Cornell University
Division of Nutritional Sciences

EE: Going Beyond Nutrition to Understand Child Growth and Development

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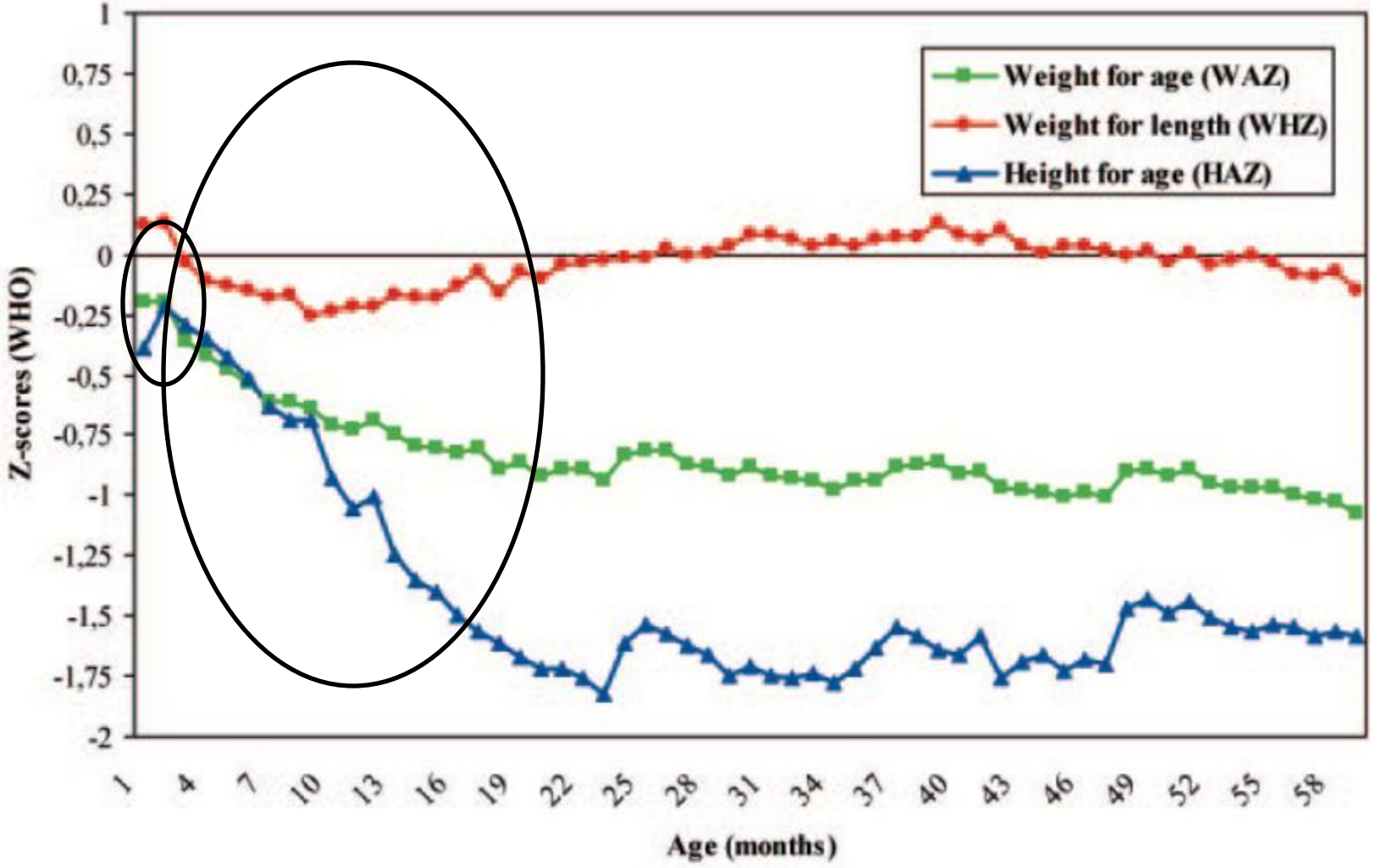
Stunting and EE: What We Know and….

What we are trying to figure out

The "**Window of Opportunity**" for Improving Nutrition is very small… Pre-pregnancy until 18-24 months of age



(Victora et al. 2010)

What is causing all this stunting?

Cause #1: Malnourished Mother

- Malnourished mothers give birth to babies that are smaller and shorter than normal
- 50% of Guatemalan babies are born stunted (Ruel 2001)
  - Prevalence of stunting at birth not well documented
  - Good length data on newborns is very hard to get!

Estimates of 20-50% of stunting is due to intra-uterine factors. Effective macronutrient interventions for pregnant women are not well established.

Cause #2: Poor Diet

- Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries
  - Dewey & Adu-Afarwuah, 2008
  - 42 studies/programs, most published 1996-2006
- Children who received interventions gained:
  - 0.0 – 0.76 Z scores weight-for-age
  - 0.0 – 0.64 Z scores length-for-age

The best studies caused a 0.7 Z score improvement. BUT: the average growth deficit of African and Asian children is -2.0 Z At best, diet solved 1/3 of the problem.

