

Effectiveness and sustainability of water, sanitation and hygiene interventions in combating diarrhoea

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Contents of the presentation

1. Background to Synthetic Review
2. Motivation and objectives
3. Theory
4. Methodology
5. Effectiveness
6. Compliance and sustainability
7. Conclusions



1. What is Synthetic Review?

- Synthetic reviews (SRs) examine the existing evidence on a particular intervention or programme
 - E.g. WSS, nutrition, education, health, micro-credit, social cohesion, HIV/AIDS, agriculture, etc...
 - Help us to answer:
 - What works and why?
 - How to assess the range of programmatic evidence?

- NOT standard literature review - aims to provide unbiased assessment of what works and why through systematic identification of relevant studies and synthesis of quantitative and qualitative evidence

- Draws on both Campbell/Cochrane Collaboration systematic review methodology and realist evaluation (context and behavioural mechanisms) focusing on:
 1. Outcomes (intermediate/final) => assess WHETHER interventions/ programmes work and under which circumstances (context)
 2. Analysis of causal chain => assess HOW and WHY interventions/ programmes work, or not, drawing on programme theory (behavioural change)



Key steps in production of SR

1. Rigorous search to identify published and unpublished literature and application of strict inclusion criteria, set out in Study Protocol
2. Systematic data collection and coding of information relating to:
 1. Intervention + comparison group
 2. Study quality (assessment of internal validity)
 3. Contextual factors (external validity)
 4. Causal chain (behavioural change)
 5. Outcomes (impact 'effect size')
3. Quantitative synthesis using meta-analysis, incl assessment of impact heterogeneity
4. Synthesis of quantitative/qualitative information relating to causal chain
5. Review updated as new evidence emerges



2. Motivation

- 1.1 billion people worldwide lack access to clean water, and 2.6 billion without adequate sanitation (WHO/UNICEF, 2004)
=> ill-health, death, poverty, illiteracy, inequities
- Diarrhoea is a major global child killer, responsible for an estimated 21% or 2.5 million deaths annually (Kosek et al, 2003)
- Communicable disease transmitted from unsanitary environment into human body and back
- 4 main types of interventions providing barriers to diarrhoeal disease transmission from environment to human body:
 - Water supply: new or improved supply at source or point-of-use
 - Water quality: treatment/protection at source or point-of-use
 - Sanitation: provision of facilities (improved latrines, sewer connection)
 - Hygiene: soap, hygiene education



Evidence from previous reviews examining child diarrhoea disease morbidity

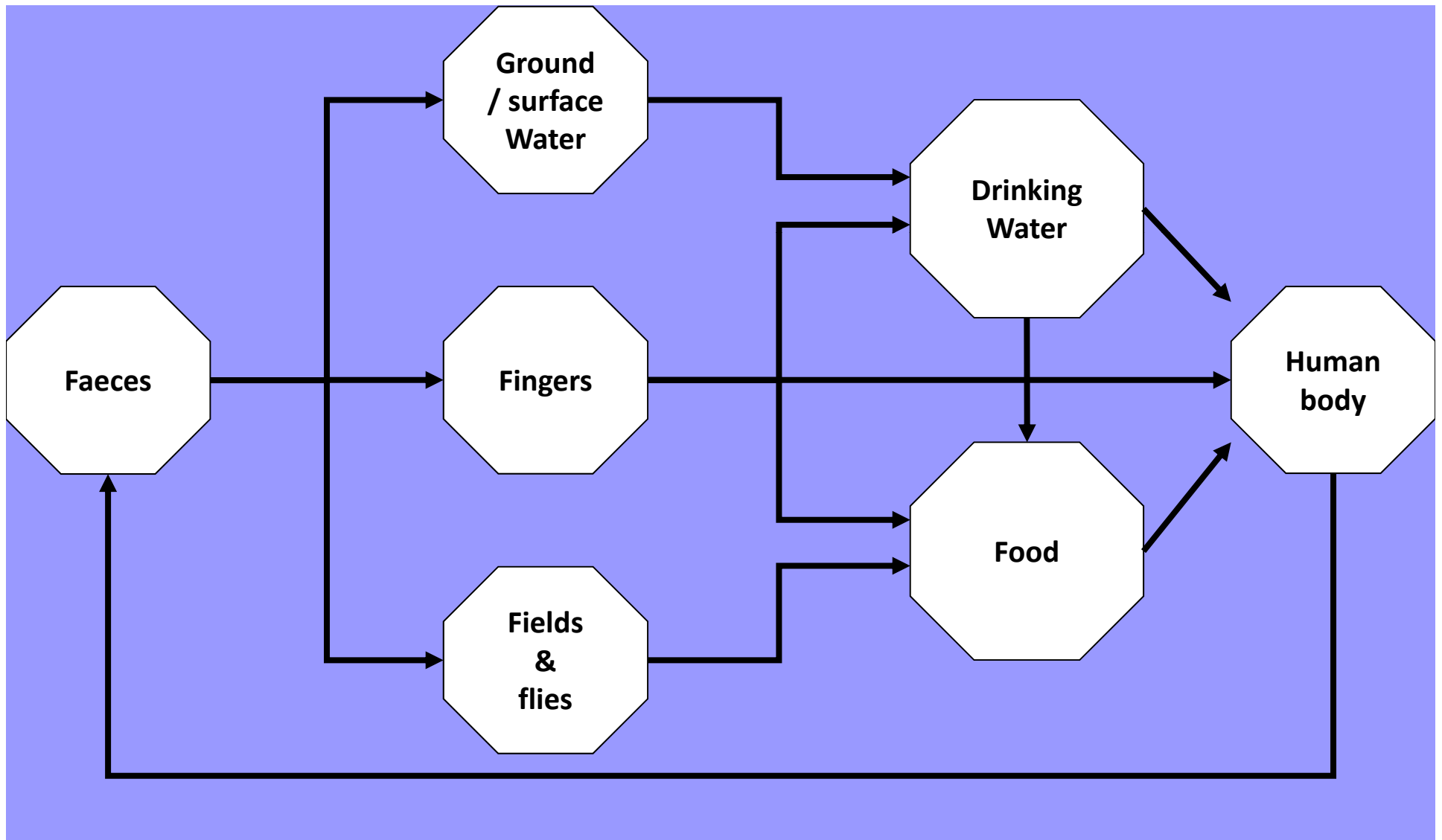
- Effectiveness: interventions providing WATER TREATMENT/SAFE STORAGE at point-of-use or safe HYGIENE practices are the most effective
- SOURCE WATER improvements ineffective (recontamination)
- SANITATION less effective
- MULTIPLE INTERVENTIONS do not tend to have bigger impacts than single interventions
 - ⇒ WHO (2003) conclude that point-of-use water treatment is the most cost-effective approach to reach the water MDG
- But more recent concerns regarding PLACEBO BIAS in household water treatment interventions (Schmidt & Cairncross, 2009; Hunter, 2009), as well as ADOPTION and SUSTAINABILITY of interventions requiring substantial behavioural change (water quality, hygiene) – barriers to diffusion.



