Linking toilets to stunting
UNICEF ROSA ‘Stop Stunting’ Conference
Delhi (November 2013)

Prof Sandy Cairncross
Environmental Health Group
London School of Hygiene and Tropical Medicine
Stunting globally

Short-term
• ↑ risk of mortality
• ↑ susceptibility to infections/morbidity

Long-term
• Educational achievement
• Work capacity
• Economic productivity

34 countries which account for 90% of undernutrition. Source: Bhutta et al, 2013
Here in India

Stunted: <-2 s.d. below median h/a of ref. pop.
Underweight: <-2 s.d. below median w/a
Wasted: <-2 s.d. below median w/h
SOURCE: Paul et al. Reproductive health, and child health and nutrition in India: meeting the challenge. (Lancet 2011)
A tough nut to crack

Benefits during the life course
- Cognitive, motor, and socioemotional development
- School performance and learning capacity
- Adult stature and obesity
- Work capacity and productivity

Optimum fetal and child nutrition and development
- Breastfeeding, nutrient-rich foods, and eating routine
- Feeding and caregiving practices, parenting, and stimulation
- Low burden of infectious diseases
- Food security, including availability, economic access, and use of food
- Feeding and caregiving resources (maternal, household, and community)
- Access to and use of health services, a safe and hygienic environment

Nutrition specific interventions and programmes
- Adolescent health and preconception nutrition
- Maternal dietary supplementation
- Micronutrient supplementation or fortification
- Breastfeeding and complementary feeding
- Dietary supplementation for children
- Dietary diversification
- Feeding behaviours and stimulation
- Treatment of severe acute malnutrition
- Disease prevention and management
- Nutrition interventions in emergencies

Nutrition sensitive programmes and approaches
- Agriculture and food security
- Social safety nets
- Early child development
- Maternal mental health
- Women’s empowerment
- Child protection
- Classroom education
- Water and sanitation
- Health and family planning services

Knowledge and evidence
- Politics and governance
- Leadership, capacity, and financial resources
- Social, economic, political, and environmental context (national and global)

Building an enabling environment
- Rigorous evaluations
- Advocacy strategies
- Horizontal and vertical coordination
- Accountability, incentives regulation, legislation
- Leadership programmes
- Capacity investments
- Domestic resource mobilisation

Nutrition-specific interventions

Nutrition-specific interventions & programmes:
• Adolescent health, preconception nutrition
• Maternal dietary supplementation
• Micronutrient supplementation or fortification
• Breastfeeding and complementary feeding
• Dietary supplementation for children
• Dietary diversification
• Feeding behaviours and stimulation
• Treatment of severe acute malnutrition
• Disease prevention and management
• Nutrition interventions in emergencies

If 10 core nutrition specific interventions were scaled up at 90% coverage, they could reduce stunting by 20% (Bhutta et al 2013)

How do we close the gap?
Nutrition-sensitive interventions

Nutrition sensitive programmes and approaches
• Agriculture and food security
• Social safety nets
• Early child development
• Maternal mental health
• Women’s empowerment
• Child protection
• Classroom education
• Water and sanitation
• Health and family planning services

What is the contribution of sanitation and water... and hygiene?
## WASH costs & income affect nutrition

<table>
<thead>
<tr>
<th>Costs</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Then</strong></td>
<td>Chadwick’s dream for 19th century London: sewage farming to feed the urban poor</td>
</tr>
<tr>
<td><strong>Now</strong></td>
<td>Eco-San, composting toilets, in rural settings if safe operation is possible. Payments to water vendors typically consume 20% of household income. This comes from the food budget. Water supply frees the money for food.</td>
</tr>
<tr>
<td>Landlords in India increase rent for a property with a (subsidised) latrine. This is one reason why SPARC India promotes communal toilet blocks.</td>
<td></td>
</tr>
</tbody>
</table>
Plants on the right were grown with cattle kraal manure, those on left with “humanure”.
Linking WASH to undernutrition

- Poor WASH
  - Faecal-oral exposure
    - Environmental Enteropathy
    - Nematode infection
    - Diarrhoeal Diseases

- Poor nutritional status
Diarrhoea and stunting

Diarrhoea is associated with poor nutritional status but causal link is hard to demonstrate

