Childhood stunting in Bangladesh – what worked well, what else do we need to do

Dr Tahmeed Ahmed

Executive Director
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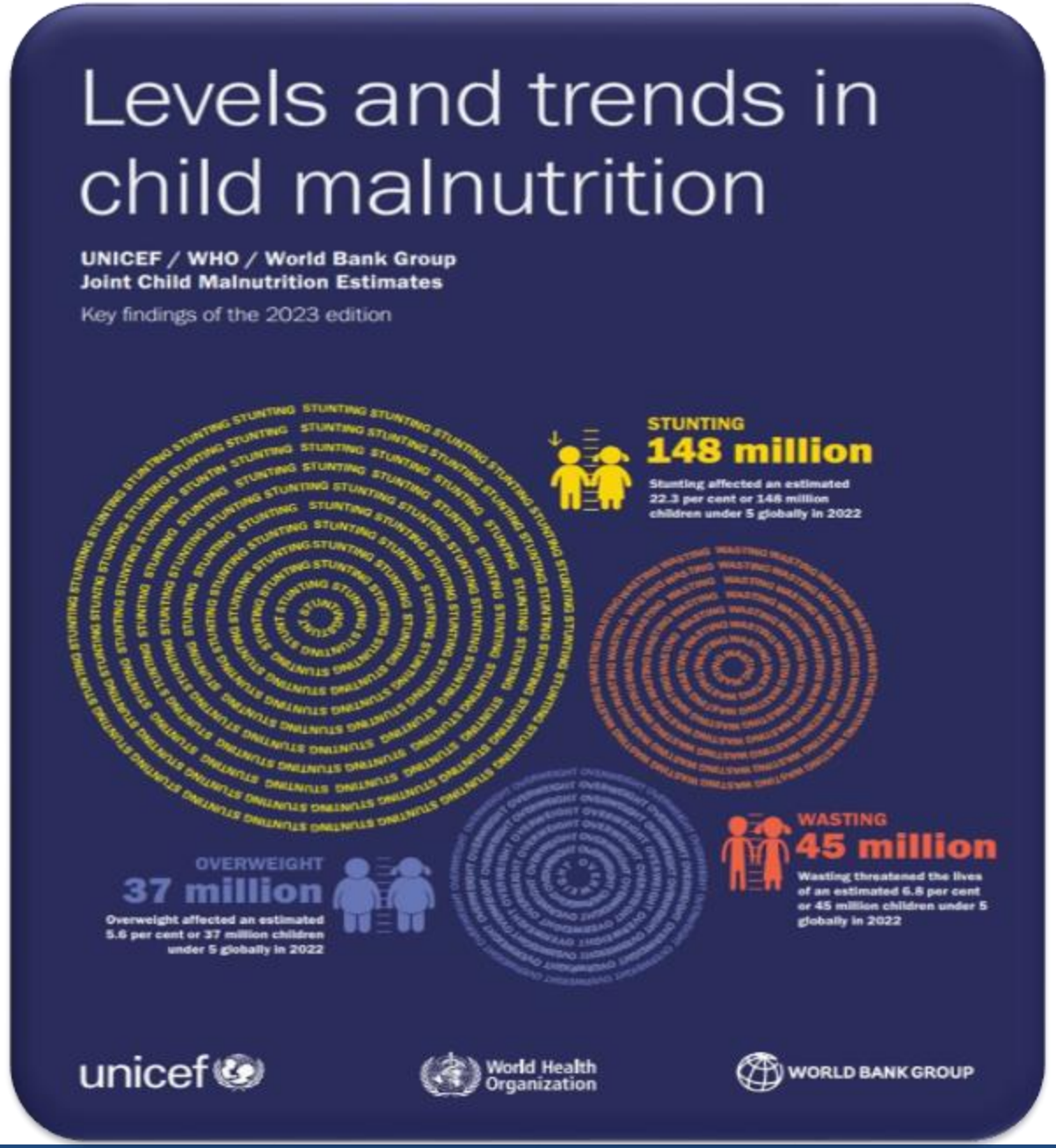
James P. Grant School of Public Health
BRAC University

Key elements of my talk

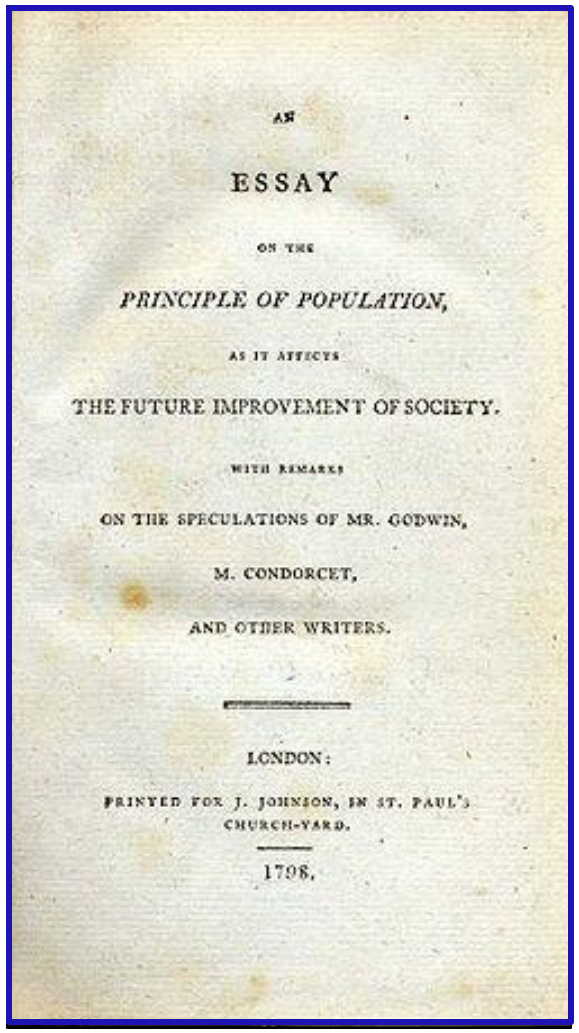
- The burden of childhood stunting
- An ecological analysis of stunting in Bangladesh
- WASH – an important area for reducing stunting
- An innovation for a life cycle approach to solve this problem

The burden of childhood stunting



The world produces so much food, yet malnutrition persists

Thomas Robert Malthus



AN

ESSAY

ON THE

PRINCIPLE OF POPULATION,

AS IT AFFECTS

THE FUTURE IMPROVEMENT OF SOCIETY.

WITH REMARKS

ON THE SPECULATIONS OF MR. GODWIN,

M. CONDORCET,

AND OTHER WRITERS.

LONDON:

PRINTED FOR J. JOHNSON, IN ST. PAUL'S CHURCH-YARD.

1798.

