Supplementary Materials

Table of Contents

A. Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Table A-1 PRISMA table

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title, p.1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract, p.1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction, p.3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction, p.3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods: eligibility, p.4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Methods: eligibility (used 2 existing reviews), p.4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Methods: eligibility (used 2 existing reviews) , p.4
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Methods: eligibility (used 2 existing reviews), p.4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Methods: data extraction, p.5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Methods: outcomes (used 2 existing reviews) , p.4
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Methods: outcomes / data extraction, p.4-5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods: Risk of bias assessment (used 2 existing reviews), p.5
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Methods: outcomes, p.4

Section and Topic	Item #	Checklist item	Location where item is reported
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Methods: Statistical analysis, p.6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Methods: Statistical analysis, p.6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Methods: Statistical analysis, p.6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Methods: Statistical analysis, p.6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Methods: Statistical analysis, p.6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Methods: Statistical analysis, p.6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Methods: Risk of bias assessment, p.5
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Methods: Risk of bias assessment, p.5
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Results: Included studies, p.7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Results: Included studies (p.7), Supplementary Material B
Study characteristics	17	Cite each included study and present its characteristics.	Results: Table 3, p.8
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Results: Supplementary Material E
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Results: Table 3, p.8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results: Meta-regression for visit

Section and Topic	Item #	Checklist item	Location where item is reported
			frequency, p.11
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Results: Meta-regression for visit frequency (p.11), Table F-1
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Results: Meta-regression for visit frequency (p.11), Supplementary Material F
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Supplementary Material F
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	n/a (reported in 2 underlying reviews)
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	n/a (reported in 2 underlying reviews)
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion, p.12
	23b	Discuss any limitations of the evidence included in the review.	Discussion, p.14
	23c	Discuss any limitations of the review processes used.	Discussion, p.14
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion, p.14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Methods, p.4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Methods, p.4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p.15
Competing interests	26	Declare any competing interests of review authors.	p.15
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Code and data available via OSF.io link (p.15)

B. Categorisation of interventions

We included studies of combined interventions, distinguishing categories per Ross et al. [1] – see Table C-1.

Table B-1: Categories of the extent of combination of hygiene interventions

	Descriptor
1. Majority (HW or HWT only)	Interventions focused on • handwashing alone (or alongside bathing or face-washing) • household water treatment alone (or alongside safe storage)
2. Majority (HW or HWT ≥50% of messages)	Interventions focused on HW or HWT alongside other components, but where the HW/HWT handwashing component was the behavioural target in ≥50% of intervention messages. No distinction is made regarding what HW or HWT handwashing is combined with.
3. Minority (<50% of messages)	Interventions where handwashing is a major part of a broad intervention, but is the behavioural target in <50% of intervention messages.

C. Intensity data availability and procedures for missing data

Missing data and contacting corresponding authors

When emails of corresponding authors were available or could be found online if they had moved institution, we contacted them at least twice with a structured questionnaire focused on intensity data (see below) to supplement or verify extracted data. Where specific intensity variables remained absent, we left studies uncategorised and they were excluded from analyses. However, where there was sufficient information to make an assumption about high/low category without specifying a numeric value for the variable, we did so. For health outcomes, we extracted the RRs already processed and reported in the two underlying systematic reviews. The one exception to this was where multiple sites had been included as independent comparisons despite an "overall" result being available[2]. Therefore, we extracted and used the overall result from the original study.

Intensity data availability

Amongst the 23 HWWS studies in Table 3 in the manuscript, we relied on authors' responses in 12 cases (48%) and the paper in 12 (48%). For the remaining HWWS study (4%), the paper was insufficiently clear on promotion intensity and authors responded but had insufficient records[3]. As this intervention was very large-scale in targeting 2.7 million people across 10 rural districts, it was categorised as "low" intensity for both measures. Amongst the 44 HWT studies, we relied on authors in 14 cases (32%) and the paper in 29 (66%). For the remaining HWT filter study (2%) authors were uncontactable and there was no clear rationale for assuming high or low intensity so it was uncategorised[4]. No trials were ended early due to apparent benefit, so all intervention and outcome follow-ups were as originally intended by the investigators.

Questionnaire sent to corresponding authors

We appreciate that many or most interventions are multimodal, with household visits comprising only one mode of delivery, but those are the focus of this study. We also appreciate that, in many cases, some or most of the requested information is reported, but there are very few studies which report all four of these variables. Many of these studies happened a long time ago, but please respond to the best of your knowledge.

1. Title of paper responding about

2. Email of person responding

3. Which of these did the studied intervention promote?

Do not report interventions outside these categories (e.g. sanitation). Only use the "other" option if there is a nuanced hand hygiene or household water treatment intervention which sits outside these categories for some reason.

- Checkboxes for hand hygiene, chlorination or flocculation, filtration ,solar disinfection, other (specify)

4. Regularity and timeframe of household visits *which included promotion* (excluding monitoring-only visits)

(e.g. "every 3 days for 2 weeks", or "weekly for 2 months". If the regularity was more complex, explain, e.g. "weekly for 4 weeks, then every 2 months for a further 6 months". If regularity varied across study sites, report what was most common. Report only household visits not group-based activities. If regularity/timeframe varied by behaviours listed in Q3 above or by study arm, please explain. If there is important context, add it in the last question.

5. Total number of visits per household *which included promotion* (excluding monitoring-only visits)

(e.g. "6" - please input, as in many cases this is not obvious from above answer. If this varied by behaviours or study arm, please explain. If there is important context, add it in the last question.)

6. Total number of behaviours targeted in household visits (including and beyond that in question 3)

(e.g. "3". Please include behaviours beyond those listed in Q3, so if the intervention promoted handwashing and mask-wearing, put "2" here. If an intervention promoted handwashing at multiple critical times, please only count as 1 behaviour.)

7. Length in minutes of a household promotional visit, on average (across all behaviours in Q6)

(e.g. "30 minutes". Please comment if this varied during the course of the intervention)

8. Any comments or context you think we should know (e.g. non-promotional visits, multi-household visits)

D. List of excluded studies with reasons

Table D-1: List of excluded studies with reasons

Author & year	Title	Journal	Primary reason for exclusion	Comment
Handwashing on ARI (Ross et al., 2023)				
Arnold 2009	Evaluation of a pre-existing, 3-year household water treatment and handwashing intervention in rural Guatemala	Int J Epidemiol.	non-randomised	n/a
Ban 2015	Effects of multiple cleaning and disinfection interventions on infectious diseases in children: a group randomized trial in China	Biomed Environ Sci.	wrong setting	childcare
Bowen 2007	A cluster-randomized controlled trial evaluating the effect of a handwashing-promotion program in Chinese primary schools	Am J Trop Med Hyg	wrong setting	school
Chard 2019	Impact of a school-based water, sanitation, and hygiene intervention on school absence, diarrhea, respiratory infection, and soil-transmitted helminths: results from the WASH HELPS cluster-randomized trial	J Glob Health	wrong setting	school
Huda 2012	Interim evaluation of a large scale sanitation, hygiene and water improvement programme on childhood diarrhea and respiratory disease in rural Bangladesh	Soc Sci Med	non-randomised	n/a
Liu 2019	A hand hygiene intervention to decrease hand, foot and mouth disease and absence due to sickness among kindergarteners in China: a cluster-randomized controlled trial	J Infect.	wrong setting	childcare
Mangklakeree 2014	Effectiveness of influenza control using nonpharmaceutical interventions at primary schools in Nakhon Phanom Province, northeast Thailand	Asian Biomed	wrong setting	school
Morse 2020	Health outcomes of an integrated behaviour-centred water, sanitation, hygiene and food safety intervention–a randomised before and after trial	Int J Environ Res Public Health	non-randomised	n/a
Patel 2012	Impact of a hygiene curriculum and the installation of simple handwashing and drinking water stations in rural Kenyan primary schools on student health and hygiene practices	Am J Trop Med Hyg	wrong setting	school
Pickering 2013	Access to waterless hand sanitizer improves student hand hygiene behavior in primary schools in Nairobi, Kenya	Am J Trop Med Hyg	wrong setting	school
Ram 2015	Impact of intensive handwashing promotion on secondary household influenza-like illness in rural Bangladesh: findings from a randomized controlled trial	PLoS One	follow-up	<1 month
Simmerman 2011	Findings from a household randomized controlled trial of hand washing and face masks to reduce influenza transmission in Bangkok, Thailand	Influenza Other Respir Viruses	follow-up	<1 month
Talaat 2011	Effects of hand hygiene campaigns on incidence of laboratory-confirmed influenza and absenteeism in schoolchildren, Cairo, Egypt	Emerg Infect Dis.	wrong setting	school
Trinies 2016	The impact of a school-based water, sanitation, and hygiene program on absenteeism, diarrhea, and respiratory infection: a matched-control trial in Mali	Am J Trop Med Hyg	wrong setting	school
Handwashing on diarrhoea (Wolf et al., 2022)				

Ahmed 1993	A longitudinal study of the impact of behavioural change intervention on cleanliness, diarrhoeal morbidity and growth of children in rural Bangladesh	Soc Sci Med	non-randomised	n/a
Lee 1991	The impact of a community based health education program on the incidence of diarrheal disease in southern Thailand	Southeast Asian J Trop Med Public Health	non-randomised	n/a
Luby 2004	Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan.	Am J Trop Med Hyg	non-randomised	n/a
Patel 2012	Impact of a hygiene curriculum and the installation of simple handwashing and drinking water stations in rural Kenyan primary schools on student health and hygiene practices.	Am J Trop Med Hyg	wrong setting	school, also non-randomised
Pinfold 1996	Measuring the effect of a hygiene behaviour intervention by indicators of behaviour and diarrhoeal disease.	Trans R Soc Trop Med Hyg	non-randomised	n/a
Shahid 1996	Hand washing with soap reduces diarrhoea and spread of bacterial pathogens in a Bangladesh village.	J Diarrhoeal Dis Res.	non-randomised	n/a
Wilson 1991	Hand-washing reduces diarrhoea episodes: a study in Lombok, Indonesia.	Trans R Soc Trop Med Hyg	non-randomised	n/a
HWT on diarrhoea (Wolf et al., 2022)				
Arnold 2009	Evaluation of a pre-existing, 3-year household water treatment and handwashing intervention in rural Guatemala	Int J Epidemiol	non-randomised	Chlorination & solar
Garrett 2008	Diarrhoea prevention in a high-risk rural Kenyan population through point-of-use chlorination, safe water storage, sanitation, and rainwater harvesting	Epidemiol. Infect	non-randomised	Chlorination
Graf 2010	Health gains from solar water disinfection (SODIS): Evaluation of a water quality intervention in Yaounde, Cameroon.	Journal of Water and Health	non-randomised	Solar
Harshfield 2012	Evaluating the sustained health impact of household chlorination of drinking water in rural Haiti	Am J Trop Med Hyg	non-randomised	Chlorination
Iijima 2001	Prevention of bacterial diarrhea by pasteurization of drinking water in Kenya	Microbiology & Immunology	non-randomised	Pasteurization
Kirby 2017	Use, microbiological effectiveness and health impact of a household water filter intervention in rural Rwanda—A matched cohort study	Int J Hyg & Env Health	non-randomised	Filter
Kirchhoff 1985	Feasibility and efficacy of in-home water chlorination in rural North-eastern Brazil	J Hyg	HWT not user-administered	Chlorination
Luby 2004	Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan	Am J Trop Med Hyg	non-randomised	Chlorination
Quick 2002	Diarrhea Prevention through Household-Level Water Disinfection and Safe Storage in Zambia	Am J Trop Med Hyg	non-randomised	Chlorination

E. Further study characteristics

Table E-1: mean and median numbers of visits by intervention type

	Handwashing (n=22)	Chlorination (n=18)	Filter (n=15)	Solar/UV (n=11)
Median visits	15.2	23.0	1.0	7.0
Mean visits	25.7	29.5	2.6	13.1
studies with 0 visits, n(%)*	5 (22%)	0 (0%)	0 (0%)	0 (0%)
studies with 1 visit, n(%)*	1 (4%)	0 (0%)	14 (93%)	4 (36%)
studies with >1 visit, n(%)	16 (70%)	18 (100%)	1 (7%)	7 (64%)

note. means/medians include zeroes (i.e. studies with no visits). *these studies are excluded in primary analyses, but included in a sensitivity analysis

Three studies included both a HWWS arm and HWT chlorination arm as independent comparisons[5-7], so we retained these as separate interventions. However, we excluded the combined intervention arms in those studies.

