

Water and sanitation interventions for better child health

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1. Background

- One billion people worldwide lack access to clean water, and 2.5 billion do without adequate sanitation (United Nations, 2008)
=> ill-health, poverty, illiteracy, inequities
- Diarrhoea is the major global child killer, responsible for an estimated 15% or 6 million deaths annually (WHO/UNICEF, 2000)
- 4 main types of intervention which provide barriers to diarrhoeal disease transmission from environment to human body:
 - Water supply: source or point-of-use
 - Water quality: water treatment/protection at source or point-of-use
 - Sanitation: provision of facilities, sewer connection
 - Hygiene: soap, education ('software')

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Existing 'consensus': implications for diarrhoea

- Interventions to improve WATER QUALITY at point-of-use or safe HYGIENE practices are the most effective
- WATER SUPPLY or SOURCE WATER improvements not effective
- HYGIENE interventions more effective than SANITATION
- MULTIPLE INTERVENTIONS do not tend to have bigger impacts than single interventions (interventions are substitutes)

=> WHO (2003) conclude that point-of-use water treatment is the most cost-effective approach to reach the water MDG

BUT

- Behavioural interventions (water treatment & hygiene) conducted under trial conditions, with plenty of within intervention follow-up and possibilities for bias
- Concerns regarding SUSTAINABILITY over time and SCALABILITY over populations – barriers to 'technological' diffusion.

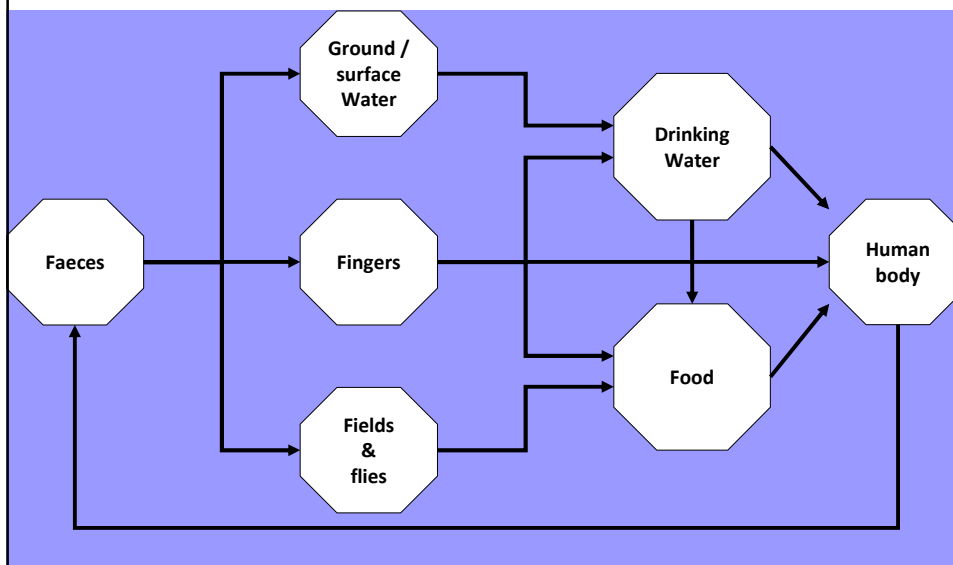
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2. Objectives of the synthetic review

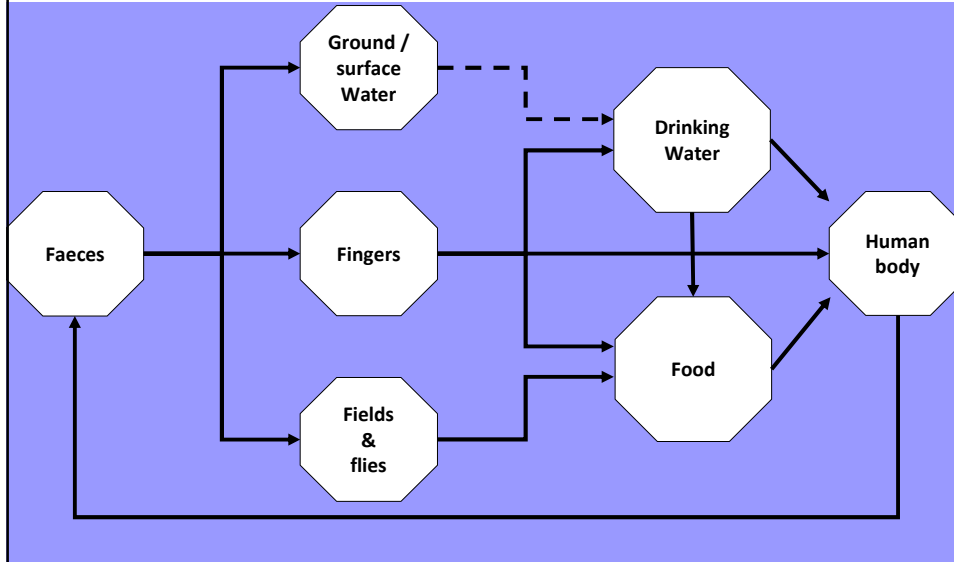
- Conduct review to Cochrane/Campbell standards
- Mixed methods: analysis of quantitative and qualitative information
- Synthesise quantitative information using meta-analysis: assess whether existing 'consensus' stands up to inclusion of new studies, quality (internal validity)
- Theory-based: emphasise behavioural and contextual factors shaping effectiveness and sustainability