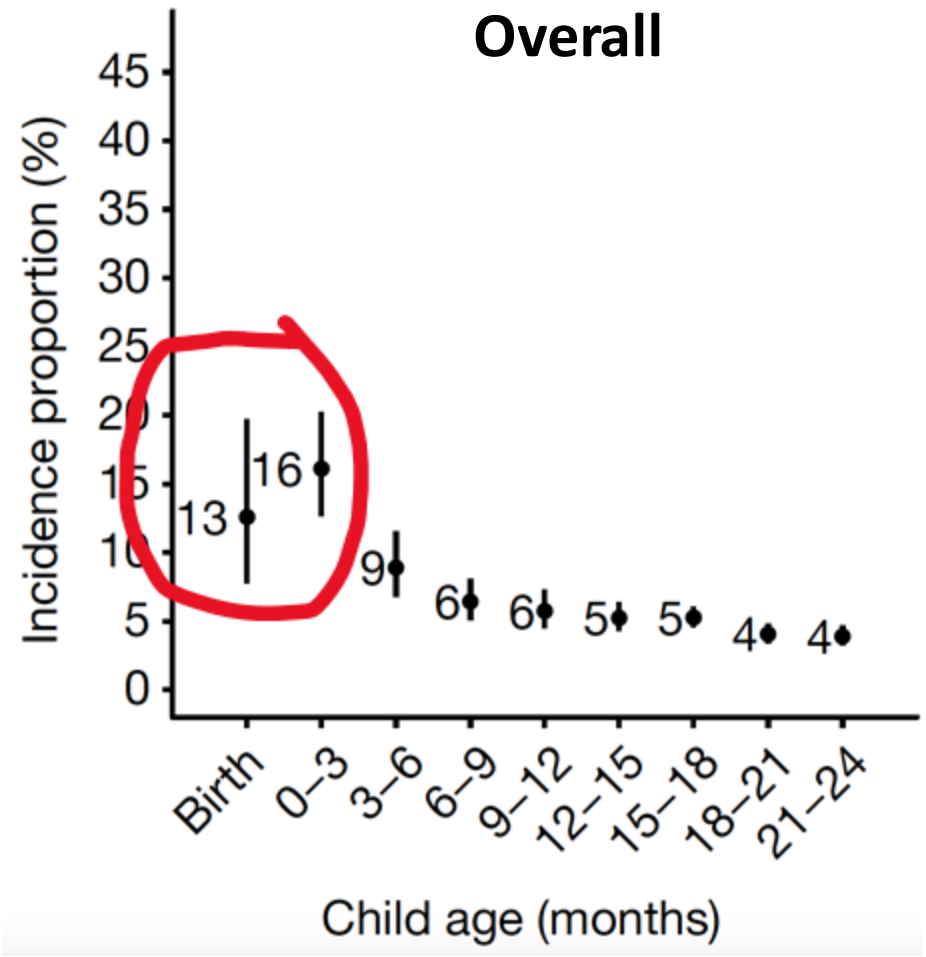
Population grows exponentially while food production increases linearly

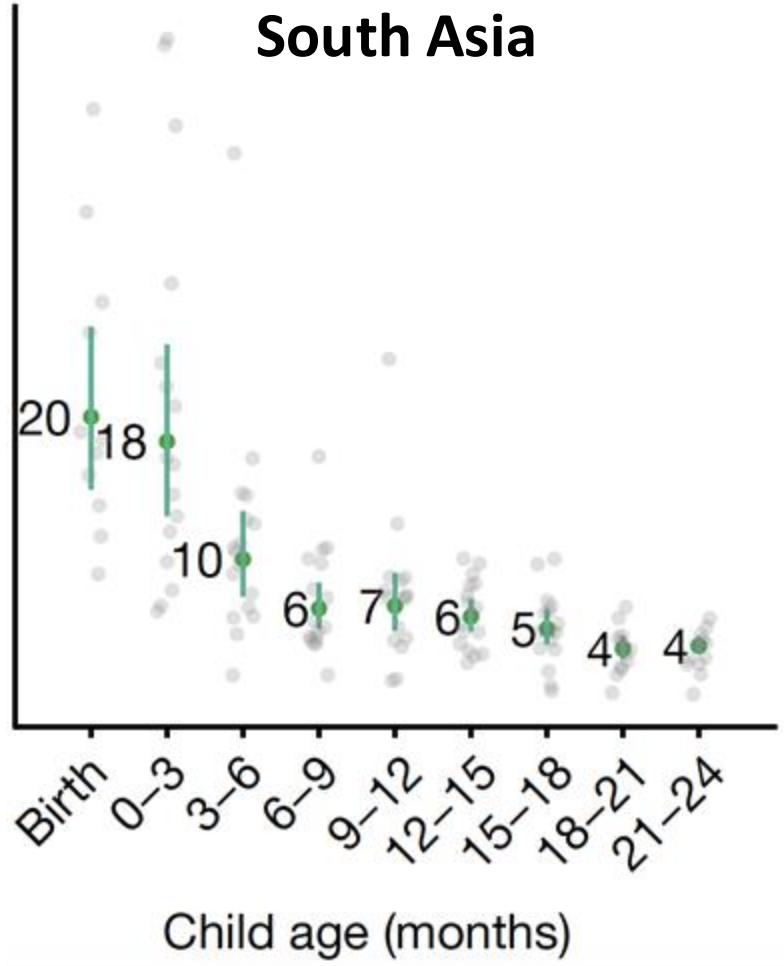
Amartya Sen
Nobel Prize in Economics 1998

Famines are not primarily caused by a sudden drop in food supply, but by failures in "entitlement," which is people's ability to access food through legal means like production, trade, or state transfers