Table E-2: Sample sizes for intervention and control groups in included handwashing and chlorination studies

Study	Country	Milieu	Intervention group (n)	Control group (n)	Risk of bias score (/9)
Handwashing with soap (n=25)					
Begum et al. (2020)	Bangladesh	rural	202	202	1
Briceño et al. (2015)	Tanzania	rural	1442	1442	4
Chase et al. (2012)	Vietnam	rural	2483	1236	3
Galiani et al. (2015)	Peru	rural	763	707	2
Haggerty et al. (1994)	Democratic Republic of Congo	rural	977	977	2
Han et al. (1989)	Myanmar	urban	236	258	5
Hartinger et al. (2016)	Peru	rural	267	267	4
Hashi et al. (2017)	Ethiopia	rural	603	596	4
Humphrey et al. (2019)	Zimbabwe	rural	1,909	1,777	4
Hussam et al. (2021)	India	rural	1,162 (HHs)	1,785 (HHs)	3
Langford et al. (2011)	Nepal	urban	45	43	2
Luby et al. (2004) / (2005)	Pakistan	urban	3163	1528	2
Luby et al. (2006)	Pakistan	urban	262	282	3
Luby et al. (2018) / Ashraf et al. (2020)	Bangladesh	rural	978	1944	4
Ma et al. (2019)	Ghana	rural	999	957	4
Manaseki-Holland et al. (2021)	Gambia	rural	377	377	4
Najnin et al. (2019)	Bangladesh	urban	25,566	13,523	1
Nicholson et al. (2014)	India	urban	1190	1279	1

Null et al. (2018) / Swarthout et al. (2020)	Kenya	rural	690	1511	3
Opryszko et al. (2010)	Afghanistan	rural	247	330	4
Pickering et al. (2015)	Mali	rural	3140	2872	3
Sinharoy et al. (2017)	Rwanda	rural	7011	3782	3
Stanton et al. (1988)	Bangladesh	urban	675	675	4
Chlorination (n=18)					
Austin (1993)	The Gambia	rural	215	215	5
Boisson et al. (2013)	India	mixed	1,378	1,366	7
Chiller et al. (2006)	Guatemala	rural	336	340	5
Crump et al. (2005)	Kenya	rural	404	201	4
Ercumen et al. (2015)	Bangladesh	rural	600	600	5
Humphrey et al. (2019)	Zimbabwe	rural	1,909	1,777	5
Jain et al. (2010)	Ghana	urban	281	268	7
Luby et al. (2006)	Pakistan	urban	527	282	3
Luby et al. (2018)	Bangladesh	rural	986	1,944	6
Lule et al. (2005)	Uganda	rural	122	122	6
Mengistie et al. (2013)	Ethiopia	rural	425	420	5
Null et al. (2018)	Kenya	rural	716	1,511	5
Opryszko et al. (2010)	Afghanistan	rural	279	330	4
Quick et al. (1999)	Bolivia	urban	34	34	5
Reller et al. (2003)	Guatemala	rural	197 (HHs)	96 (HHs)	3
Semenza et al. (1998)	Uzbekistan	urban	88	80	3
Sobsey et al. (2003)	Bangladesh	urban	137 (HHs)	137 (HHs)	3
Solomon et al. (2020)	Ethiopia	rural	203	202	4

*HH = household. Where there were discrepancies between Wolf et al. and Ross et al., we took the values from Ross et al.

Table E-2 provides equivalent information to Table 3 in the manuscript for filter and solar/UV studies. Per Table 2 in the manuscript 93% and 36% of filter and solar/UV studies respectively had only one visit, so were not eligible for primary analyses. Such visits were typically to install and explain the technology, with subsequent visits for monitoring/compliance purposes only. There were no household visits at all in 22% of handwashing studies (Table 2 in manuscript). In these cases, interventions typically relied on group activities e.g. regular meetings where representatives from participating households gathered[8,9].

Table E-3: Visits and effectiveness variables for filter and solar/UV studies

Study	Frequency of HH visits		Total HH visits		Durations (months)		Effectiveness on diarrhoea (RR, 95% CI)
	Every X weeks	Cat.	Total visits	Cat.	promo-tion	outcome follow-up	
Household water filter (n=15)							
Brown et al. [10]	n/a	n/a	1	n/a	5	5	0.61 (0.45 - 0.83)

Clasen et al. [11]	n/a	n/a	1	n/a	6	6	0.33 (0.13 - 0.70)
Clasen et al. [2]	n/a	n/a	1	n/a	6	6	0.40 (0.21 - 0.76)
du Preez et al. [12]	n/a	n/a	1	n/a	6	6	0.21 (0.12 - 0.36)
Fabiszewski et al. [13]	n/a	n/a	1	n/a	6	6	0.58 (0.30 - 1.09)
Fagerli et al. [14]	n/a	n/a	1	n/a	12	12	1.08 (0.84 - 1.32)
Hill et al. [15]	4.3	low	24	high	24	24	1.17 (0.70 - 1.96)
Kirby et al. [16]	n/a	n/a	1	n/a	20	20	0.71 (0.59 - 0.87)
Peláez et al. [4]	unknown	n/a	unknown	n/a	11	11	0.38 (0.04 - 3.61)
Lindquist et al. [17]	n/a	n/a	1	n/a	4	4	0.21 (0.15 - 0.30)
Morris et al. [18]	n/a	n/a	1	n/a	6	7	0.87 (0.66 - 1.14)
Stauber et al. [19]	n/a	n/a	1	n/a	6	6	0.47 (0.36 - 0.61)
Stauber et al. [20] (Cambodia)	n/a	n/a	1	n/a	5	5	0.45 (0.26 - 0.77)
Stauber et al. [21](Ghana)	n/a	n/a	1	n/a	4	4	0.26 (0.07 - 0.89)
Tiwari et al. [22]	n/a	n/a	1	n/a	6	6	0.49 (0.24 - 1.02)
Household solar / ultraviolet (n=11)							
Bitew et al. [23]	4.3	low	6	low	6	6	0.60 (0.52 - 0.70)
Conroy et al. [24]	n/a	n/a	1	n/a	3	3	0.75 (0.60 - 0.91)
Conroy et al. [25]	n/a	n/a	1	n/a	12	12	0.76 (0.71 - 0.81)
du Preez et al. [26]	2.0	low	26	high	12	12	0.64 (0.39 - 1.05)
du Preez et al. [27]	2.0	low	37	high	17	17	0.63 (0.48 - 0.81)
Gruber et al. [28]	n/a	low	7	low	15	15	0.80 (0.51 - 1.27)
Hartinger et al. [29]	4.3	low	12	low	12	12	0.78 (0.58 - 1.04)
Maeusezahl et al. [30]	2.0	low	26	high	12	12	0.91 (0.64 - 1.30)
McGuigan et al. [31]	2.0	low	26	high	12	12	0.43 (0.28 - 0.66)
Rai et al. [32]	n/a	n/a	1	n/a	2	5	0.24 (0.10 - 0.60)
Rose et al. [33]	n/a	n/a	1	n/a	6	6	0.64 (0.48 - 0.86)

n/a for visit columns denotes household visits not being part of the intervention. [%]denotes a study without intensity information. Similar to some other filter studies, there were fortnightly visits for outcome data collection and to check whether the filter was being used correctly. We therefore assumed that, similar to the other filter studies, specific promotion of use of the filter was undertaken only in the installation visit.

Figure E-1: Scatter plot of visit frequency against total visits for HWWS and HWT chlorination

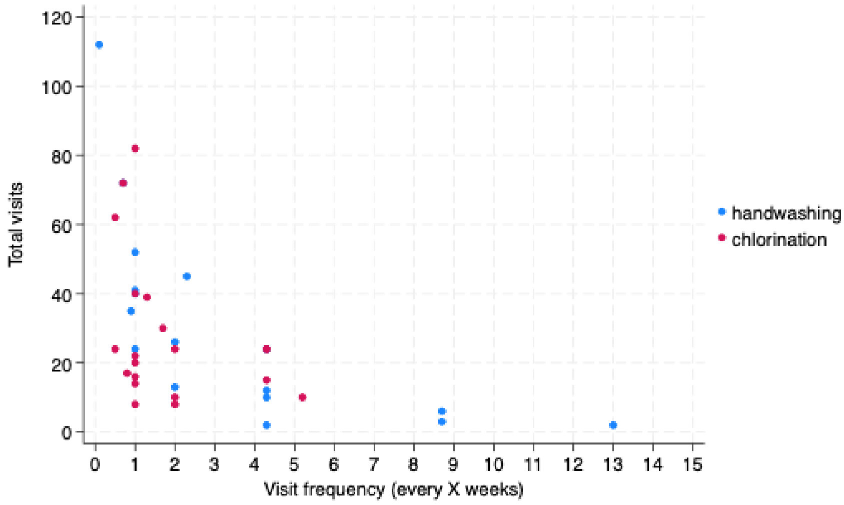
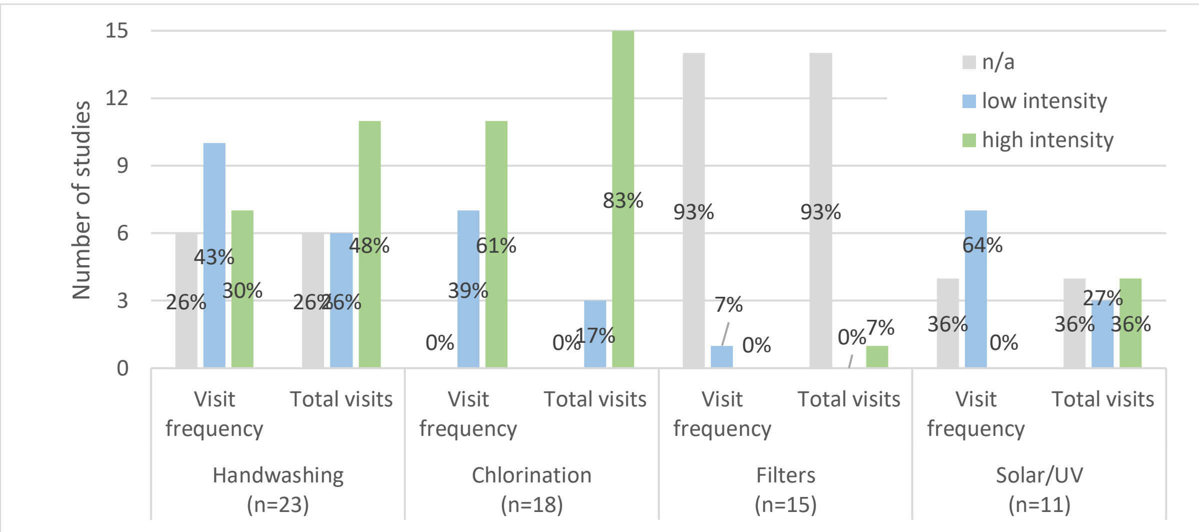


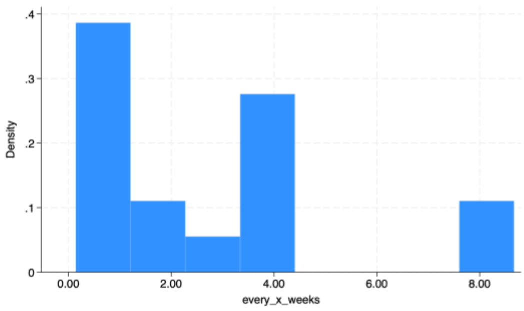
Figure E-2: numbers of studies in intensity categories by intervention type



Category definitions for high/low are as per Table 1 primary analysis.

Figure E-3: Histograms of key variables for HWWS interventions (amongst those included in primary analyses)

(a) Visit frequency (every X weeks)



(b) Total visits

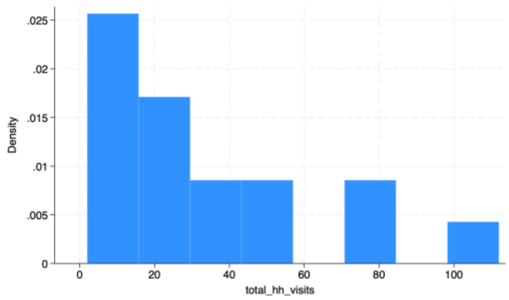
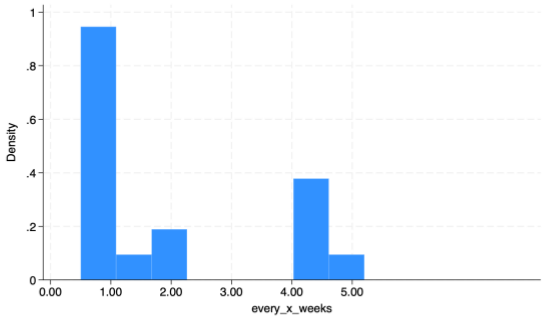
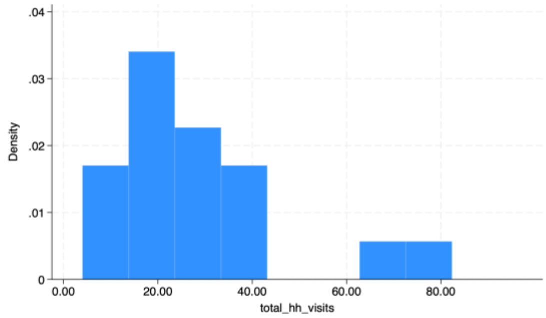


Figure E-4: Histograms of key variables for HWT chlorination interventions (amongst those included in primary analyses)

(a) Visit frequency (every X weeks)

(b) Total visits


Density
1
.8
.6
.4
.2
0
0.00
1.00
2.00
3.00
4.00
5.00
every_x_weeks


Density
.04
.03
.02
.01
0
0.00
20.00
40.00
60.00
80.00
total_hh_visits

F. Tabulated primary results and sensitivity analyses

Table F-1: coefficients on intensity in meta-regression alongside change in heterogeneity (I^2)

		Meta-regression		Sub-group meta-analysis		
		Coeff. on intensity variable (95% CI)	p-value	I^2 SGA	I^2 pooled	I^2 decrease with SGA
Frequency	HWWS-ARI (n=9)	0.30 (0.10 - 0.49)	0.003	67.4%	78.2%	10.8%
	HWWS-diarrhoea (n=15)	0.23 (-0.09 - 0.55)	0.100	80.2%	79.5%	-0.7%
	Chlorine-diarrhoea (n=20)	0.19 (-0.12 - 0.49)	0.229	89.6%	89.6%	0.0%
Total visits	HWWS-ARI (n=9)	0.18 (-0.06 - 0.43)	0.146	77.2%	78.2%	1.0%
	HWWS-diarrhoea (n=15)	0.03 (-0.25 - 0.30)	0.843	78.8%	79.5%	0.7%
	Chlorine-diarrhoea (n=20)	-0.13 (-0.53 - 0.26)	0.515	89.2%	89.6%	0.4%

SGA = sub-group analysis. Coeff. = coefficient. All meta-regression coefficients (β) are hypothesised to be positive (except sensitivity analyses in which frequency was modelled as a continuous variable).