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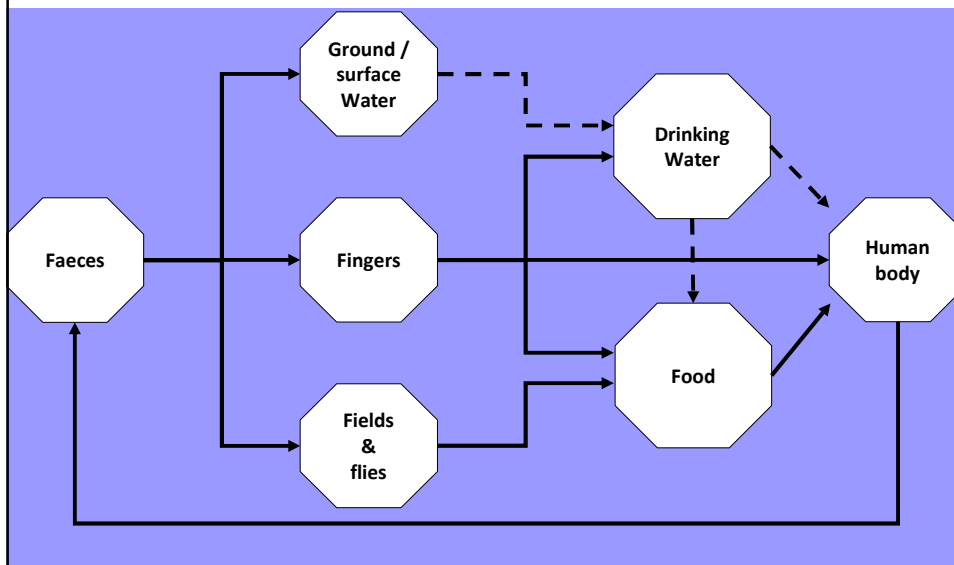
3. Theory: faecal-oral transmission pathways