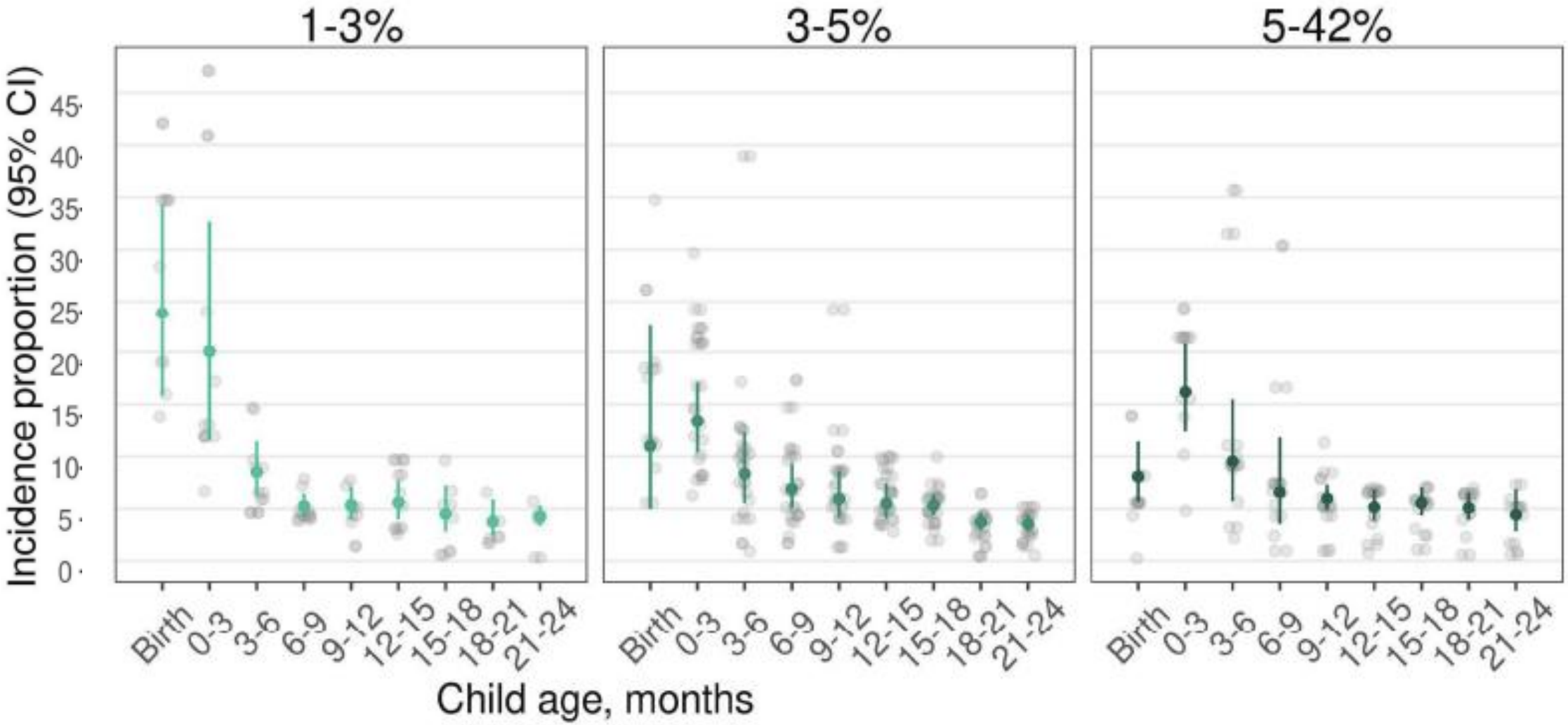
Stunting onset highest from birth to 3 months

