Stunting, a Chronic Problem in Low- and Middle-Income Countries

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Stunting, a Chronic Problem in Low- and Middle-Income Countries

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Talk Outline

- Burden of stunting and overview of major risk factors
- “Vicious Cycle” of infection and malnutrition
- Interventions to reduce stunting of young children
- Impact of parenting groups on child cognitive development

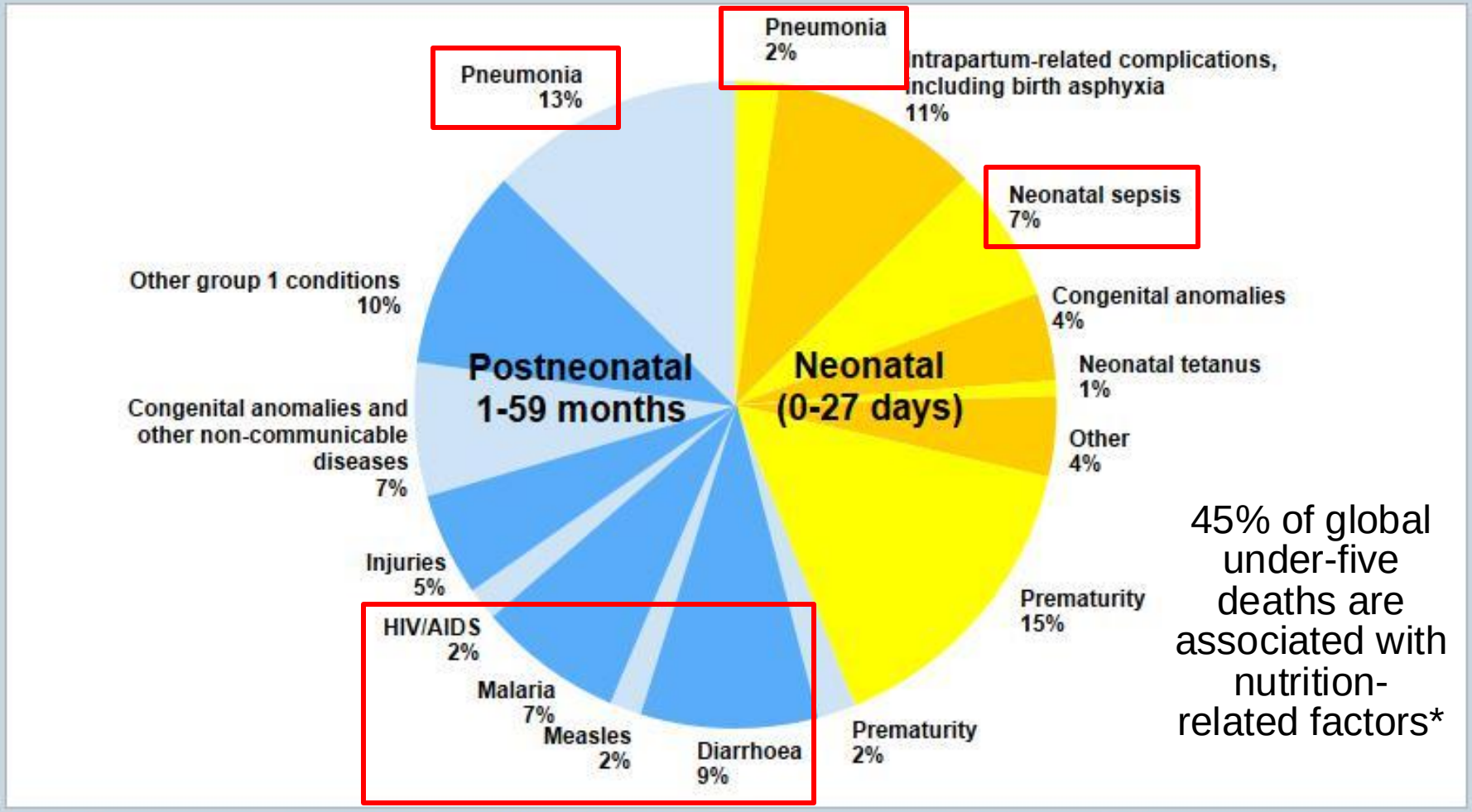
Child Nutrition Targets

- 2012 target – reduce stunting by 40% by 2025

- SDG Target 2.2 | Malnutrition: End all forms of malnutrition, including achieving targets on stunting and wasting in children under 5 years of age, and address nutritional needs of adolescent girls, pregnant and lactating women and older persons

Causes of deaths among children under 5 years, 2013

World Health Organization



45% of global under-five deaths are associated with nutrition-related factors*

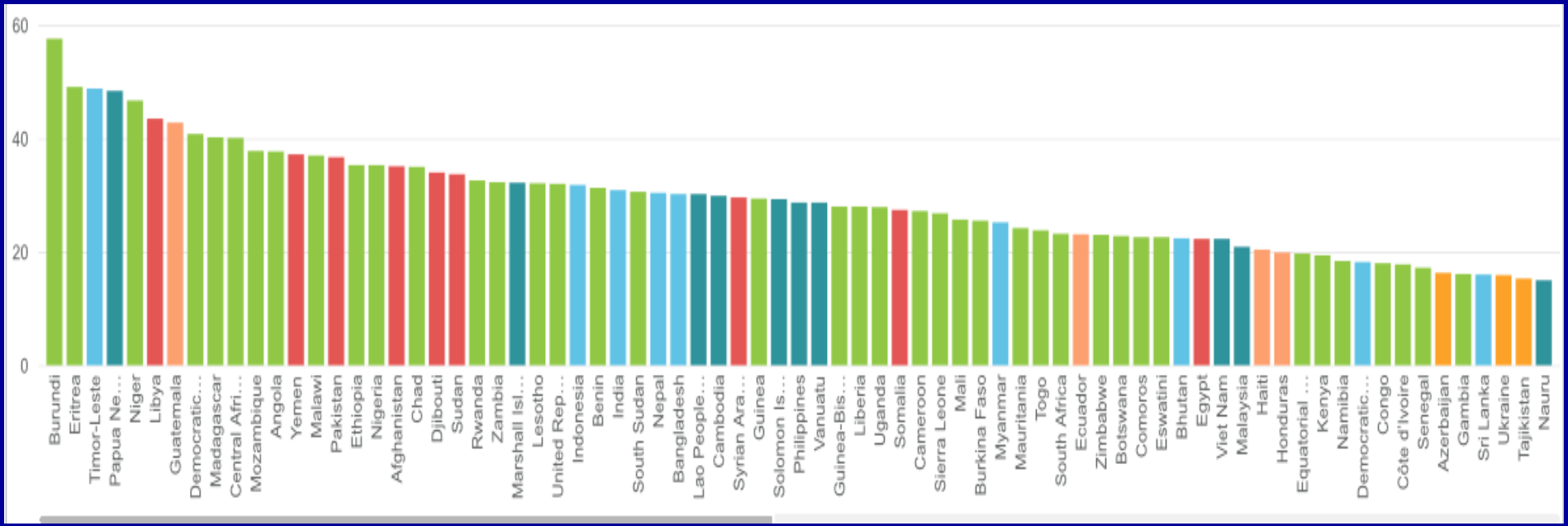
Source: CHERG-WHO methods and data sources for child causes of death 2000-2013 (Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2014.6.2)

Black R et al. Lancet, 2013

Stunting (<-2 height-for-age Z score) prevalence among children under 5 years of age (%) – substantial country by country variability

2020: 22% of all children <5 y stunted (149 million, down from 203 million in 2000)

https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-jme-country-children-aged-5-years-stunted-(-height-for-age--2-sd)