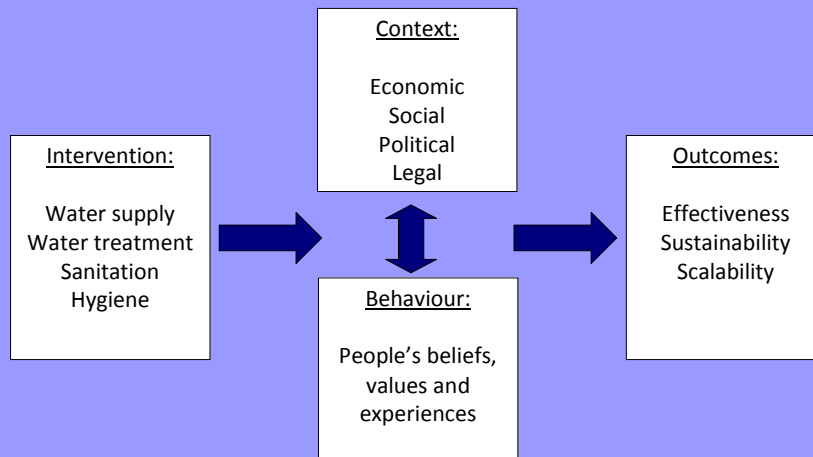
Theory: Source water treatment



Theory: home (POU) water treatment

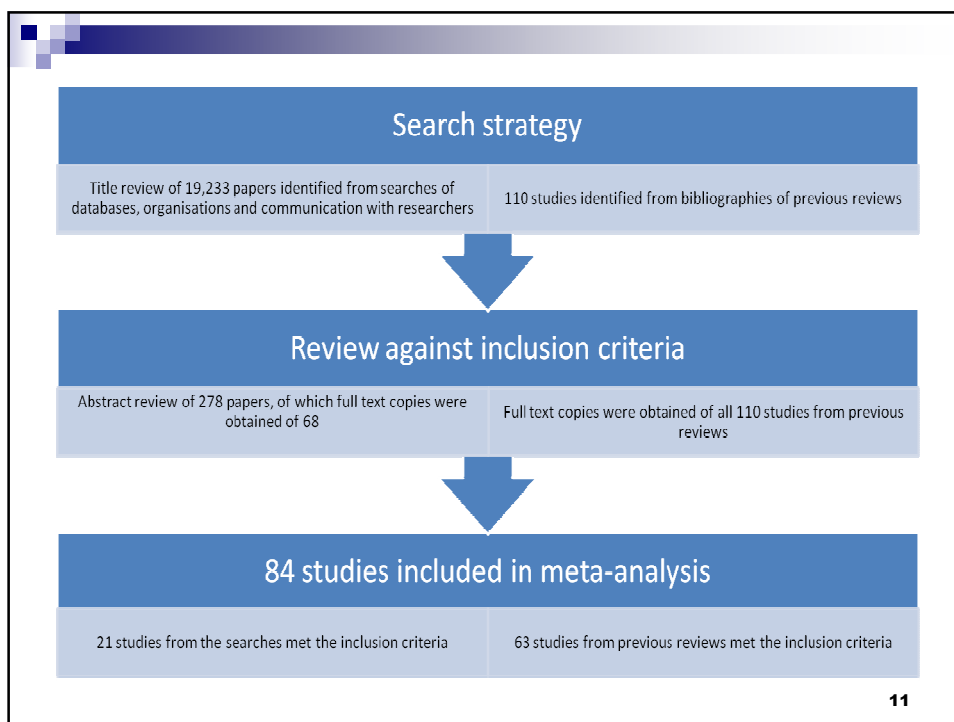


Compliance/adoption determined by context and behaviour



4. Methodology

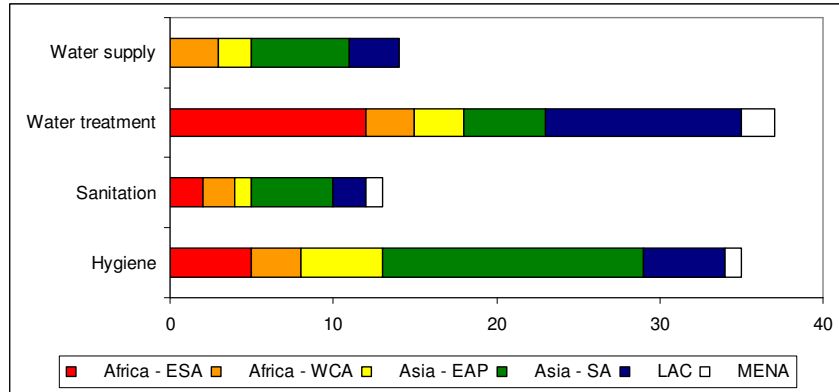
- Extensive search (published and unpublished sources)
- Inclusion criteria: impact of intervention on diarrhoea; experimental and quasi-experimental methods
- Coding of data:
 - Internal validity: study design; data quality
 - External validity: contextual + behavioural information
 - Quantitative and qualitative data: effectiveness, confounding, moderation, process, sustainability
 - Data collected on process: access & functionality; behavioural change; knowledge; compliance among beneficiaries (practice)
- Effectiveness of interventions assessed using:
 - Meta-analysis of effectiveness using fixed/random effects models; impact heterogeneity
 - Meta-regression of factors determining effectiveness (process)
- Sustainability of interventions assessed using quantitative and qualitative information relating to process, study length and size



