

# Hygienic Environments for Infants & Young Children

A Review of the Literature  
April 5, 2018

**Presenters**

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# What is WASHPaLS?



- *Water, Sanitation, & Hygiene Partnerships for Learning and Sustainability.* 5-year (2016–2021) research and technical assistance project
- **Goal:** Enhance global learning and adoption of the evidence-based programmatic foundations needed to achieve the SDGs and strengthen USAID’s WASH programming at the country level



# The WASHPaLS Research Design Summary

Achieve  
universal  
sanitation and  
hygiene

Goal

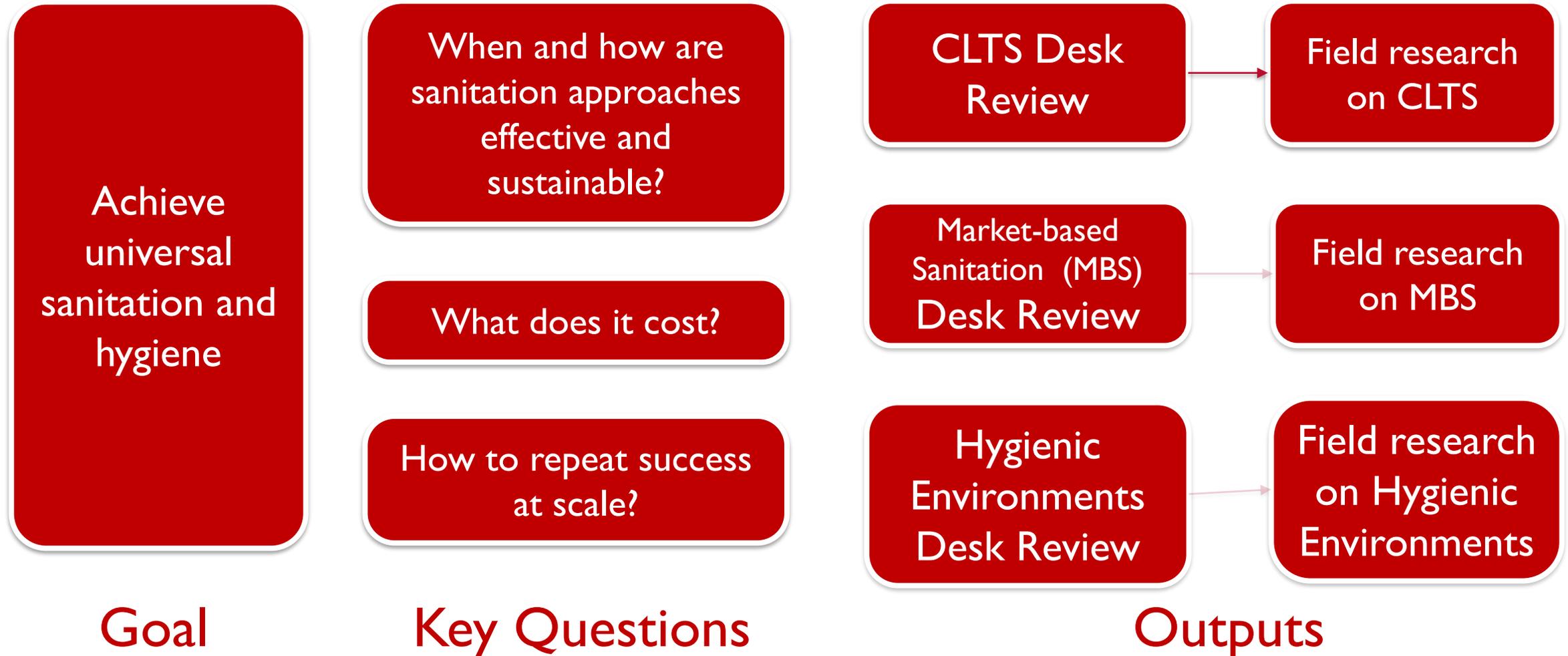
When and how are  
sanitation approaches  
effective and  
sustainable?

What does it cost?

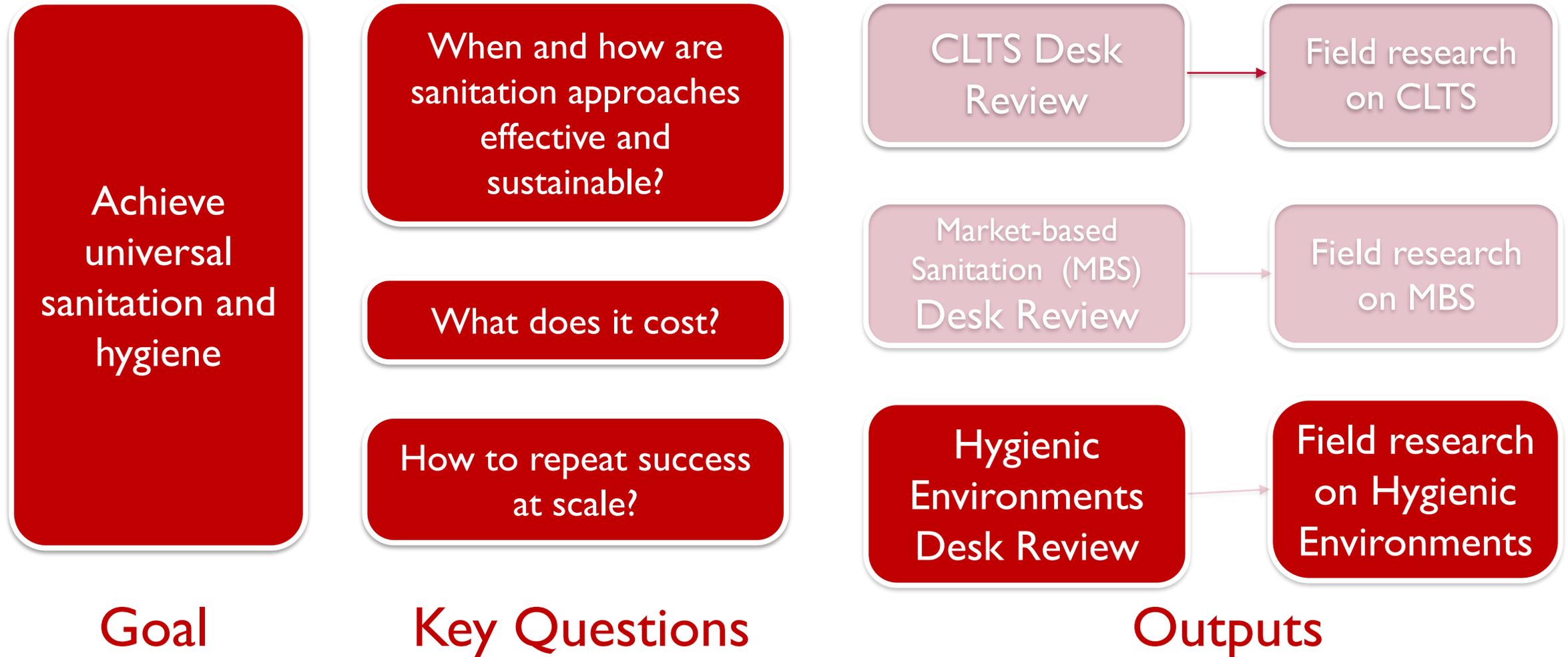
How to repeat success  
at scale?