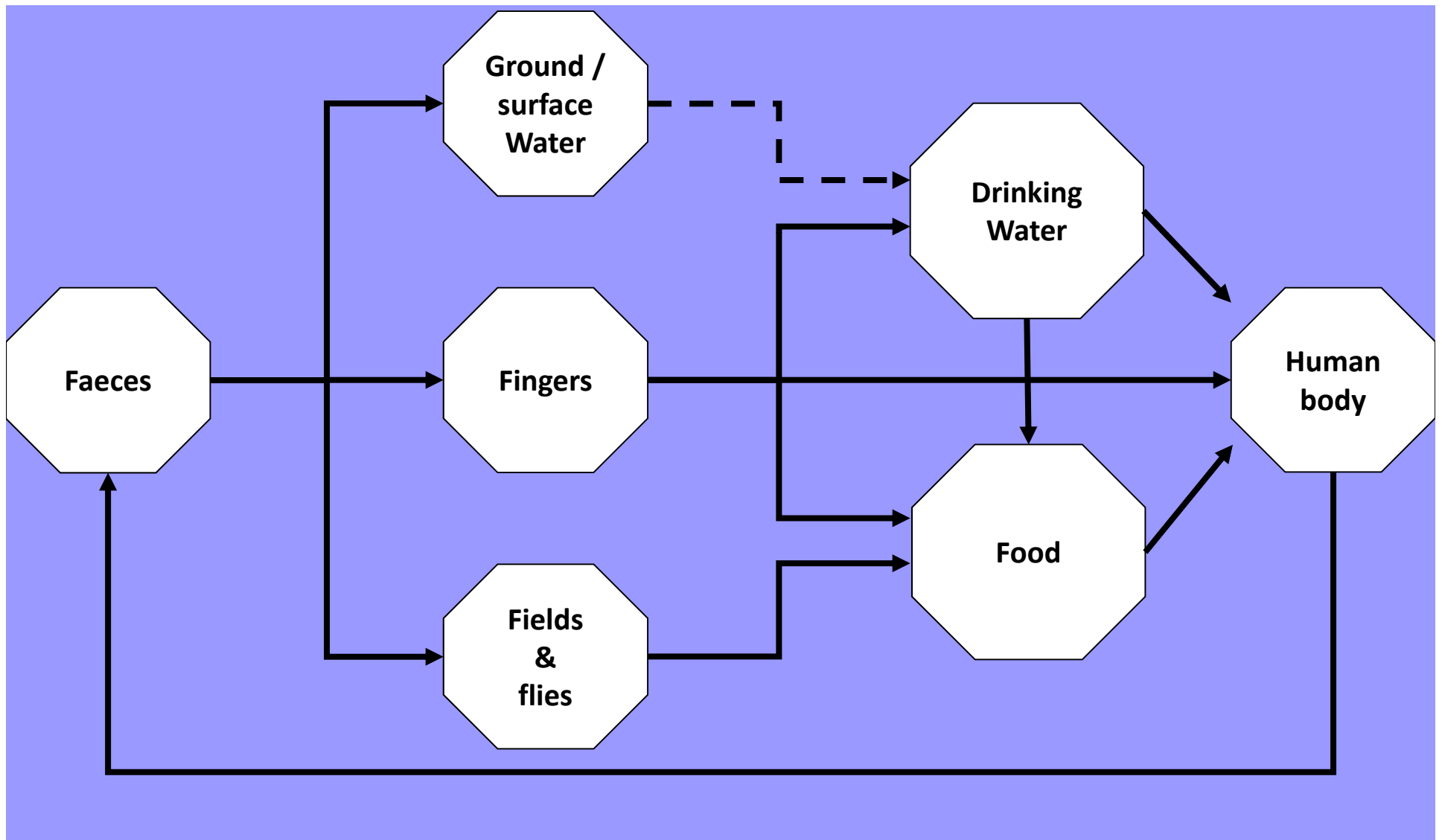
Objective: Update WSS evidence

- Conduct review to Cochrane/Campbell standards of systematic review
- Assess whether existing 'consensus' stands up to inclusion of new studies and use of rigorous IEs (experimental and quasi-experimental studies) only
- Examine impact heterogeneity: do outcomes vary by contextual factors?
- Theory-based: emphasise behavioural change and contextual factors shaping effectiveness and sustainability, using quantitative and qualitative information contained in studies

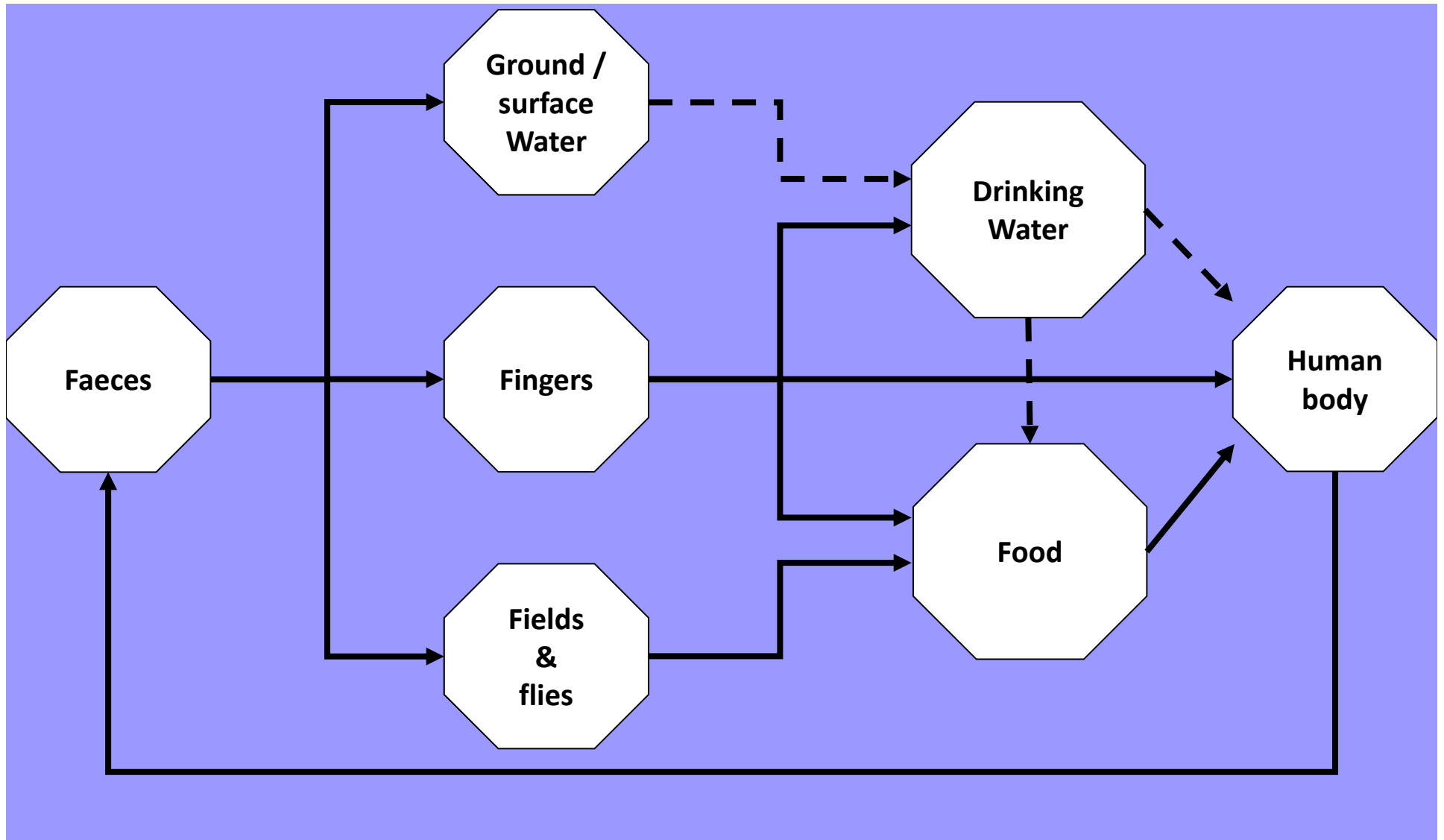
3. Theory: Disease transmission pathways




Theory: Source water treatment



Theory: water treatment incl POU





BUT, interventions are embedded in social systems determining adoption and impact in the real world

- Active interventions: adoption requires substantial behavioural change
- Adoption (compliance) determined by benefit-cost calculation
 - Health benefits may be not observed
 - Absence of other benefits (such as time-savings) may mean perceived benefits < costs
- Other factors influencing demand include income, education, taste/smell, agency, community factors (interpersonal networks/beliefs/herd behaviour)



4. Methodology

- Extensive search of published and unpublished sources
 - PubMed, Embase, LILACs, Web of Science
 - JOLIS, IDEAS, British Library for Development Studies (BLDS), Cochrane Library, scholar.google
 - Personal communication with leading researchers
 - Hand-search, back-referencing and citation tracking

- Inclusion criteria:
 - IEs measuring impact of intervention on diarrhoea morbidity using experimental (RCTs) and quasi-experimental methods
 - reported specific water, sanitation, and/or hygiene intervention(s);
 - were conducted in low- or middle-income countries;
 - use an infant or child as the unit of observation; and
 - estimate impact on diarrhoea morbidity, measured under non-outbreak conditions.