5. Results: about the interventions

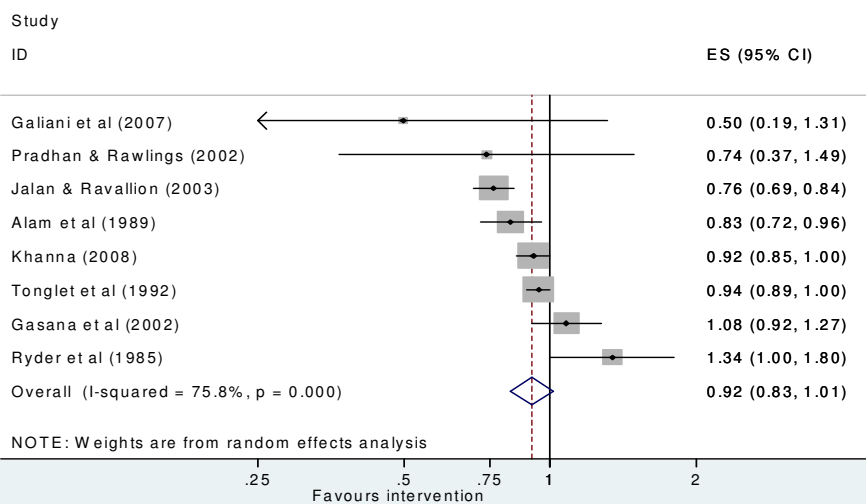
	<i>Total obs</i>	<i>Num RCTs</i>	<i>Total num Children</i>	<i>Ave Num</i>	<i>Ave length (months)</i>
Water supply	17	0	77,000	5,100	19
Water treatment	48	32	19,000	550	9
<i>Point of use water treatment (POU)</i>	44	31	13,500	450	8
<i>Source water treatment</i>	4	1	5,000	1,000	15
Sanitation	15	2	33,682	3,500	16
Hygiene	26	9	35,000	1,000	13
<i>Hand-washing with soap</i>	12	6	8,500	1,500	8
<i>Education</i>	14	3	26,000	579	16
TOTAL	106	56	150,000	1,500	16

Geographical distribution of interventions

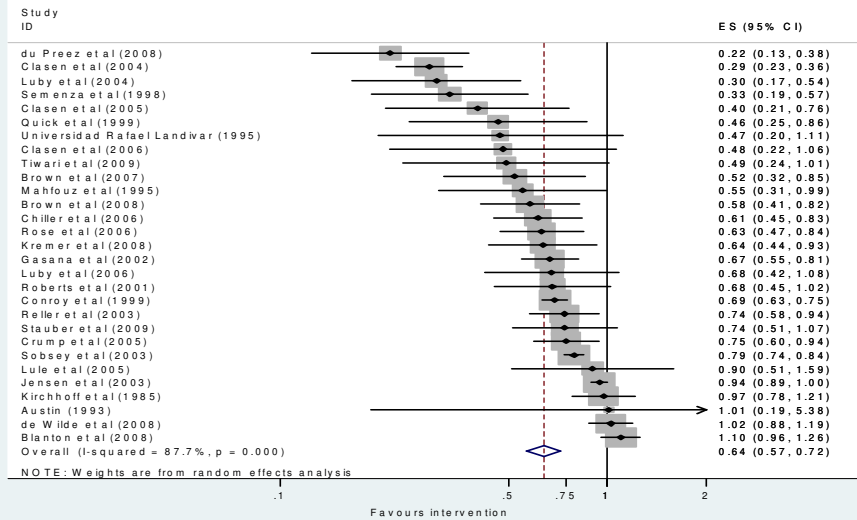


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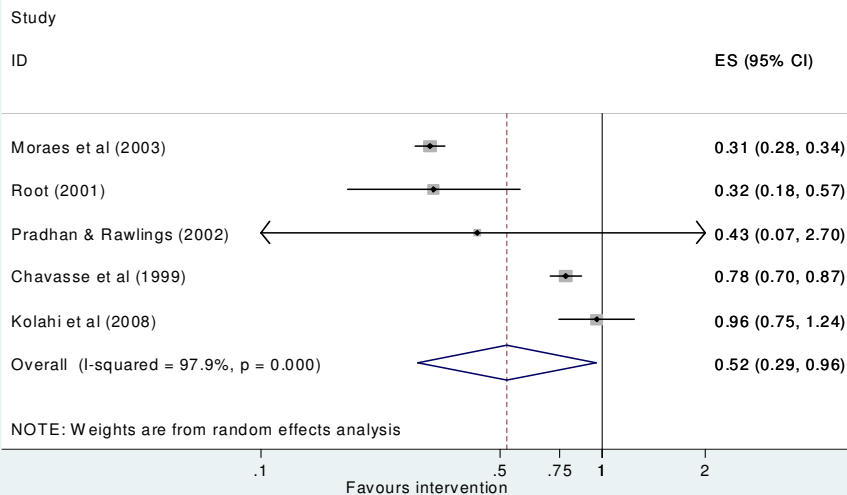
Effectiveness: Water supply interventions