Key Questions

# The WASHPaLS Research Design Summary



# The WASHPaLS Research Design Summary



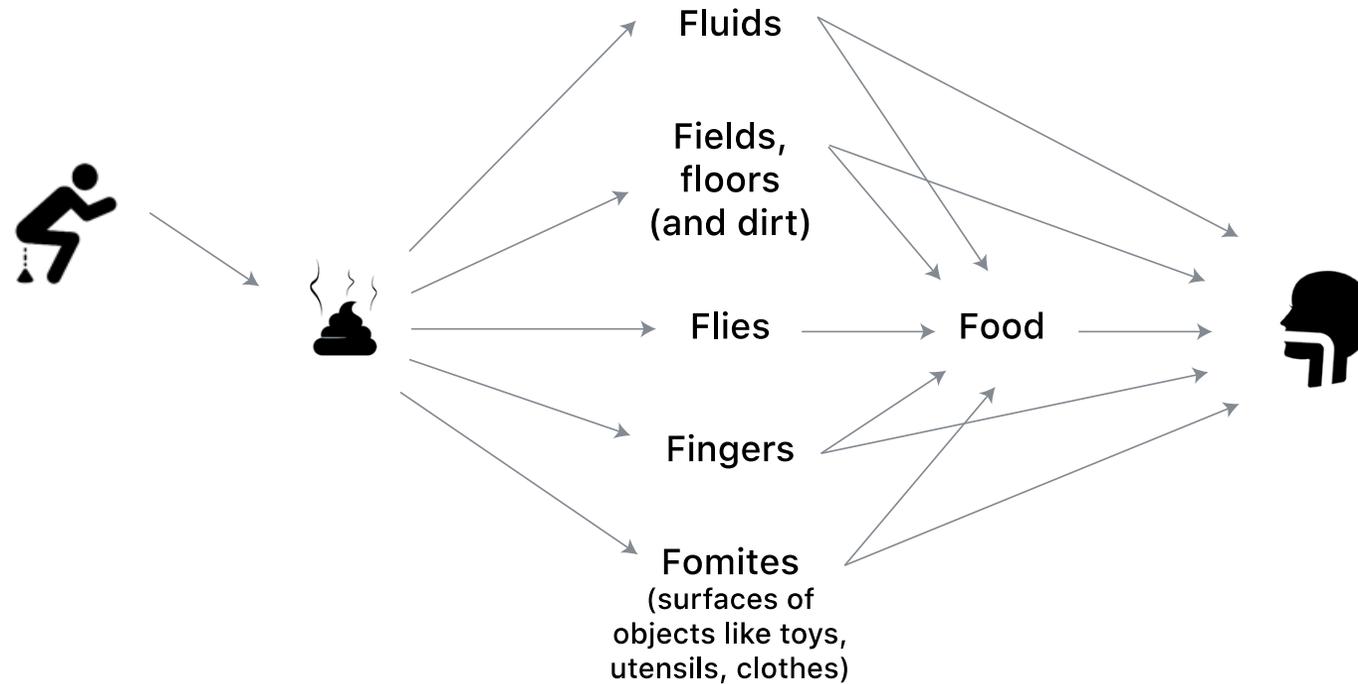
# Why study hygienic environments?

- Achieving widespread reductions in child stunting in low- and middle-income countries remains elusive
- Enteric disease and child growth faltering persist even with the provision of traditional nutrition and WASH interventions
- There is growing research interest in the relationship between hygienic environments and child growth
- Interventions to reduce infant and young child (IYC) exposure to excreta in the home environment are being deployed, but their effectiveness is unknown