Methodology (cont'd)

- Coding of data:
 - Internal validity: study design; study quality (recall <2 weeks, standard definition of diarrhoea, assessment of confounders)
 - Context: location, baseline disease exposure, season
 - Compliance + behavioural mechanisms (quant/qual)
 - Impact: quantitative data on effectiveness + statistical precision
- Effectiveness measured using risk/prevalence/odds ratio (ITT):

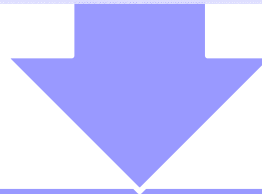
$$\text{Ratio} = \frac{\text{Morbidity } t}{\text{Morbidity } c} \quad < 1 \quad \text{treatment effective}$$
$$\text{Ratio} = \frac{\text{Morbidity } t}{\text{Morbidity } c} \quad \geq 1 \quad \text{treatment ineffective/harmful}$$

- Analysis:
 - Effectiveness results synthesised using meta-analysis; examination of impact heterogeneity
 - Relationship between compliance and effectiveness (meta-regression)
 - Sustainability assessed using quantitative and qualitative information

Search strategy

Title review of 19,233 papers identified from searches of databases, organisations and communication with researchers

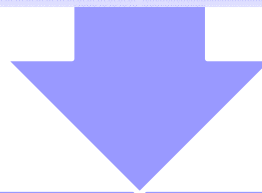
110 studies identified from the bibliographies previous reviews



Review against inclusion criteria

Abstract review of 278 papers, with full text copies obtained for 68 of these

Full text copies obtained of all 110 studies



65 studies (71 interventions) included in meta-analysis

11 studies from searches met the inclusion criteria

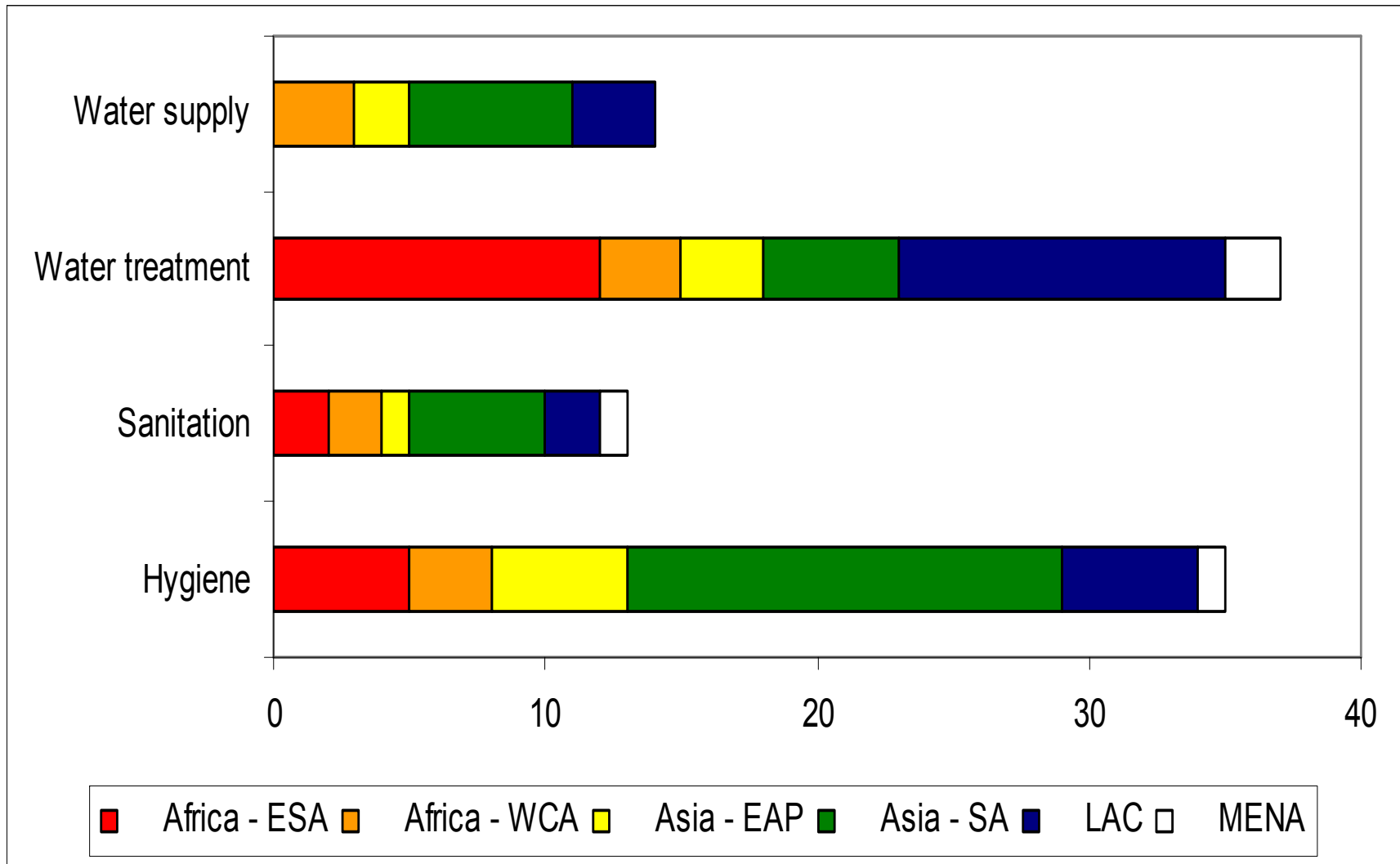
54 studies from previous reviews met the inclusion criteria

Information on the interventions

	<i>Total num</i>	<i>Num RCTs</i>	<i>Total sample</i>	<i>Ave sample</i>	<i>Ave length (months)</i>
Water supply	8	0	61,000	7,700	19
Water quality	31	27	14,500	450	11
<i>Point of use (POU)</i>	28	25	12,000	400	8
<i>Source</i>	3	2	2,500	800	12
Sanitation	8	0	13,500	2,200	30
Hygiene	17	5	18,000	1,100	8
<i>Hand-washing with soap</i>	9	3	5,000	600	9
<i>Education</i>	8	2	13,000	1,600	7
Multiple interventions	7	2	13,000	2,200	23
TOTAL	71	34	136,000	1,900	15