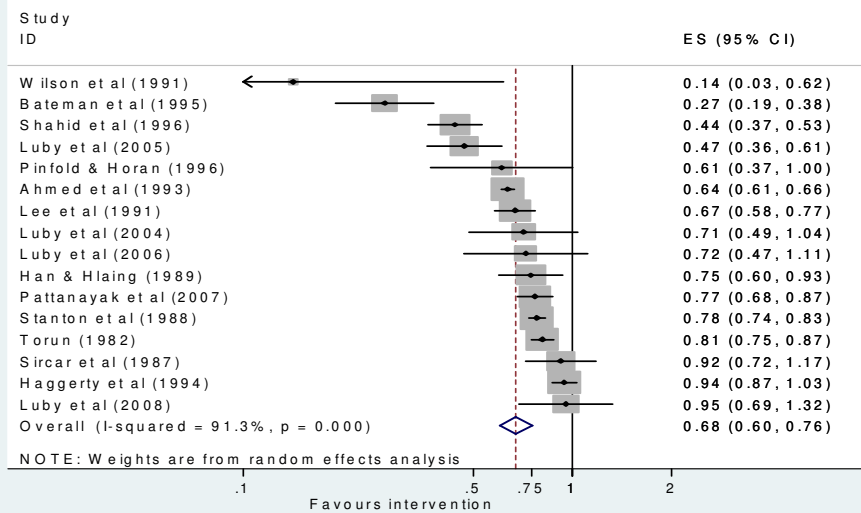
Effectiveness: Water treatment interventions



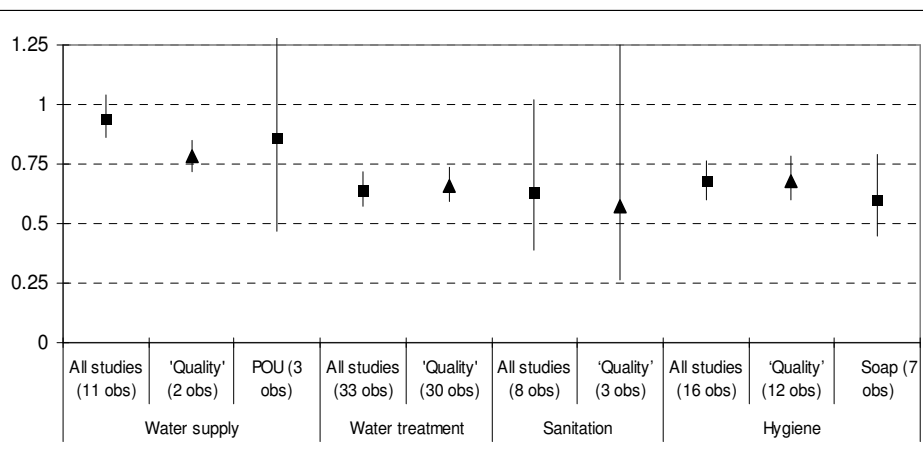
Effectiveness: Sanitation interventions



Effectiveness: Hygiene interventions



Looking across interventions: quality



Impact heterogeneity

- Some evidence for publication bias: studies not published in refereed journals tend to show smaller effect sizes overall (marginally significant at 10% level).
- Evidence that beneficiary participation in intervention design improves effectiveness (water supply, sanitation, multiple)
- Ratio type: prevalence ratios and odds ratios tend to be further from the point of no effect than risk/rate ratios, but does not explain differences in effectiveness across interventions
- Differences not consistently observed for other variables: location (rural/urban), baseline water/sanitation environment, study type (RCT vs not), seasonality, recall period

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A closer look at water treatment interventions

	<i>Effect</i>	<i>95% CI</i>	<i>Num. obs</i>
Point of use	0.63	0.56 0.71	30
Source	0.74	0.51 1.09	3
Placebo/blinded trials	0.76	0.62 0.94	4
Placebo (Schmidt & Cairncross, 2008)	0.90	0.65 1.25	4
No placebo/blinding	0.62	0.53 0.71	25
Possible conflict of interest	0.51	0.36 0.73	7
No conflict of interest declared	0.66	0.58 0.75	15
Beneficiary compliance >50%	0.62	0.51 0.77	14
Compliance <50%	0.65	0.54 0.77	10
Data collection >12 mos	0.80	0.67 0.96	4
Data collection <12 mos	0.61	0.53 0.70	25

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Process evaluation to assess compliance

1. Intervention provided

Hardware e.g. water pump, chlorine tablets, water filter, latrine, soap.
Software e.g. hygiene education, instructions on use or maintenance.

2. Access/ functionality (hardware)

Observation: access/functioning
Survey: beneficiaries describe functionality

2. Knowledge transferral (software)

Survey: beneficiaries describe knowledge acquired, including correct methods for use of intervention.