32 longitudinal cohorts
14 LMICs South Asia
SSA, Latin America
52,000 children





Stunting associated with national health expenditure



Benjamin-Chung et al, Nature 2023

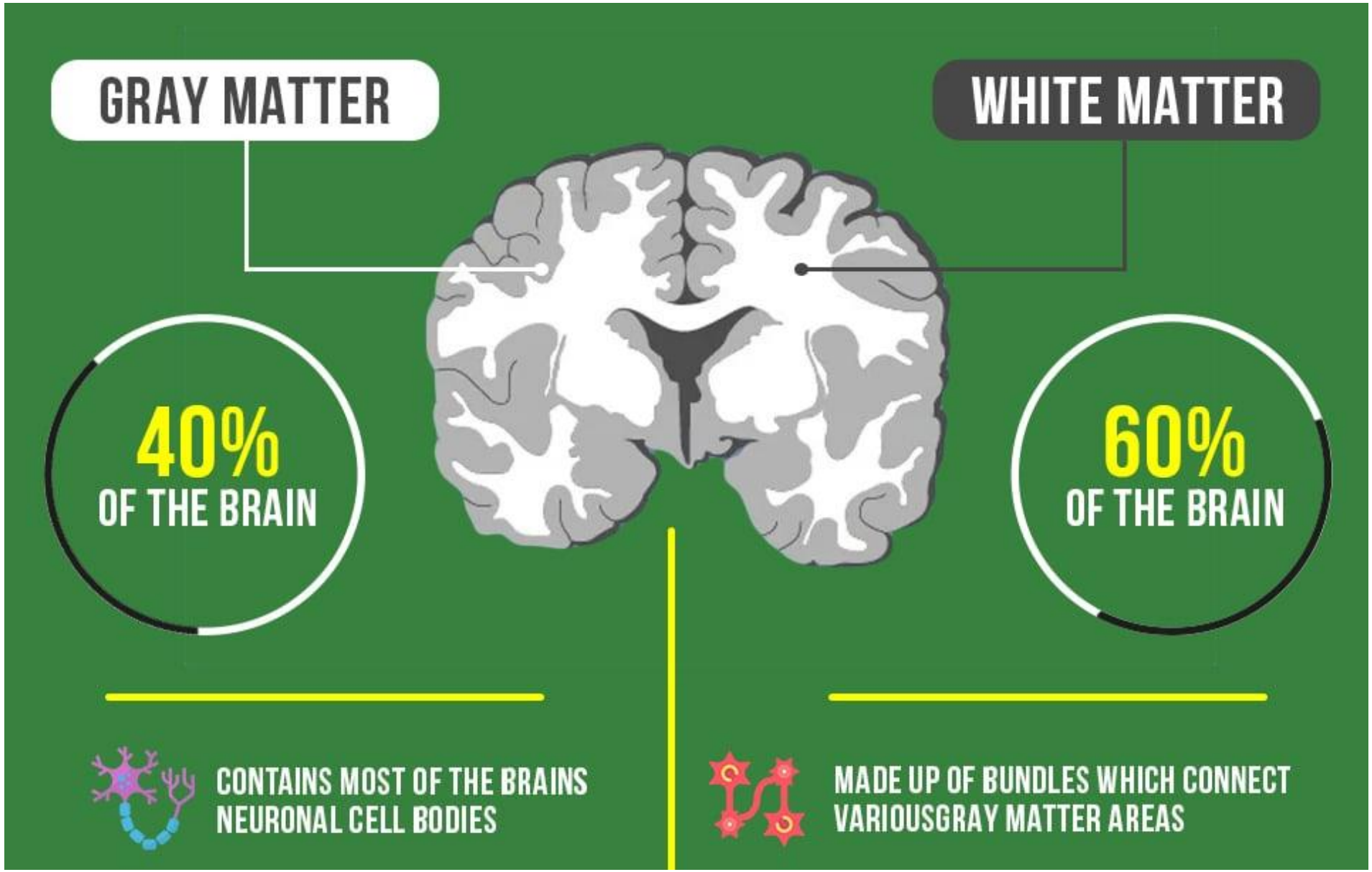
icddr,b

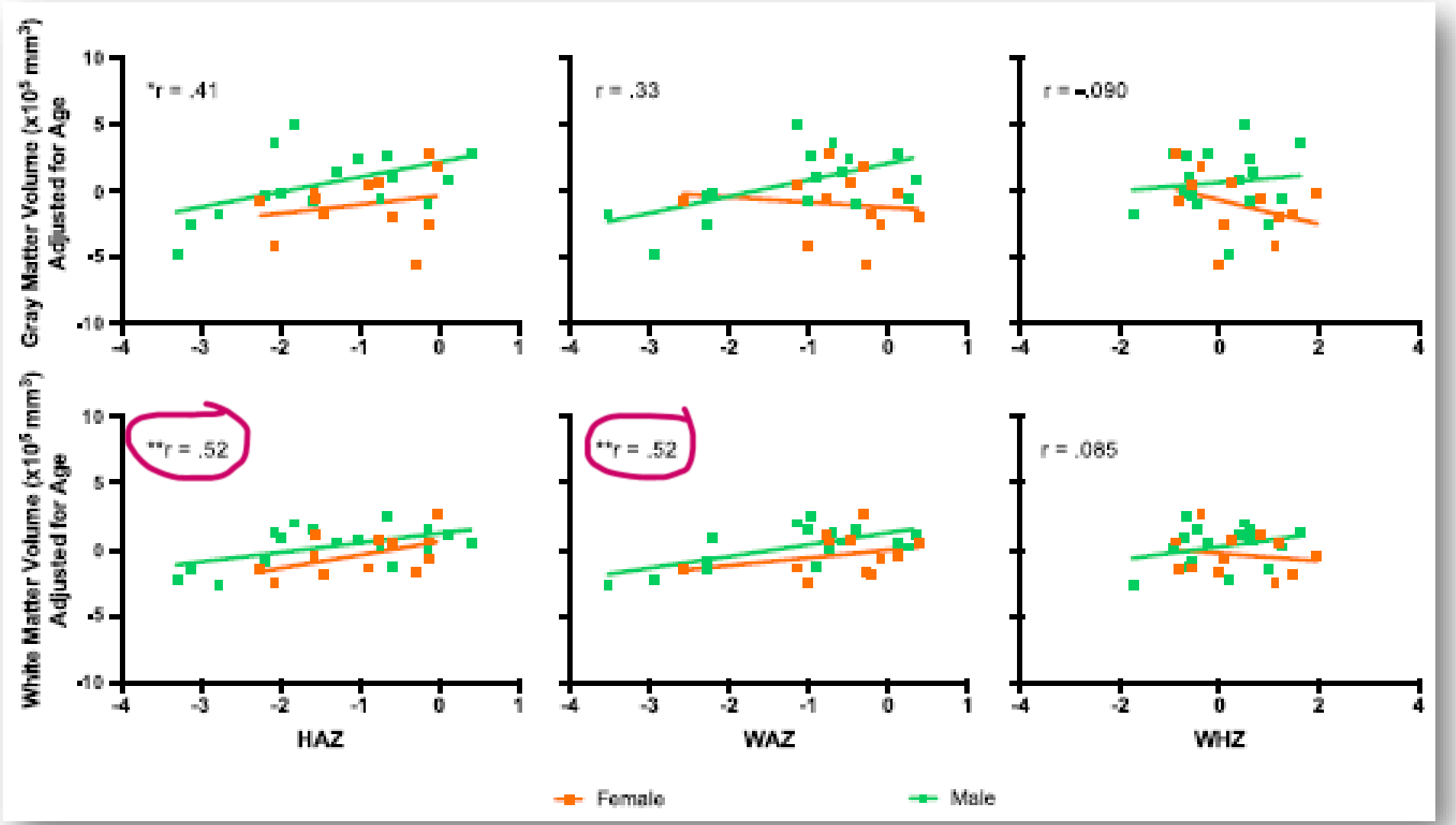
Why are we worried?

Stunting increases the risk of death

Reduces educational and employment opportunities

It affects development of the brain


GRAY MATTER
WHITE MATTER
40%
OF THE BRAIN
60%
OF THE BRAIN
CONTAINS MOST OF THE BRAINS
NEURONAL CELL BODIES
MADE UP OF BUNDLES WHICH CONNECT
VARIOUSGRAY MATTER AREAS