Cause #3: Diarrhea

- Between 6-18 months of age, children in developing countries have around 9 episodes of diarrhea.
- Many authors reported that diarrhea accounts for 10-80% of growth faltering
- But others contend that children grow at "catch-up rates" between episodes, and thus recover these deficits

The Lancet Nutrition Series (2008) concluded that by implementing sanitation and hygiene interventions with 99% coverage, child malnutrition would be reduced by only 2.4%

However:

Evidence exists that the effect of WASH interventions on linear growth is independent of its effect on diarrhea.

In several studies, WASH had a bigger effect on growth than it did on diarrhea

Peru:
(Checkley, et al)

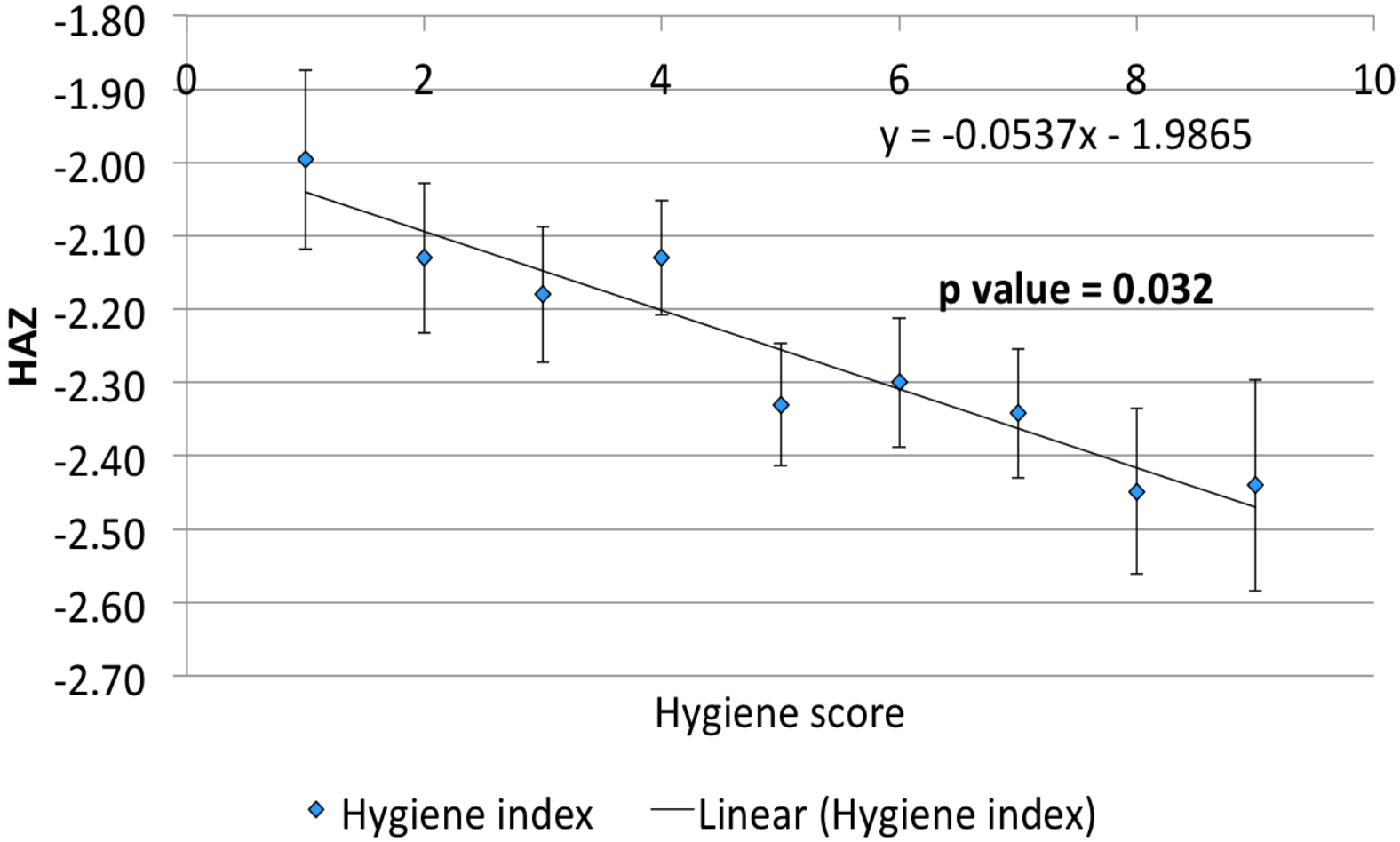
- Children assessed for diarrhea and growth from birth to 2 years
- Household sanitation and water assessed
- What predicted height deficit at 2 years?

  16% explained by how much diarrhea the child had experienced

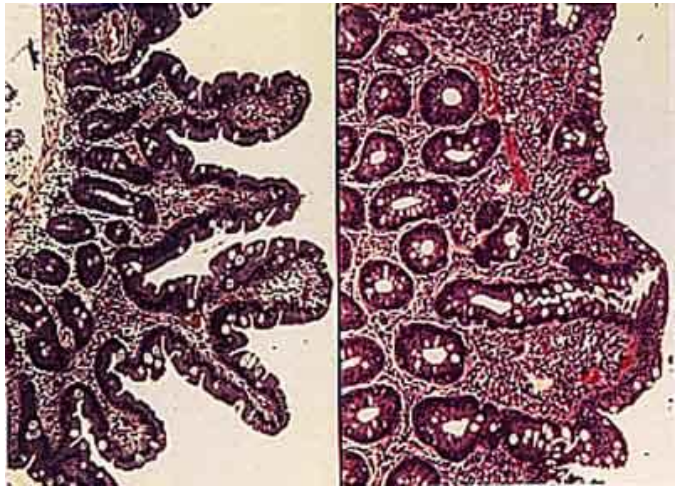
  40% explained by the level of sanitation and water in child's household