Victora C et al. Lancet 2021

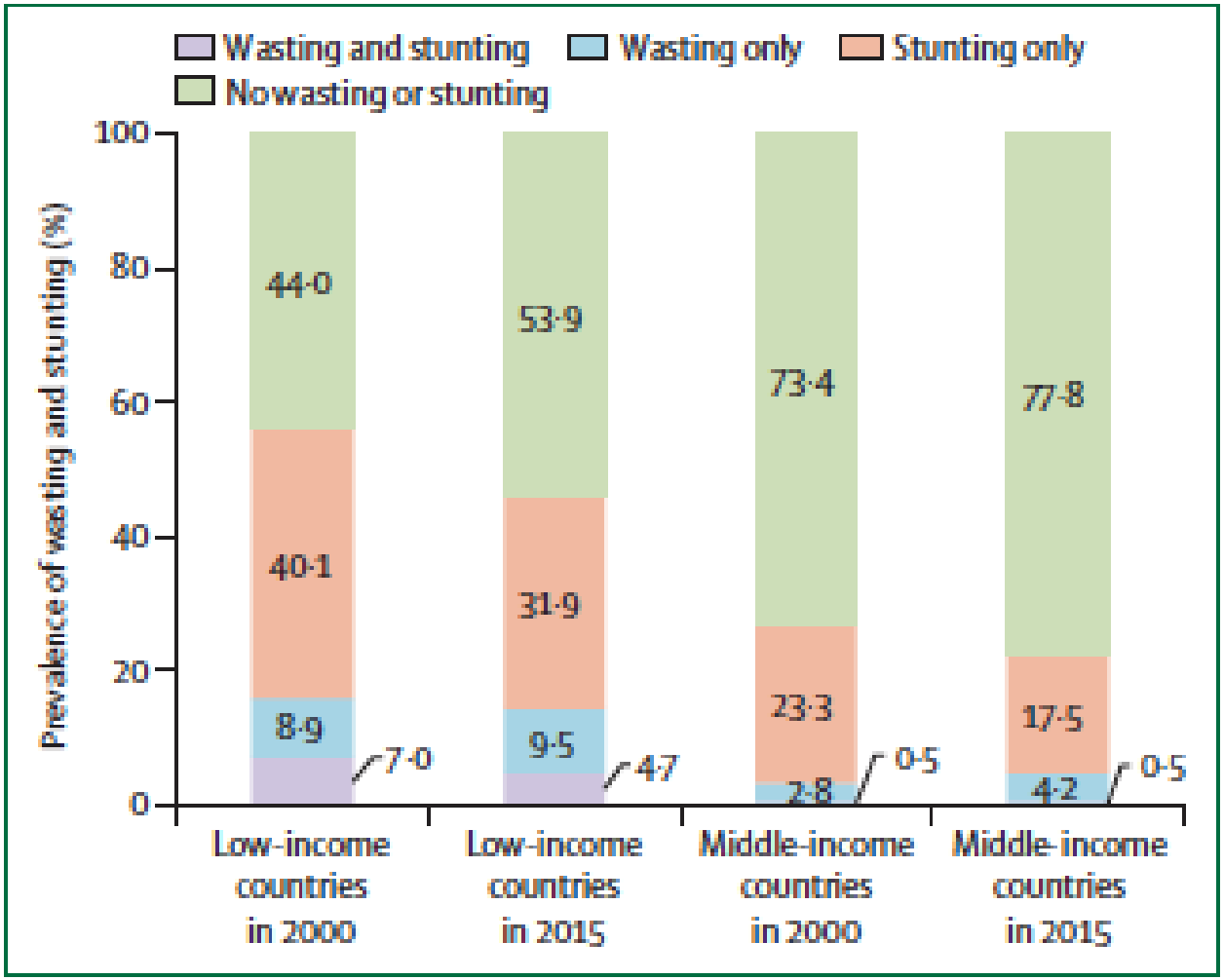
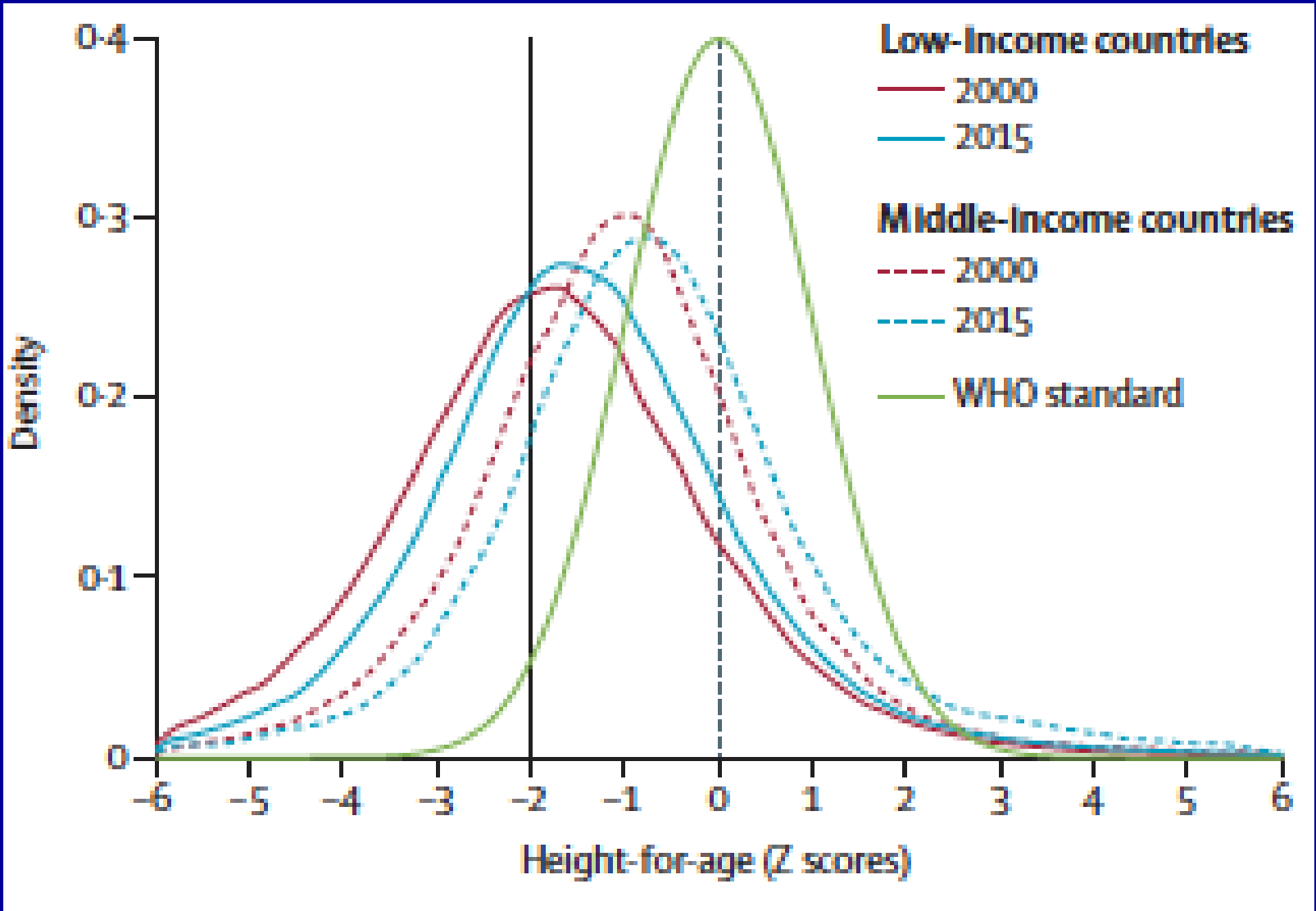


Figure 1: **Prevalence of wasting and stunting in children younger than 5 years**

Data are for 31 low-income countries and 19 middle-income countries, taken from Demographic and Health Surveys and Multiple Indicator Cluster Surveys (appendix pp 1–5). We refer to data collected from 1996 to 2005 as 2000 data, and data collected from 2010 to 2018 as 2015 data.