3. Behaviour change: Implementation of knowledge

Direct observation of beneficiaries using intervention correctly or chemical test (drinking water shows residuals of active ingredient).
Indirect observation of use of intervention e.g. through use of soap, used chlorine packets.
Quality: Micro-biological test for residual environmental bacteria

4. Reduced morbidity

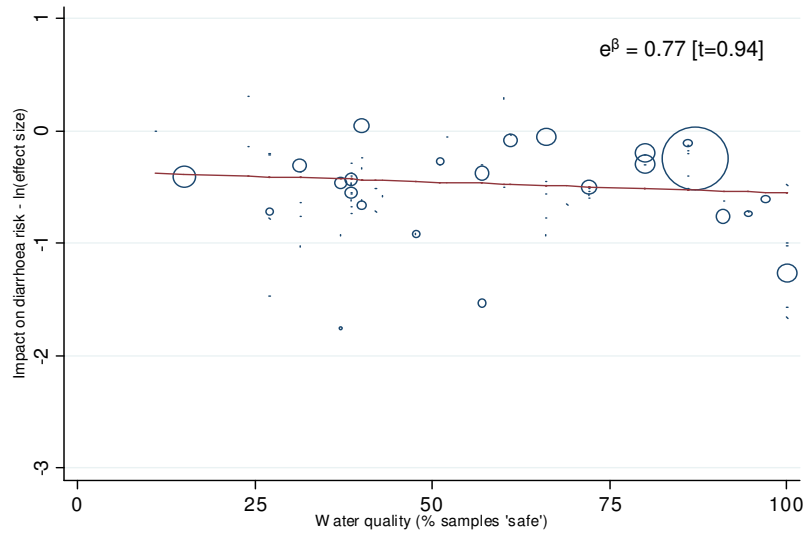
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Compliance

- Most studies collect some data on compliance, at various levels:
 - Water supply: 70% (mainly access)
 - Water quality: 100% (water quality and/or observed practice)
 - Sanitation: 80% (access and/or observed practice)
 - Hygiene: 100% (knowledge and/or observed practice)
- Water treatment: meta-regression does not suggest strong relationship between 'water quality' and effectiveness (though observed 'use' of intervention is marginally insignificant)
 - ⇒ either poor data quality or possible evidence of bias in trials
- Other interventions: compliance data not readily comparable

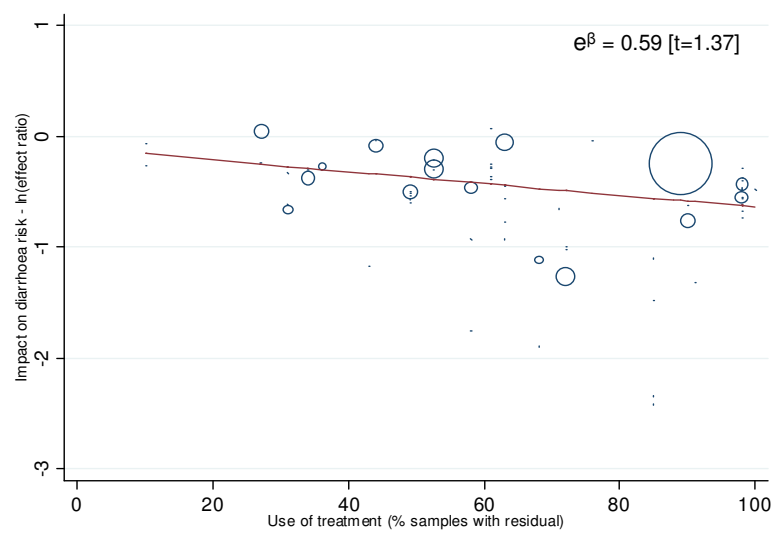
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Water treatment: quality and effectiveness



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Water treatment: use and effectiveness



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Evidence on compliance: source water treatment

- 1 study finds low contamination at source in Rwanda finds significantly higher contamination levels at POU (Gasana, 2001)
- 1 study assessing 'safe' storage in Malawi container finds low contamination at POU and bigger impact (Roberts, 2001)
- 1 study in Mexico evaluated the reasons for low compliance of unsuccessful intervention (de Wilde et al 2008):
 - Only 2/21 communities met all requirements for effective programme performance
 - Community capacity to manage, physical faults or under-valuing of safe water by users were NOT found to be limiting the intervention's effectiveness
 - Constraints (money & time) and availability of other sources, meant households chose more convenient water sources