White matter correlated with height-for-age Z score and WAZ

Ecological Analysis of Stunting in Bangladesh

Risk factors for Stunting in Bangladesh

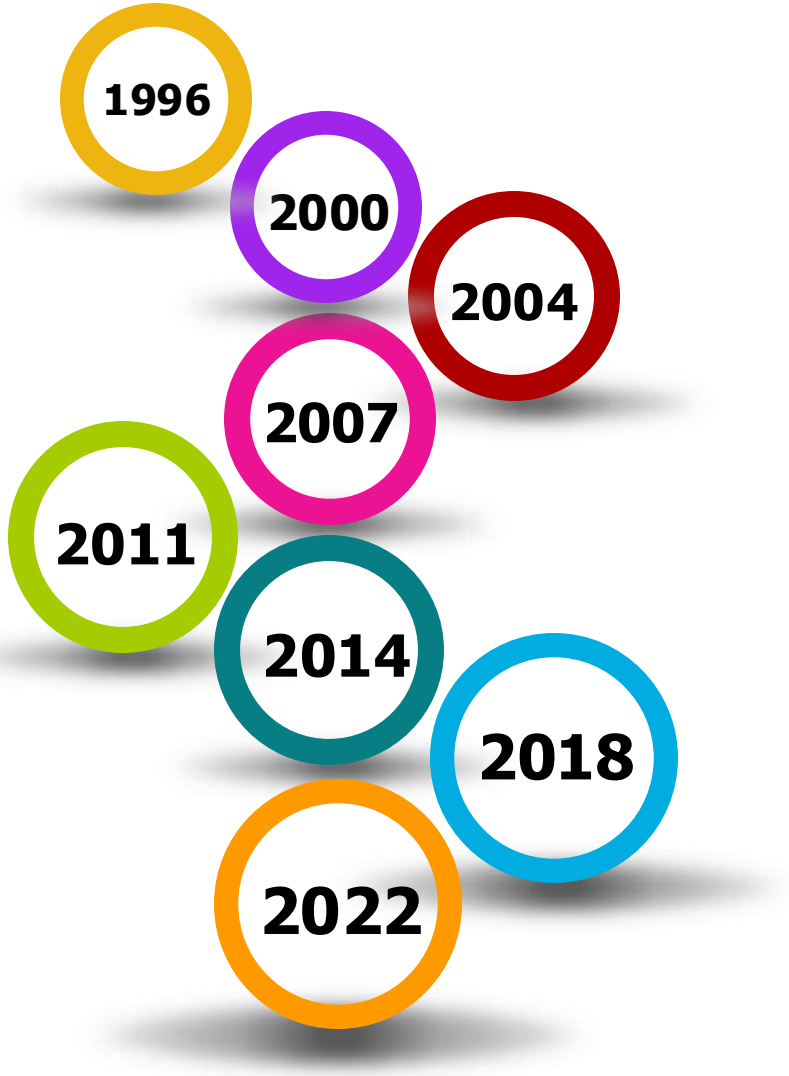
Ecological Analysis

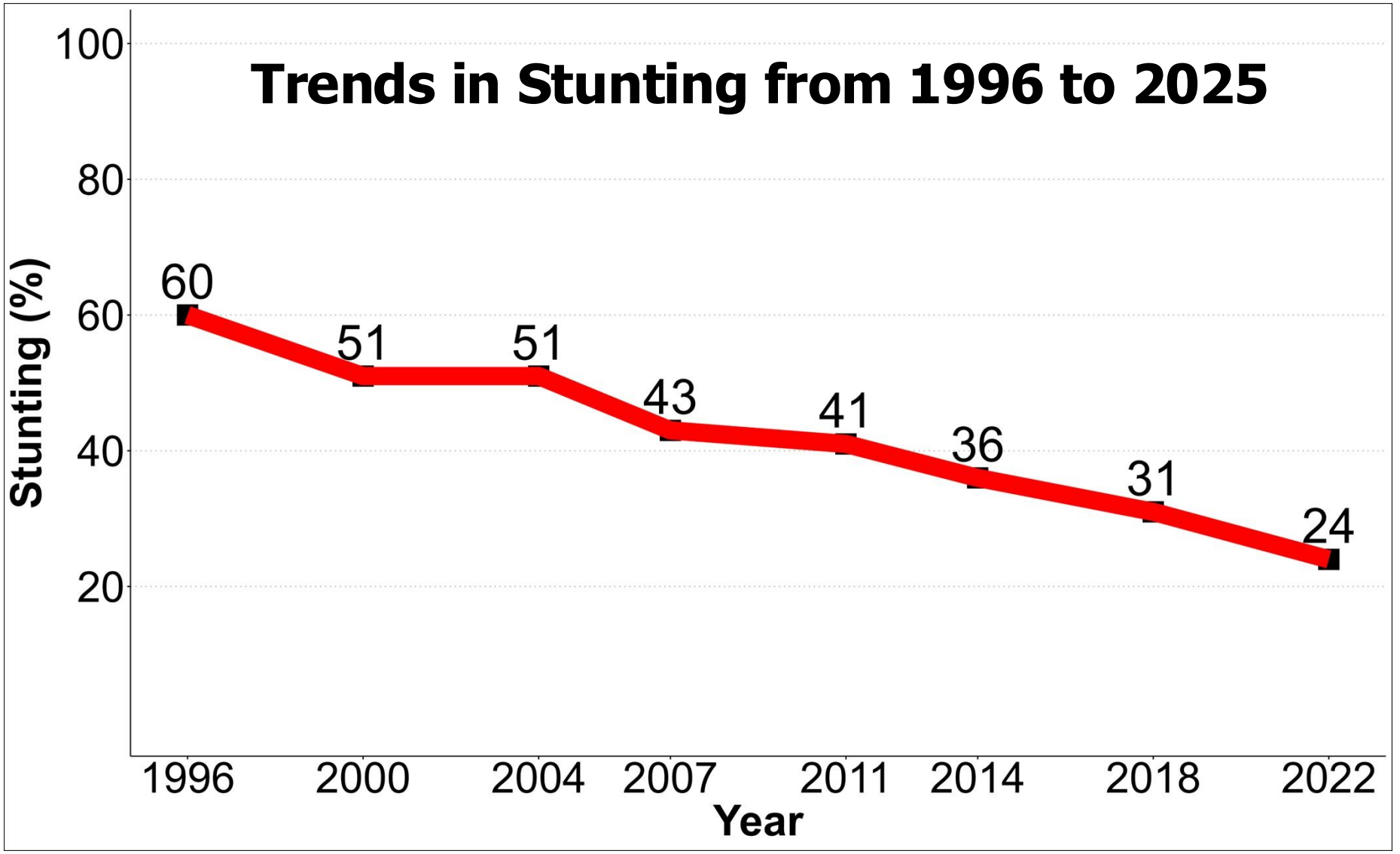
Ecological Approach

- ❑ Population level estimates rather than individual
- ❑ Unit of analysis was the survey years (1996 to 2022) instead of individuals
- ❑ Simple linear Regression with robust standard error

Data sources

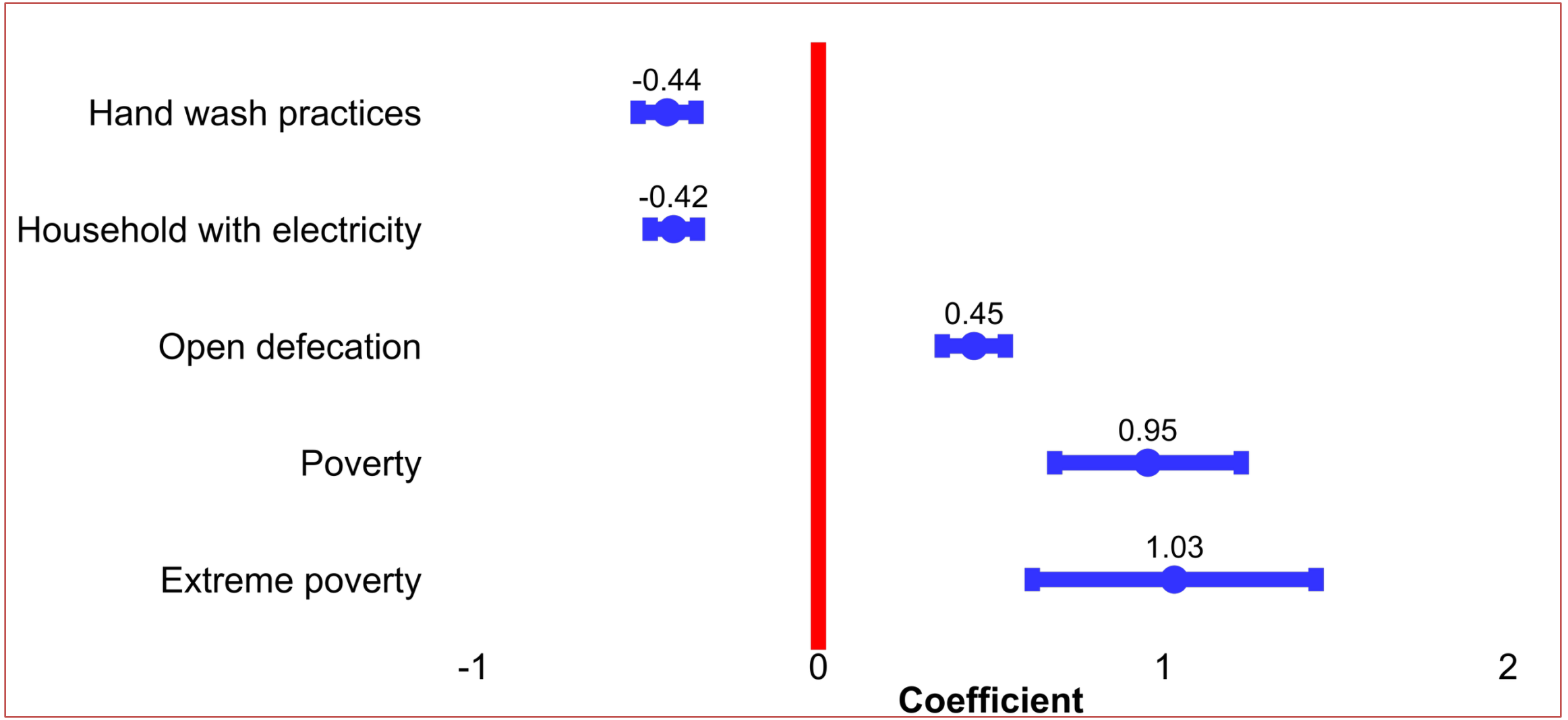
- Bangladesh Demographic and Health Survey
- Bangladesh Bureau of Statistics
- Food Security and Nutrition Surveillance Project
- Ministry of Fisheries and Livestock
- World Bank