Recent analysis of 9 studies with daily diarrhoea morbidity data and longitudinal anthropometry (Checkley et al, 2008):

Odds of stunting at age 24 months increased by 1.13 (95% C.I. 1.07, 1.19) for every five episodes

Consistent with hypothesis that higher cumulative burden of diarrhoea increases risk of stunting
Diarrhoea and stunting

Cf. CHERG:

“Proportion of stunting attributable to five or more episodes of diarrhoea before 2 years of age was 25% (C.I. 8–38%)”

Diarrhoea is associated with poor nutritional status but causal link is hard to demonstrate

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Nematode infections

Parasitic worm infections associated with poor sanitation that limit growth and cognitive development:

• *Ascaris lumbricoides* (Roundworm)
  Intestinal obstruction & Vit A malabsorption

• *Trichuris trichiura* (Whipworm)
  Dysentery syndrome, colitis, rectal prolapse

• *N. americanus & A. duodenale* (Hookworms)
  Intestinal blood loss, iron deficiency, PEM

SOURCE: Bethony et al, 2006
Environmental Enteric Dysfunction

SOURCES:
Images - Garcia, 1968;
What does this mean for South Asia? India as an example

Diarrhoea
A leading cause of under-5 deaths in India (13%)

Nematodes
284 million nematode infections

Environmental enteric dysfunction Plausibly high prevalence but not measured; strong association found in Bangladesh (Lin et al 2013)

Reproductive health, and child health and nutrition in India: meeting the challenge. Lancet
A double threat: open defecation amid high population density
1. Lots of ways in which faecally contaminated environments might influence nutritional status.

2. Nutrition-specific interventions alone will not address stunting

3. What evidence is there that WASH interventions are effective in improving childhood nutrition?
Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children (Review)

Review protocol

• All included studies to have controlled design
  – RCTs, BACC, ITS

• Participants: children < 18 years old

• Intervention types
  – Improving access to facilities which separate human excreta hygienically from human contact
  – Promotion of hand washing with soap
  – Introducing a new/improved water supply and/or improved distribution
  – Improving the microbiological quality of drinking water
Outcomes, search strategy

• Primary outcomes (z-scores)
  – Weight-for-height (wasting)
  – Weight-for-age (underweight)
  – Height-for-age (stunting)

• Secondary outcomes
  – All other child anthropometric measures
  – Biochemical measures of micronutrient status

• 6 databases searched; keyword and MeSH terms
• 3 main Chinese databases searched
Search results

<table>
<thead>
<tr>
<th>Study</th>
<th>MD (95% CI)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Du Preez 2010</td>
<td>0.28 (-0.06 to 0.62)</td>
<td>332</td>
</tr>
<tr>
<td>Du Preez 2011</td>
<td>0.11 (-0.19 to 0.41)</td>
<td>325</td>
</tr>
<tr>
<td>McGuigan 2011</td>
<td>0.22 (-0.04 to 0.48)</td>
<td>750</td>
</tr>
<tr>
<td>Luty 2004</td>
<td>-0.01 (-0.37 to 0.35)</td>
<td>873</td>
</tr>
<tr>
<td>Luty 2006 (Soap)</td>
<td>0.08 (-0.13 to 0.29)</td>
<td>534</td>
</tr>
<tr>
<td>Luty 2006 (Soap &amp; Floc)</td>
<td>0.06 (-0.12 to 0.24)</td>
<td>549</td>
</tr>
<tr>
<td>Luty 2006 (Floc &amp; Bleach)</td>
<td>0.04 (-0.08 to 0.16)</td>
<td>1054</td>
</tr>
<tr>
<td>Arnold 2009</td>
<td>0.04 (-0.10 to 0.27)</td>
<td>876</td>
</tr>
<tr>
<td>Bowen 2012</td>
<td>-0.08 (-0.29 to 0.13)</td>
<td>461</td>
</tr>
<tr>
<td>Ferr 2012</td>
<td>0.22 (0.11 to 0.33)</td>
<td>1899</td>
</tr>
<tr>
<td>Hasan 1989</td>
<td>No statistically significant differences between intervention and control group</td>
<td>405</td>
</tr>
<tr>
<td>Langford 2011</td>
<td>-0.13 (-0.54 to 0.28)</td>
<td>88</td>
</tr>
</tbody>
</table>