HAZ for U5 children 2000 vs. 2015

Victora C et al. Lancet 2021



Global Impact of Stunting

- Stunting before age 2 y predicts poorer cognitive and educational outcomes in later childhood and adolescence
- 1% loss of adult height from stunting associated with 1.4% loss economic productivity
- Stunted children earn 20% less than non-stunted children

Stunting Policy Brief: Global Nutrition Targets 2025

Risk Factors for Stunting

- Social determinants:
  - Maternal nutritional status and postnatal diet
  - Maternal and paternal education
  - Household assets
  - Early marriage
  - Early complementary feeding
- Commercial determinants:
  - Increased marketing and sales of formula milk and industrialized foods
  - Increased consumption fast foods and sweetened beverages

Victora CG et al. Lancet 2021

Additional Risk Factors

- Small-for-gestational age
  - Responsible for about 20% of stunting in LMICs and up to a third in South Asia
- Low birth weight
- Maternal height
- Maternal low BMI

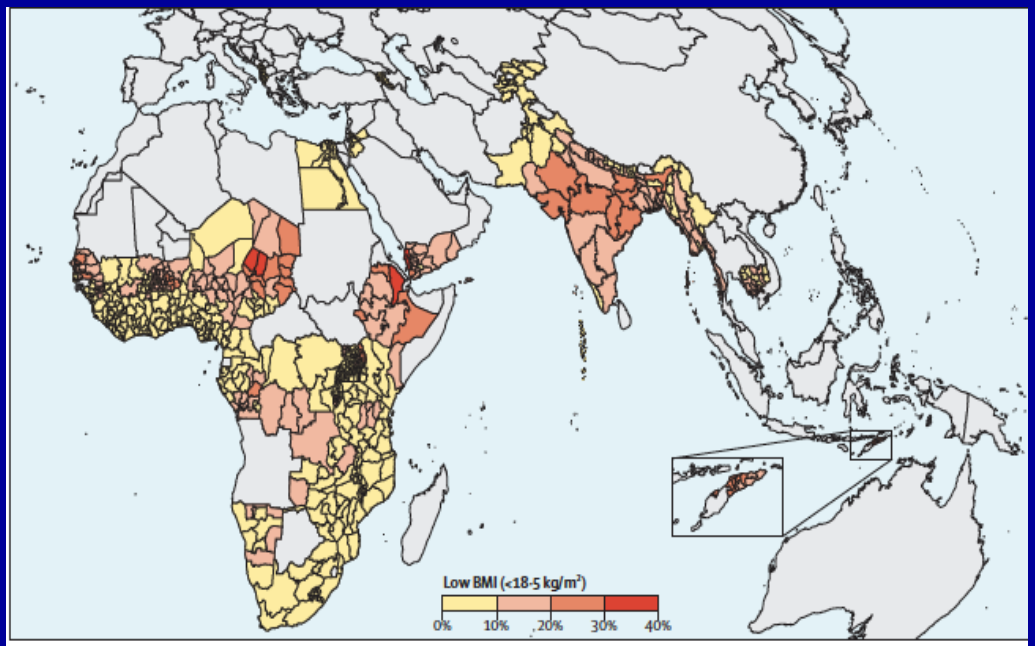


Figure 5: Map of low body-mass index (<18·5 kg/m²) prevalence in women aged 15–49 years by subnational regions in African and Asian countries with available data from 2010 or later

Prevalence low BMI (<18.4 kg/m^2 among women aged 15-49 y)

Victora CG et al. Lancet 2021

What is the role of infection in stunting?

- Stunting associated with diarrhea, febrile respiratory infections, and malaria
- However, community-based cohort studies found no effect of diarrhea or ALRI on growth
- Higher prevalence of enteropathogens in non-diarrheal stools associated with reduced linear growth
- Enteric enteropathy

MAL-ED Network Investigatorrs. PLoS Med 2017

Global Enteric Multicenter Study Results: 8077 Children with MSD

Stunting associated with:

- *Cryptosporidium*, EPEC, and untreated *Shigella* (infants)
- ETEC (heat-stable toxin) and *Cryptosporidium* (toddlers)
- Treatment of *Shigella* associated with improved linear growth

Nasrin D et al. JID 2021

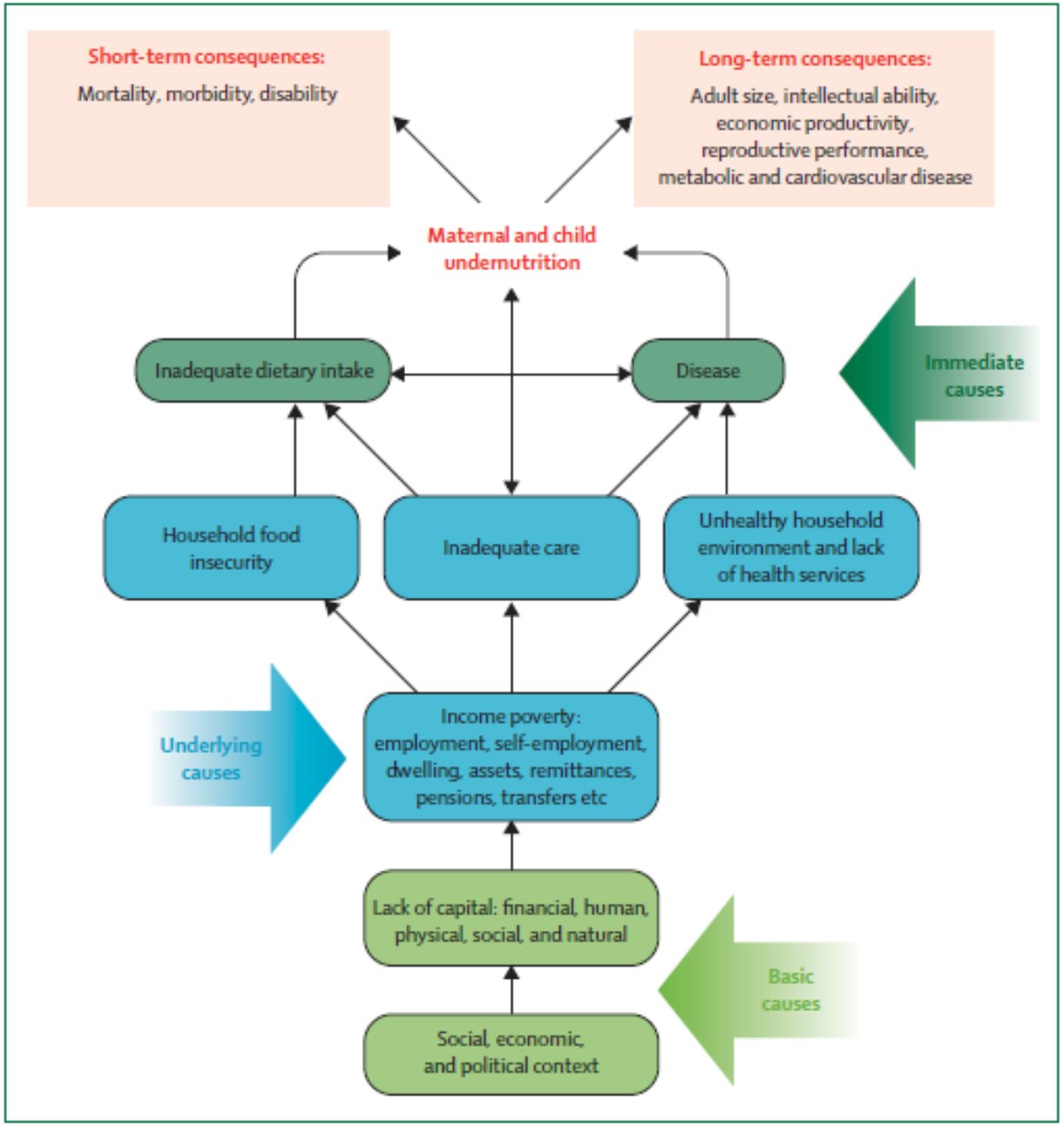
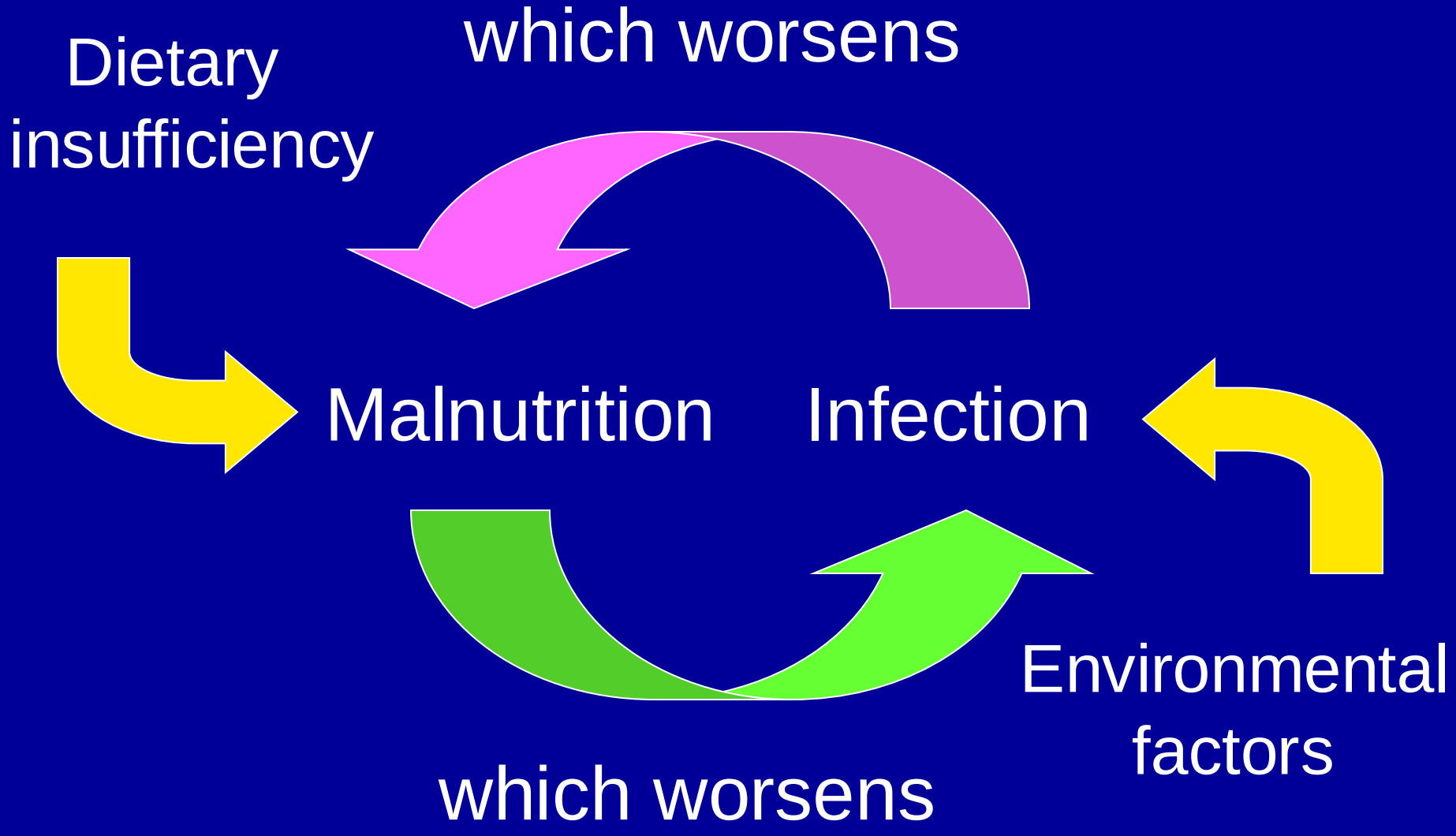