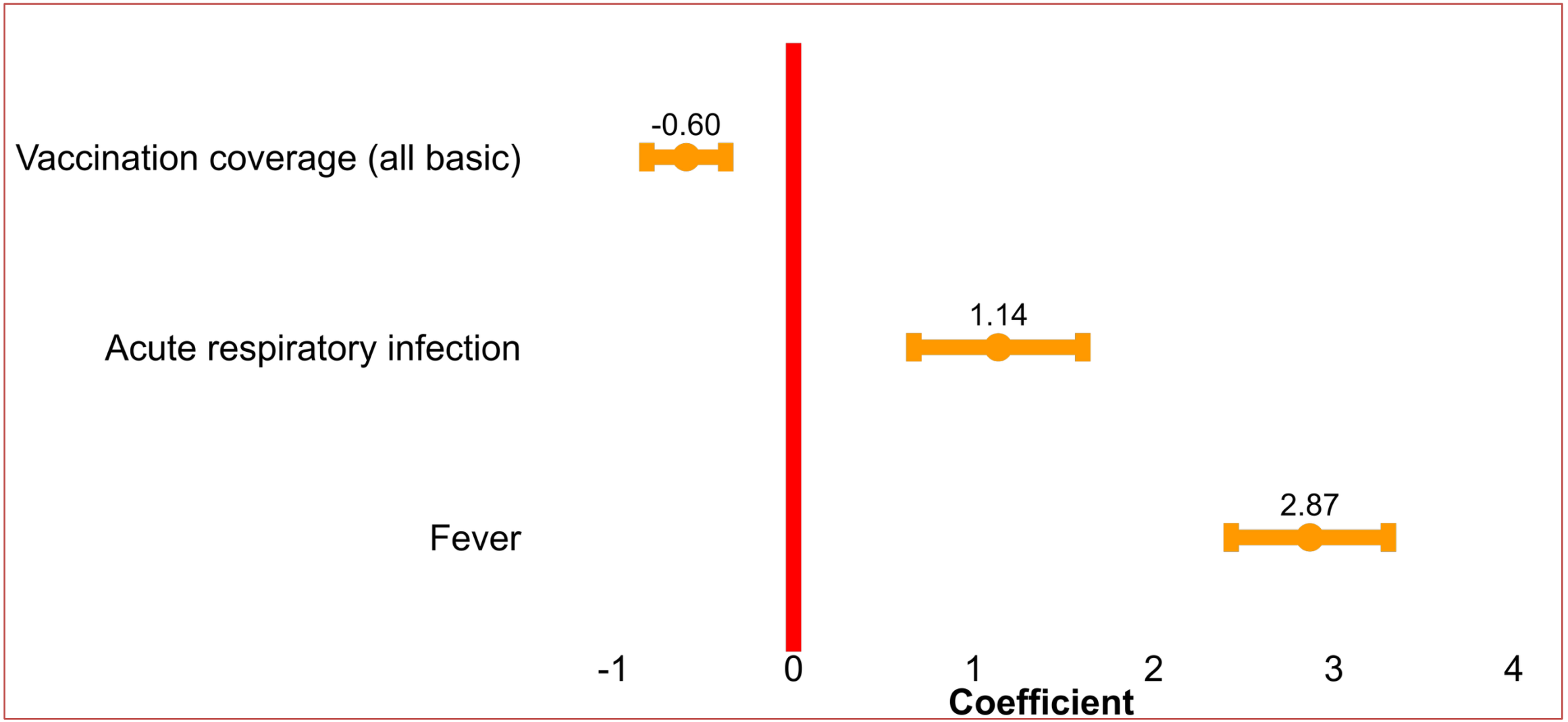

Trends in Stunting from 1996 to 2025
Stunting (%)
100
80
60
40
20
60
51
51
43
41
36
31
24
1996
2000
2004
2007
2011
2014
2018
2022
Year

24%
2025

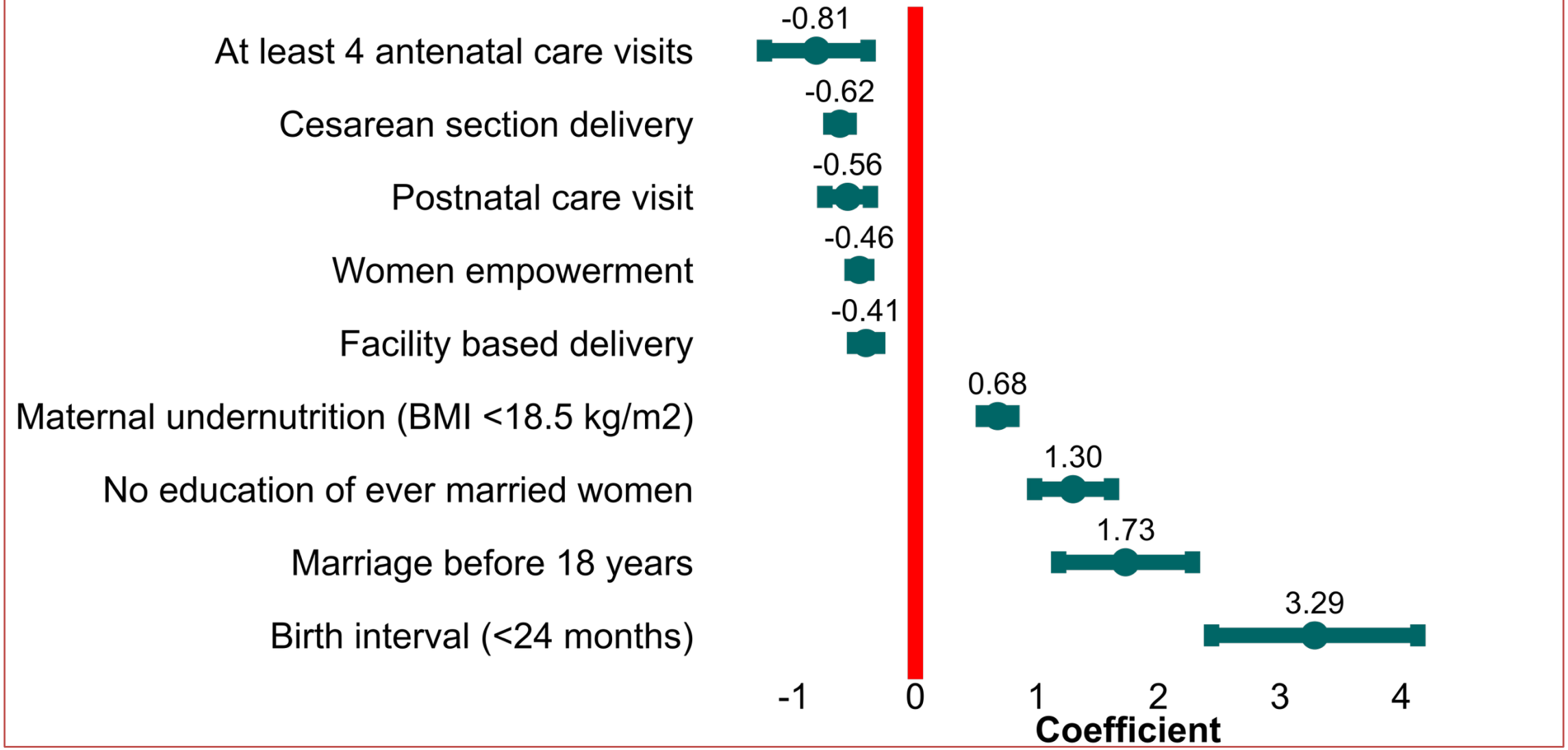
Socioeconomic, Household factors and Stunting