# Presentation overview

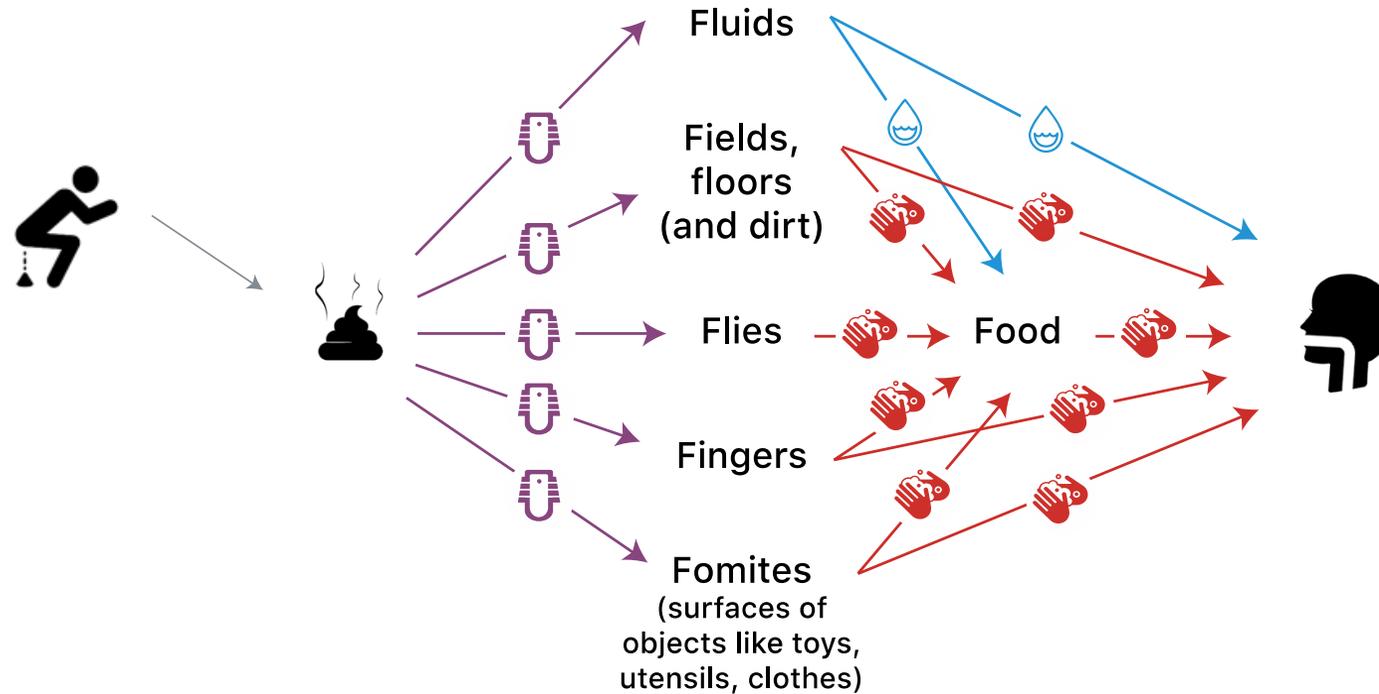
- Review the pathways presenting major exposure risks to IYC
- Summarize the evidence of WASH interventions reducing the risk of diarrhea and growth faltering among <5s
- Discuss underemphasized sources and pathways, and their impact on IYC
- Highlight current efforts to block the underemphasized pathways of exposure, and their effectiveness
- Discuss WASHPaLS next steps

# The F-diagram model of disease transmission



Adapted from Wagner & Lanoix, 1958. This diagram is a derivative of Figures 1 and 3 in Penakalapati et al., 2017 (DOI: [10.1021/acs.est.7b02811](https://doi.org/10.1021/acs.est.7b02811)), under a Creative Commons CC-BY 4.0 Usage Agreement with the American Chemical Society.

# WASH barriers to transmission (general)



Disrupted by

-  → Sanitation, safe feces disposal
-  → Water treatment
-  → Personal, household, and food hygiene

Adapted from Wagner & Lanoix, 1958. This diagram is a derivative of Figures 1 and 3 in Penakalapati et al., 2017 (DOI: [10.1021/acs.est.7b02811](https://doi.org/10.1021/acs.est.7b02811)), under a Creative Commons CC-BY 4.0 Usage Agreement with the American Chemical Society.

## POLL #1:

What poses the greatest risk to the health of infants and young children in home environments?

- A. Inadequate water supply
- B. Unsafe water supply
- C. Open defecation by humans
- D. Unclean hands
- E. Domestic animal excreta
- F. Poor food hygiene
- G. B, C and F
- H. All of the above

(you must answer or “pass”  
to see subsequent slides)

# WASH and diarrhea: dozens of observational studies, trials, several systematic reviews and meta-analyses

Tropical Medicine and International Health

doi:10.1111/tmi.12331

VOLUME 19 NO 8 PP 928–942 AUGUST 2014



## Systematic Review

### Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: systematic review and meta-regression

Jennyfer Wolf<sup>1,2,3</sup>, Annette Prüss-Ustün<sup>1</sup>, Oliver Cumming<sup>4</sup>, Jamie Bartram<sup>5</sup>, Sophie Bonjour<sup>1</sup>, Sandy Cairncross<sup>4</sup>, Thomas Clasen<sup>6</sup>, John M. Colford Jr<sup>7</sup>, Valerie Curtis<sup>4</sup>, Jennifer De France<sup>1</sup>, Lorna Fewtrell<sup>8</sup>, Matthew C. Freeman<sup>6</sup>, Bruce Gordon<sup>1</sup>, Paul R. Hunter<sup>9,10</sup>, Aurelie Jeandron<sup>4</sup>, Richard B. Johnston<sup>1,11</sup>, Daniel Mäusezahl<sup>2,3</sup>, Colin Mathers<sup>12</sup>, Maria Neira<sup>1</sup> and Julian P. T. Higgins<sup>13,14</sup>

#### Hand washing promotion for preventing diarrhoea (Review)

Ejemot-Nwadiaro RI, Ehiri JE, Arikpo D, Meremikwu MM, Critchley JA

#### Interventions to improve disposal of human excreta for preventing diarrhoea (Review)

Clasen TF, Bostoen K, Schmidt WP, Boisson S, Fung ICH, Jenkins MW, Scott B, Sugden S, Cairncross S