Figure 1: **Framework of the relations between poverty, food insecurity, and other underlying and immediate causes to maternal and child undernutrition and its short-term and long-term consequences**

Consequences go far beyond the cycle of malnutrition and infection… intellect, productivity, social status, reproductive capacity, "chronic" diseases & disabilities

Maternal and Child Undernutrition 1
Black et al Lancet 371:243 2008


Dietary insufficiency
which worsens
Malnutrition
Infection
Environmental factors
which worsens

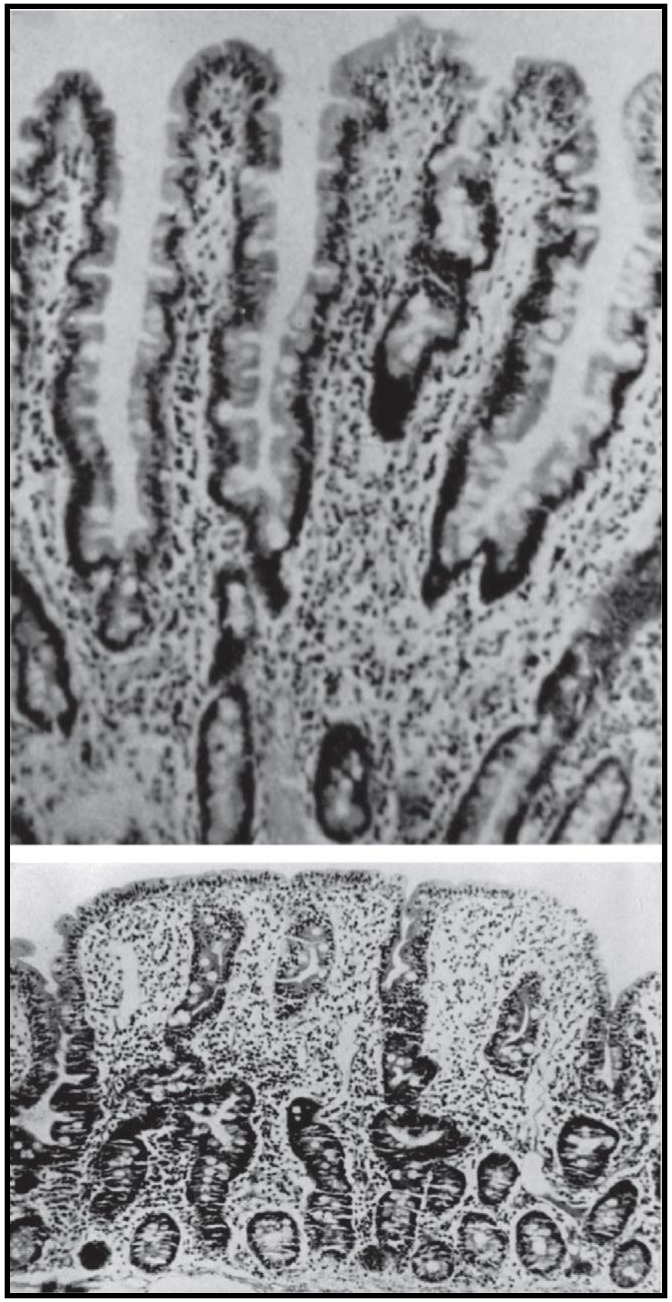
Poor Sanitation and Hygiene. Fecal Contamination of Domestic Environment

Feces Ingestion Infants; Children and Enteric Infections

(1) Increased gut permeability; (2) Bacteria (and gut contents) leak into body; (3) Intestinal inflammation

ENVIRONMENTAL ENTEROPATHY

In studies dating to 1993, 43% of stunting explained by increased gut permeability