Table F-2: p-values for intensity coefficients in meta-regression under different sensitivity analysis scenarios

			Primary analysis	Sensitivity - three-level		Sensitivity - two-level				Continu-ous variable	Pooling HWWS and chlorine for diarrhoea
				med.*	low*	Higher quality	Interventions w/ ≤1 visits as "low"	Alt. cut-off	Incl. monitoring		
Frequency	HWWS-ARI	p-value	0.003	0.003	n/a	0.021	0.011	0.003	0.035	0.003	
		coeff	0.30	0.30	n/a	0.33	0.25	0.26	0.22	n/a	
		change in I2	11%	11%		29%	9%	15%	4%	15%	
	HWWS-diarrhoea	p-value	0.100	0.139	0.309	0.071	0.103	0.014	0.011	0.052	0.079
		coeff	0.23	0.22	0.25	0.28	0.19	0.30	0.32	n/a	0.18
		change in I2	-1%	-2%		4%	-1%	7%	8%	3%	0%
	Chlorine-diarrhoea	p-value	0.229	0.114	n/a	0.229	0.229	0.557	0.166	0.443	see above pooled
		coeff	0.19	0.25	n/a	0.19	0.19	0.10	0.25	n/a	
		change in I2	0%	1%		0%	0%	0%	0%	0%	
Total visits	HWWS-ARI	p-value	0.146	0.100	0.090	0.236	0.495	0.022	0.253	0.004	
		coeff	0.18	0.29	0.23	0.12	0.07	0.23	0.18	n/a	
		change in I2	1%	3%		1%	-1%	7%	1%	13%	
	HWWS-diarrhoea	p-value	0.843	<0.001	0.081	0.866	0.797	0.003	0.447	0.100	0.919
		coeff	0.03	0.40	0.17	-0.03	0.03	0.32	0.13	n/a	-0.01
		change in I2	1%	40%		4%	0%	13%	-1%	2%	1%
	Chlorine-diarrhoea	p-value	0.515	0.108	0.269	0.515	0.515	0.878	0.762	0.246	see above pooled
		coeff	-0.13	0.27	-0.19	-0.13	-0.13	-0.03	-0.08	n/a	
		change in I2	0%	9%		0%	0%	-1%	0%	1%	

For p-values, dark green denotes $p<0.05$ in hypothesised direction, light green denotes $p<0.10$ in hypothesised direction, grey denotes $p>0.10$, dark orange denotes $p<0.05$ in opposite direction, light orange denotes $p<0.10$ in opposite direction. For change in I^2, dark green denotes change in $I^2 \geq 2\%$ (when $p<0.10$), light green denotes change in $I^2 \geq 1\%$ (when $p<0.10$). *reference category is "high". n/a = not applicable as only 1 study in the respective category.

Table F-3: Leave-one-out meta-regression results for handwashing

	Frequency				Total visits			
	HWWS-ARI		HWWS-DD		HWWS-ARI		HWWS-DD	
	p	coeff	p	coeff	p	coeff	p	coeff
Primary analysis	**0.003**	**0.30**	**0.100**	**0.23**	**0.146**	**0.18**	**0.843**	**0.03**
Briceño 2015	.	.	0.150	0.21	.	.	0.883	-0.02
Chase 2012	0.012	0.30	0.115	0.24	0.403	0.16	0.933	0.01
Haggerty 1994	.	.	**0.013**	**0.30**	.	.	0.669	0.07
Han 1989	.	.	0.116	0.23	.	.	0.893	0.02
Hartinger 2016	0.006	0.31	0.100	0.24	0.236	0.21	0.852	0.03
Hashi 2017	.	.	**0.028**	**0.29**	.	.	0.550	0.09
Humphrey 2019	0.004	0.29	0.205	0.18	0.120	0.19	0.599	0.07
Hussam 2021	0.002	0.33	.	.	0.176	0.19	.	.
Langford 2011	.	.	0.136	0.21	.	.	0.948	0.01
Luby 2004/ 2005	0.027	0.15	0.182	0.18	0.149	0.11	0.756	-0.04
Luby 2006	.	.	0.139	0.22	.	.	0.962	0.01
Luby 2018 / Ashraf 2020	0.011	0.29	0.150	0.21	0.207	0.16	0.995	0.00
Ma 2019	.	.	0.094	0.24	.	.	0.816	0.03
Najnin 2019	0.005	0.30	.	.	0.112	0.21	.	.
Nicholson 2014	0.000	0.49	0.098	0.25	0.198	0.20	0.839	0.03
Null 2018 / Swarthout 2020	0.012	0.32	0.176	0.20	0.094	0.22	0.634	0.07
Opryszko 2010	.	.	0.100	0.23	.	.	0.845	0.03

Note. Named studies in rows are the study left out

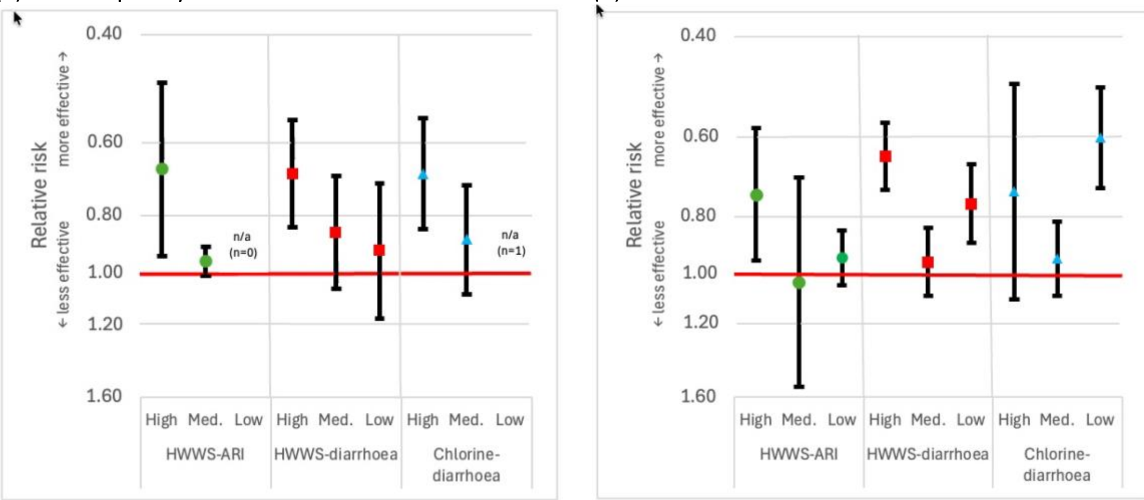
Table F-4: Leave-one-out meta-regression results for HWT chlorination

	Frequency		Total visits	
	p	coeff	p	coeff
Primary analysis	**0.229**	**0.19**	**0.515**	**-0.13**
Austin 1993	0.256	0.18	0.411	-0.17
Boisson 2013	0.370	0.15	0.604	-0.11
Chiller 2006	0.276	0.17	0.474	-0.15
Crump 2005	0.217	0.20	0.550	-0.12
Ercumen 2015	0.141	0.24	0.748	-0.09
Humphrey 2019	0.429	0.13	0.611	-0.10
Jain 2010	0.119	0.24	0.615	-0.10
Luby 2006	0.327	0.15	0.415	-0.16
Luby 2018	0.183	0.21	0.570	-0.12
Lule 2005	0.200	0.20	0.543	-0.12
Mengistie 2013	0.386	0.11	0.134	-0.22
Null 2018	0.390	0.14	0.606	-0.10
Opryszko 2010	0.179	0.22	0.496	-0.14
Quick 1999	0.225	0.19	0.523	-0.13
Reller 2003	0.201	0.20	0.552	-0.12
Semenza 1998	0.361	0.14	0.392	-0.17
Sobsey 2003	0.239	0.20	0.642	-0.11
Solomon 2020	0.136	0.24	0.752	-0.09

Note. Named studies in rows are the study left out

Figure F-1: Sub-group analysis of the effectiveness of handwashing and household water chlorination interventions on ARI and diarrhoeal disease using three-category variables for (a) visit frequency and (b) total visits

(a) visit frequency (b) total visits



G. Forest plots for sub-group meta-analysis: primary analyses

Primary analysis for frequency

Figure G-1: HWWS-ARI by frequency category

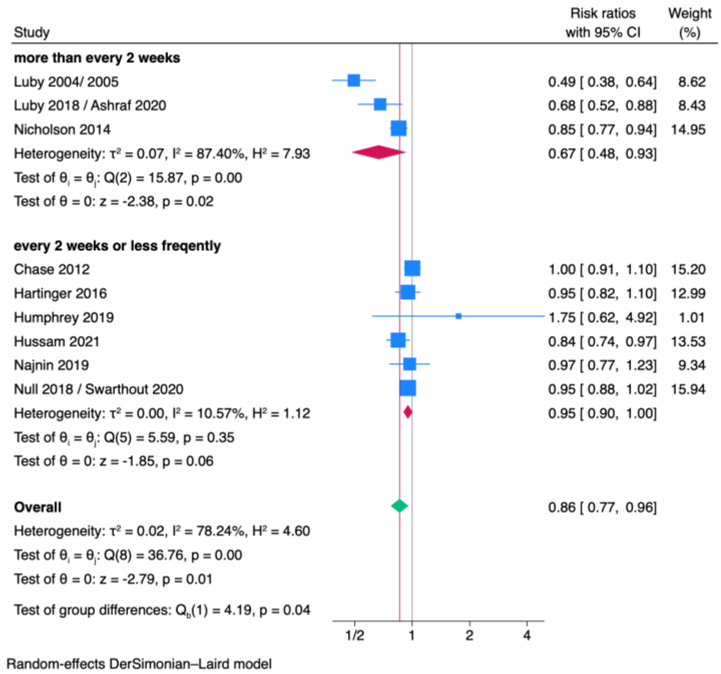


Figure G-2: HWWS-diarrhoea by frequency category

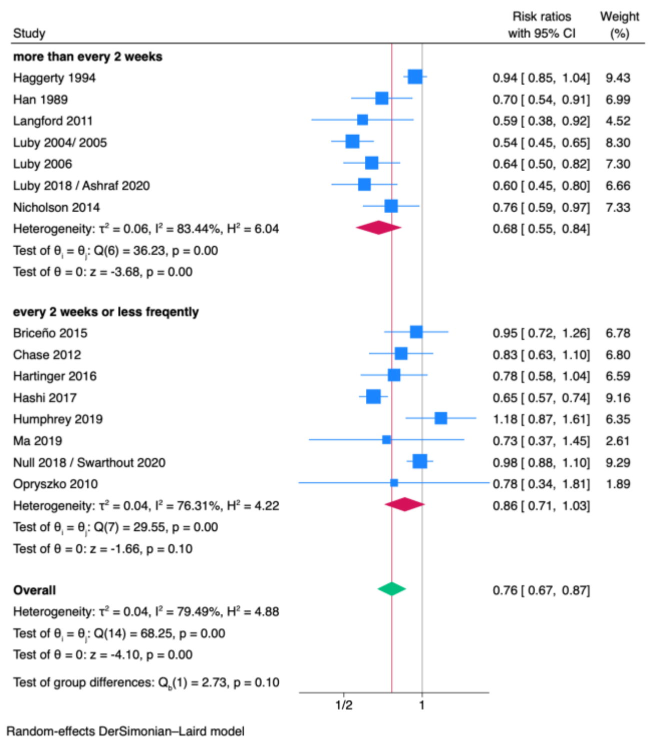
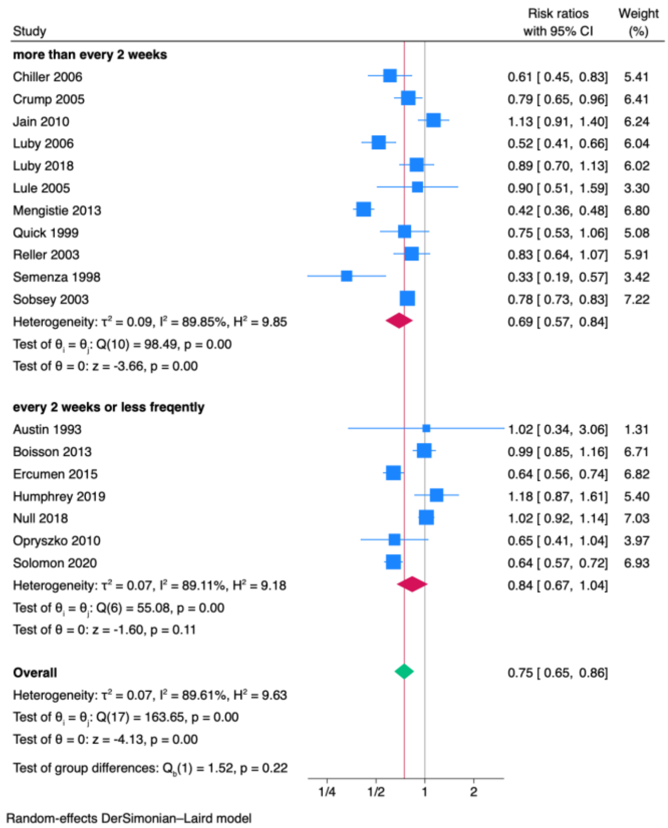