Geographical distribution of interventions

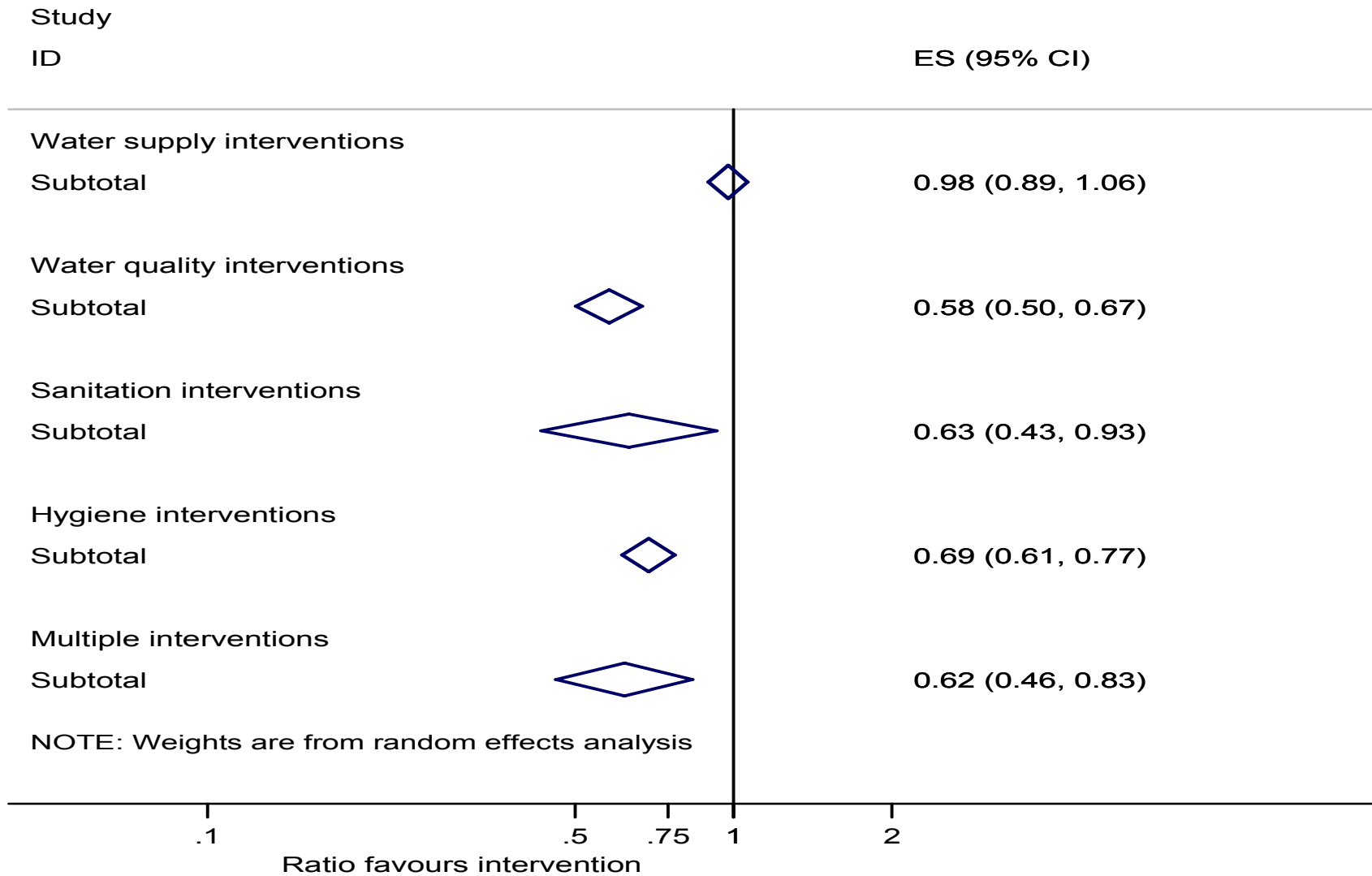




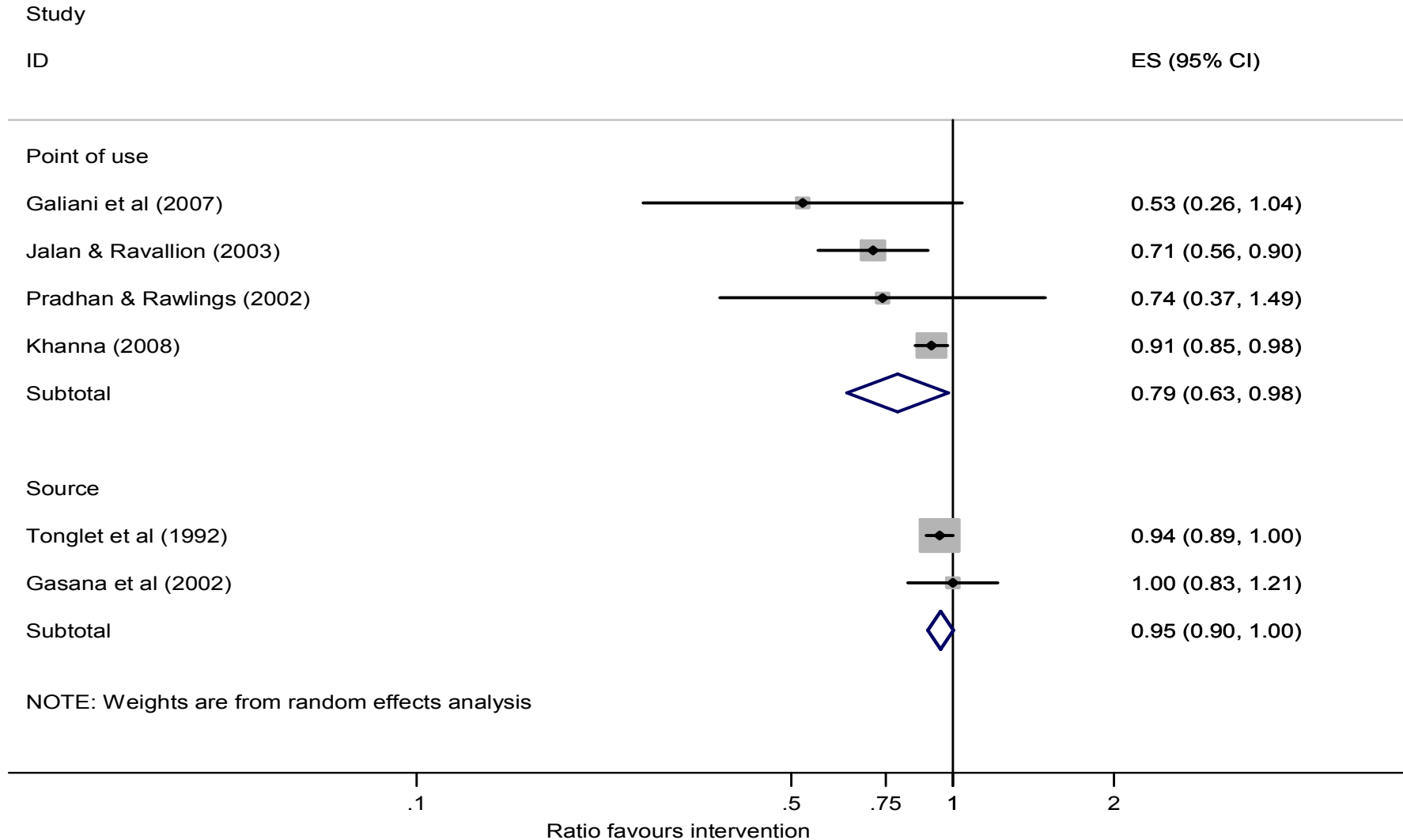
Including LAC coverage for the following:

- Water supply: Argentina, Honduras, Nicaragua, Panama
- Water quality: Bolivia, Brazil, Colombia, Dominican Rep, Guatemala
- Sanitation: Brazil, Honduras, Nicaragua
- Hygiene: Guatemala, Mexico

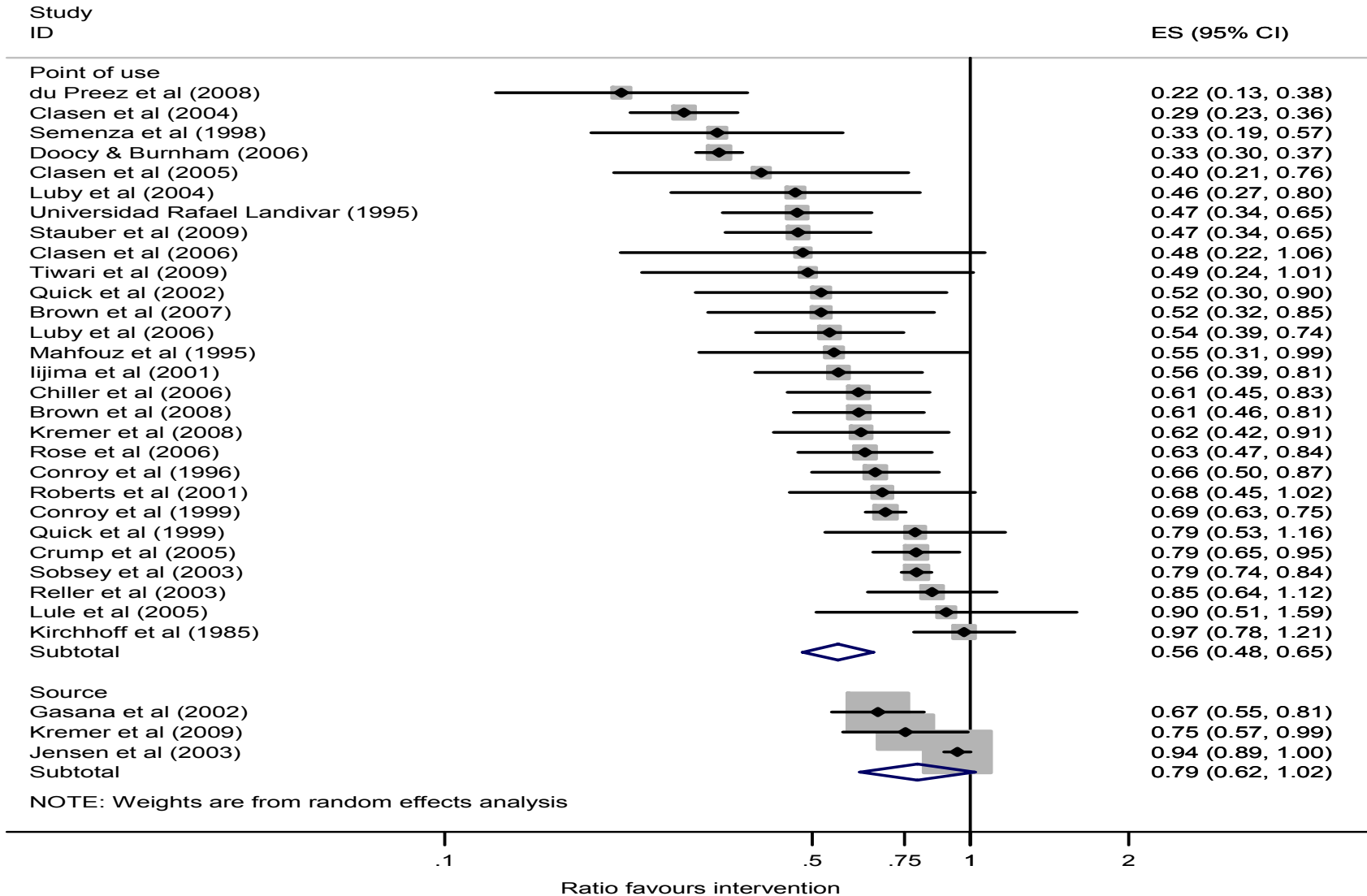
5. Effectiveness results across interventions