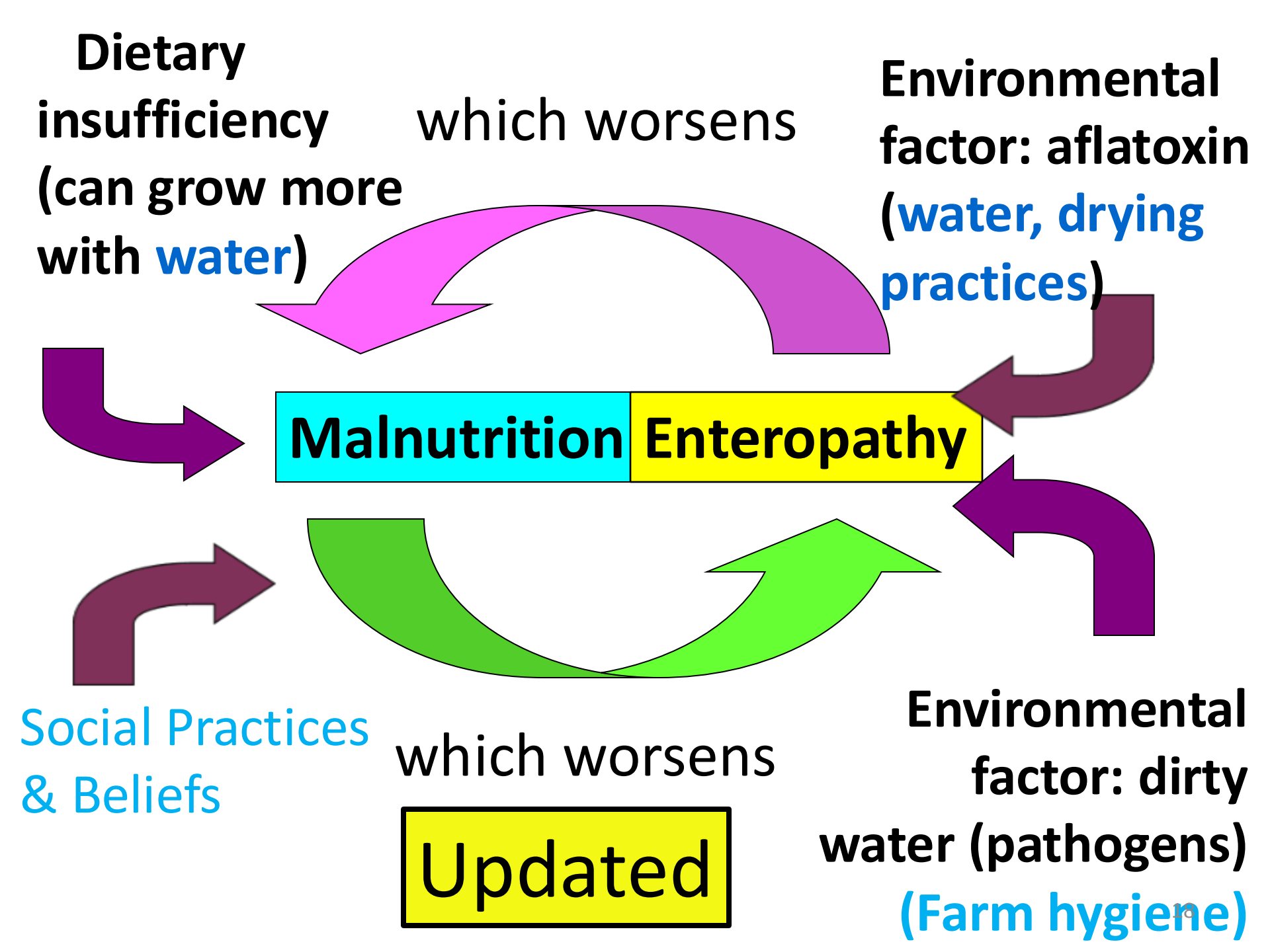
ENVIRONMENTAL ENTEROPATHY (EE)

People living in contaminated environments have leaky, chronically inflamed intestines

EE - Short blunted villi, tissue infiltrated with inflammatory cells. 15% less protein and 5% less carbohydrate absorbed. ↑ nutritional needs, bacteria leak into body, leads to anemia.

Bad bacteria = likely cause.

Korpe & Petri, Trends in Molecular Medicine June 2012, Vol. 18, No. 6


Dietary insufficiency (can grow more with water)
which worsens
Environmental factor: aflatoxin (water, drying practices)
Malnutrition
Enteropathy
Social Practices & Beliefs
which worsens
Environmental factor: dirty water (pathogens) (Farm hygiene)
Updated

Key findings from Spear's analysis of 140 DHS from 65 LMICs

- Open defecation (a marker of a "contaminated environment") linked to **1.24 S.D. decrease** in height of children
- **Sanitation alone** accounts for **54%** of between country height variation
- Open defecation and lack of sanitation in an household, along with country GDP, predict child height *more than* mother's height or education; governance; or infrastructure

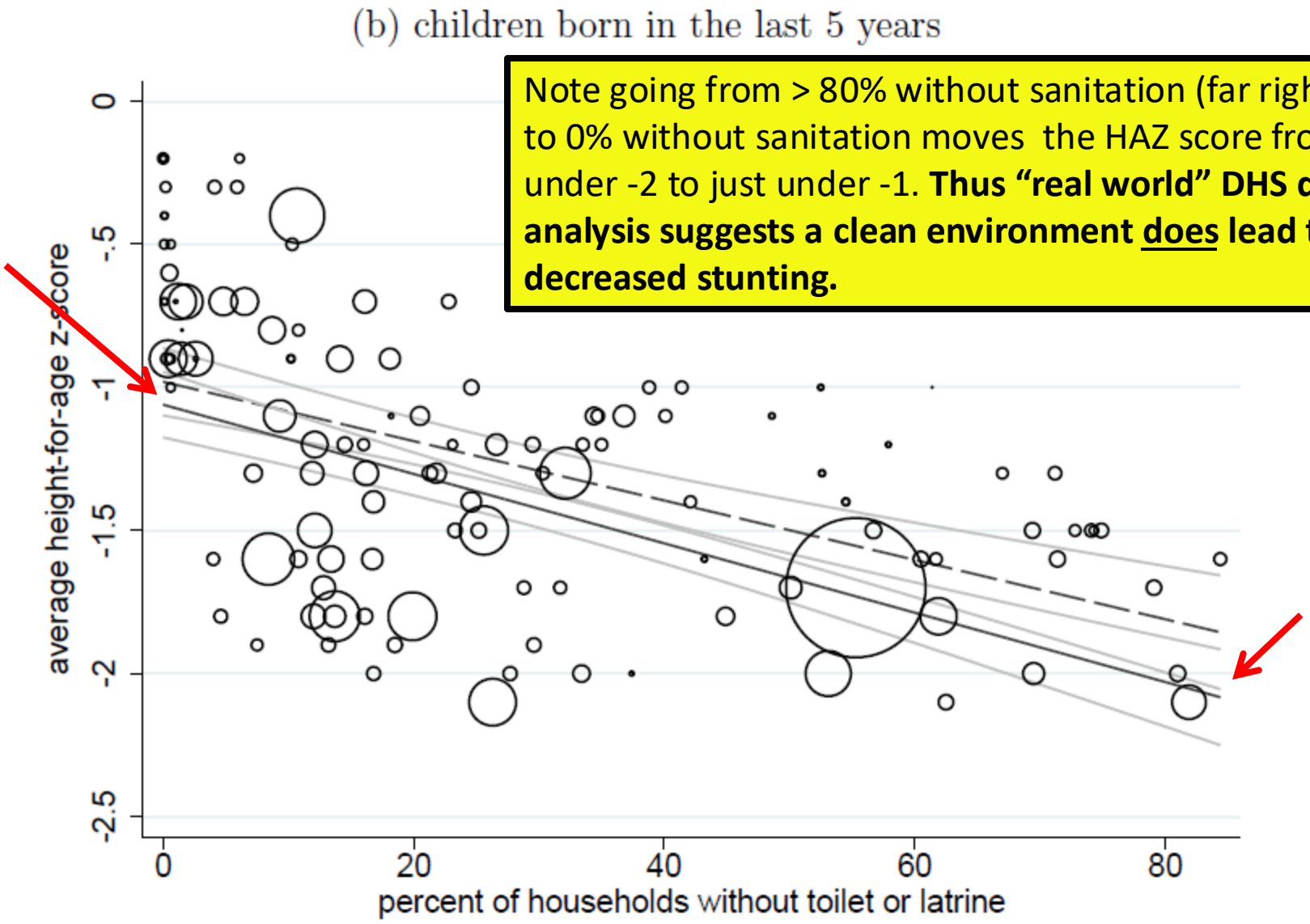


Figure 1: Open defecation predicts child height, across DHS survey round country-years

Solid OLS regression lines weight by country population; dashed lines are unweighted.