Figure G-3: Chlorination-diarrhoea by frequency category



Primary analysis for total visits

Figure G-4: HWWS-ARI by total visits category

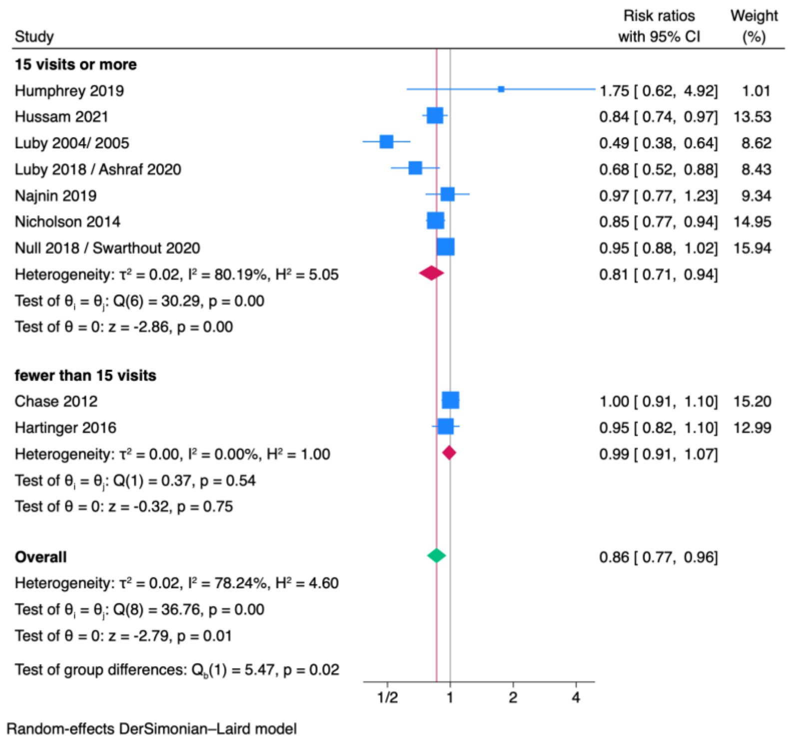


Figure G-5: HWWS-diarrhoea by total visits category

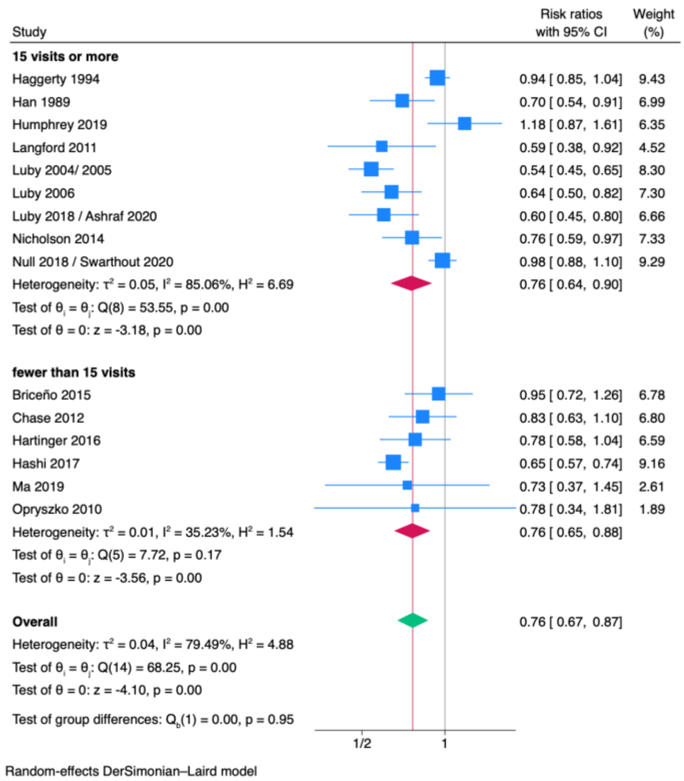
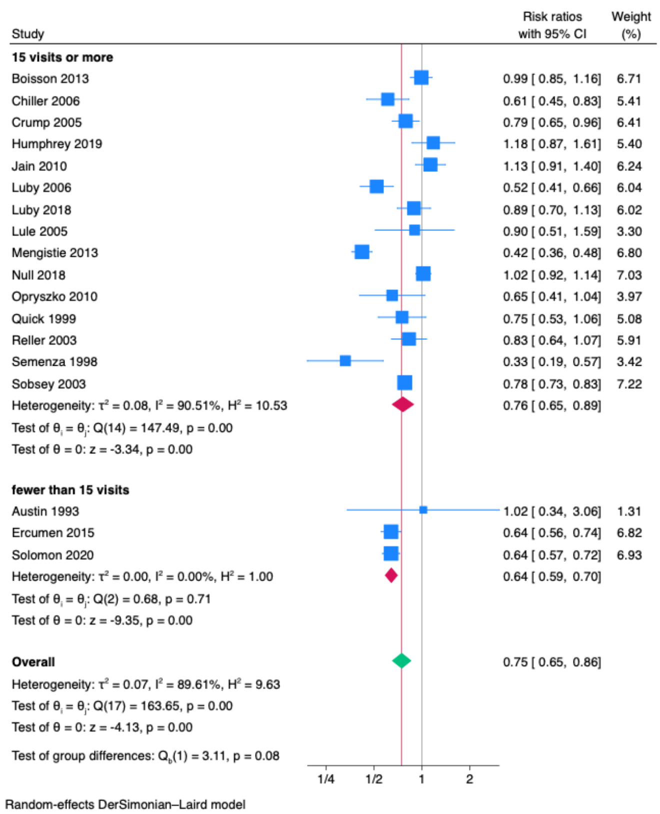


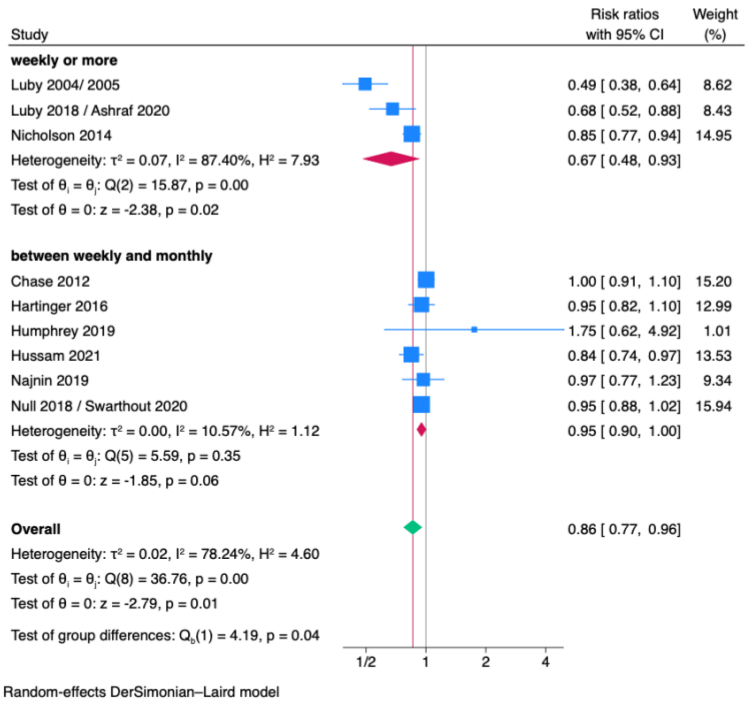
Figure G-6: Chlorination-diarrhoea by total visits category



H. Forest plots for sub-group meta-analysis: sensitivity analyses

Sensitivity analyses for HWWS-ARI by frequency category

Figure H-1: HWWS-ARI frequency with three-level variable



Note. No studies were in the category 3, and no studies switched between categories 1 and 2, so results are identical to primary analysis.

Figure H-2: HWWS-ARI frequency with alternative cut-off

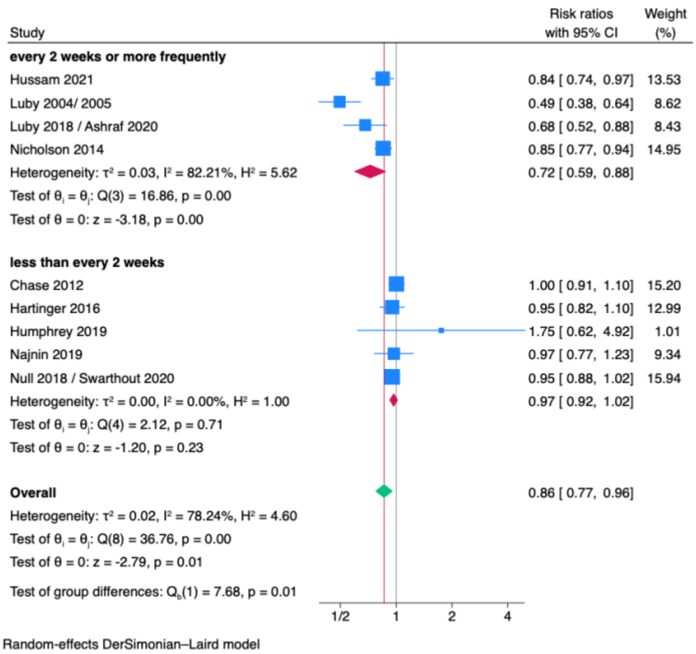


Figure H-3: HWWS-ARI frequency with only higher-quality studies

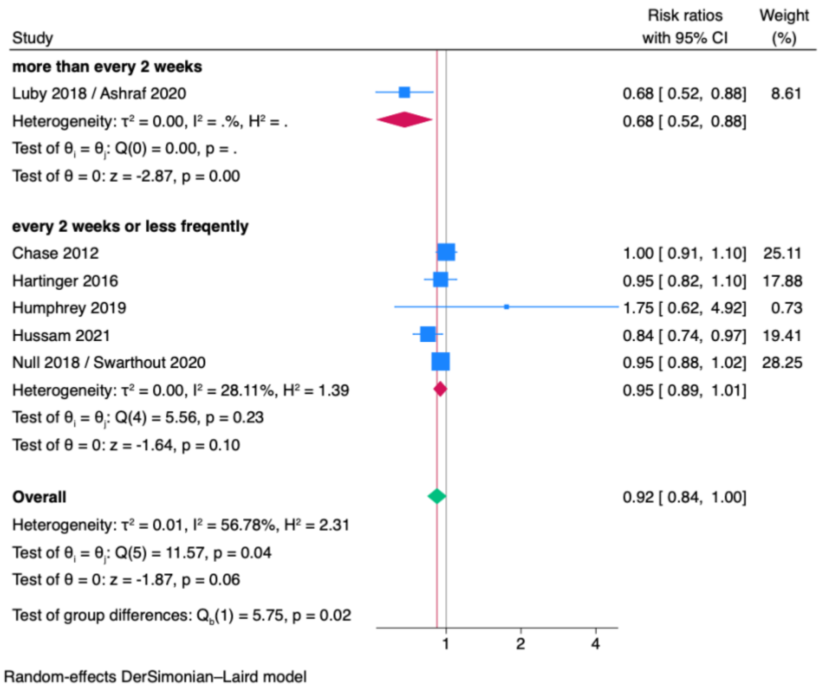


Figure H-4: HWWS-ARI frequency including interventions with ≤1 visits in the "low" category

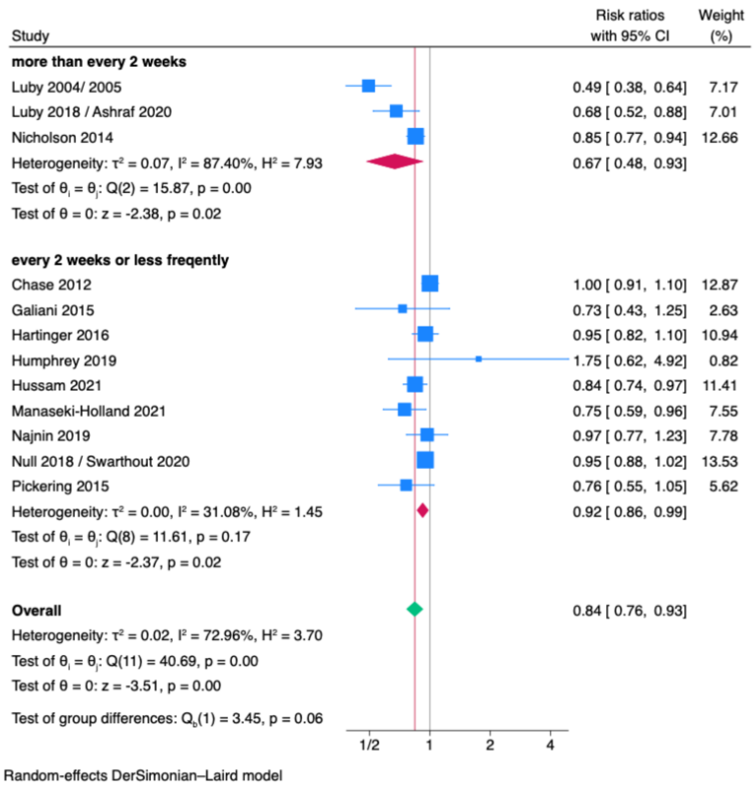
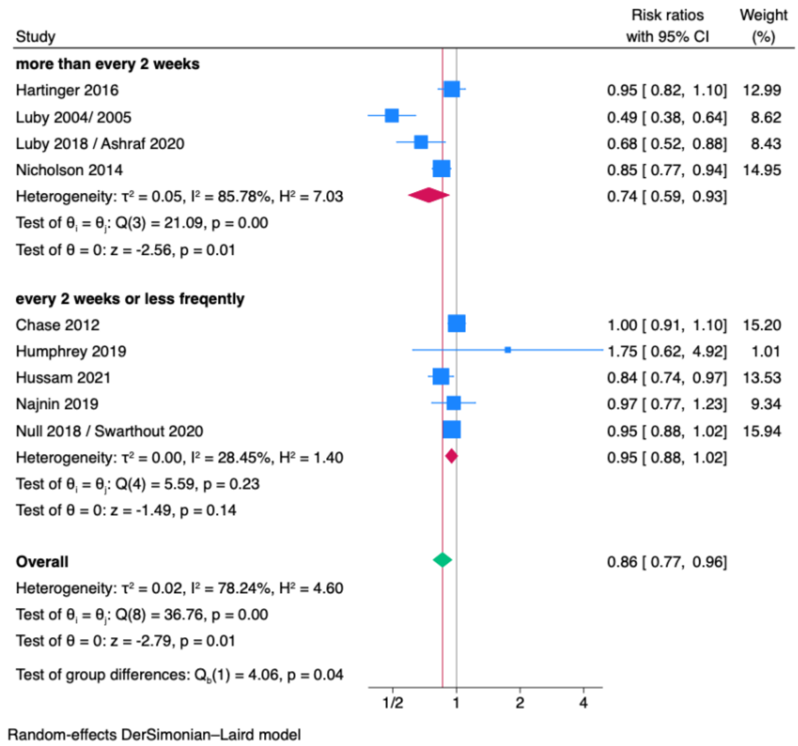