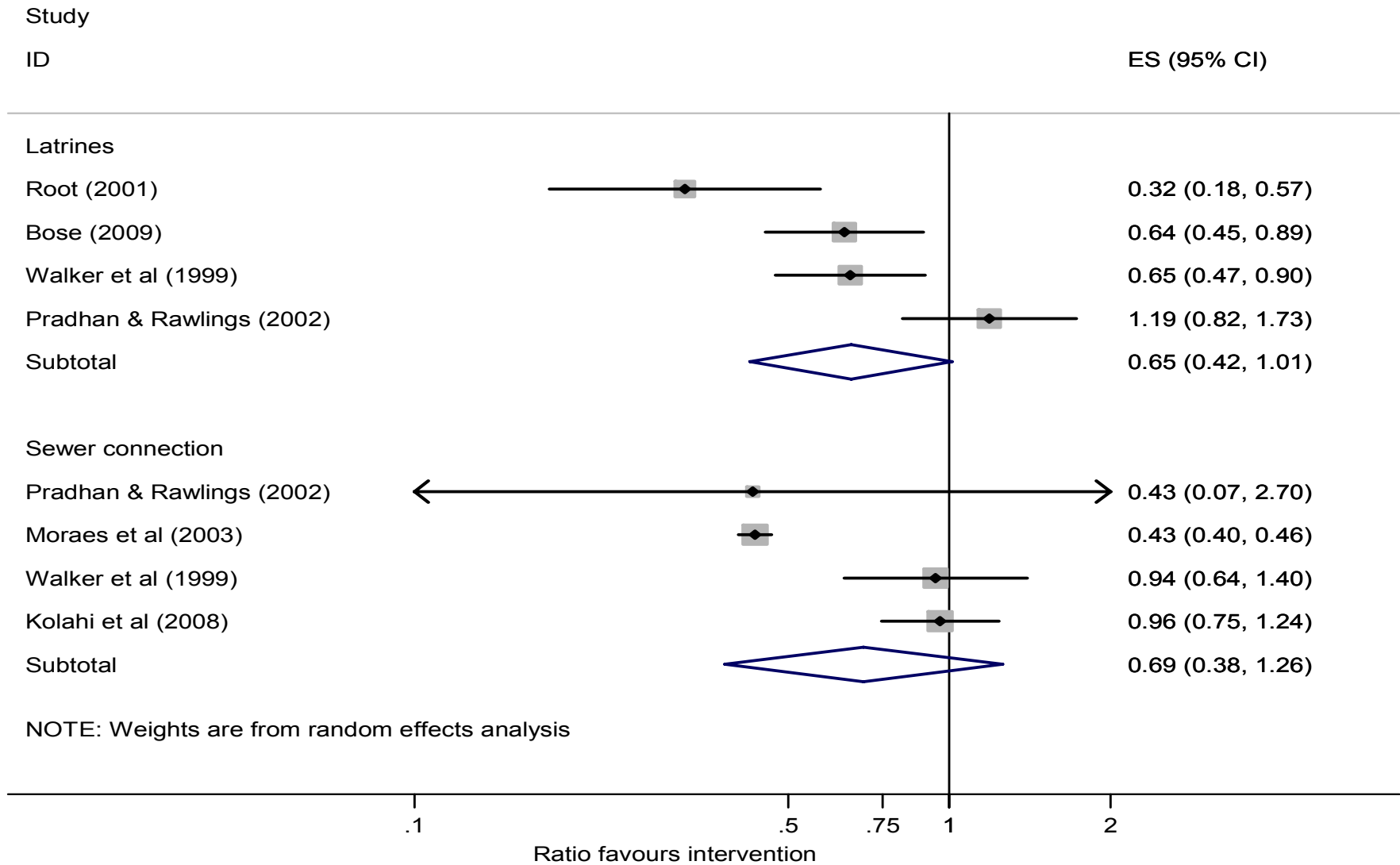
Effectiveness: Water supply interventions



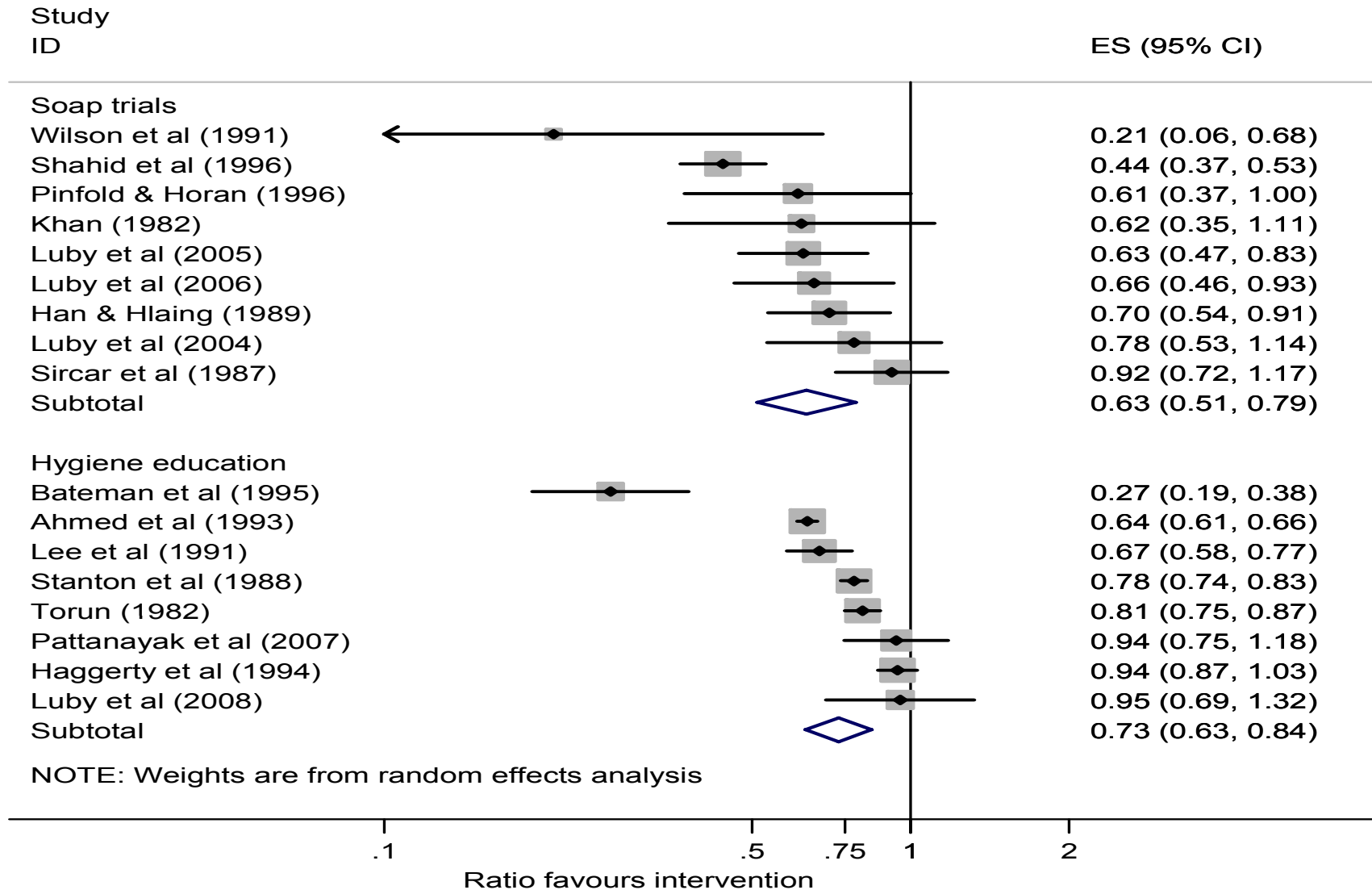
Effectiveness: Water quality interventions