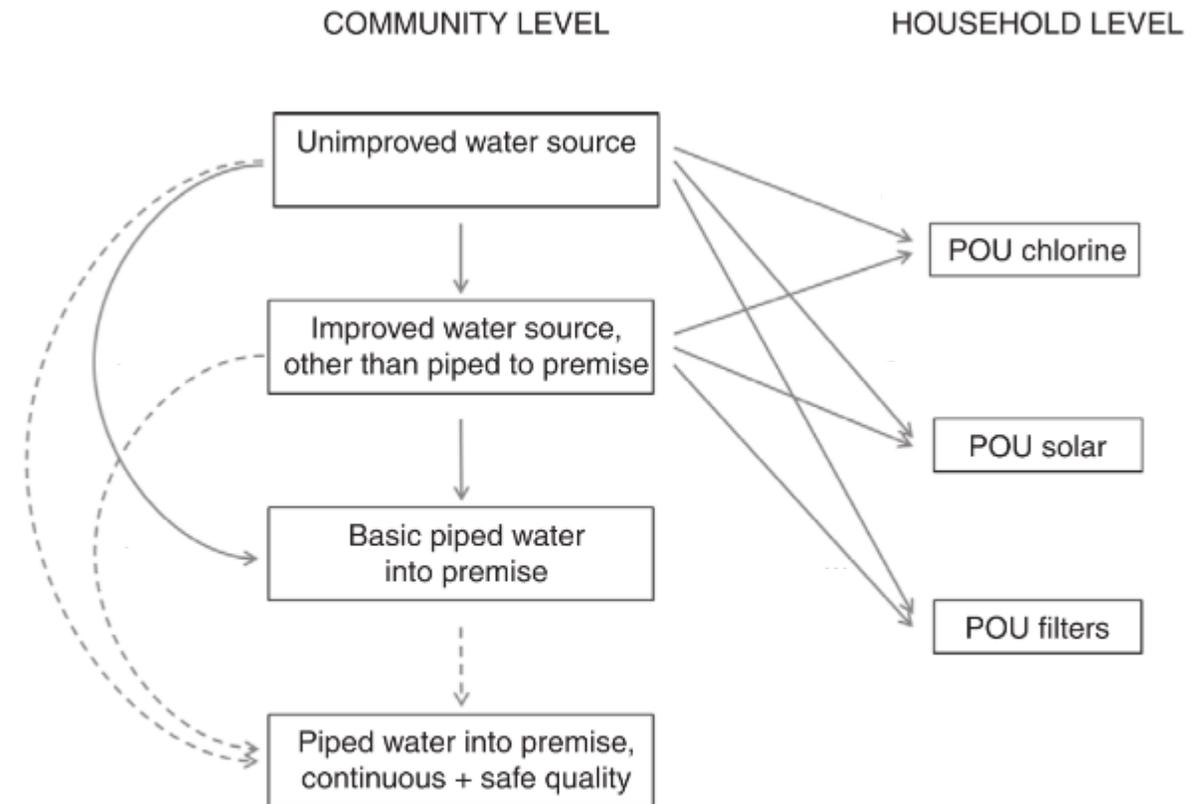
#### Interventions to improve water quality for preventing diarrhoea (Review)

Clasen TF, Alexander KT, Sinclair D, Boisson S, Peletz R, Chang HH, Majorin F, Cairncross S

# Improvements in water quality (and supply), sanitation, and hand washing associated with lower diarrhea risks.

## However:

- The quality of the evidence is varied
- There is great effect variability by and within intervention type
- The combination of baseline condition and intervention type matter significantly



Wolf et al. 2014

# WASH and child growth: fewer studies than for diarrhea

## WASH Benefits RCTs

### Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Bangladesh: a cluster randomised controlled trial

*Stephen P Luby, Mahbubur Rahman, Benjamin F Arnold, Leanne Unicomb, Sania Ashraf, Peter J Winch, Christine P Stewart, Farzana Begum, Faruq Hussain, Jade Benjamin-Chung, Elli Leontsini, Abu M Naser, Sarker M Parvez, Alan E Hubbard, Audrie Lin, Fosiul A Nizame, Kaniz Jannat, Ayse Ercumen, Pavani K Ram, Kishor K Das, Jaynal Abedin, Thomas F Clasen, Kathryn G Dewey, Lia C Fernald, Clair Null, Tahmeed Ahmed, John M Colford Jr*

### Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial

*Clair Null, Christine P Stewart, Amy J Pickering, Holly N Dentz, Benjamin F Arnold, Charles D Arnold, Jade Benjamin-Chung, Thomas Clasen, Kathryn G Dewey, Lia C H Fernald, Alan E Hubbard, Patricia Kaniger, Audrie Lin, Stephen P Luby, Andrew Mertens, Sammy M Njenga, Geoffrey Nyambane, Pavani K Ram, John M Colford Jr*



### Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children (Review)

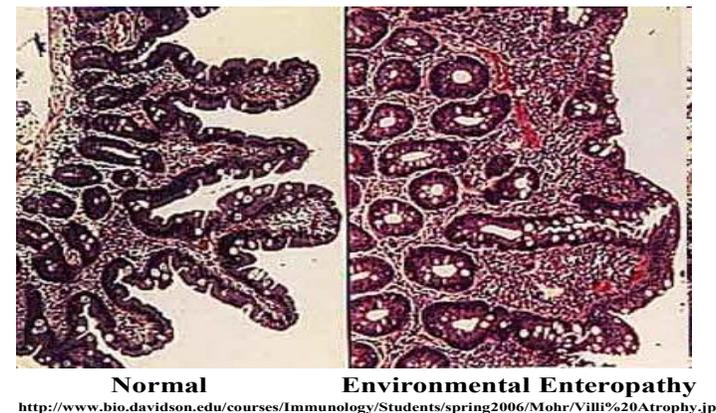
Dangour AD, Watson L, Cumming O, Boisson S, Che Y, Velleman Y, Cavill S, Allen E, Uauy R