(none-randomised studies)
Included studies

- 12 studies from 10 countries (not India unfortunately)
- Wide range of WASH interventions (including sanitation)
- Duration: 6 mo to 5 years
- Large sample of <5 observations: n=8,500
- Range of study designs; generally poor quality (risk of bias)
  - Randomised controlled trials (3)
  - Follow-up of cluster randomised controlled trial (1)
  - Longitudinal study with control group (3)
  - Repeat cross-sectional with control group (3)
  - Controlled before-and-after study (1)
  - Cross-sectional with intervention and historic control group matched by propensity score matching (1)
## Results table n=8,500

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Reported effect (HAZ unless stated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmed 1993</td>
<td>298</td>
<td>Mean WAZ: P&lt; 0.05</td>
</tr>
<tr>
<td>Arnold 2009</td>
<td>877</td>
<td>MD: 0.04 (-0.19, 0.27)</td>
</tr>
<tr>
<td>Bowen 2012</td>
<td>461</td>
<td>MD: -0.08 (-0.29, 0.13)</td>
</tr>
<tr>
<td>Du Preez 2010</td>
<td>329</td>
<td>MD: 0.15 (-0.14, 0.44) (not published)</td>
</tr>
<tr>
<td>Du Preez 2011</td>
<td>521</td>
<td>MD: 0.12 (-0.15, 0.39)</td>
</tr>
<tr>
<td>Fenn 2012</td>
<td>1899</td>
<td>MD: 0.22 (0.11, 0.33)</td>
</tr>
<tr>
<td>Guzman 1968</td>
<td>N.D.</td>
<td>Mean height: no stat. test</td>
</tr>
<tr>
<td>Hasan 1989</td>
<td>405</td>
<td>No statistically different differences</td>
</tr>
<tr>
<td>Huttly 1990</td>
<td>180 – 368</td>
<td>Decline in % children with low W/H: P&lt;0.005</td>
</tr>
<tr>
<td>Langford 2011</td>
<td>88</td>
<td>MD: -0.13 (-0.54, 0.28)</td>
</tr>
<tr>
<td>McGuigan 2012</td>
<td>753</td>
<td>MD: 0.18 (-0.06, 0.42) (not published)</td>
</tr>
<tr>
<td>Schlesinger 1983</td>
<td>199</td>
<td>% low weight: P&lt;0.05 for change in control group</td>
</tr>
</tbody>
</table>
# HAZ meta-analysis

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>WASH Intervention</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Total</td>
<td>Mean</td>
</tr>
<tr>
<td>Du Preez 2010</td>
<td>-1.12</td>
<td>1.74</td>
<td>171</td>
<td>-1.4</td>
</tr>
<tr>
<td>Du Preez 2011</td>
<td>-0.74</td>
<td>1.65</td>
<td>275</td>
<td>-0.85</td>
</tr>
<tr>
<td>McGugan 2011</td>
<td>-1.56</td>
<td>1.66</td>
<td>418</td>
<td>-1.76</td>
</tr>
<tr>
<td>Luby 2004</td>
<td>-2.67</td>
<td>2.58</td>
<td>603</td>
<td>-2.66</td>
</tr>
<tr>
<td>Luby 2006 (Soap)</td>
<td>-0.97</td>
<td>2.11</td>
<td>425</td>
<td>-1.05</td>
</tr>
<tr>
<td>Luby 2006 (Soap &amp; Floc)</td>
<td>-0.99</td>
<td>1.79</td>
<td>441</td>
<td>-1.05</td>
</tr>
<tr>
<td>Luby 2006 (Floc &amp; Bleach)</td>
<td>-1.01</td>
<td>1.29</td>
<td>838</td>
<td>-1.05</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>3174</td>
<td></td>
<td>1450</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.00, Chi² = 3.11, df = 6 (P = 0.79), I² = 0%
Test for overall effect: Z = 1.99 (P = 0.05)

