteria												
C. perfringens	85%	73%	95%	98%	86%	100%	100%	100%	100%	100%	100%	100%
Campylobacter	48%	26%	71%	77%	62%	89%	68%	59%	77%	80%	76%	84%
E. coli O157	53%	37%	68%	NA	NA	NA	76%	66%	85%	68%	62%	73%
Listeria monocytogenes	93%	87%	98%	98%	90%	100%	84%	77%	91%	100%	100%	100%
Salmonella non typhoidal	90%	86%	94%	72%	53%	86%	80%	73%	87%	94%	92%	95%
Shigella	26%	3%	62%	12%	5%	23%	18%	11%	25%	31%	26%	37%
Parasites												
Cryptosporidium	6%	2%	12%	10%	1%	27%	9%	5%	13%	8%	7%	10%
Giardia	22%	7%	41%	6%	1%	50%	7%	6%	9%	7%	6%	9%
Viruses												
Adenovirus	2%	1%	4%	2%	1%	3%	1%	0%	1%	NA	NA	NA
Astrovirus	1%	0%	2%	2%	1%	3%	1%	0%	1%	1%	0%	1%
Norovirus	12%	11%	14%	18%	5%	35%	31%	20%	42%	26%	22%	31%
Rotavirus	2%	1%	4%	2%	1%	3%	1%	0%	1%	1%	0%	1%
Sapovirus	3%	2%	3%	18%	5%	35%	1%	0%	1%	1%	0%	1%

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Figure S4: Proportion of cases attributed to food by pathogen by country (90% credible intervals shown with the mean)