# How important are community-wide measures?

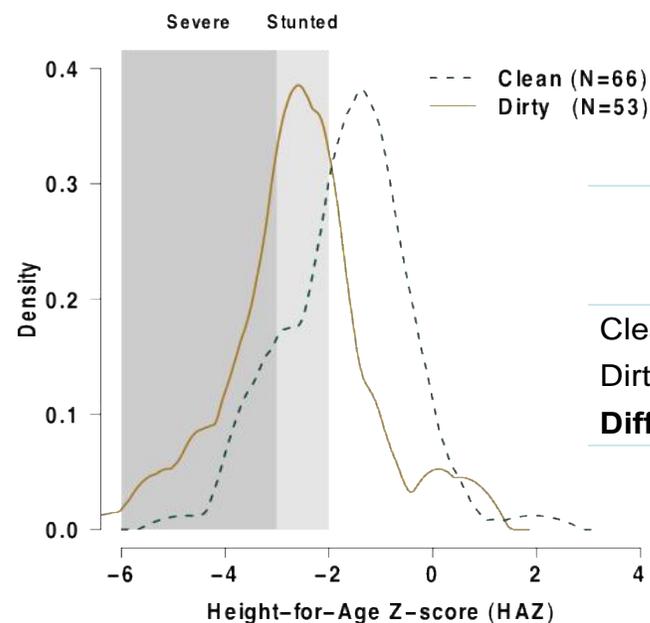
- There is reason to believe that community-level toilet coverage imparts herd protection against diarrhea and growth faltering, **particularly in remote, sparsely populated settings** (*Jung et al, 2015, Fuller et al 2016, Harris et al, 2017*)
- A high-quality CLTS program in rural Mali showed improvements in child linear growth (though without an effect on diarrhea) (*Pickering et al, 2015.*)

# The Environmental Enteric Dysfunction (EED) hypothesis

- Evidence exists that dirty environments can impair child growth even in the absence of diarrhea (*Lin et al 2013*)
- Is EED, a condition of low intestinal permeability and poor nutrient absorption, the cause?
- EED is proving difficult to measure. The widely used urine test (L:M ratio) was recently shown to have poor agreement with blood and stool biomarkers of intestinal function (*Campbell et al 2017*)



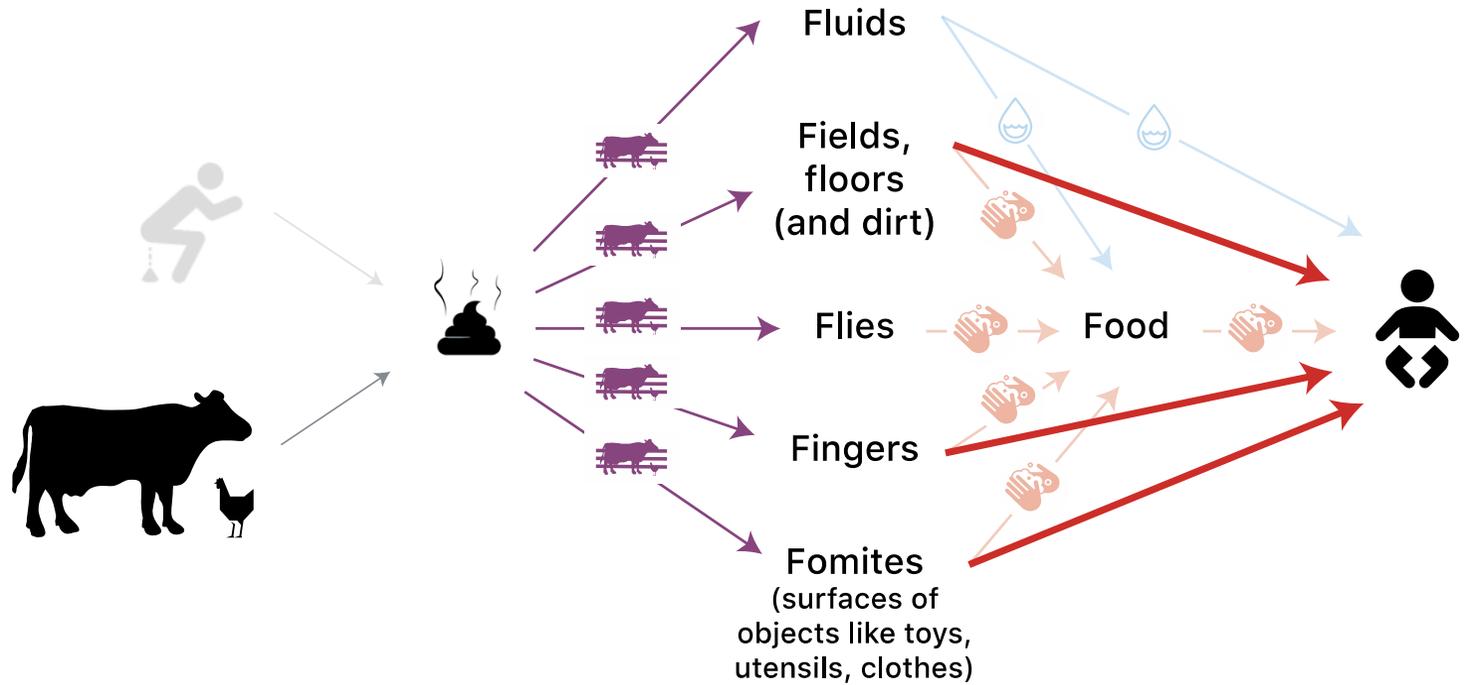
Children from cleaner households  
0.9 SDs taller



	Mean HAZ (2010)	Stunting % (2010)
Clean	-1.66	33%
Dirty	-2.57	74%
<b>Difference</b>	<b>0.91</b>	<b>-40%</b>

Lin et al 2013

# Emphasizing IYC and the Animal Feces Pathway



Disrupted by

-  Animal containment
-  Water treatment
-  Personal, household, and food hygiene

Adapted from Wagner & Lanoix, 1958. This diagram is a derivative of Figures 1 and 3 in Penakalapati et al., 2017 (DOI: [10.1021/acs.est.7b02811](https://doi.org/10.1021/acs.est.7b02811)), under a Creative Commons CC-BY 4.0 Usage Agreement with the American Chemical Society.

## **POLL #2:**

Has your organization attempted to address the ‘under-emphasized’ sources or pathways?