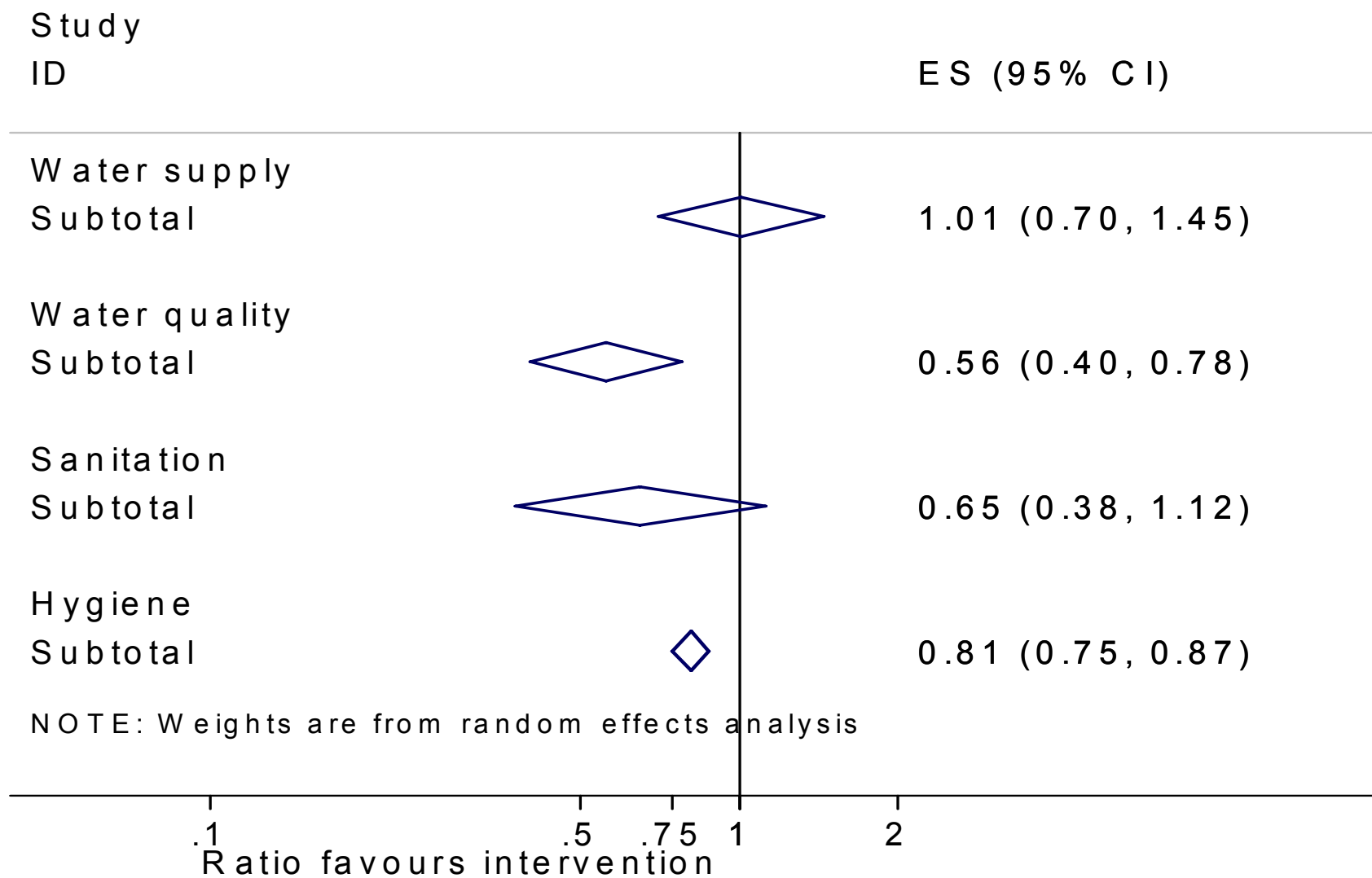
Effectiveness: Sanitation interventions



Effectiveness: Hygiene interventions



Effectiveness: LAC studies only



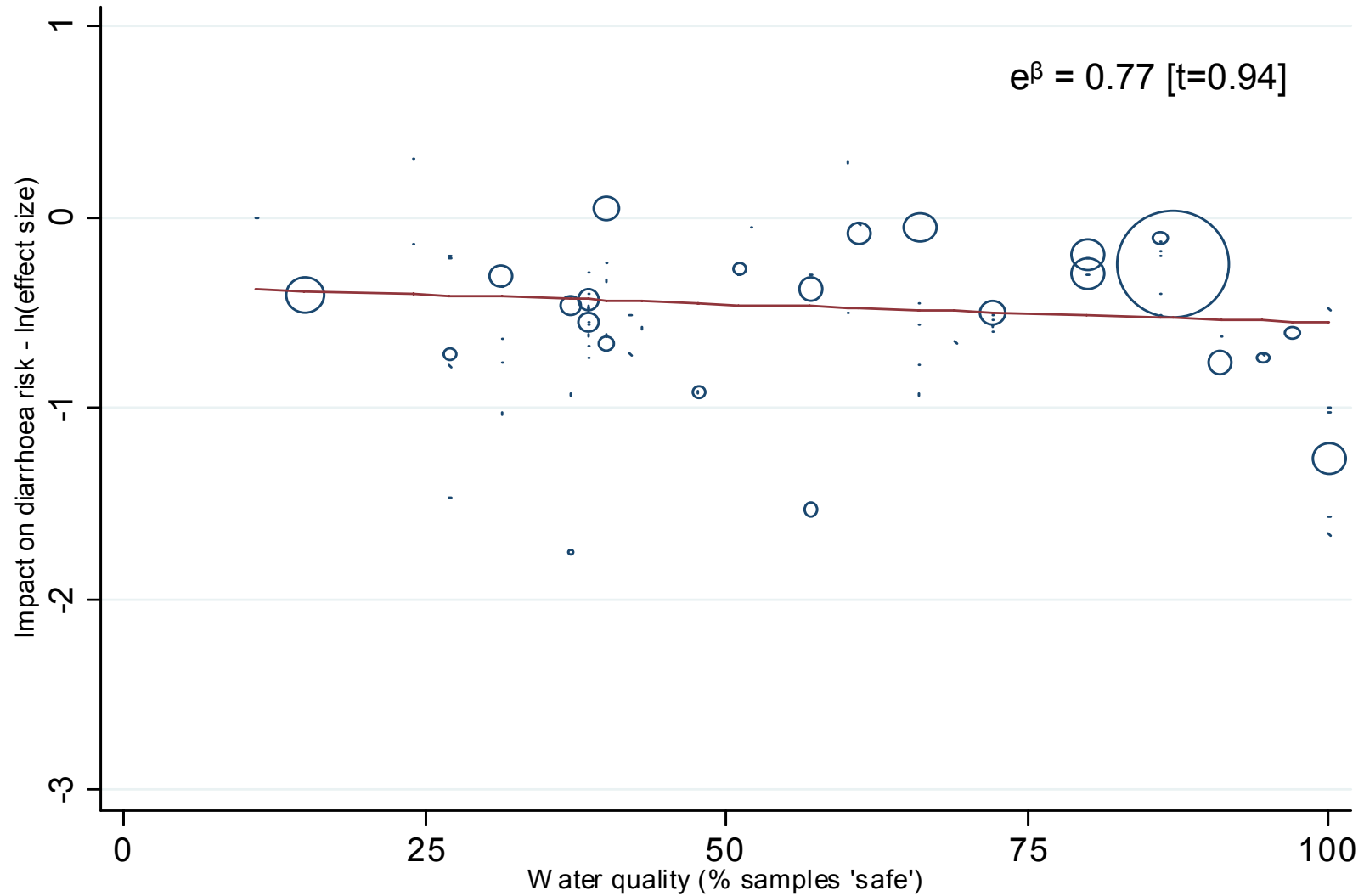


6. Causal chain analysis

- Evidence sought on why interventions work (or fail to work): collection of quantitative and qualitative information relating to causal chain - access, knowledge transmission, compliance (behaviour change)
- Quantitative information: most studies collect some data on compliance, at various levels:
 - Water supply, sanitation, hygiene: mainly degree of physical access or observed practice - compliance data low quality & not readily comparable
 - Water quality: bacteriological content, residual chlorine and/or observed use
- POU Water treatment:
 - Meta-regression suggests weak relationship between compliance and effectiveness
 - ⇒ Together with information on placebo-effect, conflict of interest and publication bias, suggests bias in existing trial evidence (Schmidt and Cairncross, 2009; Hunter, 2009)



Water quality and effectiveness

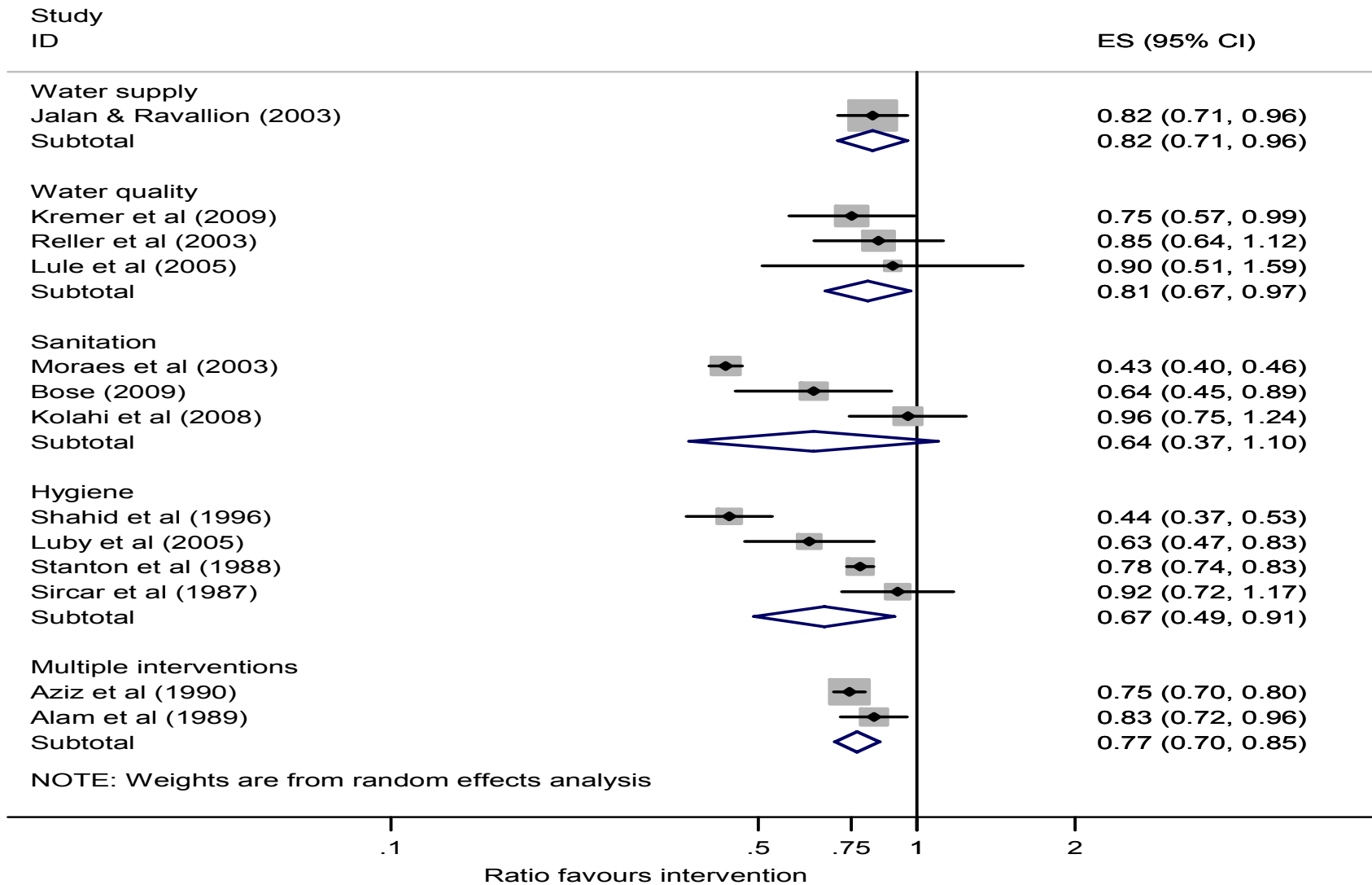




Sustainability

- Water supply and sanitation: studies conducted over large samples, multiple-years
- Water quality and hygiene: replicability demonstrated, but smaller samples and shorter-term
- Evidence on long-term sustainability limited
 - Only 5 follow-up studies assess health impact over one year after intervention completed
 - Only 3 studies (water quality) assess compliance more than a year after trial ended