Figure H-5: HWWS-ARI frequency including monitoring visits



Sensitivity analyses for HWWS-ARI by total visits category

Figure H-6: HWWS-ARI total visits with three-level variable

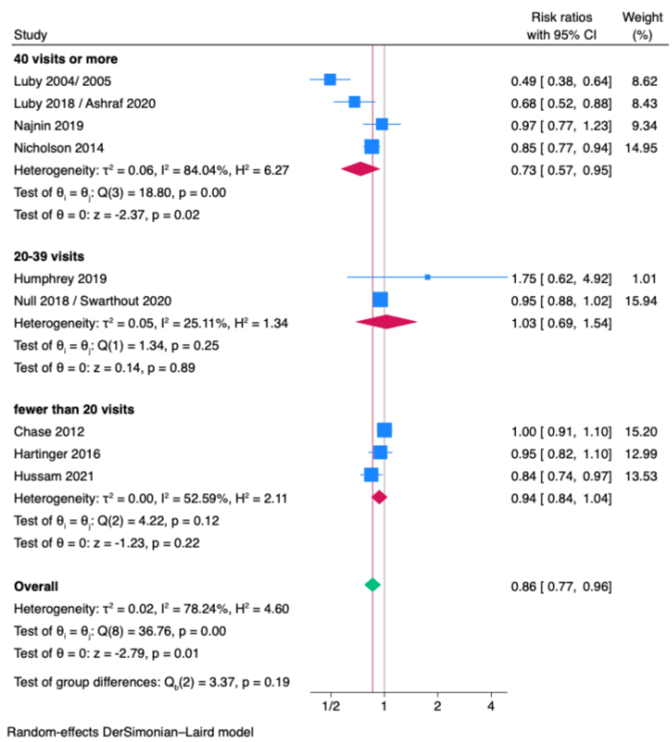


Figure H-7: HWWS-ARI total visits with alternative cut-off

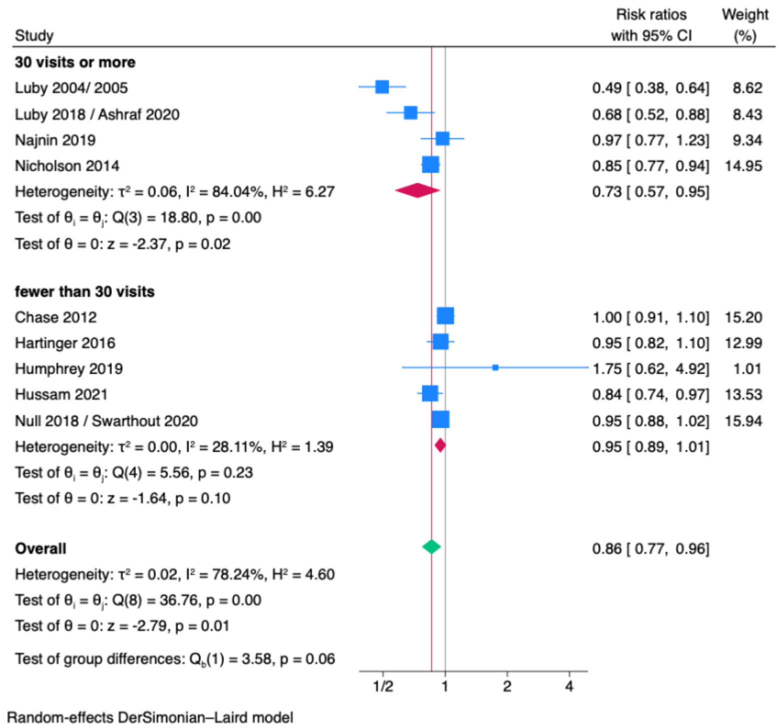


Figure H-8: HWWS-ARI total visits with only higher-quality studies

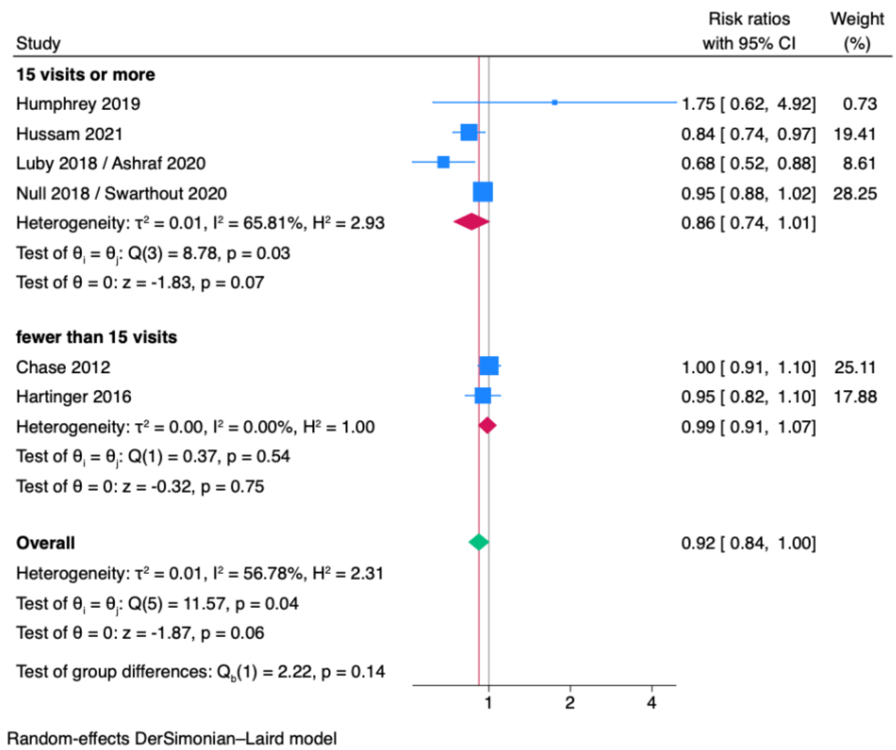


Figure H-9: HWWS-ARI total visits including interventions with ≤1 visits in the "low" category

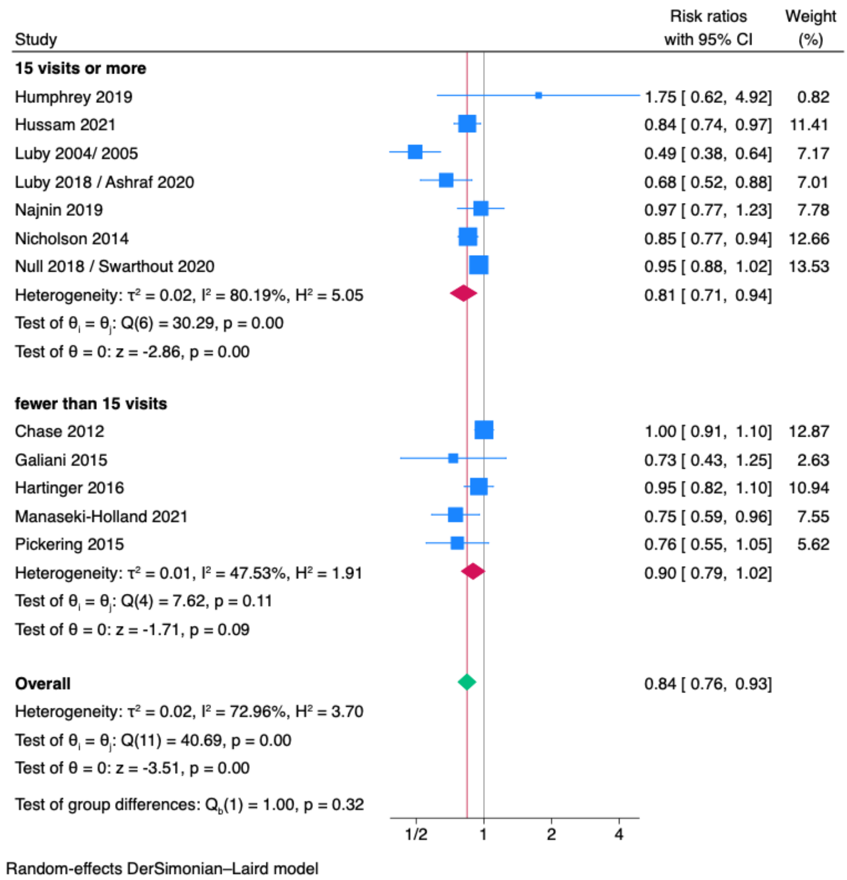
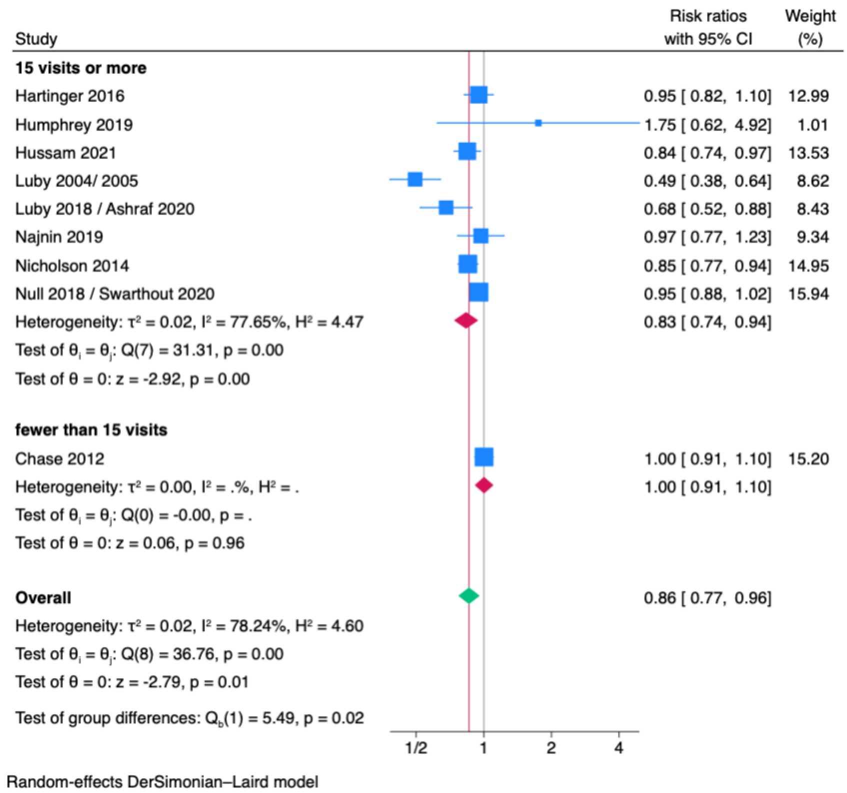