Rural Ethiopia: HH Hygiene Index was the variable most strongly associated with stunting

Alive and Thrive baseline data; F Ngure (2013, in prep)

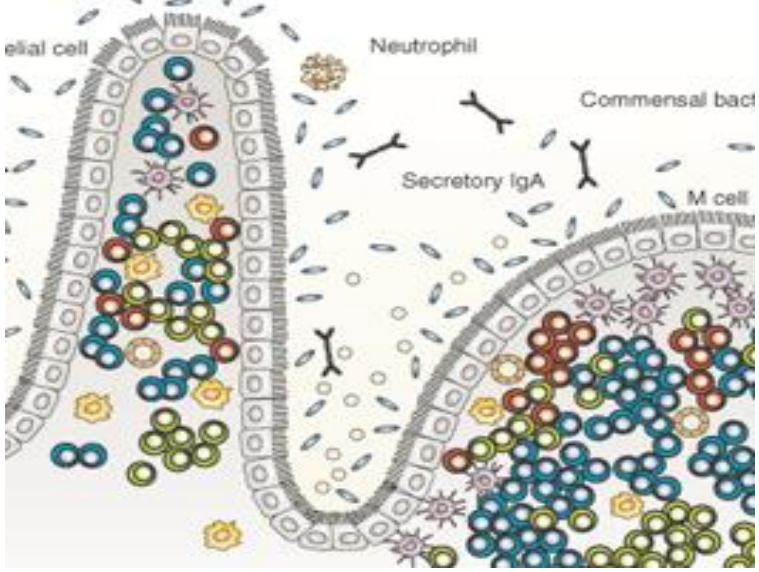


Cause #4: The Environmental Enteropathy Hypothesis

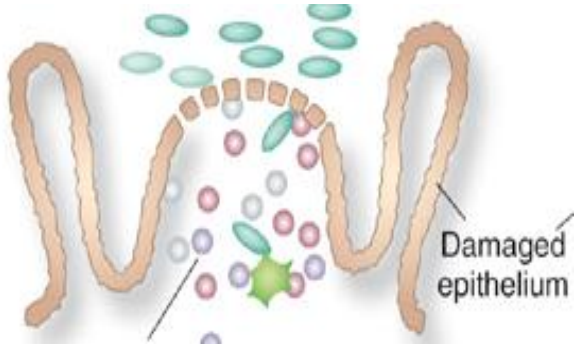


- A subclinical condition of the small intestine, called environmental enteropathy (EE)
- Characterized by:
  - Flattening of the villi of the gut, reducing its surface area
  - Thickening of the surface through which nutrients must be absorbed
  - Increased permeability to large molecules and cells (microbes)
- Likely causes:
  - Too many microbes in the gut
  - Effects of toxins on the gut