A = Yes

B = Contemplating, under development

C= No

# Safe Disposal of Infant & Young Child Feces



**Don't worry!  
That's just  
for adults**



## *Underemphasized Source:* **IYC feces**

- In 15 of 25 LMIC, over half of households practiced unsafe disposal of child <3 feces (WSP, 2015)
- Unsafe IYC feces linked with
  - 5 times greater odds of detecting *E. coli* in areas where children were observed playing
  - higher EED scores
  - greater odds of being wasted
  - change in weight-for-age z-scores

*(George et al., 2015)*

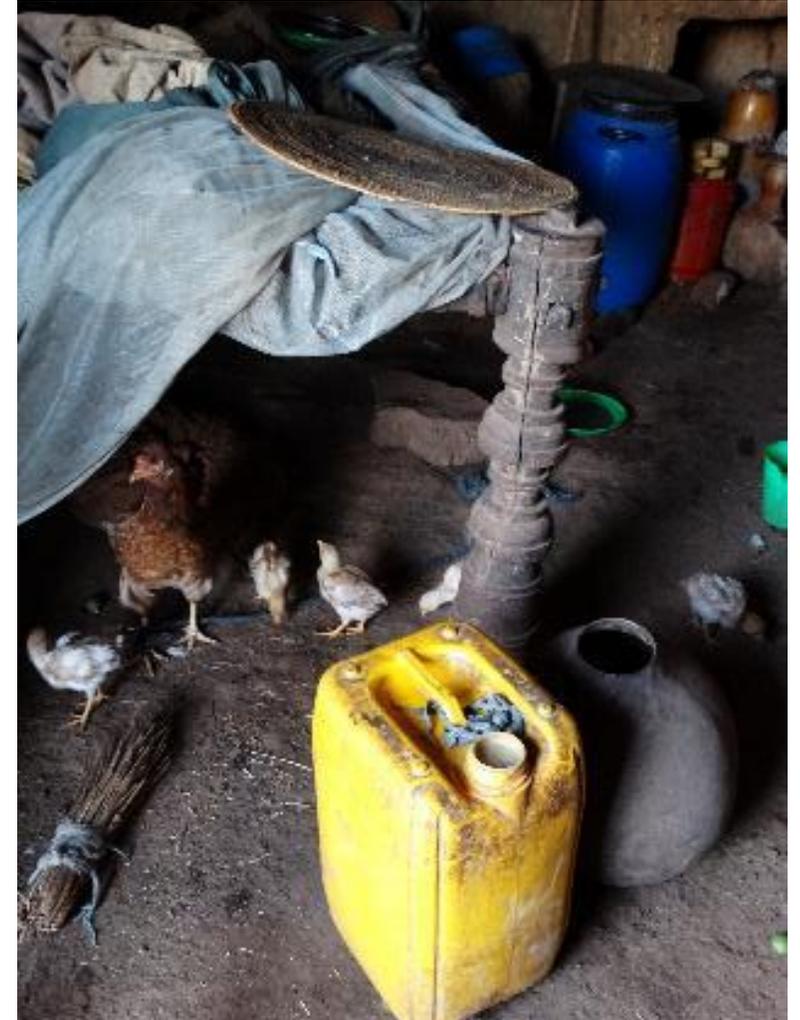
## *Underemphasized Source*

# Animal feces

- Animal feces are important sources of zoonotic bacteria and protozoa
  - Bacteria: *Campylobacter*, Enteropathogenic *E. coli*, and *Salmonella*
  - Protozoa: *Cryptosporidium* and *Giardia*
- Animal feces are abundant
- Exposure to domestic animals and their feces is a significant risk, but much is unknown about link to child health

# Animal feces are abundant

- Animal feces are more widespread where free-range animal husbandry is practiced and concentrated when animals are corralled within environments where children sleep and play.
- Nearly every fecal-oral pathway explored was highly contaminated with animal feces in both the public and private domains in a study in rural India (*Schriever et al., 2015*)
  - >50% of household-stored water
  - 90% of mothers and children's hands



# Much is still unknown about link between exposure, health and child growth

- The net gain or loss to child growth status attributable to domestic animals is a complicated equation not yet fully understood
- Systematic reviews find mixed associations between domestic animals and risk of infection (*Kaur et al., 2017*)
- However, high quality studies document that the presence of animal and their feces is associated with increased infection, undernutrition and stunting (*Zambrano et al, 2014*)
- Risk most pronounced when IYC and animals, particularly poultry share sleeping quarters.

# Little has been documented on risks from productive uses of animal feces



*Underemphasized Pathway #1*  
Direct ingestion of animal excreta and  
fecally contaminated soil