- Cochrane meta-analysis suggests that WASH improves HAZ by ~0.15 SD
- Approximately equivalent to 0.5 cm at 24 months; relative reduction in stunting prevalence of 15%
- “Suggestive evidence of a small benefit”

**But:**
- All studies medium to high risk of bias
- Mostly PoU water treatment (1* HWWS)
- No sanitation studies
New studies since June 2012

Major contribution to the literature since the review was conducted is randomised controlled trials for the effect of sanitation on stunting

5 new ‘effectiveness’ studies published since June 2012 (3 in South Asia [India] and another nearby [Indonesia]):

• Cameron et al 2013 (Indonesia)
• Hammer & Spears 2013 (India)
• Patil et al 2014 (India)
• Clasen et al 2014 (India)
• Alzua et al [forthcoming] (Mali)
Mixed results

Delivery (fidelity/compliance) varied significantly:
Open defecation fell by 70% in Mali (Alzua) but likely much lower in Indian settings and Indonesia
(Hammer & Spears 2014; Patil et al 2014; Clasen et al 2014)

Intermediary outcomes (household stored water quality)
Small (Patil et al 2014) or no effect (Clasen et al 2014; Alzua et al forthcoming) on microbial quality of source and/or household stored water (+/- faecal indicator organisms)

Health outcomes
No statistically significant effect in ‘intention to treat’ (ITT) analysis:
(Patil et al 2014, Clasen et al 2014, Cameron et al 2013*)

Statistically significant effect in ‘intention to treat’ (ITT) analysis:
0.3-0.4 HAZ SD (Hammer & Spears 2013), 0.13 HAZ SD (Alzua et al forthcoming)

* Cameron reported an effect in sub-group analysis on ‘non-poor sample with no sanitation at baseline’
** Both Hammer & Spears (2013) and Alzua et al (forthcoming) used a difference in difference approach
Enduring questions

• Are the interventions included in the review effective? Sustainable? Uptake was often poor, even in relatively short-term interventions.
• It is unclear if the intake of pathogens in the children has actually decreased – missing steps in the causal pathway?
• Insufficient evidence to review effect of intervention duration – did outcomes improve over time?
• Limitations of interventions – are these appropriate for a target population of toddlers <2 yrs?
Looking ahead

A number of important RCTs are currently in progress:

- Colford et al: Bangladesh & Kenya (z-scores, MUAC, EE markers)
- Humphrey et al: Zimbabwe (z-scores, MUAC, EE markers)
- Brown et al: Maputo (z-scores, EE markers, specific infections)
And what about Maharashtra?

- Stunting fell from 39% to 24% in 2006 – 2012
- Decline there was modest in 1993 – 2006
- Most possible determinants were average or poor: HH income, Governance, food security, PDS, open defecation, health system.
- High performing indicators included GDP, poverty reduction, women’s status and ICDS front-line staffing  (Haddad et al. 2014)

*Analysis of recent surveys indicated that:*

- Broad range of determinants have improved: age of mother at first birth, maternal underweight, maternal literacy, antenatal visits, delivery at home, child feeding practices, access to toilets, access to ICDS
- Some determinants have not improved: educational attainment, improved water access; some breastfeeding practices (e.g. early initiation); child dietary diversity
- Household food security and water and sanitation access are not associated with stunting in the regressions.

*It appears that the mother’s competence and actual behaviour is more relevant than access to physical facilities; e.g. water supplies, latrines.*
South Asia –
A challenge and an opportunity

Challenge – high levels of OD and high levels of stunting
Opportunity – a link between them provides an opportunity for action

How can WASH interventions benefit nutrition more?

• Affordable WASH to put water vendors out of business and keep sanitation prices down
• Make sanitation = open defecation free (also bolsters deworming efforts)
• Implement effective hygiene promotion
• Economic/anthropometric data to target WASH at vulnerable populations
• In India, support SBM and AWW recruitment

Design and deliver WASH interventions to prevent exposure among children <24 months:

• Safe disposal of child faeces
• Complementary/infant/child food hygiene
• Management of animal waste
• Play pens etc
Thank you!

www.shareresearch.org
sandy.cairncross@lshtm.ac.uk

Shaping WASH policy and practice: research into action