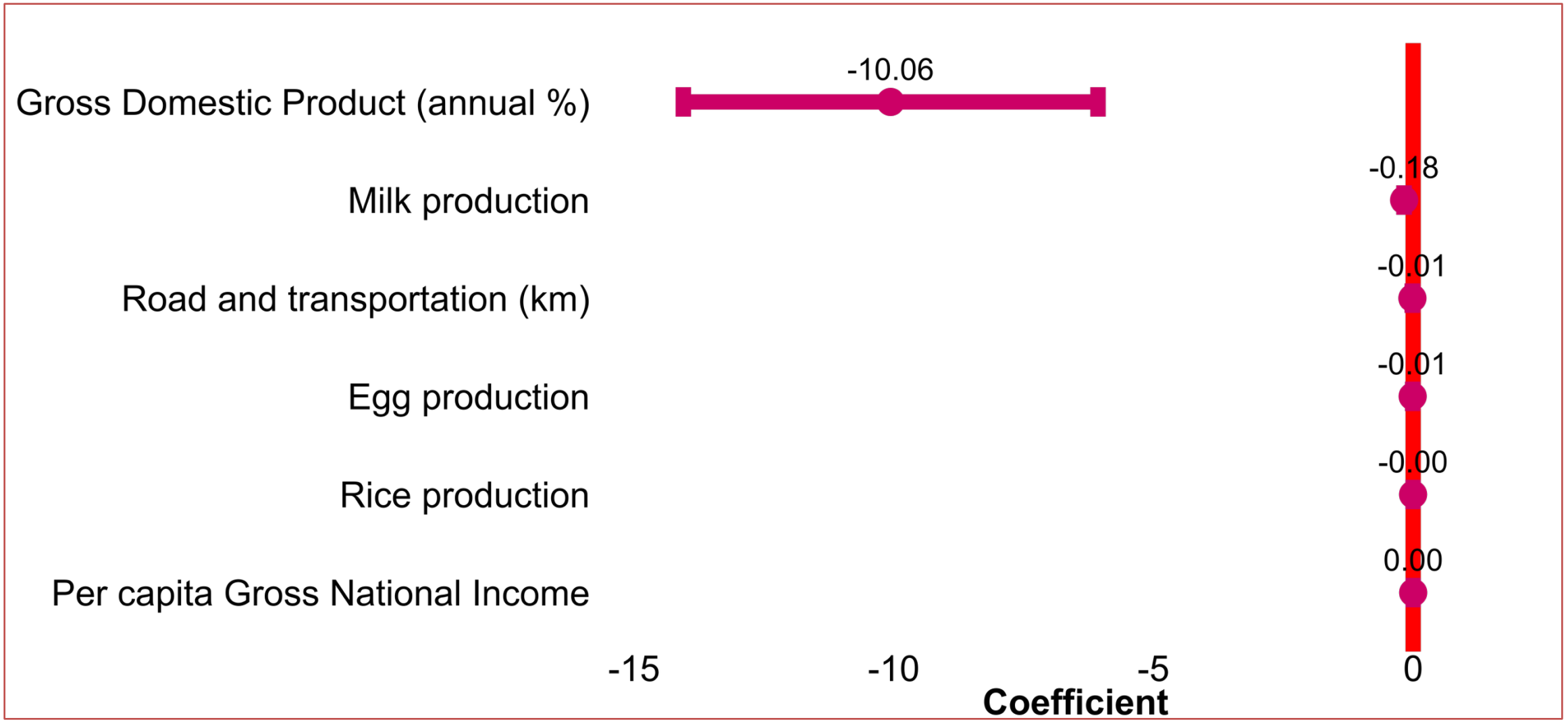
Morbidity and Stunting



Maternal factors and Stunting



National-level indicators



Poverty and food insecurity are still major drivers of stunting

Can Bangladesh achieve the Stunting target for SDG-2?

Stunting prevalence in baseline year 2012 **42%**

Average Annual Rate of Reduction **4.3%**

Government of Bangladesh SDG Tracker target prevalence for 2030 **15.5%**

Projected prevalence in 2030 **19.2%**

Projected prevalence in 2035 **15.4%**

Water, Sanitation, Hygiene and Environmental Enteropathy

Intestinal permeability, mucosal injury, and growth faltering in Gambian infants

Peter Lunn, The Lancet 1991

43% of linear growth faltering in children under-2 can be explained by small gut enteropathy

Bangladesh Environmental Enteric Dysfunction (BEED) Study

Gut dysbiosis causes Environmental Enteric Dysfunction

Normal villous architecture in the small intestine

Hossain S, Ahmed T et al. Nature Scientific Reports, 2021

Gut dysbiosis causes Environmental Enteric Dysfunction

Distorted architecture of villi in the small intestine

Hossain S, Ahmed T et al. Nature Scientific Reports, 2021

Gut dysbiosis causes Environmental Enteric Dysfunction

Complete distortion of the architecture of villi in the small intestine

Hossain S, Ahmed T et al. Nature Scientific Reports, 2021

Gut dysbiosis causes Environmental Enteric Dysfunction

Normal intestinal architecture

Distorted intestinal architecture

Completely distorted intestinal architecture

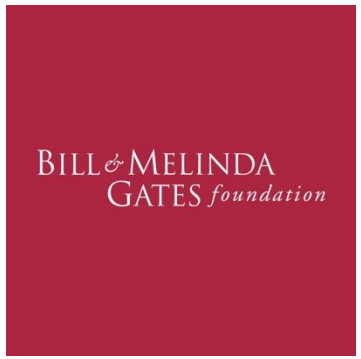
Hossain S, Ahmed T et al. Nature Scientific Reports, 2021