## IYC ingest soil and animal feces

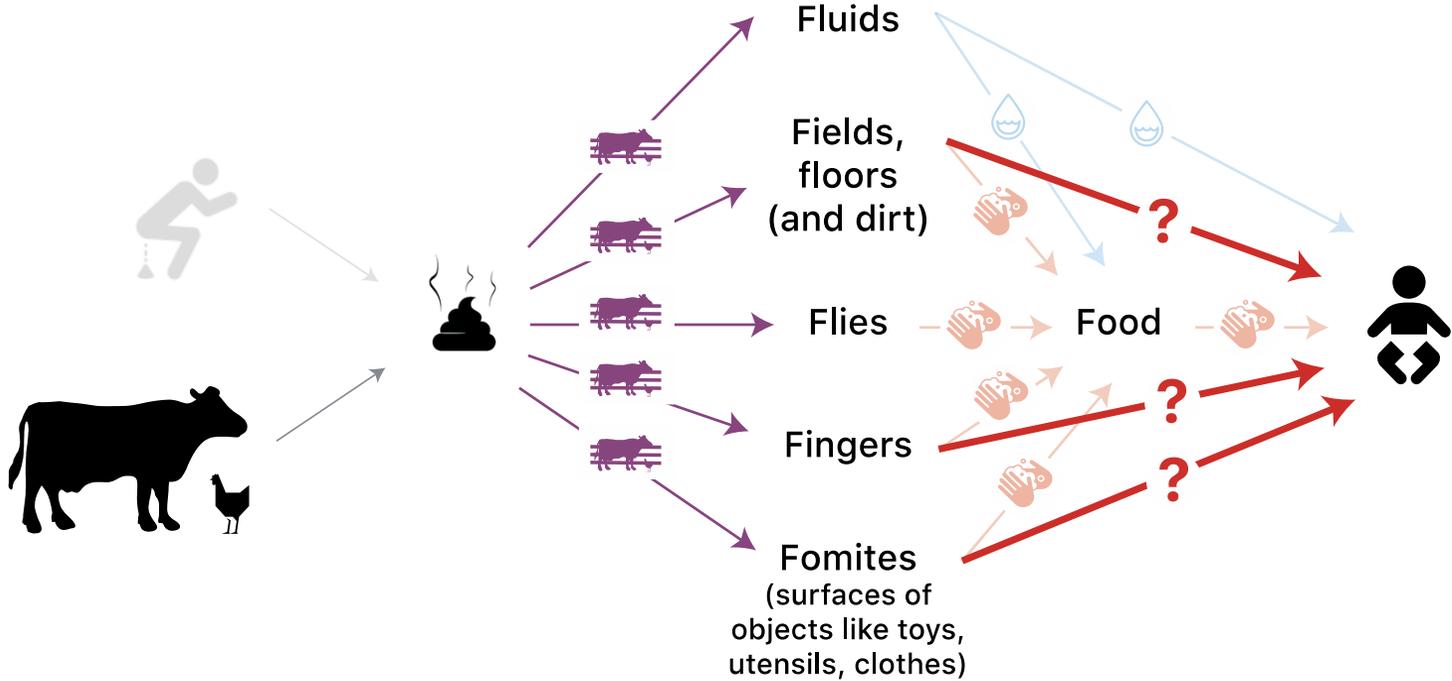
Context	Ingestion of soil  <i>Average # events</i>	Ingestion of animal feces  <i># events</i>	Majority of animals	Sample size	Study
Peru		3.9	Poultry	10	Marquis et al., 1990
Zimbabwe	11.3 (n=3)	2.0 (n=2)	Poultry	23	Ngure et al., 2013
Zambia	6.1 (n=14)	6.0 (n=1)	Poultry	30	Reid et al., 2018
Burkina Faso	1.3 (n=9)	0	Poultry	20	Ngure et al., 2018 (under review)
Ethiopia		9 * CONTACTS not ingestion	Several including poultry	12	ENGINE, 2014

## Underemphasized Pathway #2: Food hygiene

- Food is among the most important factors in transmitting pathogens that cause diarrheal illness
- Most decline in growth occurs during the complementary feeding age (*Saha et al., 2009*)
- Appropriate food hygiene practices have been shown to reduce the risk of diarrhea by 33% (*Sheth et al. 2006*)
- Because most studies and surveillance focus on diarrhea and not EED, magnitude of this pathway may be further underestimated



# How best to block the underestimated pathways



Disrupted by

-  Animal containment
-  Water treatment
-  Personal, household, and food hygiene
-  Hygienic Play Space Interventions

Adapted from Wagner & Lanoix, 1958. This diagram is a derivative of Figures 1 and 3 in Penakalapati et al., 2017 (DOI: [10.1021/acs.est.7b02811](https://doi.org/10.1021/acs.est.7b02811)), under a Creative Commons CC-BY 4.0 Usage Agreement with the American Chemical Society.

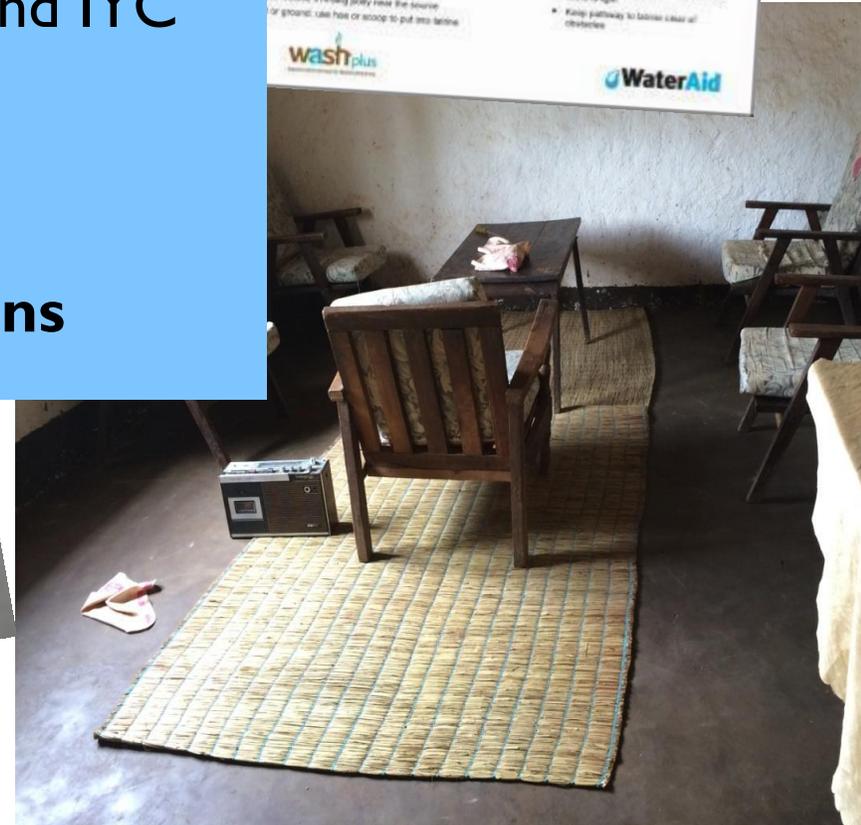
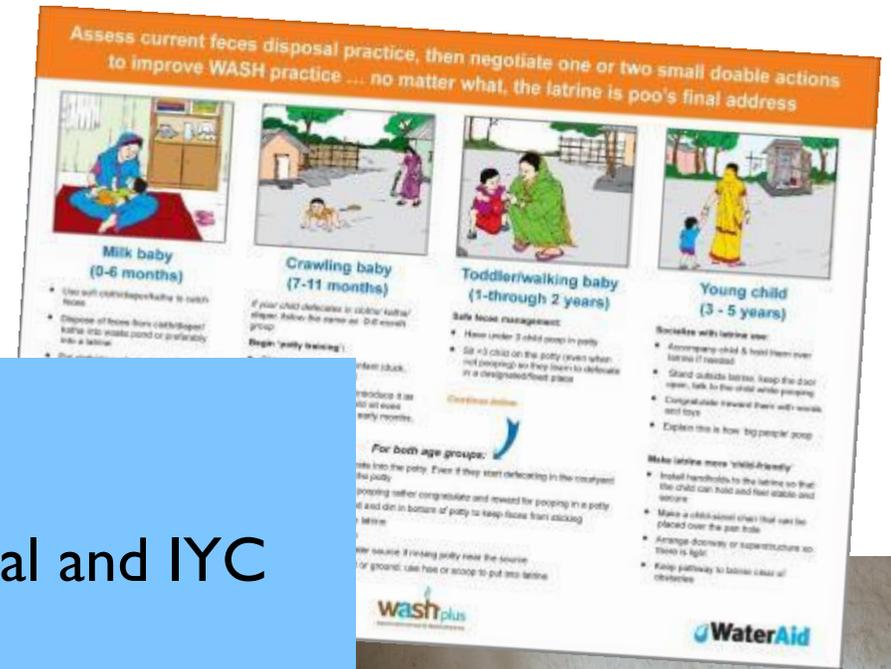
# Interventions focused on hygienic environments and direct ingestion pathways are occurring