Lancet June 2013

Maternal and Child Nutrition 2

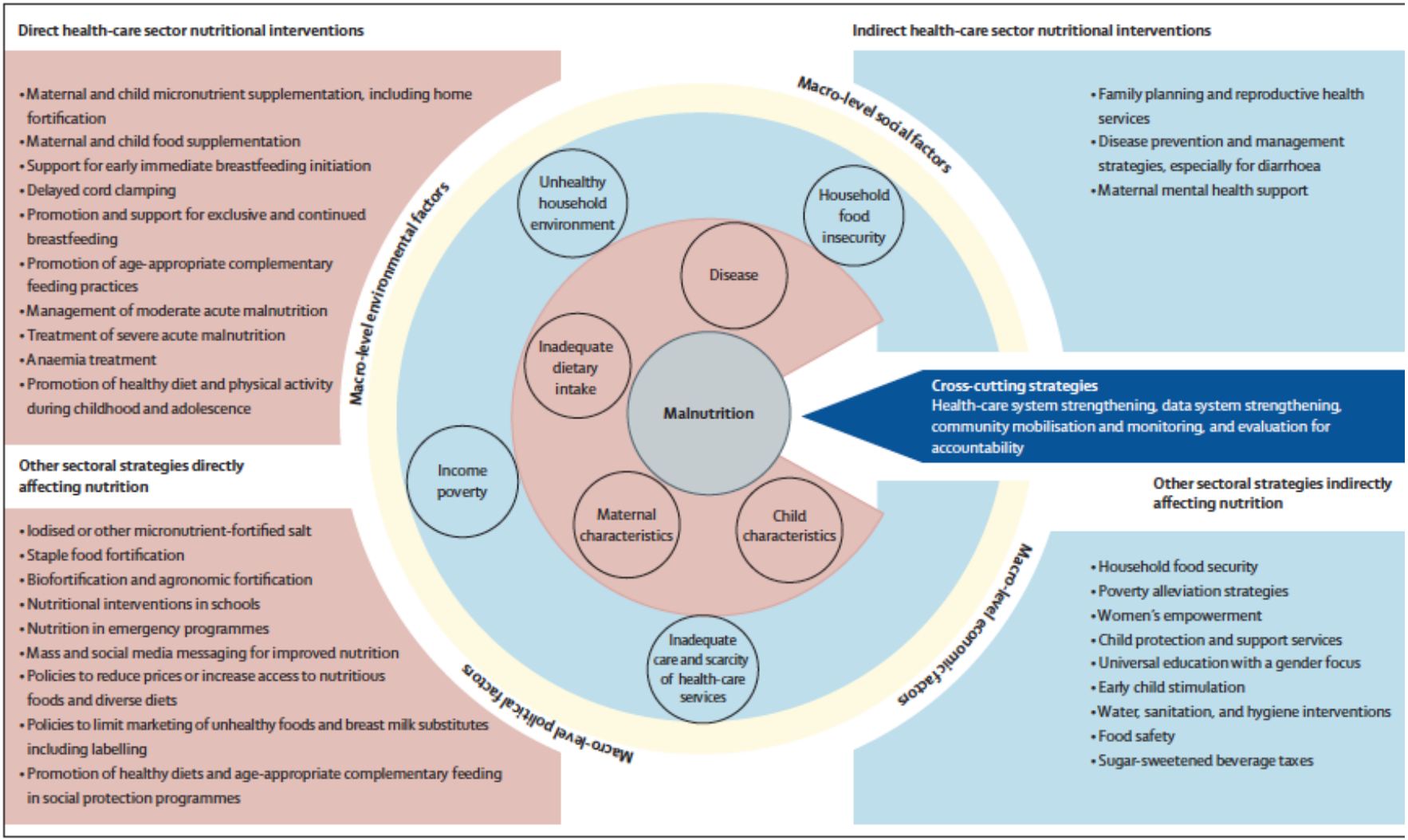
Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost?

Zulfiqar A Bhutta, Jai K Das, Arjumand Rizvi, Michelle F Gaffey, Neff Walker, Susan Horton, Patrick Webb, Anna Lartey, Robert E Black, The Lancet Nutrition Interventions Review Group, and the Maternal and Child Nutrition Study Group

- 165 million stunted children
- If top 10 nutrition interventions targeted to 34 countries with 90% of childhood deaths …
- Could reduce deaths by **15%**, stunting by **20%**, and acute wasting by **61**%
  - For < $10 billion per year)

Revised Framework for Classification of Nutrition Interventions

Keats EC et al. Lancet 2021



Recommended Evidence-Based Interventions to Address Malnutrition, Strong Evidence

Keats EC et al. Lancet 2021

Strong evidence for implementation	• Multiple micronutrient supplementation in pregnancy • Kangaroo mother care for preterm and low birthweight newborn babies • Delayed cord clamping for preterm newborn babies • Breastfeeding promotion and counselling • Complementary feeding education with food provision in food insecure populations • Vitamin A supplementation for children in vitamin A-deficient contexts • Therapeutic zinc supplementation for diarrhoea management • Small-quantity lipid-based nutrient supplements for growth among children • Ready-to-use supplementary food for management of acute malnutrition • Family planning and birth spacing* • Insecticide-treated bednets for the control of malaria* • Large-scale food fortification for the prevention of micronutrient deficiencies†

Recommended Evidence-Based Interventions to Address Malnutrition, Moderate, Weak, and Emerging Evidence

Keats EC et al. Lancet 2021

Moderate evidence for implementation	• Water, sanitation, and hygiene interventions‡ • Calcium supplementation in pregnancy in low intake populations • Balanced-energy protein supplementation in pregnancy for women who are undernourished • Complementary feeding education without food provision in food secure populations • Preventive zinc supplementation to reduce diarrhoea incidence • Micronutrient powders to reduce iron deficiency and anaemia among children
Weak evidence for implementation	• Food distribution programmes during pregnancy • Kangaroo mother care for term newborn babies
Emerging evidence	• Probiotics for preterm and low birthweight newborns • Emollient use (ie, coconut oil) for preterm and low birthweight newborns

Community-based parenting groups - ?

Improving Early Child Development in Zambia

- Aim: to assess impact of a community-based parenting group intervention on early childhood development in rural Zambia
- Primary outcome measures:
  - Stunting (HAZ <-2 Z score)
  - Five domains of neurocognitive development measured using Bayley Scale for Infant and Toddler Development (BSID-III)

- Cluster RCT in five rural health facility catchment areas in Southern Province (Pemba and Choma Districts)
- Caregivers eligible if they had a child 6-12 months old at baseline
- Intervention clusters, fortnightly parenting group meetings focused on child nutrition and early childhood development

Community-Based Parenting Groups

- Fortnightly group meetings
- Train-the-trainer model with group selected ‘head mother’
- Each meeting focused on different aspect of parenting:
  - Cognitive stimulation and play practices
  - Child nutrition and cooking practices
  - Self-care for good mental health

*Rockers PC, et al. *PLoS Medicine* 2018;15(4):e1002555.

Results

Table 1. Caregiver–child interaction at each period of data collection

Caregiver–child interaction z-score[b]	Mean (SD)	ICC	Unadjusted		Adjusted[a]	
			β (95% CI)	p value	β (95% CI)	p value
Baseline						
Control	0·00 (1·04)	-	-	-	-	-
Intervention	0·00 (0·96)	0·32	-0·01 (-0·48, 0·47)	0·981	0·06 (-0·35, 0·48)	0·757
Year one follow-up						
Control	-0·37 (0·93)	-	-	-	-	-
Intervention	0·35 (0·94)	0·13	0·72 (0·52, 0·92)	<0·001	**0·72 (0·54, 0·89)**	**<0·001**
Re-consent						
Control	-0·36 (1·07)	-	-	-	-	-
Intervention	0·33 (0·80)	0·46	0·69 (0·20, 1·18)	0·007	**0·72 (0·22, 1·23)**	**0·007**
Year two follow-up						
Control	-0·21 (1·00)	-	-	-	-	-
Intervention	0·19 (0·97)	0·09	0·40 (0·16, 0·63)	0·002	**0·29 (0·04, 0·54)**	**0·022**

Table 2. Impact of the intervention on primary outcomes at year 2 follow-up.