Decreased nutrient absorption + Infiltration of microbes



Microbial translocation



Microbial products cross into blood stream

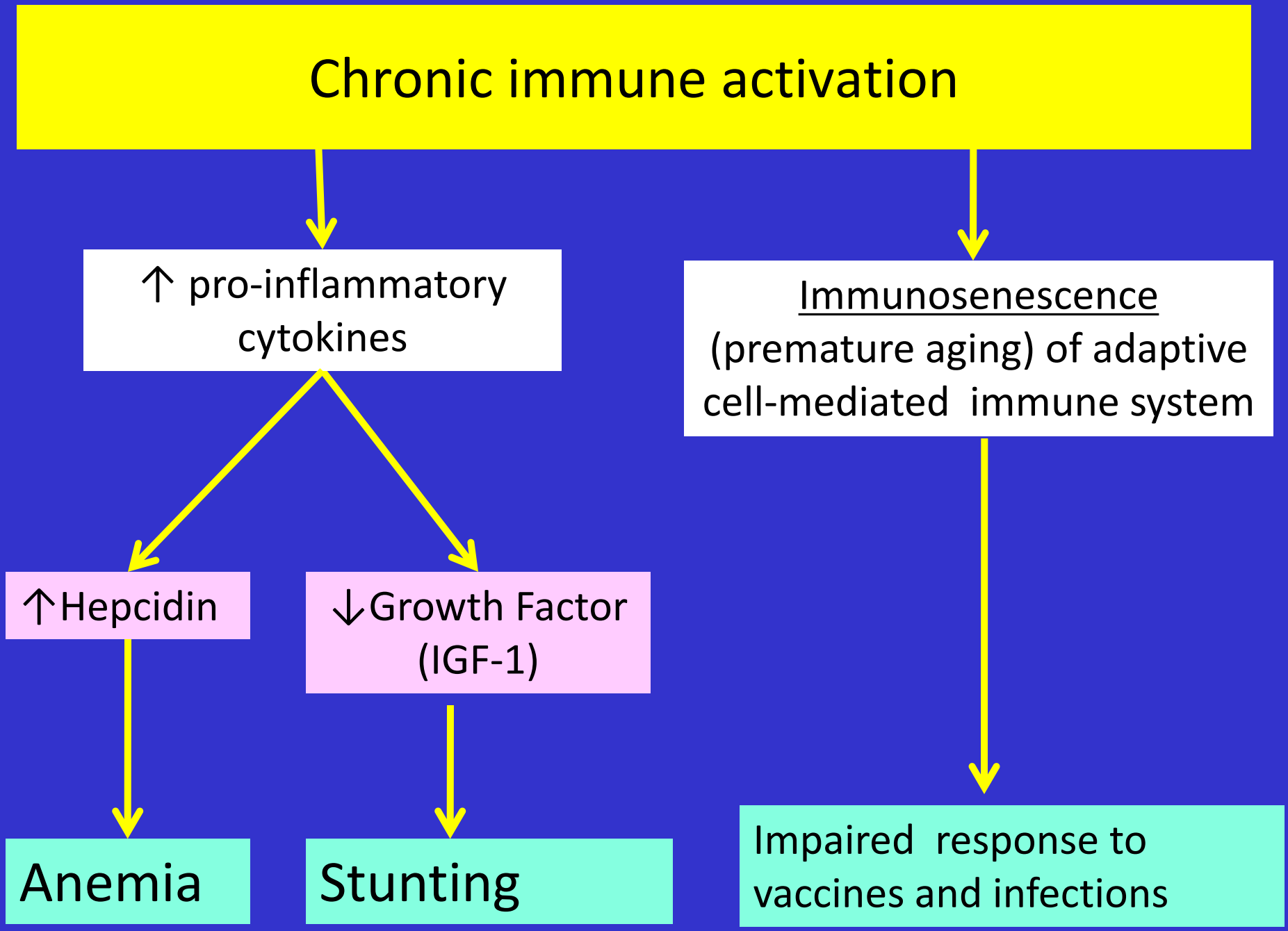
Chronic immune activation

Diverts nutrients from growth to infection-fighting

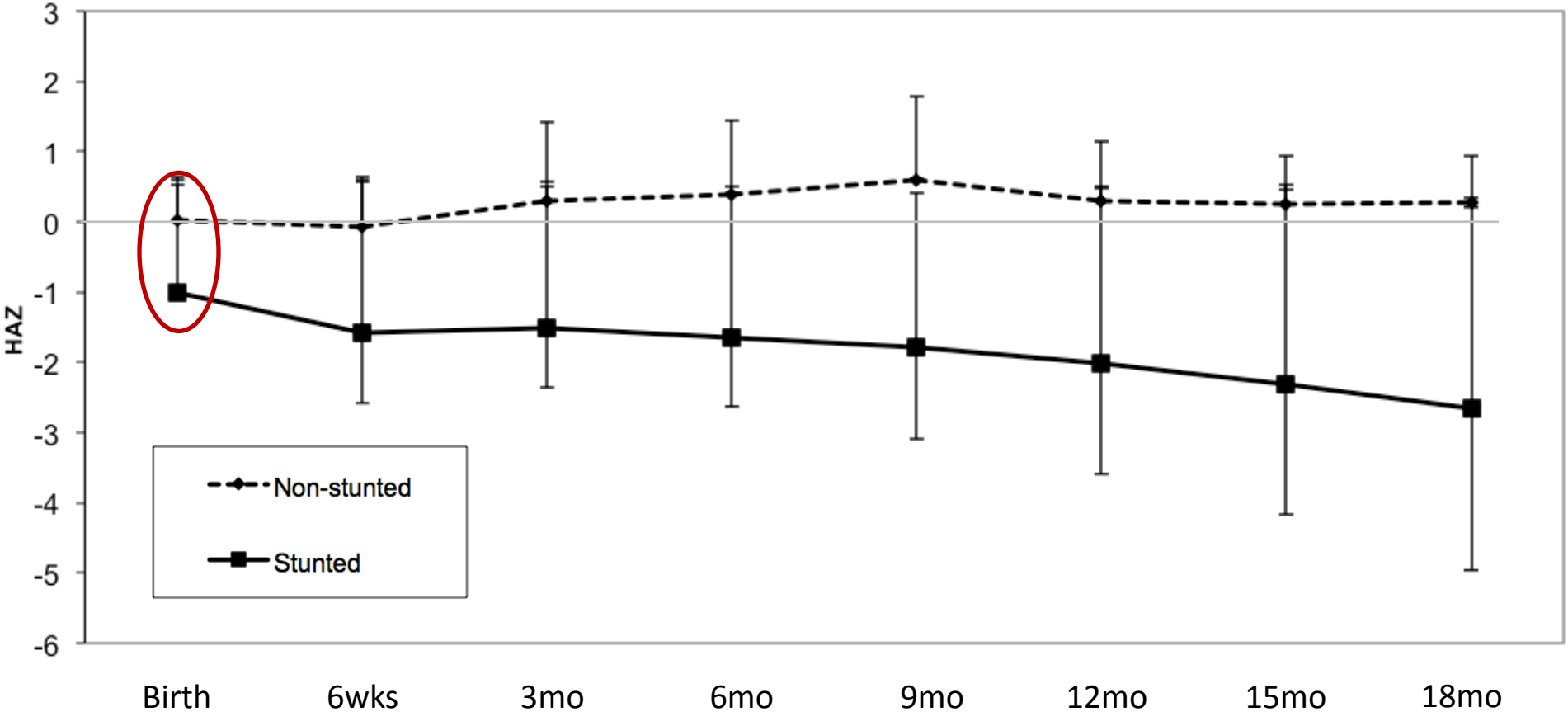
Environmental Enteropathy and Stunting Hypothesis:

EE is a major cause of post-natal stunting, anemia and immune competence

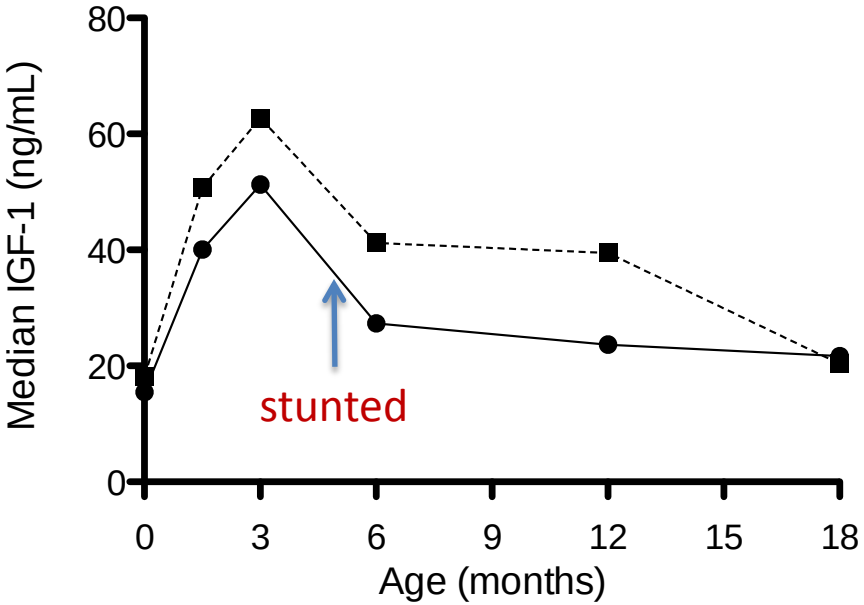
EE can be prevented or reduced by preventing infants and young children from ingesting human and animal feces through a package of interventions that improve sanitation and hygiene.


Chronic immune activation
↑ pro-inflammatory cytokines
Immunosenescence (premature aging) of adaptive cell-mediated immune system
↑Hepcidin
↓Growth Factor (IGF-1)
Anemia
Stunting
Impaired response to vaccines and infections

HAZ changes over first 18 months in stunted and non-stunted infants

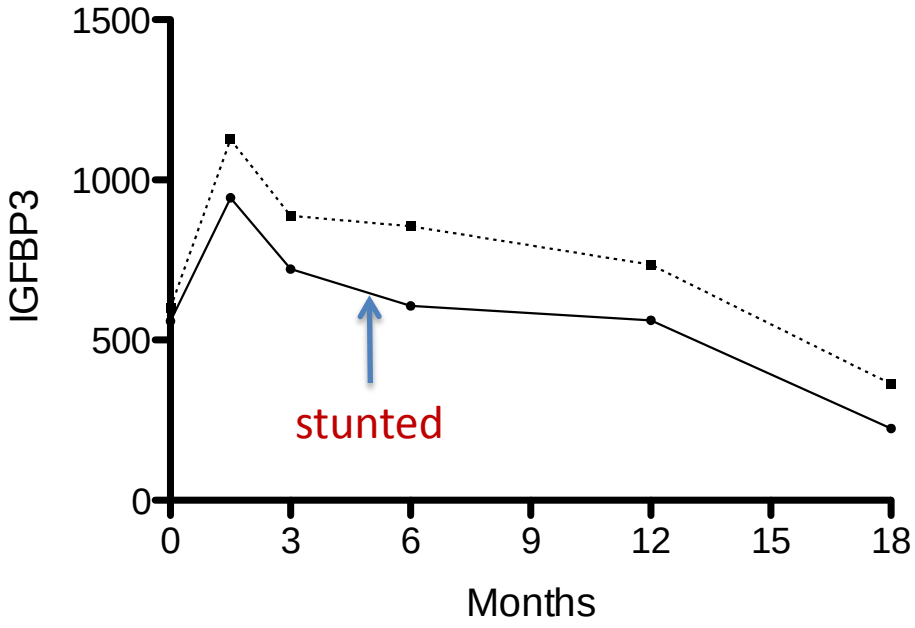


IGF-1 and IGFBP3 were lower in stunted infants, beginning at 6 wk



P values for all time points 6 w to 12 mo, p<0.001

Values for healthy European children range from 54-170 ng/mL



P values for all time points 6 w to 18 mo, p<0.001

Development of the WASH Intervention
(Efficacy = “Proof of concept”)

WASH Goal:

All infants never ingest any faeces between birth to 18 months

Conventional WASH formative research (2008-2009)

Sanitation HIGHLY valued don't have a latrine because lack money; a Blair VIP is a source of status

- Infant stools less offensive than adults'
- Handwashing is seldom with soap
- Frequently feed cold leftover food

Baby Observation Study (2011)

- 6 hour observation of 20 babies, recorded what and how often went in the mouth and if visibly dirty