- Several large implementing organizations are delivering products and services to address “BabyWASH” concerns, but with little evidence yet of their effectiveness
  - IYC handwashing
  - Food hygiene
  - Animal husbandry
  - Safe disposal of animal and IYC feces
  - Compound hygiene
  - Improved flooring
  - **Playmats and play pens**
- Plausibility of protective effects has not been established for many of these measures

# Interventions to break the underemphasized pathways



IYC handwashing  
Animal husbandry  
Safe disposal of animal and IYC feces  
Compound hygiene  
Improved flooring  
Playmats and play pens



# Interventions to break the underemphasized pathways



Assess current feces disposal practice, then negotiate one or two small doable actions to improve WASH practice ... no matter what, the latrine is poo's final address

<p><b>Milk baby (0-6 months)</b></p> <ul style="list-style-type: none"> <li>Use soft cloth/leaves/katka to catch feces</li> <li>Dispose of feces from cloth/leaves/katka into public pond or privately into a latrine</li> <li>Put cloth/leaves/katka in a dedicated bowl for washing</li> <li>Wash a few collected cloth/leaves/katka by rinsing out feces, dumping filthy water into the latrine, contained storage, or as last resort boiling away from drinking/water sources</li> <li>Washing of entire diaper, clothes and/or soiled wears where animals cannot get at feces, bury or burn</li> <li>If you hold the infant to pee into courtyard or ground, follow up with a hoe or scoop to throw into latrine</li> </ul>	<p><b>Crawling baby (7-11 months)</b></p> <p>If your child defecates in stooler/katka/leaves follow the same as 0-6 month group</p> <p><b>Begin 'potty training':</b></p> <ul style="list-style-type: none"> <li>Obtain a potty for your infant (buck, toilet or horse shaped)</li> <li>Socialize child to potty, introduce it as the child's place "sit down all week when not defecating, in early months, about child is all"</li> </ul> <p><b>For both age groups:</b></p> <ul style="list-style-type: none"> <li>Encourage child to defecate into the potty. Even if they start defecating in the courtyard ground put your baby in the potty</li> <li>Don't scold for courtyard peeing unless congested and reward for peeing in a potty</li> <li>Put some water, ash, sand and dirt in bottom of potty to keep feces from sticking</li> <li>Empty potty feces into the latrine</li> <li>Wash potty after each use</li> <li>Wipe stool away from water source if using potty near the source</li> <li>If child poos into courtyard or ground, use hoe or scoop to put into latrine</li> </ul>	<p><b>Toddler/walking baby (1-through 2 years)</b></p> <p><b>Safe toilet management:</b></p> <ul style="list-style-type: none"> <li>Have under 3 child potty in potty</li> <li>Get 4-5 child on the potty even when not pooping so they learn to defecate in a designated/food place</li> </ul> <p><b>Soaklines with latrine use:</b></p> <ul style="list-style-type: none"> <li>Accompany child &amp; hold them over latrine if needed</li> <li>Stand outside latrine, keep the door open, talk to the child while pooping</li> <li>Carry latrine material with waste and toys</li> <li>Explain this is how big people poop</li> </ul> <p><b>Make latrine more 'child-friendly'</b></p> <ul style="list-style-type: none"> <li>Install handrails to the latrine so that the child can hold and feel stable and secure</li> <li>Make a child-sized chair that can be placed over the pee hole</li> <li>Arrange doorway or superstructure so there is light</li> <li>Keep pathway to latrine clear of obstacles</li> </ul>	<p><b>Young child (3 - 5 years)</b></p>
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USAID  
washplus  
WaterAid



# The “take-home” messages

- Relative magnitudes of the transmission pathways of enteric microbes in IYC are not well defined, making it hard to conclude which pathways represent the highest risk to IYC and where to target intervention
- The evidence of traditional WASH interventions reducing the risk of diarrhea and improving growth among <5s is mixed, but some categories of WASH are more effective
- Underemphasized sources and pathways are significant to IYC, and require more research and evidence-based intervention guidance
- Significant evidence gap remains on effect of various technologies and social behavior change interventions in reducing exposure and improving outcomes

## Next Steps for WASHPaLS research

Preparing a random assignment EXPOSURE STUDY in Ethiopia, collaborating with GoE and USAID implementing partners

*testing if a playmat/play pen combo, together with motivational BC components reduces IYC exposure to harmful pathogens*

Phased study, starting with a formative phase which includes product development

Preparing to issue a small grants solicitation for testing BC innovations to address safe management of animal feces





Thank you!

Questions? Comments?

*Joining the Q & A panel:*

- *Frances Ngure*  
*Research Task Advisor*
- *Jeff Albert*  
*WASHPaLS Deputy Director*

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