- Analysis
 - Examination of effectiveness by study length (meta-analysis)
 - Data on compliance from follow-up studies

Water quality: less effective after 1 year





Evidence suggests compliance, and therefore impact, falls over time

- Follow-up studies of successful POU water treatment trials were conducted after the trial ended:
 - Ceramic filter provision in Cambodia; 3 years later only 31% households were still using the filters (Brown et al, 2007)
 - Pasteurisation in Kenya; 4 years later only 30% continued to pasteurise their water (Iijima et al, 2001)
 - Programme promoting POU water disinfectant in Guatemala 1 year later; repeated use among only 5% of households from original trials (Luby et al, 2008).
 - Water filters in Bolivia; compliance 67%; but assessment made only 4 months after trial ended (Clasen et al, 2006)



Reasons for low compliance

- Diffusion theory (Rogers, 2005) suggests compliance low because:
 - Reduction in diarrhoea not observed or seen as substantial enough benefit to warrant costs (money/time)
 - Adoption of innovations (social change) is a slow process (early adopters vs. laggards)
 - Other factors important (e.g. taste/smell, convenience, time-savings)

- Only one study evaluated the reasons low compliance: Source water treatment (UV filtration) in Mexico, conducted 5 years after programme initiation (de Wilde et al 2008)
 - No impact on diarrhoea incidence - 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



Thank you!