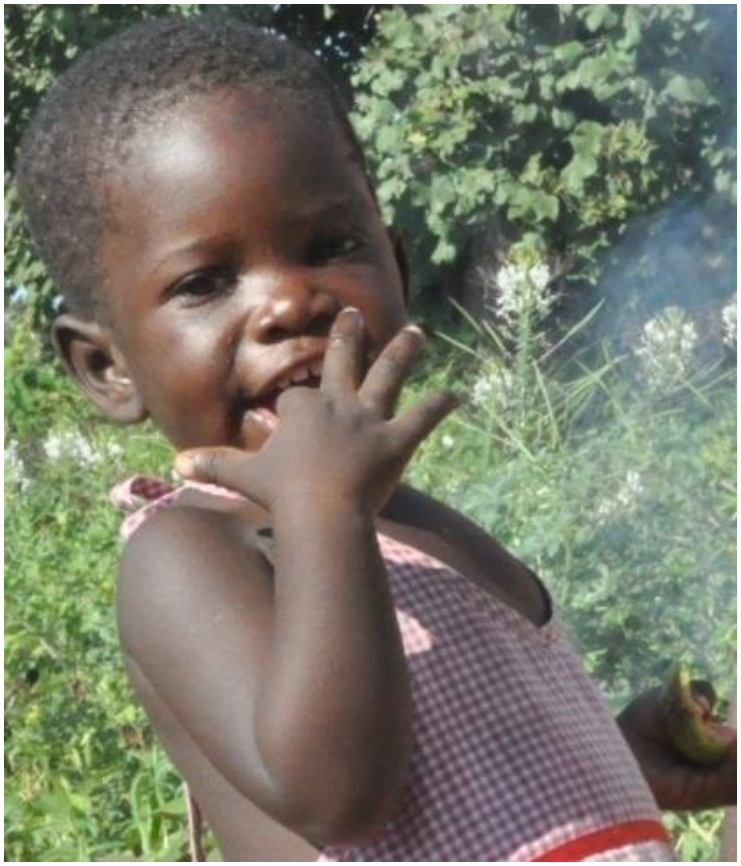
- Returned and collected samples of most frequent and dirtiest things mouthed for micro analysis

Findings

Most frequent:

38 time in 6 hours

75% visiby dirty



Dirtiest

Soil (3 ate avg 11 bites)

chicken faeces, stones

If allowed, toddlers consume poultry feces

Peruvian shantytown families:

- Households who owned free-range poultry:
  - **Average ingestion of poultry feces by toddlers per 12-hour observation period was 3.9 times**
    - Marquis GM et al., Am J Public Health 1990

Rural Zimbabwe:

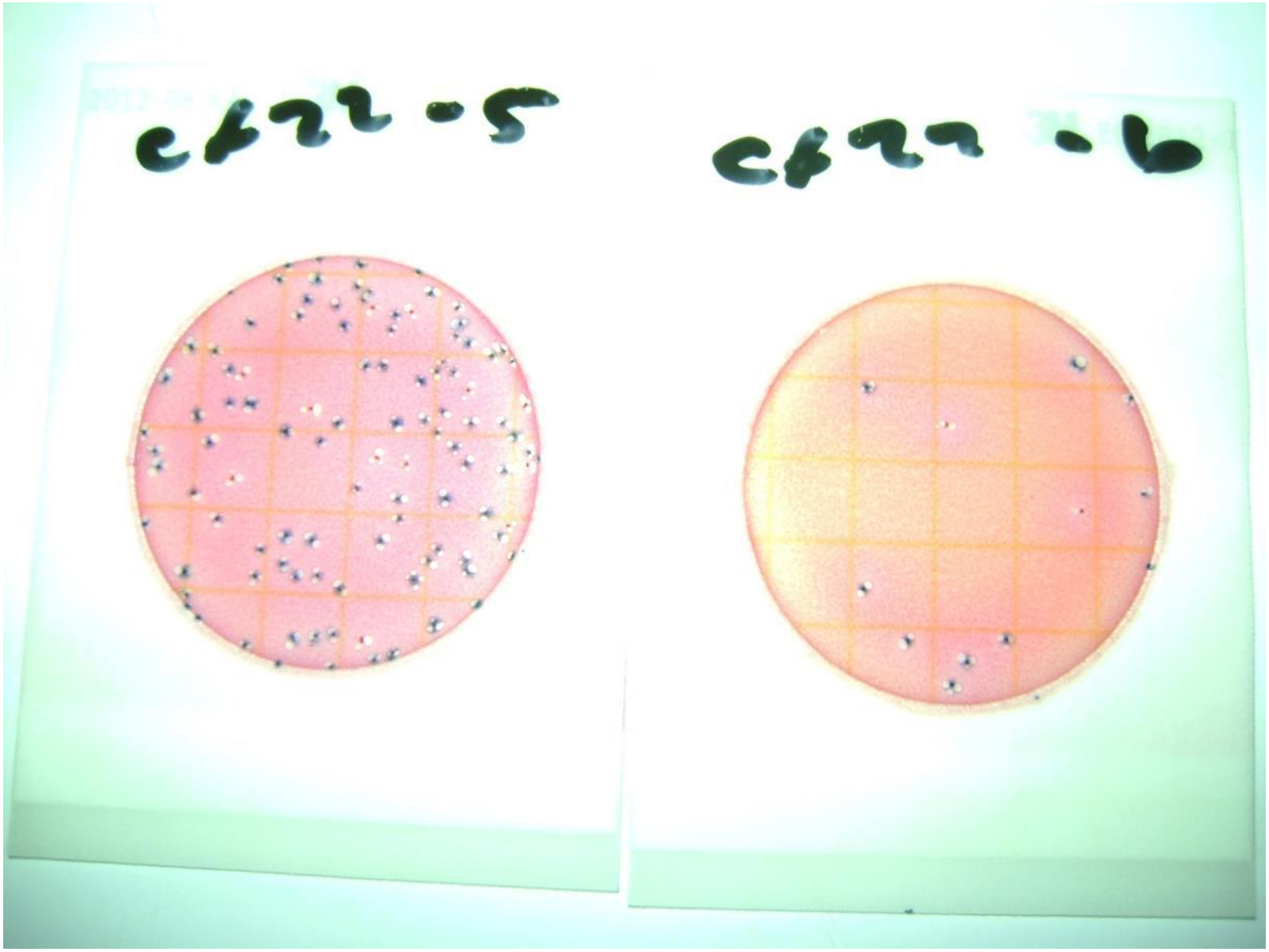
- Not selected for poultry ownership:
  - **3 of 7 toddlers directly ate chicken feces during a 6-hour observation period.**
    - Ngure F et al., submitted, 2012