Figure H-10: HWWS-ARI total visits including monitoring visits



Sensitivity analyses for HWWS-diarrhoea by frequency category

Figure H-11: HWWS- diarrhoea frequency with three-level variable

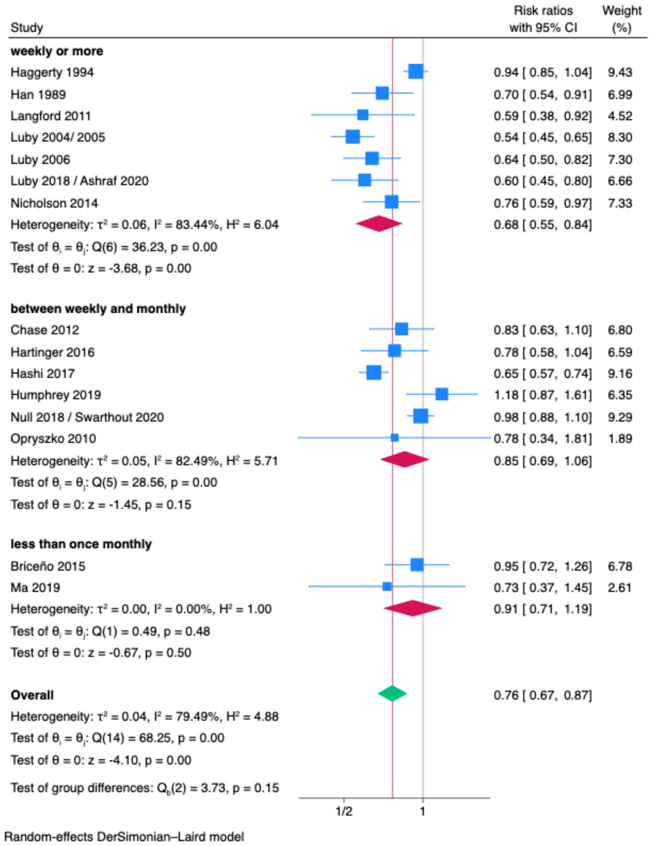


Figure H-12: HWWS- diarrhoea frequency with alternative cut-off

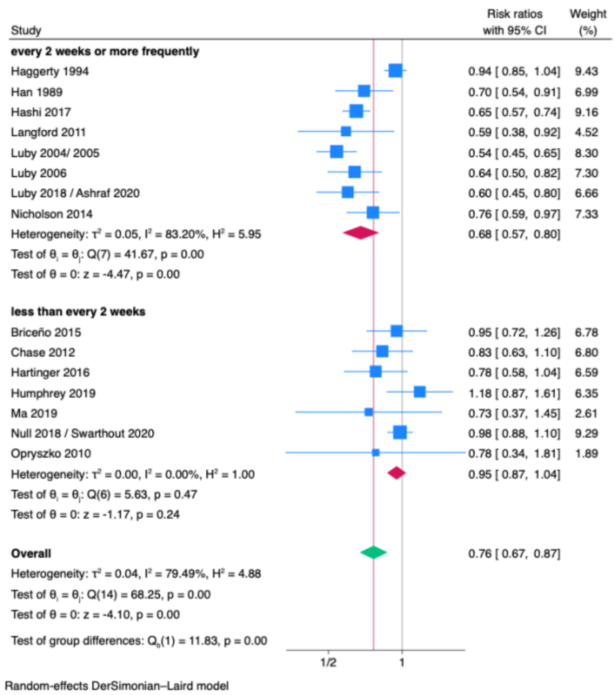


Figure H-13: HWWS- diarrhoea frequency with only higher-quality studies

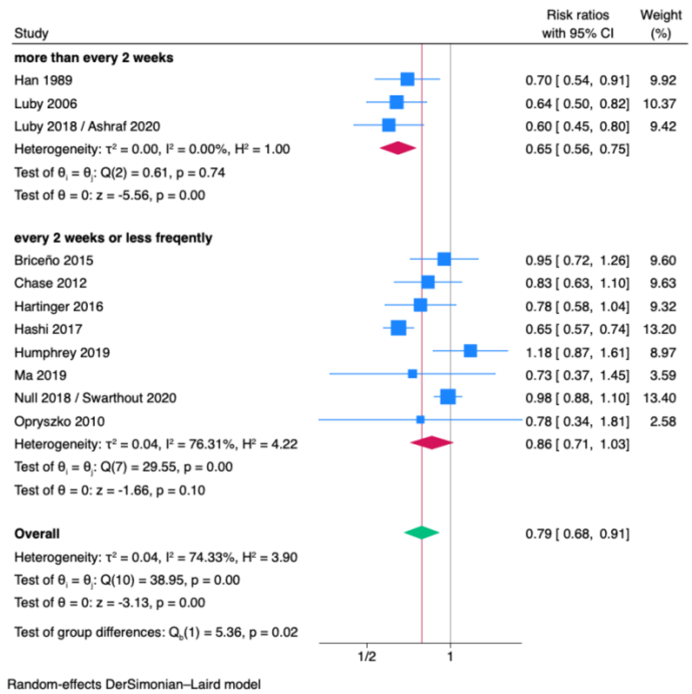


Figure H-14: HWWS- diarrhoea frequency including interventions with ≤1 visits in the "low" category

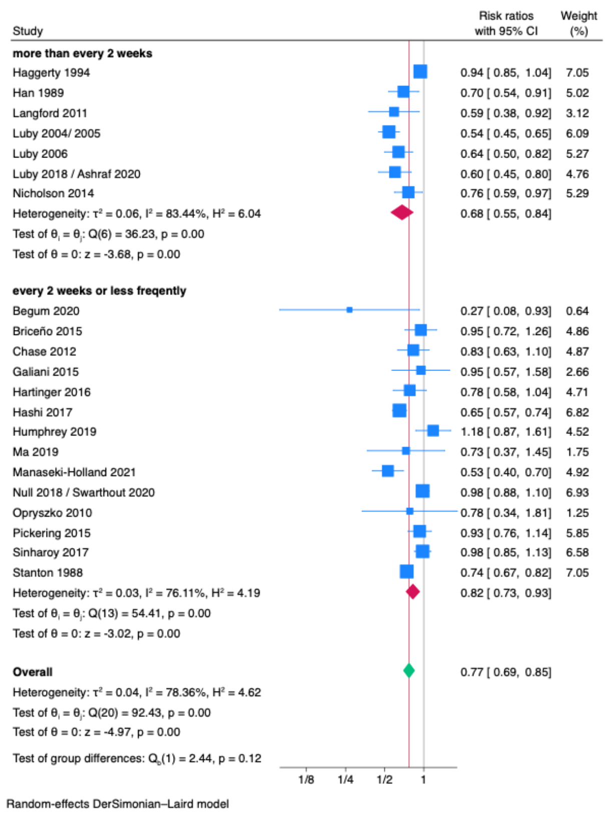
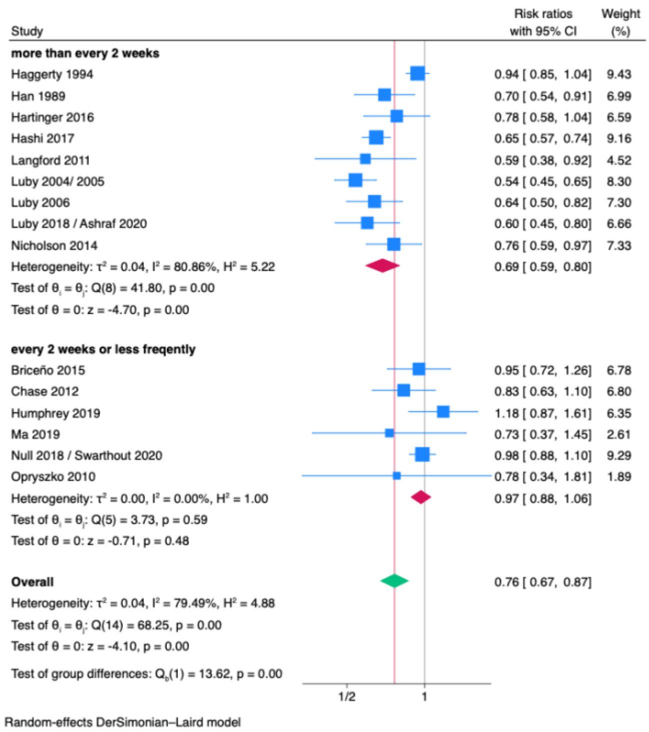


Figure H-15: HWWS- diarrhoea frequency including monitoring visits



Sensitivity analyses for HWWS- diarrhoea by total visits category

Figure H-16: HWWS- diarrhoea total visits with three-level variable

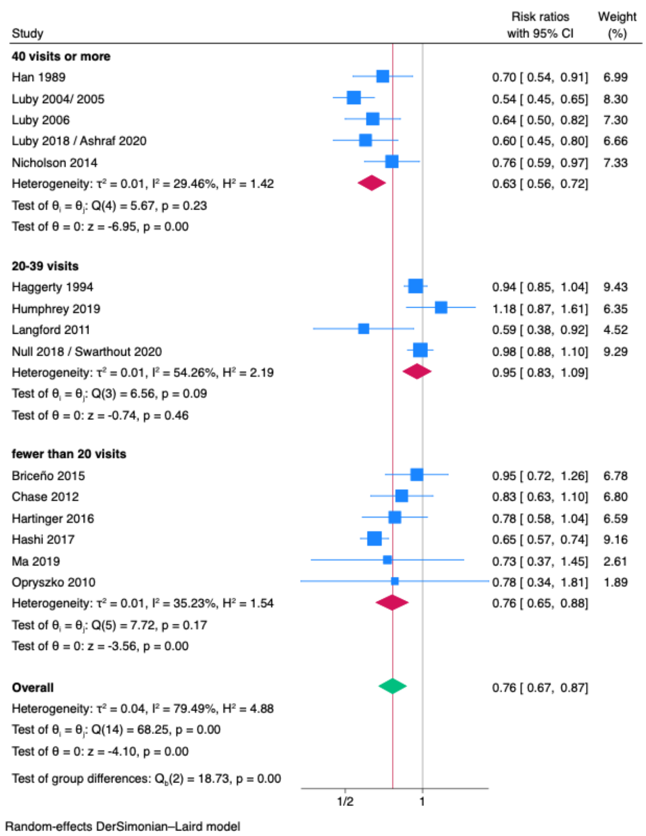


Figure H-17: HWWS- diarrhoea total visits with alternative cut-off

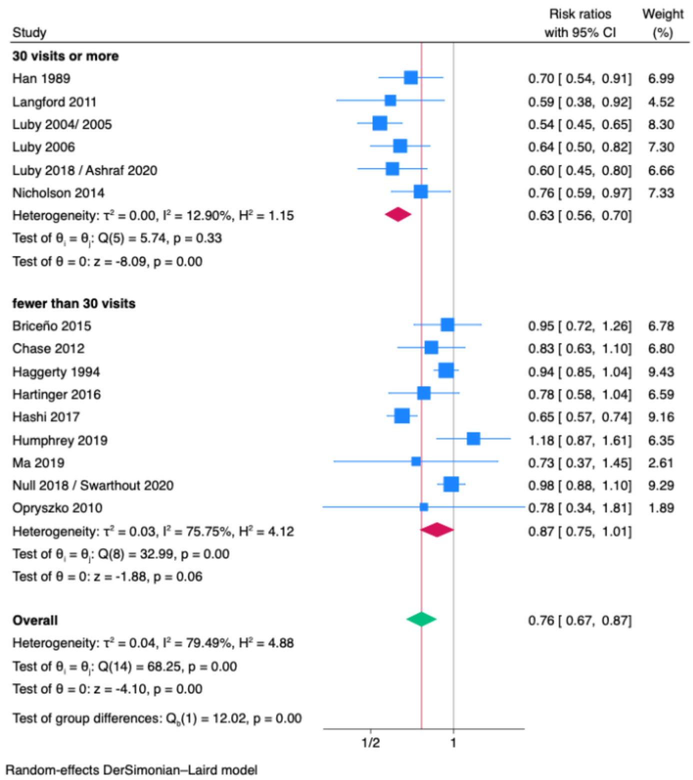


Figure H-18: HWWS- diarrhoea total visits with only higher-quality studies

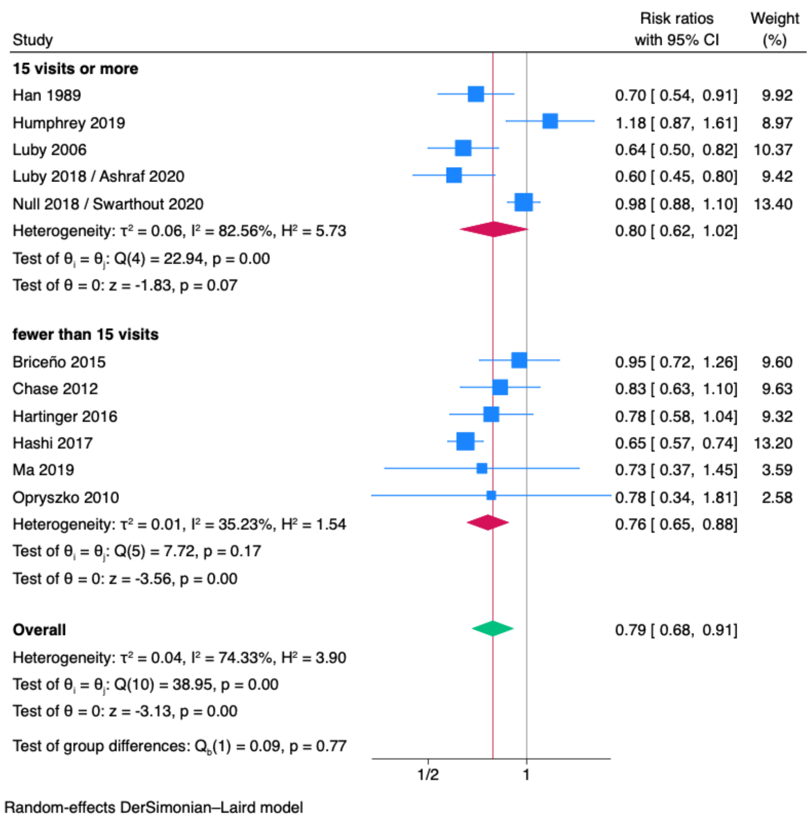


Figure H-19: HWWS- diarrhoea total visits including interventions with ≤1 visits in the "low" category

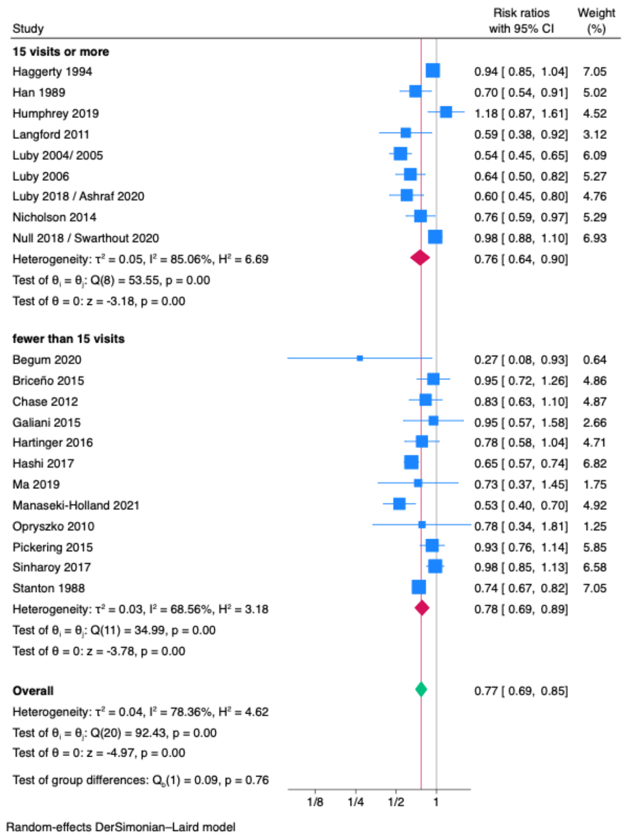
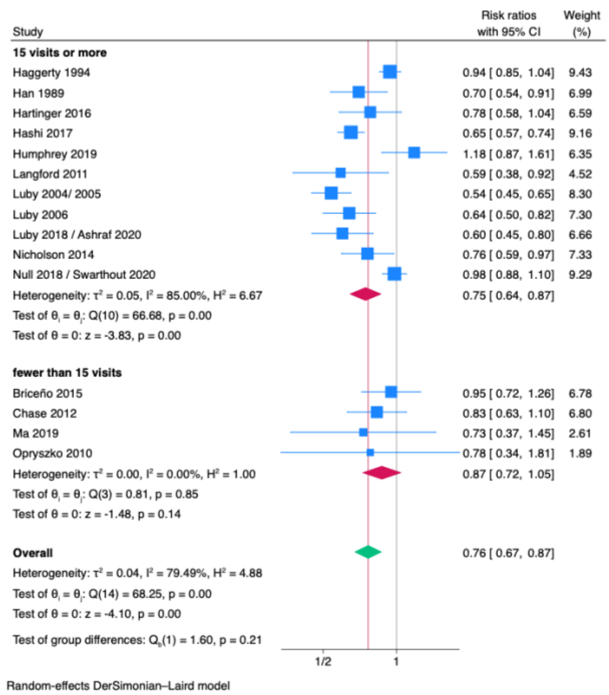