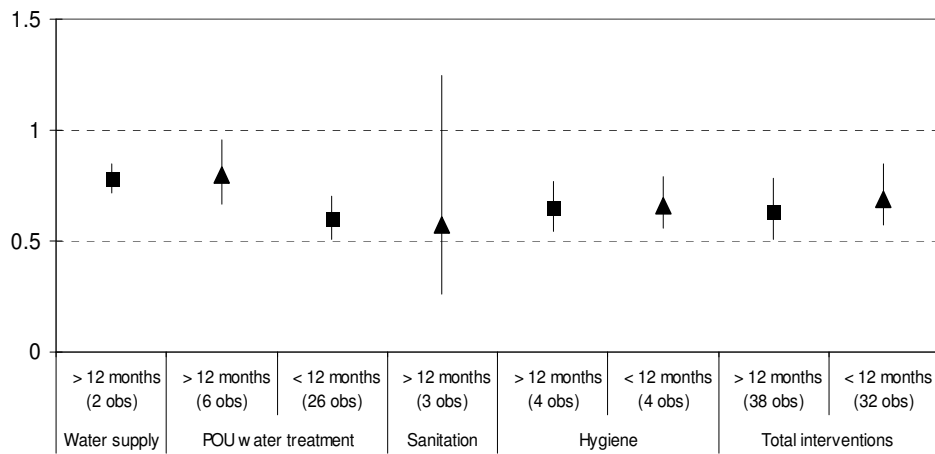
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6. Sustainability

- Water supply and sanitation: sustainability and scalability demonstrated (non-trials conditions)
- Water treatment: replicability demonstrated; sustainability and scalability not
 - Most trials conducted over small populations for short periods of time
 - Meta-regression suggests both sample size and data length are positively correlated with effectiveness (i.e. bigger, longer studies tend to show smaller effects)
 - Only 5 follow-up studies assess compliance + health impact over one year after intervention completed
- Hygiene: sustainability evidence stronger

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Sustainability: data collection period



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Sustainability of POU water treatment

- 3 follow-up studies of successful trials of POU water treatment were conducted over one year after the initial intervention ended:
 - Ceramic filter provision in Cambodia: only 31% households still using the filters 3 years' later; 59% of the households no longer using the filters had them installed < 36 months ago (Brown et al, 2007)
 - Pasteurisation in Kenya: 4 years later only 30% continue to pasteurise their water (Iijima et al, 2001)
 - Household water filter in Malawi (nationwide scale-up): among mothers in Malawi who had heard of and tried the disinfectant, only 22% were current users at the time of the survey.

- 1 follow-up study conducted 6 months after nationwide scale-up of successful trial in Guatemala (Luby et al 2008): found repeated use among only 5% of study households and among scaled-up population.
 - Neither price nor time required to use product were observed to exert substantial impact on take-up
 - Rather, belief that household drinking water made family ill was the only characteristic associated with repeated use => highlights problem that WSH interventions produce effects which are 'unseen' (they prevent ill-health)

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7. Conclusions

- No one single intervention for improving global access to water and sanitation for reducing diarrhoeal disease:
 - The 'right' solution is the one that fits the (social, economic, political) context
 - Emphasise behavioural factors, particularly where these are of overriding importance to adoption, sustainability and scalability (esp. water quality + hygiene interventions)

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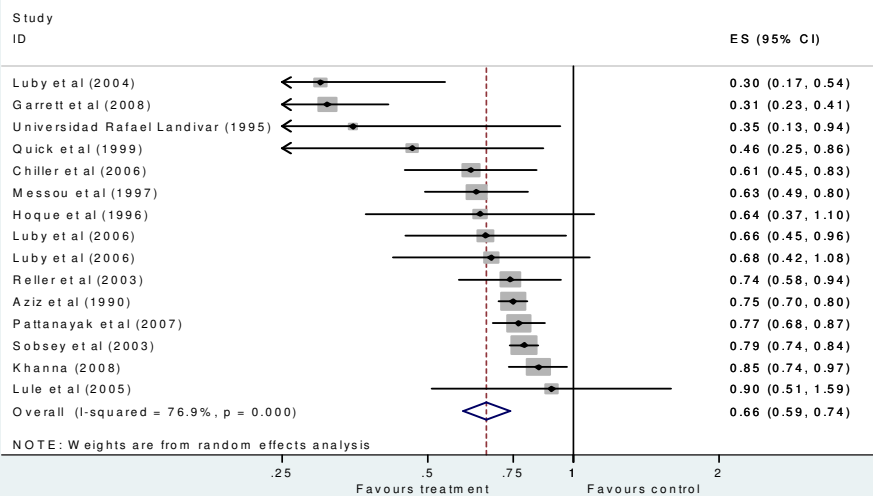
Conclusions continued

- Effectiveness:
 - Water supply interventions least effective, excl household connection
 - Water treatment at point-of-use very effective, but concerns about study quality (blinding, conflict of interest, compliance)
 - Water treatment at source less effective but few high quality studies
 - Sanitation effective – more studies needed
 - Hygiene interventions are effective but resource intensive
 - Interventions substitutes not complements (results not reported)
- More evidence needed on sustainability + scalability of water treatment interventions before scale-up