The context: IO study

Laundry area

Bare soil and animal waste

Micro team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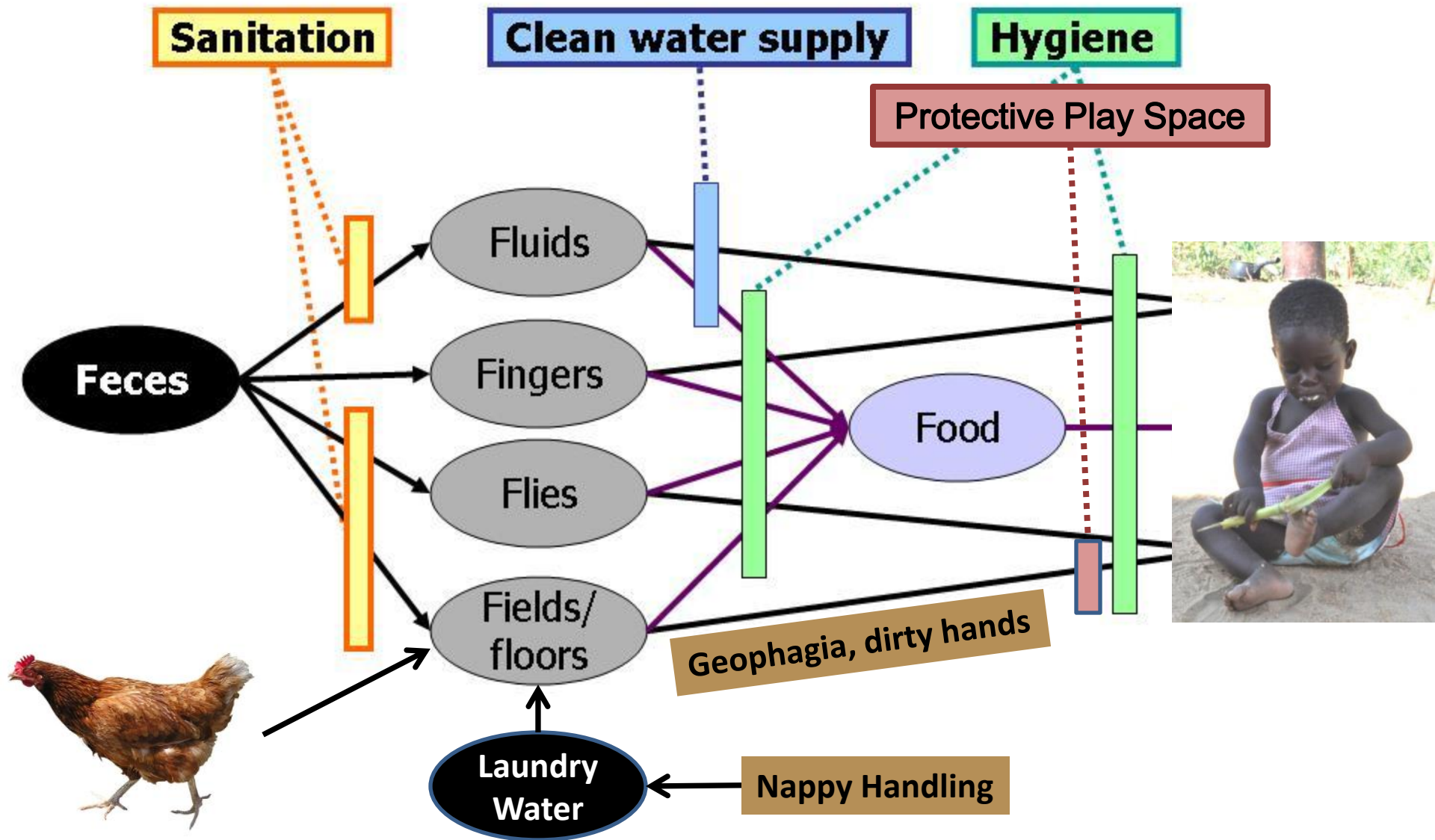
	% HH with E coli + sample	E coil/ Per gram	Average E Coli Per Day
Infant Food	0%	0	0
Drinking Water	54%	2	**800**
Soil in laundry area	60-80%	70	**1,400**
Chicken feces	100%	10,000,000	**10,000,000**

Clearly, kids must stop eating dirt and chicken poop!