Outcome	*n* (%) or mean (SD) at year 2 follow-up[a]		ICC	Unadjusted[b]		Adjusted[c]	
	Control	Intervention		OR or β[d] (95% CI)	*p*-Value	OR or β[d] (95% CI)	*p*-Value
Stunting	72 (39.6)	56 (29.2)	0.07	0.53 (0.30, 0.94)	0.029	0.45 (0.22, 0.92)	0.028
BSID-III *z*-scores							
Cognition	0.01 (1.02)	−0.01 (0.98)	0.06	0.07 (−0.14, 0.28)	0.510	0.11 (−0.06, 0.29)	0.196
Language	0.04 (0.97)	−0.04 (1.03)	0.04	−0.02 (−0.24, 0.19)	0.818	0.14 (0.01, 0.27)	0.039
Motor	0.05 (0.93)	−0.05 (1.06)	0.07	−0.03 (−0.26, 0.20)	0.782	−0.01 (−0.25, 0.24)	0.964
Adaptive behavior	−0.14 (0.99)	0.13 (1.00)	0.05	0.28 (0.06, 0.49)	0.014	0.21 (−0.03, 0.44)	0.088
Social-emotional	−0.13 (1.08)	0.12 (0.90)	0.06	0.28 (0.05, 0.51)	0.019	0.20 (−0.04, 0.44)	0.098

β estimates for all BSID-III *z*-scores are equivalent to Cohen's *d* values. Stunting is defined as height-for-age *z*-score < −2. All standard errors are adjusted to account for clustering.

[a]Stunting data are summarized as *n* (%). BSID-III *z*-score data are summarized as mean (SD).

PLOS | MEDICINE

Two-year impact of community-based health screening and parenting groups on child development in Zambia: Follow-up to a cluster-randomized controlled trial

Peter C. Rockers[1]*, Arianna Zanolini[2], Bowen Banda[3], Mwaba Moono Chipili[4], Robert C. Hughes[5], Davidson H. Hamer[1,3,6], Günther Fink[7,8]

HAZ curve shift

Rockers PC et al. PLoS Med 2018

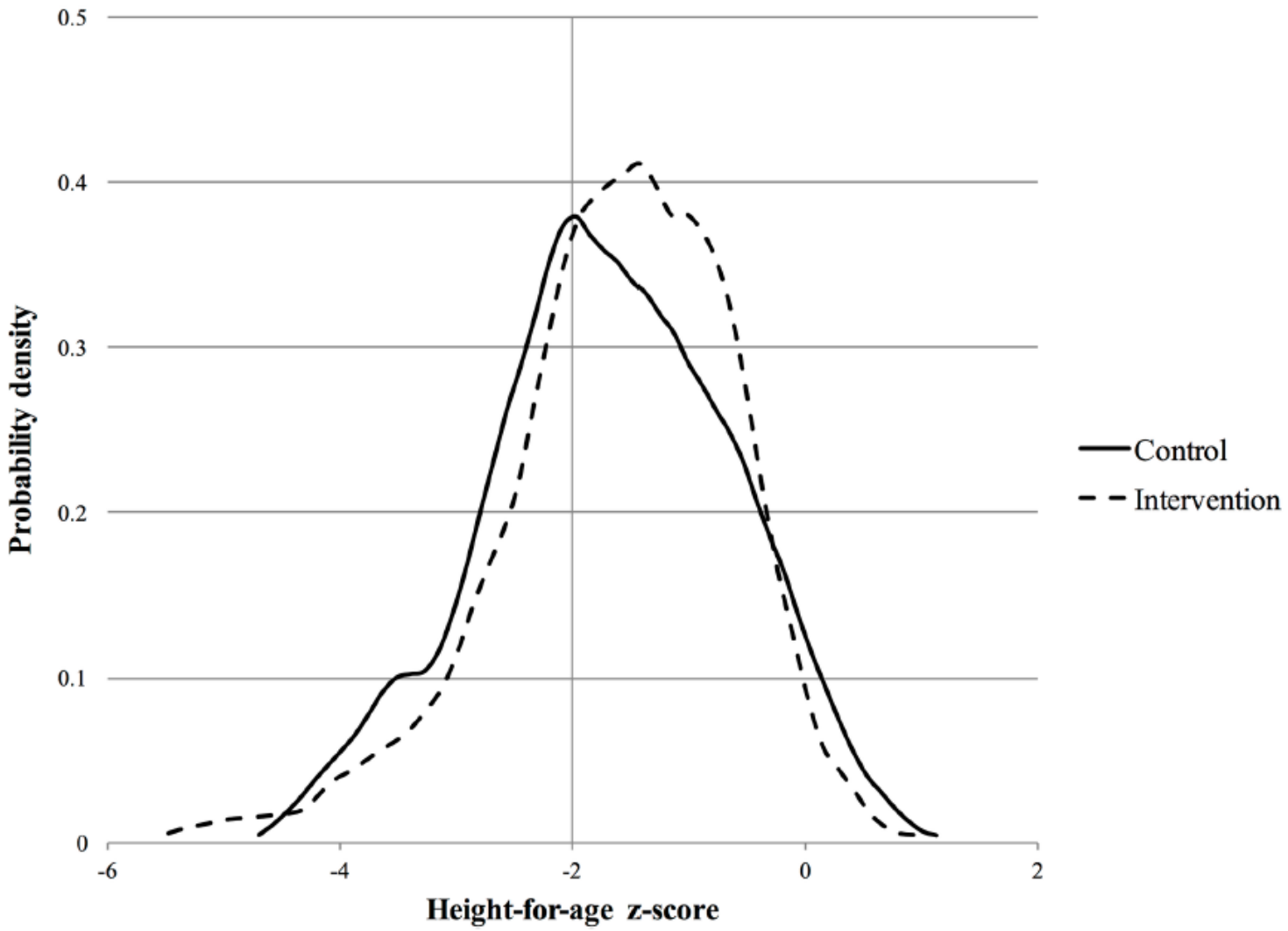


Fig 2. Probability density function for height-for-age *z*-score at year 2 follow-up.

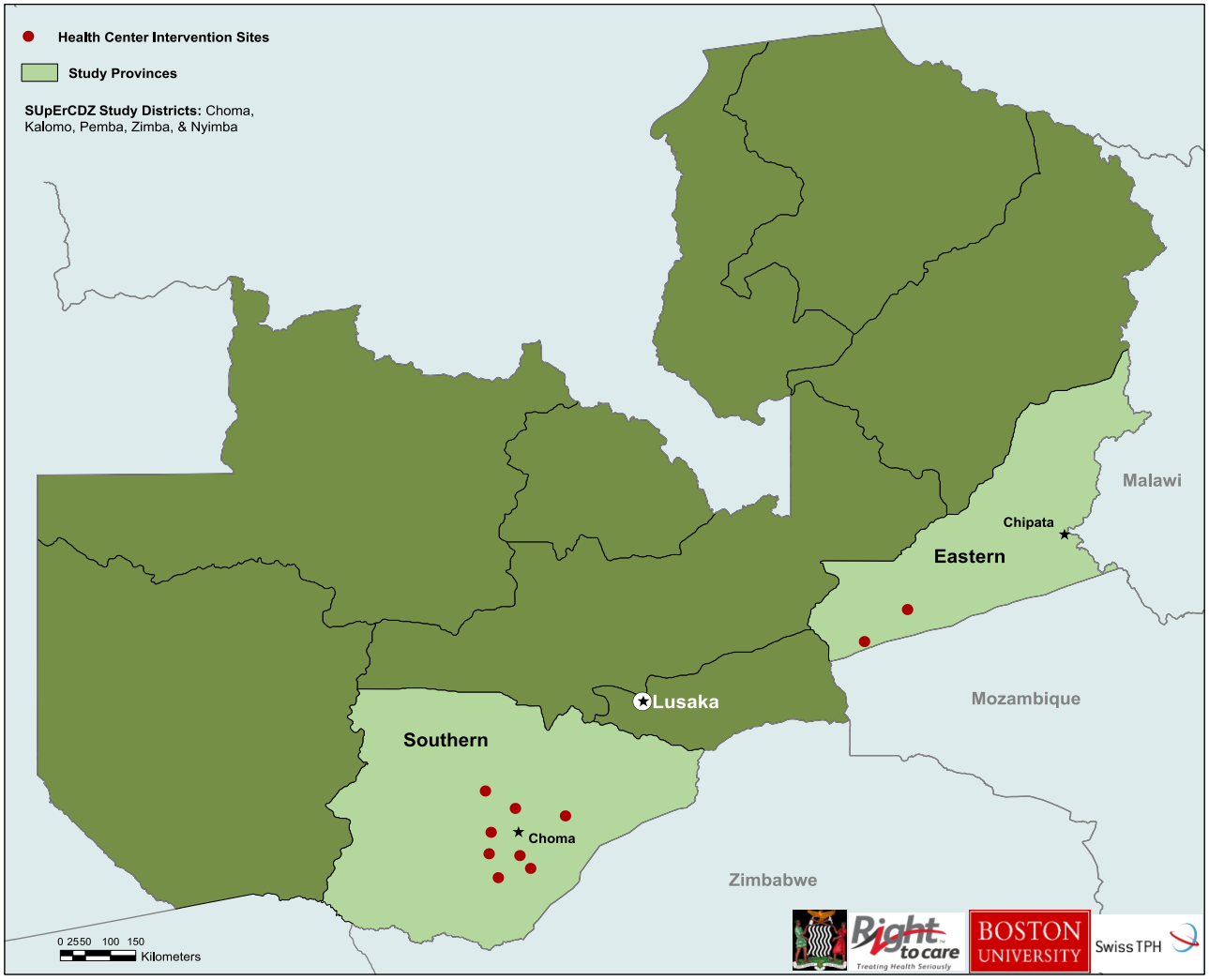
Scaling Up Early Childhood Development in Zambia (SUpErCDZ) Project Objectives