Figure H-20: HWWS- diarrhoea total visits including monitoring visits



Sensitivity analyses for HWT chlorination-diarrhoea by frequency category

Figure H-21: chlorination-diarrhoea frequency with three-level variable

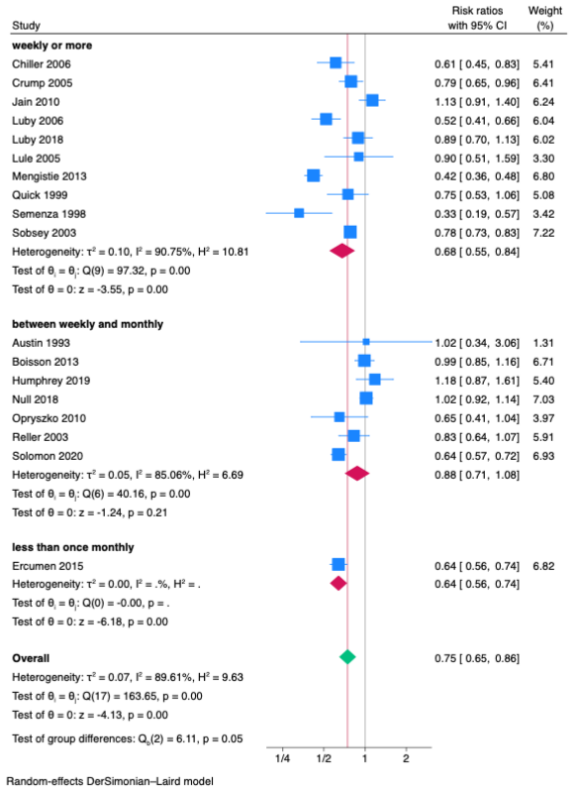


Figure H-22: chlorination-diarrhoea frequency with alternative cut-off

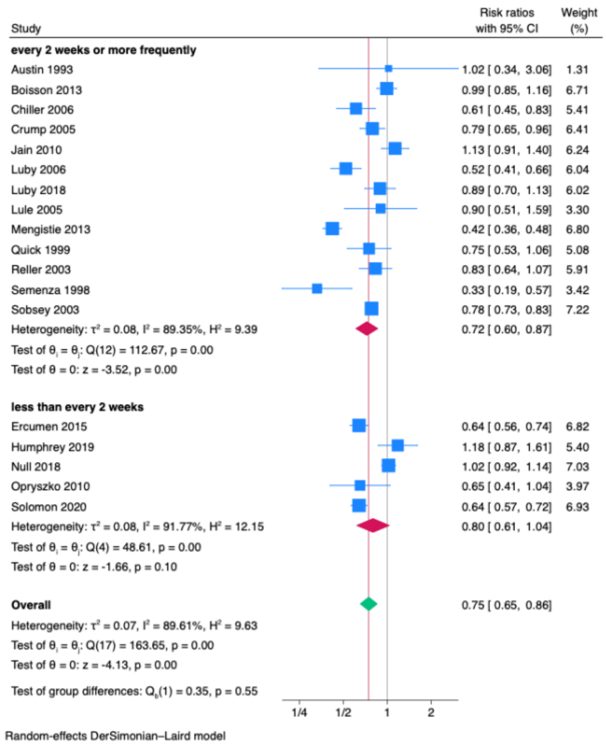


Figure H-23: chlorination-diarrhoea frequency with only higher-quality studies

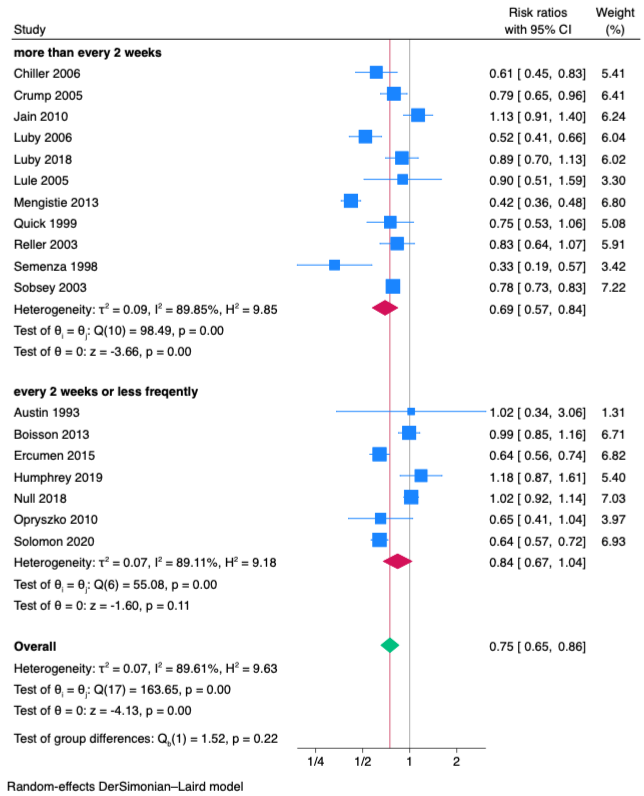


Figure H-24: chlorination-diarrhoea frequency including interventions with ≤1 visits in the "low" category

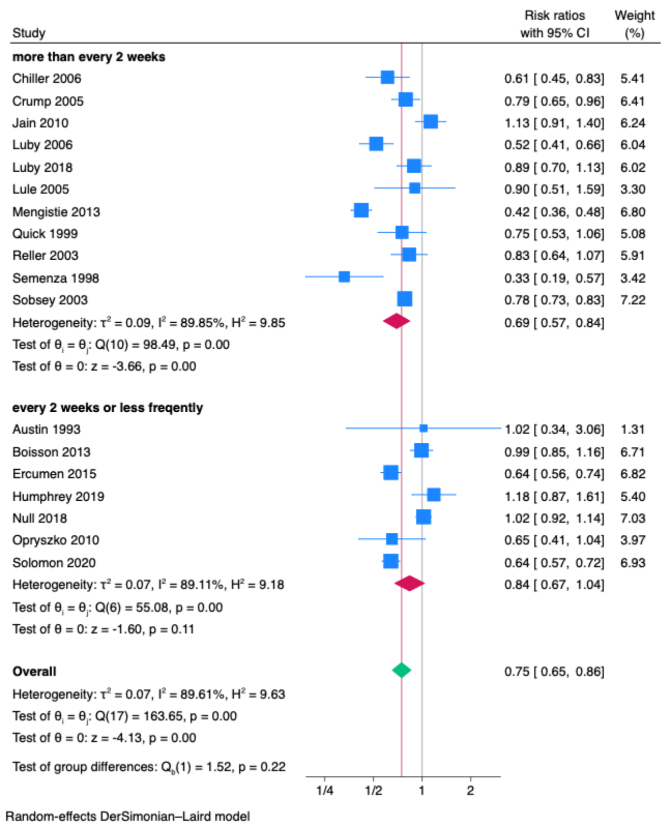
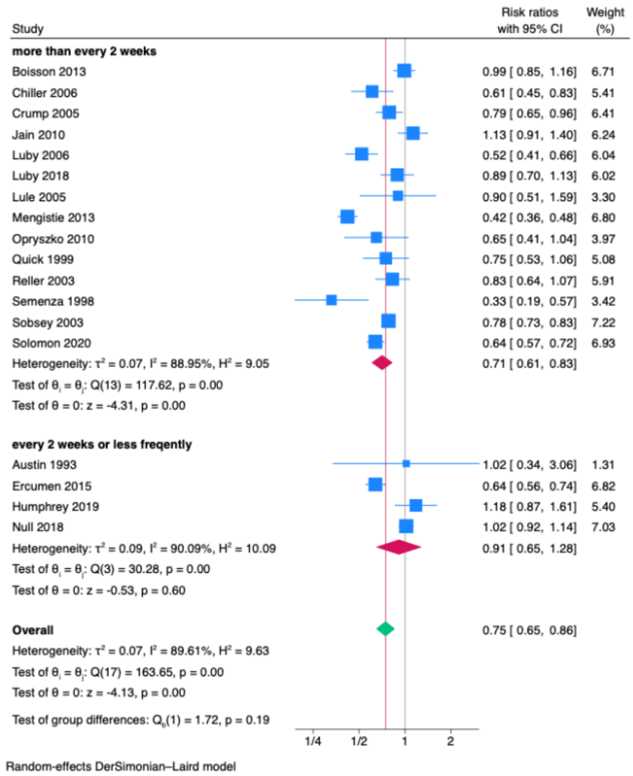


Figure H-25: chlorination-diarrhoea frequency including monitoring visits



Sensitivity analyses for HWT chlorination-diarrhoea by total visits category

Figure H-26: chlorination-diarrhoea total visits with three-level variable

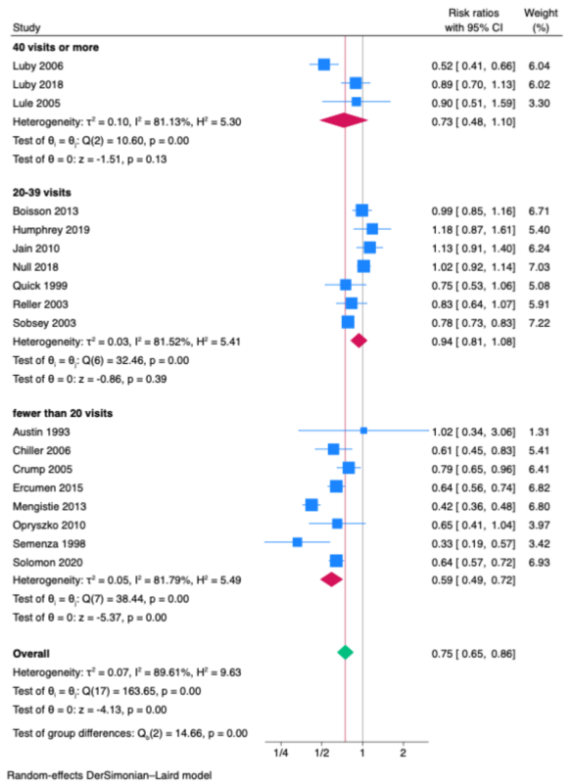


Figure H-27: chlorination-diarrhoea total visits with alternative cut-off

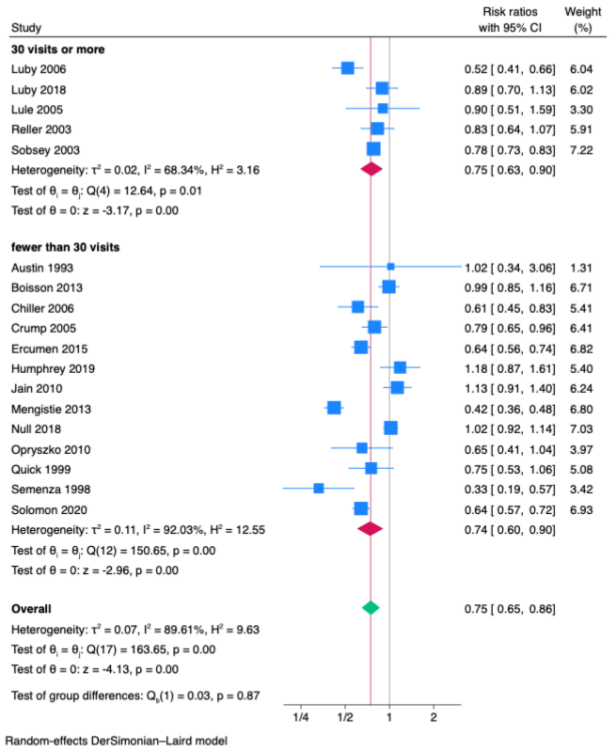


Figure H-28: chlorination-diarrhoea total visits with only higher-quality studies

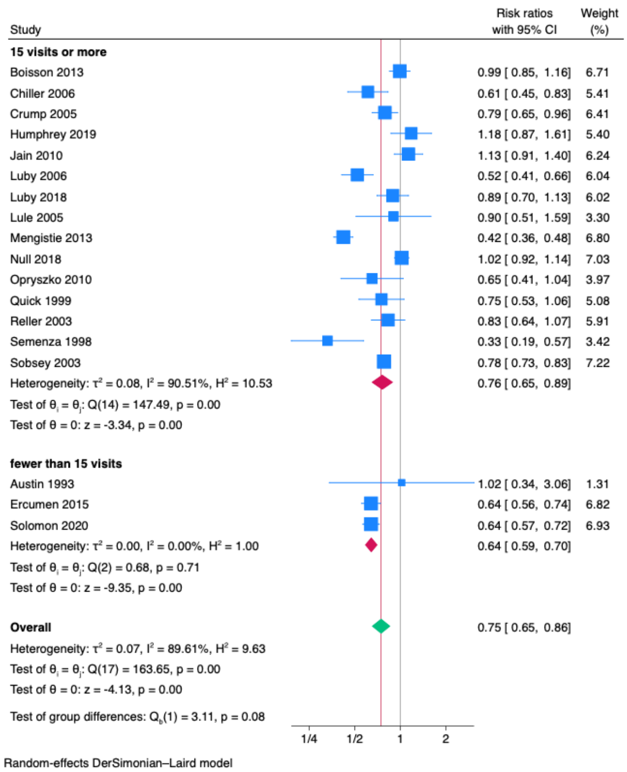


Figure H-29: chlorination-diarrhoea total visits including interventions with ≤1 visits in the “low” category