Babies are fed on
*Ground in the yard
(60-80% E coli+) or
*Kitchen floor
(81% E coli+)

Routes of fecal disease transmission and protective barriers *for babies!*



BABY WASH

A new way of thinking about WASH in the first 1000 days

- Protective play space, to protect developing child from contaminated soil and animal feces (especially chickens)
- Infant handwashing with soap, when outside of protective play space.
- Caregiver handwashing with soap after fecal contact and before preparing/serving food
- Safe disposal of feces—especially of children
- Water treatment
- Avoid feeding leftovers, or reheat

2x2 Factorial Design

Control	WASH: Integrated Water, Hygiene & Sanitation
Infant Feeding: Education + Nutributter	WASH + Infant Feeding

Objective

To measure the independent and combined effects of WASH and infant nutrition on stunting and anemia among children from birth to 18 months of age

And, on a sample of 1600 infants, measure the hypothesized “causal pathway” of EE

1000 HIV- mothers

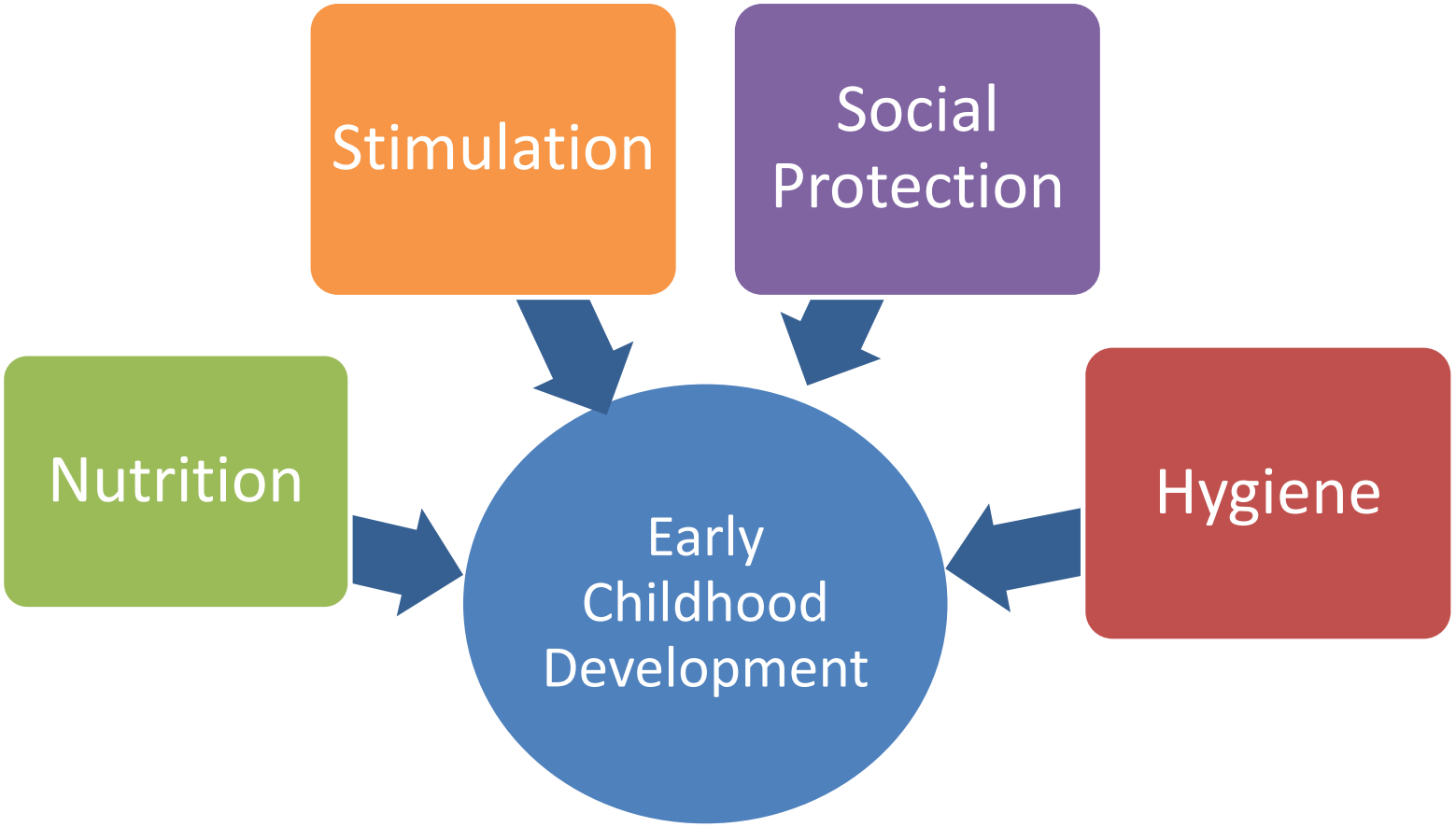
600 HIV+ mothers

Programmatic approaches for nutrition, stimulation and social protection are well developed.

UNICEF 2006 *Programming Experiences in Early Childhood Development*
Lancet 2011 Child Development Series

Hygiene for babies (Baby WASH) needs to be further developed and tested

Environmental Protection?



Research Priorities

- Identifying the causal pathway by which WASH interventions may interrupt EE and child stunting

- Developing and implementing Baby WASH interventions that support nutrition, hygiene and child development

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