- To understand the effect of parenting groups on child development when delivered at scale
- To identify aspects of the SMAG/MWH delivery model to be scaled throughout rural Zambia
- To understand effect of the Zambia Folklore Children's book on child development

- Implementing partners: Right to Care Zambia, Boston University, and Swiss Tropical and Public Health Institute

Geographical Scope

SUpErCDZ Intervention Sites



Choma

Kalomo

Pemba

Nyimba

SUpErCDZ Design

- Unmasked, two-arm, parallel blinded cluster-randomized controlled trial in the catchment areas of 10 health facilities located in Southern and Eastern Provinces
- Enrolled caregiver-infant dyads (infants aged 0-5 months) and assessed them two years later
- Curriculum focused on four core content areas:
  - child health, hygiene, safety, and sanitation
  - child nutrition, diet diversity, and cooking practices
  - psychosocial stimulation and play practices
  - caregiver self-care for good mental health

SUpErCDZ Outcomes

Primary:

- Child height-for-age z-score (HAZ)
- Stunting (HAZ <-2)
- Child development scores measured using two tools—the Malawi Development Assessment Test (MDAT) and the Caregiver Reported Early Development Index (CREDI)

Intermediary:

- Caregiver-child interactions
- Child diet diversity
- Caregiver mental and social health

Cooking and Crafts

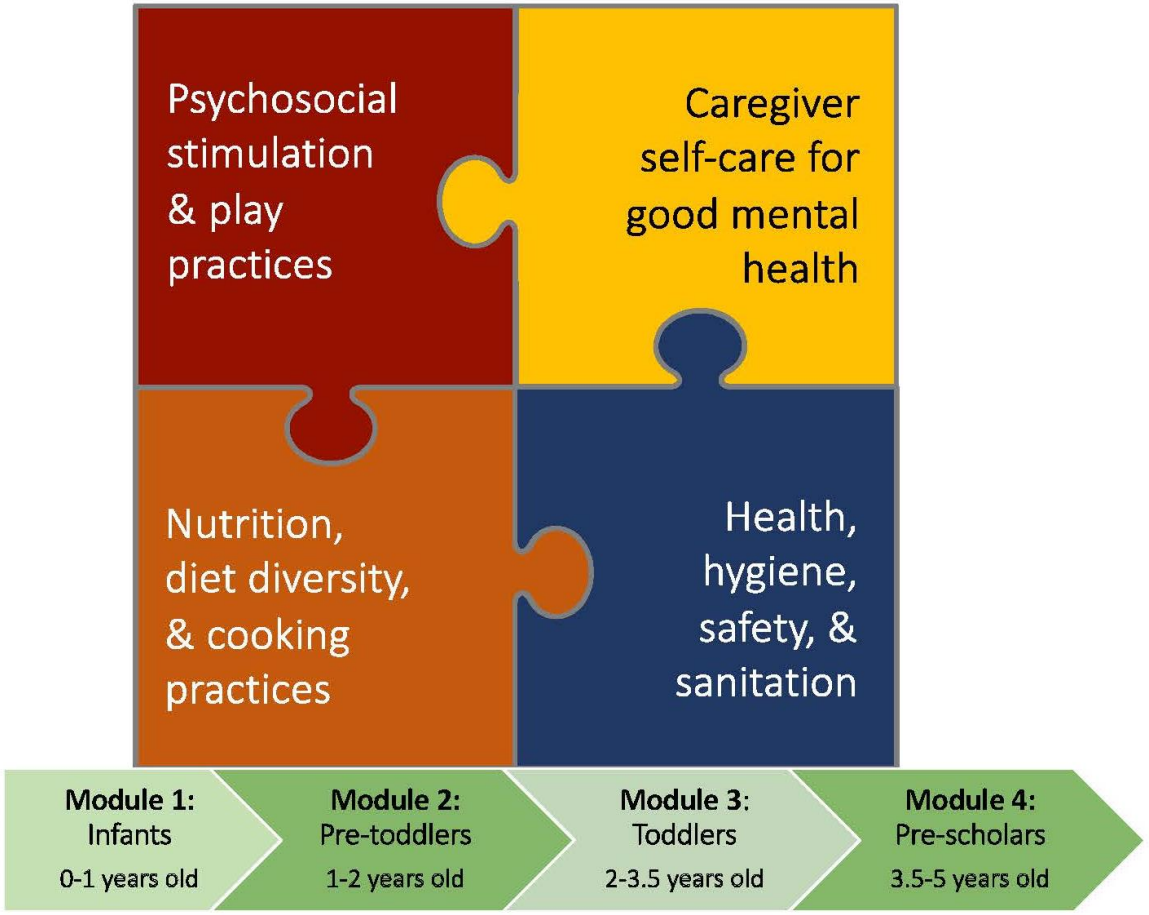



Cooking demonstration during Safe Motherhood Action Group (SMAG) training: porridge with pounded kapenta (sardines)




From left to right: dress and trousers made from chitenge, feeding bib, toy car made from recycled plastic bottles

Core early child development curriculum content areas and child ages for modules



Results

- Baseline (August 2019), 1,170 caregiver-child dyads enrolled
- 934 (515 intervention, 419 control) assessed at endline (September 2021)

- Intervention and control group similar at baseline with respect to demographics, child anthropometry, and Caregiver Reported Early Development Index (CREDI) scores

Impact on Outcome Measures

Primary:

- No effect on HAZ (adjusted β = -0.09 [95% CI -0.28, 0.09]; p=0.33), stunting (aOR 1.41 [95% CI 0.97 to 2.06]; p=0.073), or MDAT scores (adjusted β = 0.07 (-0.09, 0.23)]
- Significant for CREDI language (aβ=0.12 [0.02,0.22], p=0.014) and overall scores (aβ=0.15 [0.02,0.28], p=0.027)

Secondary:

- Caregiver-child interactions (aβ = 0.52 [0.22, 0.81]; p=0.001)
- Child diet diversity (aβ = 0.29 [0.09, 0.48]; p=0.003)
- Caregiver mental health problems (β =-0.95, [-1.52, -0.37], p=0.001)
- Caregiver social support (aβ = 2.37 [0.02, 4.73]; p=0.048)
  - Scott NA, Ngoma T, Kaiser J et al. Manuscript to be submitted soon.

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Bowen Banda, ZCAHRD, Zambia
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District Health Office of Choma and Pemba, community health workers, mothers and children

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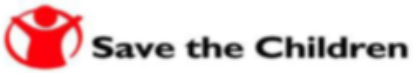
- DFID Policy Research Fund
- USAID Zambia



Conclusions

- Global burden of stunting remains high but improved since 2000
- Stunting causes multi-factorial
- Single interventions often ineffective but bundles promising
- Parenting groups with focus on early child development increase child neurocognitive outcomes (and may reduce stunting)

Any questions?