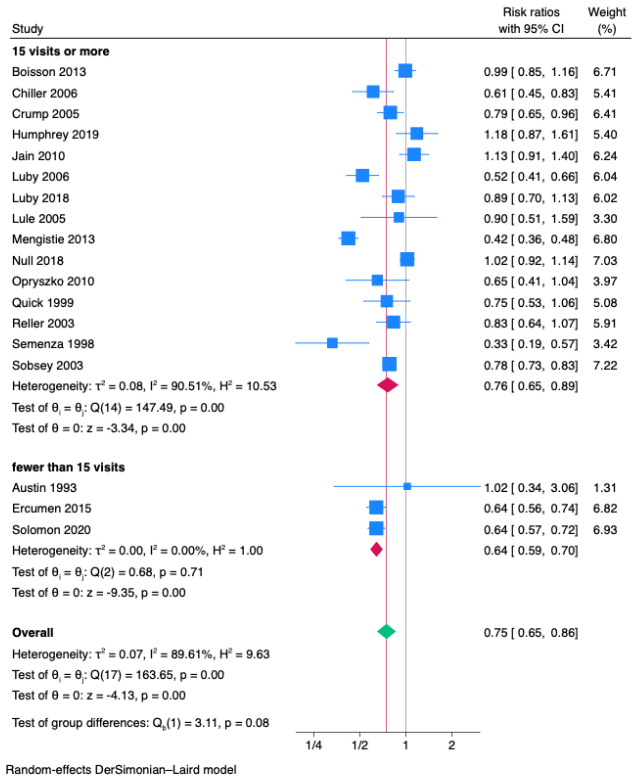
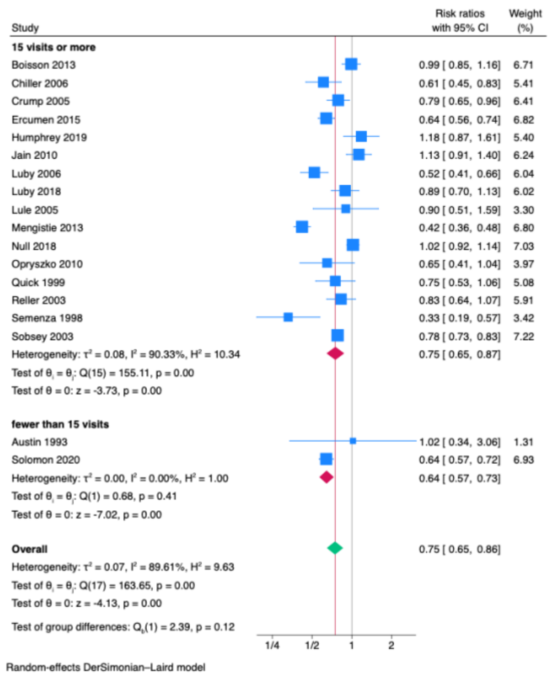


Figure H-30: chlorination-diarrhoea total visits including monitoring visits



I. Narrative description of results for total visits

For HWWS and ARI in respect of the total visits variable, results provided insufficient evidence of larger numbers of visits being associated with a larger effect of HWWS interventions on ARI (*β=0.18,* p=0.146, n=7 vs n=2). There was a 0.18 difference in RR point estimates, and I^2 was 1pp lower. About half of meta-regression sensitivity analyses supported this finding. There was stronger evidence for an association (p=0.022) when using the alternative cut-off and when assessing frequency as a continuous variable (p=0.004). Insight about total visits can also considered at the study level. Amongst HWWS interventions involving at least 1 household visit, studies finding a statistically significant effect on ARI at p<0.05 had a median of 47 household visits (n=4) compared to 24 visits amongst those finding no effect on ARI (n=5).

For HWWS and diarrhoea, there was no evidence of association with total visits (*β=-0.02,* p=0.843, n=9 vs n=6), with no difference in I^2 or RR point estimates. Most sensitivity analyses supported this finding, but there was good evidence (p=0.003) that under the alternative cut-off, having more visits was more effective (Table F-1). Using the three-level variable, there was also good evidence (p<0.001) that studies with 40 visits or more were more effective than those with 20-39 visits, and p=0.081 compared to those with <20 visits. At the study level amongst HWWS interventions with ≥1 household visit, studies finding a statistically significant effect on diarrhoea had a median of 47 household visits (n=8) compared to a median of 12 visits amongst those finding no effect on diarrhoea (n=7).

For HWT chlorination and diarrhoea, there was no evidence (*β=-0.13,* p=0.515, n=14 vs n=4) that having higher numbers of visits was more effective. The analysis was unbalanced with 78% of studies in the "high" category. The coefficient was in the opposite direction to what was hypothesised (Figure 1b), but there was <1% difference in I^2. This result was not contradicted in any sensitivity analysis. Pooling for HWWS and chlorination interventions' effectiveness on diarrhoea, there was no evidence of association with total visits (*β=-0.01,* p=0.919). Amongst HWT interventions with ≥1 household visit, studies finding a statistically significant effect on diarrhoea had a similarly higher number of visits to those finding no effect (median 18 (n=8) versus 24 (n=10)). Considering filter and solar/UV interventions, there was again insufficient variation in intensity to allow hypothesis testing (Table E-2).

References

1. Ross I, Bick S, Ayieko P, et al. Effectiveness of handwashing with soap for preventing acute respiratory infections in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet* 2023; **401**(10389): 1681-90.
2. Clasen T, Garcia Parra G, Boisson S, Collin S. Household-based ceramic water filters for the prevention of diarrhea: a randomized, controlled trial of a pilot program in Colombia. *Am J Trop Med Hyg* 2005; **73**(4): 790-5.
3. Briceno B, Coville A, Martinez S. Promoting handwashing and sanitation: evidence from a large-scale randomized trial in rural Tanzania. *Policy Research Working Paper - World Bank* 2015; (7164): 58-pp.
4. Peláez AV, von Hoegen M, Morales de Sierra ME, Simon RC, Villacorta CEL, Velarde CI. Contra la morbilidad infantil: Filtros artesanales y educación: Universidad Rafael Landivar, Guatemala, 1995.
5. Luby SP, Agboatwalla M, Painter J, et al. Combining Drinking Water Treatment And Hand Washing For Diarrhoea Prevention, A Cluster Randomised Controlled Trial. *Tropical Medicine and International Health* 2006; **11**(4): 479-89.
6. Luby SP, Rahman M, Arnold BF, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Bangladesh: A cluster randomised controlled trial. *The Lancet Global Health* 2018; (17): 30490-4.
7. Opryszko MC, Hansen PM, Myers JA, et al. Water and Hygiene Interventions to Reduce Diarrhoea in Rural Afghanistan: A Randomized Controlled Study. *Journal of Water and Health* 2010; **8**(4): 687–702-87–.
8. Sinharoy SS, Schmidt WP, Wendt R, et al. Effect of community health clubs on child diarrhoea in western Rwanda: cluster-randomised controlled trial. *Lancet Glob Health* 2017; **5**(7): e699-e709.
9. Manaseki-Holland S, Manjang B, Hemming K, et al. Effects on childhood infections of promoting safe and hygienic complementary-food handling practices through a community-based programme: A cluster randomised controlled trial in a rural area of the Gambia. *PLoS Medicine / Public Library of Science* 2021; **18**(1): e1003260-e.
10. Brown J, Sobsey MD, Loomis D. Local drinking water filters reduce diarrheal disease in Cambodia: a randomized, controlled trial of the ceramic water purifier. *Am J Trop Med Hyg* 2008; **79**(3): 394-400.
11. Clasen TF, Brown J, Collin S, Suntura O, Cairncross S. Reducing diarrhea through the use of household-based ceramic water filters: a randomized, controlled trial in rural Bolivia. *Am J Trop Med Hyg* 2004; **70**(6): 651-7.
12. du Preez M, Conroy RnM, Wright JA, Moyo S, Potgieter N, Gundry SW. Use of Ceramic Water Filtration in the Prevention of Diarrheal Disease: A Randomized Controlled Trial in Rural South Africa and Zimbabwe. *The American Journal of Tropical Medicine and Hygiene Am J Trop Med Hyg* 2008; **79**(5): 696-701.
13. Fabiszewski de Aceituno AM, Stauber CE, Walters AR, Meza Sanchez RE, Sobsey MD. A randomized controlled trial of the plastic-housing BioSand filter and its impact on diarrheal disease in Copan, Honduras. *Am J Trop Med Hyg* 2012; **86**(6): 913-21.
14. Fagerli K, Gieraltowski L, Nygren B, et al. Use, Acceptability, Performance, and Health Impact of Hollow Fiber Ultrafilters for Water Treatment in Rural Kenyan Households, 2009-2011. *Am J Trop Med Hyg* 2020; **103**(1): 465-71.
15. Hill CL, McCain K, Nyathi ME, et al. Impact of Low-Cost Point-of-Use Water Treatment Technologies on Enteric Infections and Growth among Children in Limpopo, South Africa. *Am J Trop Med Hyg* 2020; **103**(4): 1405-15.

16. Kirby MA, Nagel CL, Rosa G, et al. Effects of a large-scale distribution of water filters and natural draft rocket-style cookstoves on diarrhea and acute respiratory infection: A cluster-randomized controlled trial in Western Province, Rwanda. *PLoS Medicine* 2019; **16**(6): 1-24.
17. Lindquist ED, George CM, Perin J, et al. A cluster randomized controlled trial to reduce childhood diarrhea using hollow fiber water filter and/or hygiene-sanitation educational interventions. *Am J Trop Med Hyg* 2014; **91**(1): 190-7.
18. Morris JF, Murphy J, Fagerli K, et al. A Randomized Controlled Trial to Assess the Impact of Ceramic Water Filters on Prevention of Diarrhea and Cryptosporidiosis in Infants and Young Children-Western Kenya, 2013. *Am J Trop Med Hyg* 2018; **98**(5): 1260-8.
19. Stauber CE, Ortiz GM, Loomis DP, Sobsey MD. A randomized controlled trial of the concrete biosand filter and its impact on diarrheal disease in Bonao, Dominican Republic. *Am J Trop Med Hyg* 2009; **80**(2): 286-93.
20. Stauber CE, Printy ER, McCarty FA, Liang KR, Sobsey MD. Cluster randomized controlled trial of the plastic BioSand Water filter in Cambodia. *Environ Sci Technol* 2012; **46**(2): 722-8.
21. Stauber CE, Kominek B, Liang KR, Osman MK, Sobsey MD. Evaluation of the impact of the plastic BioSand filter on health and drinking water quality in rural Tamale, Ghana. *Int J Environ Res Public Health* 2012; **9**(11): 3806-23.
22. Tiwari SS, Schmidt WP, Darby J, Kariuki ZG, Jenkins MW. Intermittent slow sand filtration for preventing diarrhoea among children in Kenyan households using unimproved water sources: randomized controlled trial. *Trop Med Int Health* 2009; **14**(11): 1374-82.
23. Bitew BD, Gete YK, Biks GA, Adafrie TT. The effect of SODIS water treatment intervention at the household level in reducing diarrheal incidence among children under 5 years of age: a cluster randomized controlled trial in Dabat district, northwest Ethiopia. *Trials* 2018; **19**(1): 412.
24. Conroy RM, Elmore-Meegan M, Joyce T, McGuigan KG, Barnes J. Solar disinfection of drinking water and diarrhoea in Maasai children: a controlled field trial. *Lancet* 1996; **348**(9043): 1695-7.
25. Conroy RM, Meegan ME, Joyce T, McGuigan K, Barnes J. Solar disinfection of water reduces diarrhoeal disease: an update. *Arch Dis Child* 1999; **81**(4): 337-8.
26. Du Preez M, McGuigan KG, Conroy RM. Solar disinfection of drinking water in the prevention of dysentery in South African children aged under 5 years: the role of participant motivation. *Environ Sci Technol* 2010; **44**(22): 8744-9.
27. du Preez M, Conroy RM, Ligondo S, et al. Randomized Intervention Study of Solar Disinfection of Drinking Water in the Prevention of Dysentery in Kenyan Children Aged under 5 Years. *Environmental Science & Technology* 2011; **45**(21): 9315-23.
28. Gruber JS, Reygadas F, Arnold BF, Ray I, Nelson K, Colford JM. A stepped wedge, cluster-randomized trial of a household UV-disinfection and safe storage drinking water intervention in rural Baja California Sur, Mexico. *Am J Trop Med Hyg* 2013; **89**(2): 238-45.
29. Hartinger SM, Lanata CF, Hattendorf J, et al. Improving household air, drinking water and hygiene in rural Peru: a community-randomized-controlled trial of an integrated environmental home-based intervention package to improve child health. *International Journal of Epidemiology* 2016; **45**(6): 2089-99.
30. Mäusezahl D, Christen A, Pacheco GD, et al. Solar drinking water disinfection (SODIS) to reduce childhood diarrhoea in rural Bolivia: a cluster-randomized, controlled trial. *PLoS Med* 2009; **6**(8): e1000125.
31. McGuigan KG, Samaiyar P, du Preez M, Conroy RM. High compliance randomized controlled field trial of solar disinfection of drinking water and its impact on childhood diarrhea in rural Cambodia. *Environ Sci Technol* 2011; **45**(18): 7862-7.

32. Rai B, Pal R, Kar S, Tsering DC. Solar disinfection improves drinking water quality to prevent diarrhea in under-five children in sikkim, India. *J Glob Infect Dis* 2010; **2**(3): 221-5.
33. Rose A, Roy S, Abraham V, et al. Solar disinfection of water for diarrhoeal prevention in southern India. *Arch Dis Child* 2006; **91**(2): 139-41.