- Draft report available for download (comments welcomed):

<http://www.3ieimpact.org/admin/pdfs2/17.pdf>

- Review methods/examples:

www.cochrane-handbook.org/

www.campbellcollaboration.org/systematic_reviews/index.php

www.3ieimpact.org/syntheticreviews

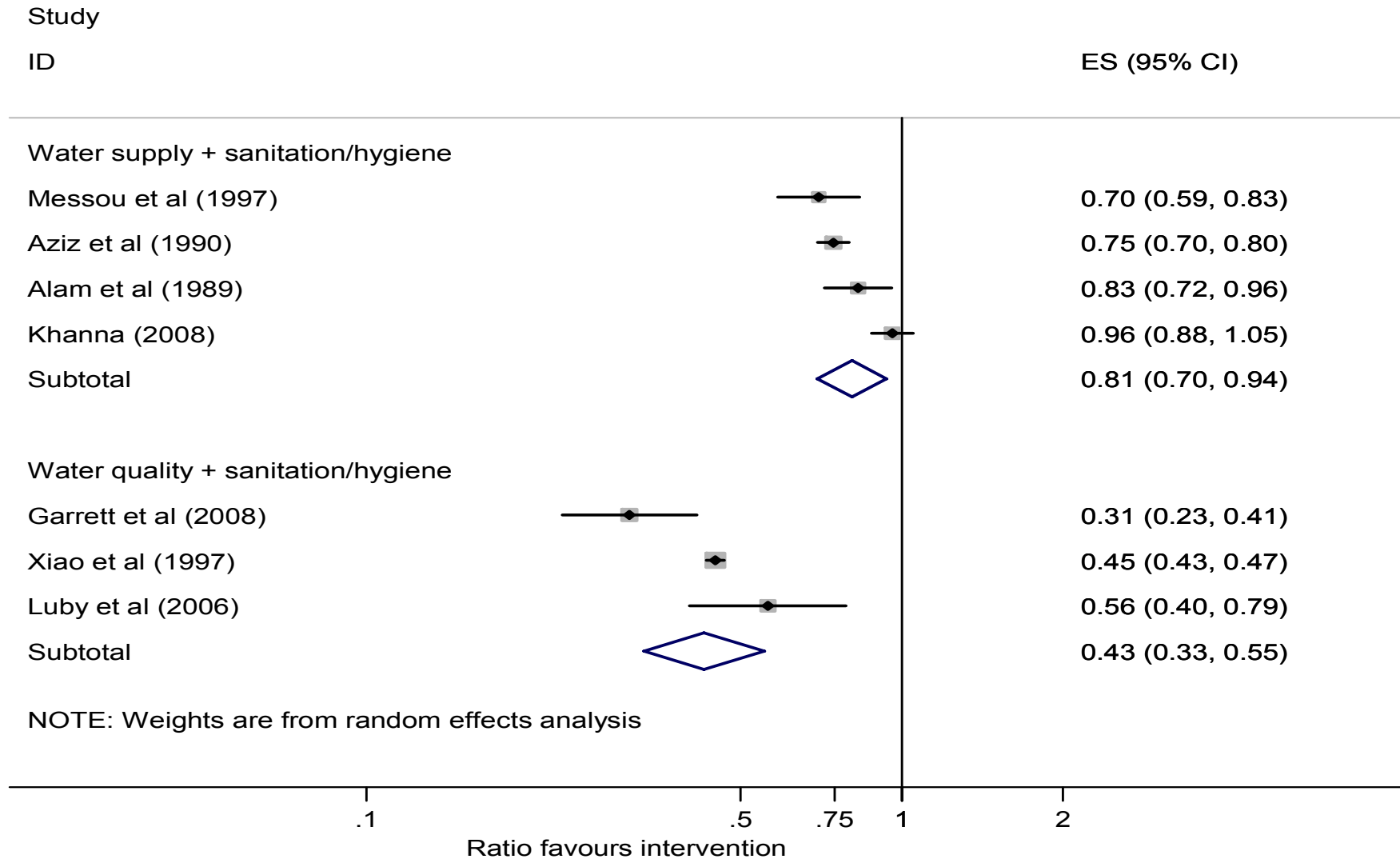


7. Conclusions

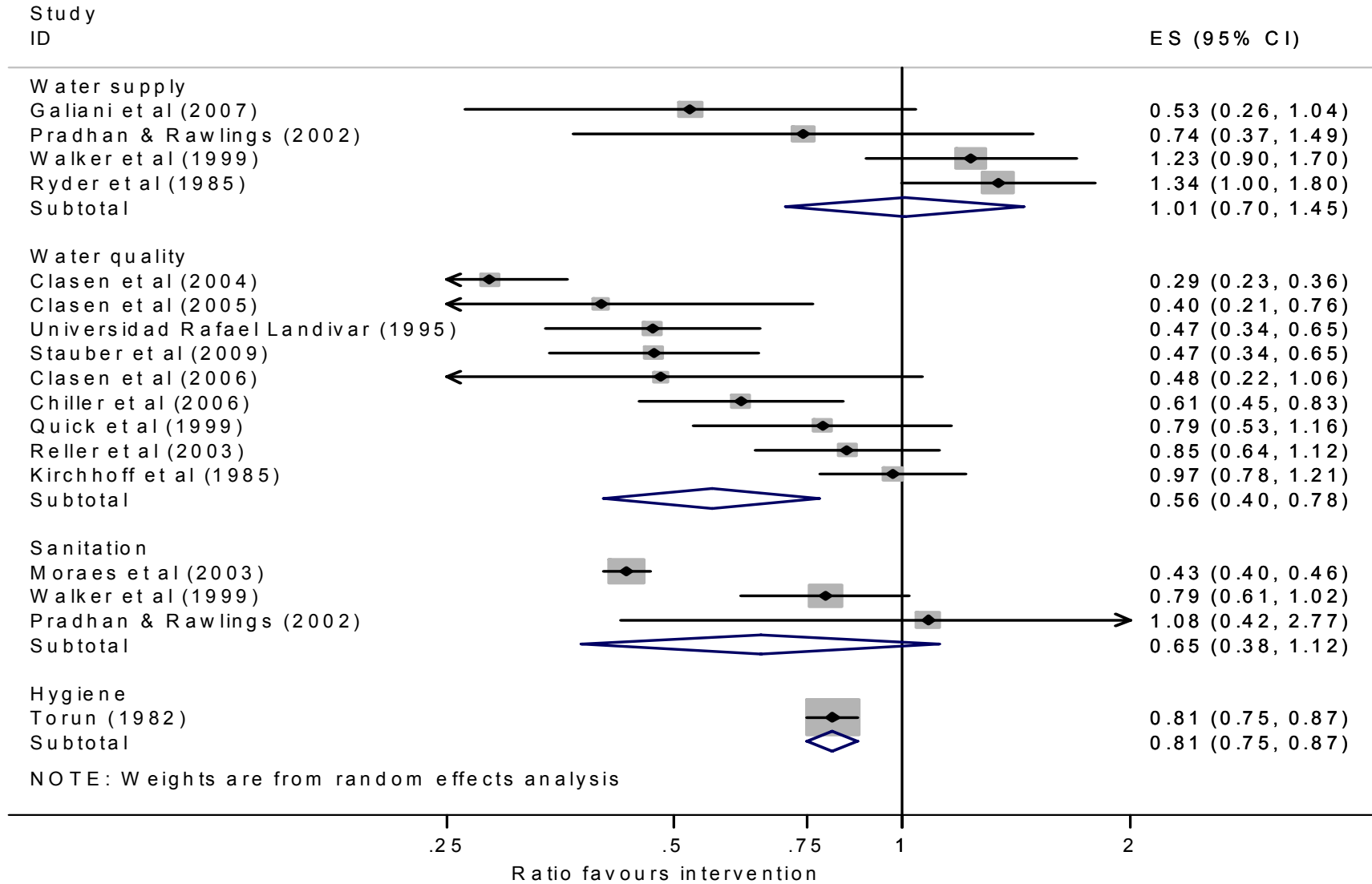
- Impact:
 - Water supply interventions do not appear effective in reducing diarrhoea (although piped water to household is)
 - Water quality at point-of-use very effective under trial conditions, but concerns about longer-term compliance and therefore impact
 - Water quality at source effective (limited range of trials)
 - Sanitation highly effective – but more studies (esp experimental) needed
 - Hygiene – effective and evidence does not suggest unsustainable
 - Multiple interventions: more evidence from factorial studies needed

- No one single intervention for improving access to water and sanitation for reducing diarrhoeal disease:
 - The ‘right’ solution is the one that fits the (social, economic) context
 - Other outcomes may be just as important for families (time-savings)
 - Emphasise behavioural factors, particularly where these are of overriding importance to adoption and sustainability

Effectiveness: Multiple interventions



Effectiveness: LAC studies (detail)





Impact heterogeneity

- Ratio type: use of risk, rate, prevalence or odds ratios does not explain differences in effectiveness between interventions
- Seasonality: no systematic difference between interventions conducted in rainy/dry seasons
- Some evidence that water quality and hygiene trials less effective when placebo-control used, and more effective when conflict of interest declared
- Evidence that water and hygiene interventions more effective when conducted in environments in which water supply and sanitation provision already improved
- Differences not consistently observed for study type (RCTs) and study quality