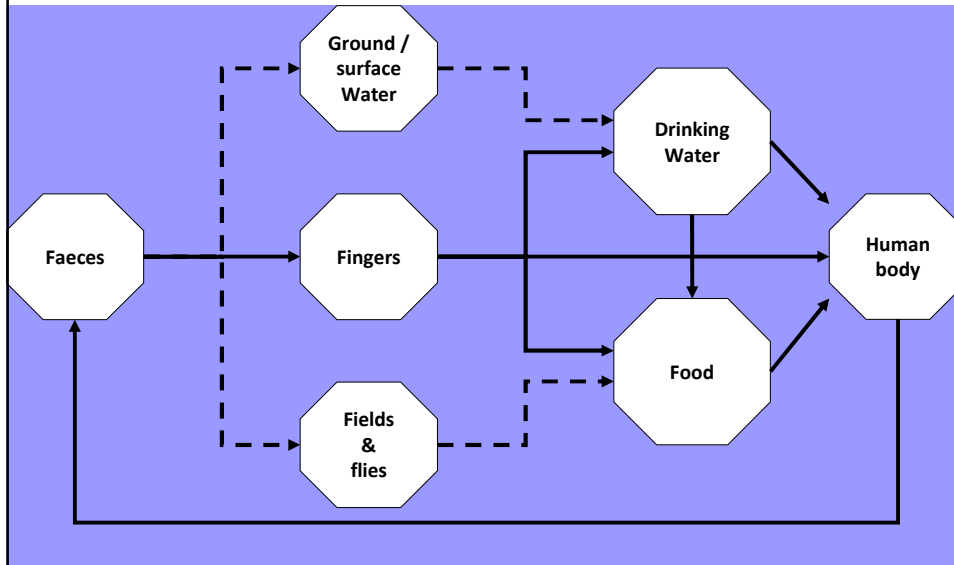
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Thank you

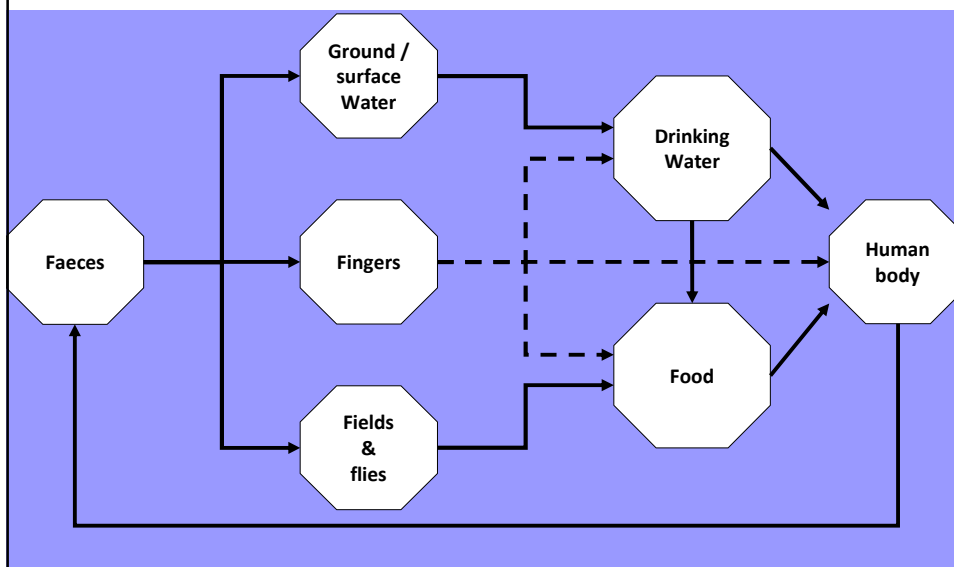
Effectiveness: multiple interventions



Theory: Sanitation barriers to transmission



Theory: Hygiene barriers to transmission



90% of studies collect data on compliance

	<i>Total # studies</i>	<i>Access/function</i>	<i>Knowledge</i>	<i>Practice</i>	<i>Water quality</i>
Water supply	15	5		1	
Water treatment	39	2	2	17	29
Sanitation	13	6		4	
Hygiene	24		6	21	

- Water treatment: meta-regression does not suggest strong relationship between 'water quality' and effectiveness (though observed 'use' of intervention is marginally insignificant)
 - either poor data quality or possible evidence of bias in trials
- Other interventions: compliance data not readily comparable