The NEW ENGLAND JOURNAL of MEDICINE

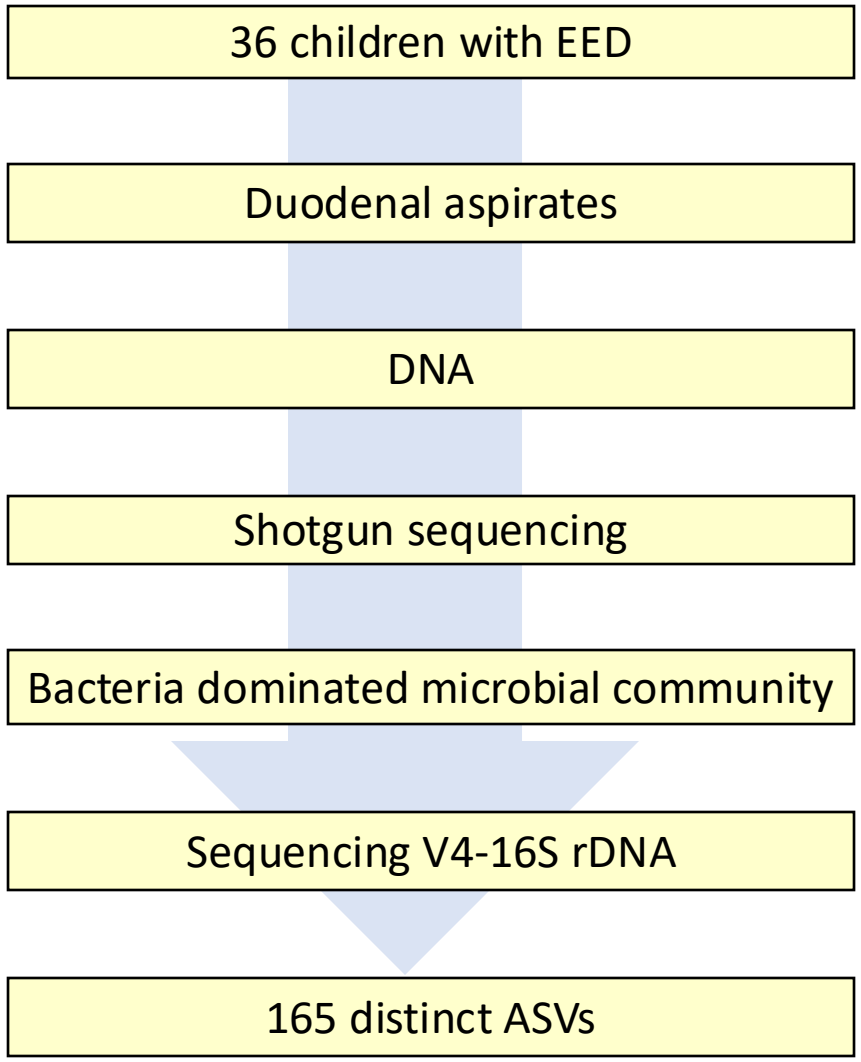
ORIGINAL ARTICLE

Duodenal Microbiota in Stunted Undernourished Children with Enteropathy

R.Y. Chen, V.L. Kung, S. Das, M.S. Hossain, M.C. Hibberd, J. Guruge, M. Mahfuz, S.M.K.N. Begum, M.M. Rahman, S.M. Fahim, M.A. Gazi, R. Haque, S.A. Sarker, R.N. Mazumder, B. Di Luccia, K. Ahsan, E. Kennedy, J. Santiago-Borges, D.A. Rodionov, S.A. Leyn, A.L. Osterman, M.J. Barratt, T. Ahmed, and J.I. Gordon



Children with Stunting & Enteropathy have 'bad bacteria' in their small gut



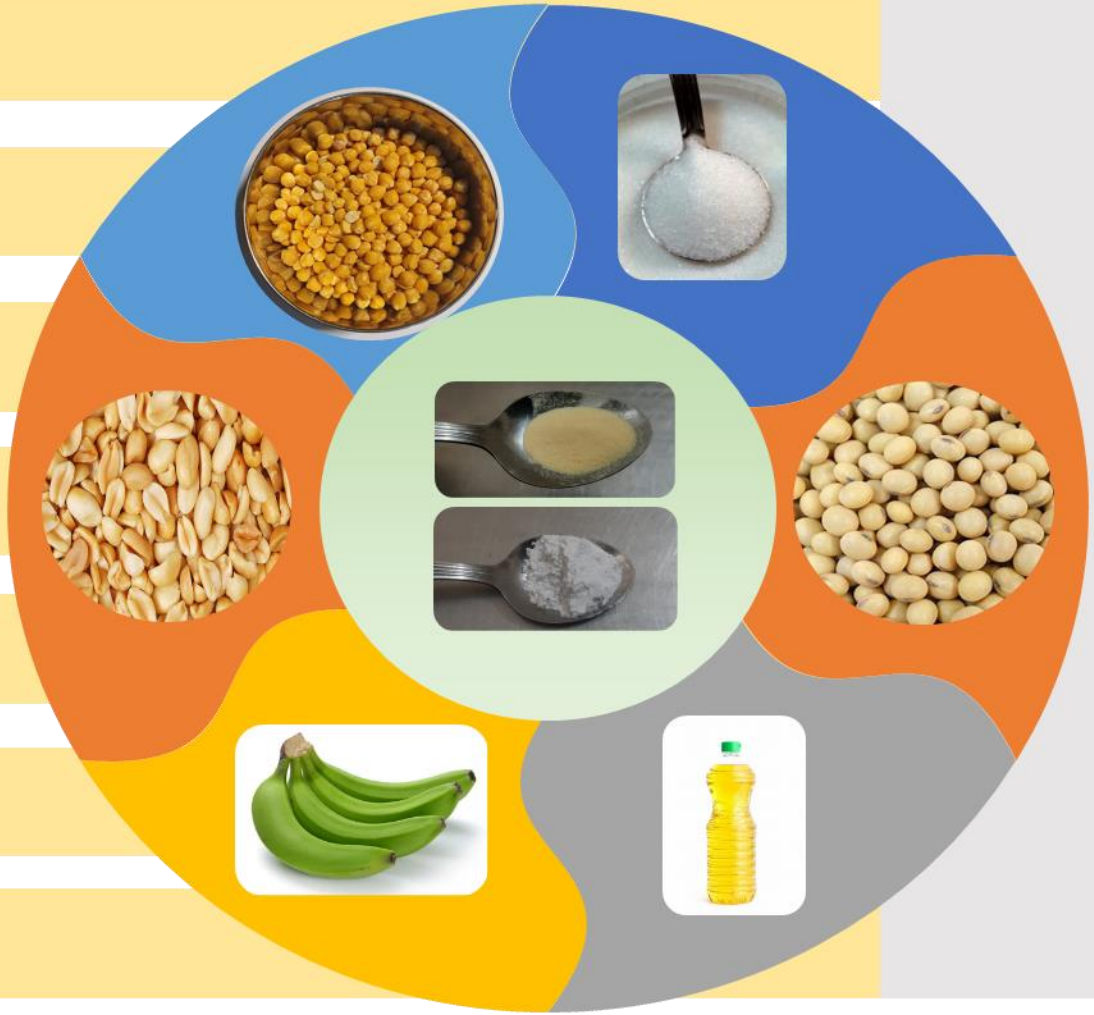
14 core duodenal bacterial taxa present in 80% of children with EED

- *Streptococcus sp.*
- *Gemella sp.*
- *Granulicatella elegans*
- *Haemophilus sp.*
- *Neisseria subflava*
- *Leptotrichia sp.*
- *Rothia mucilaginosa*
- *Veillonella sp.*
- *Fusobacterium sp.*
- *Prevotella melaninogenica*
- *Actinomyces sp.*
- *Leptotrichia sp.*
- *Corynebacterium sp.*
- *Johnsonella sp.*

What are the new innovations based on what we know so far?

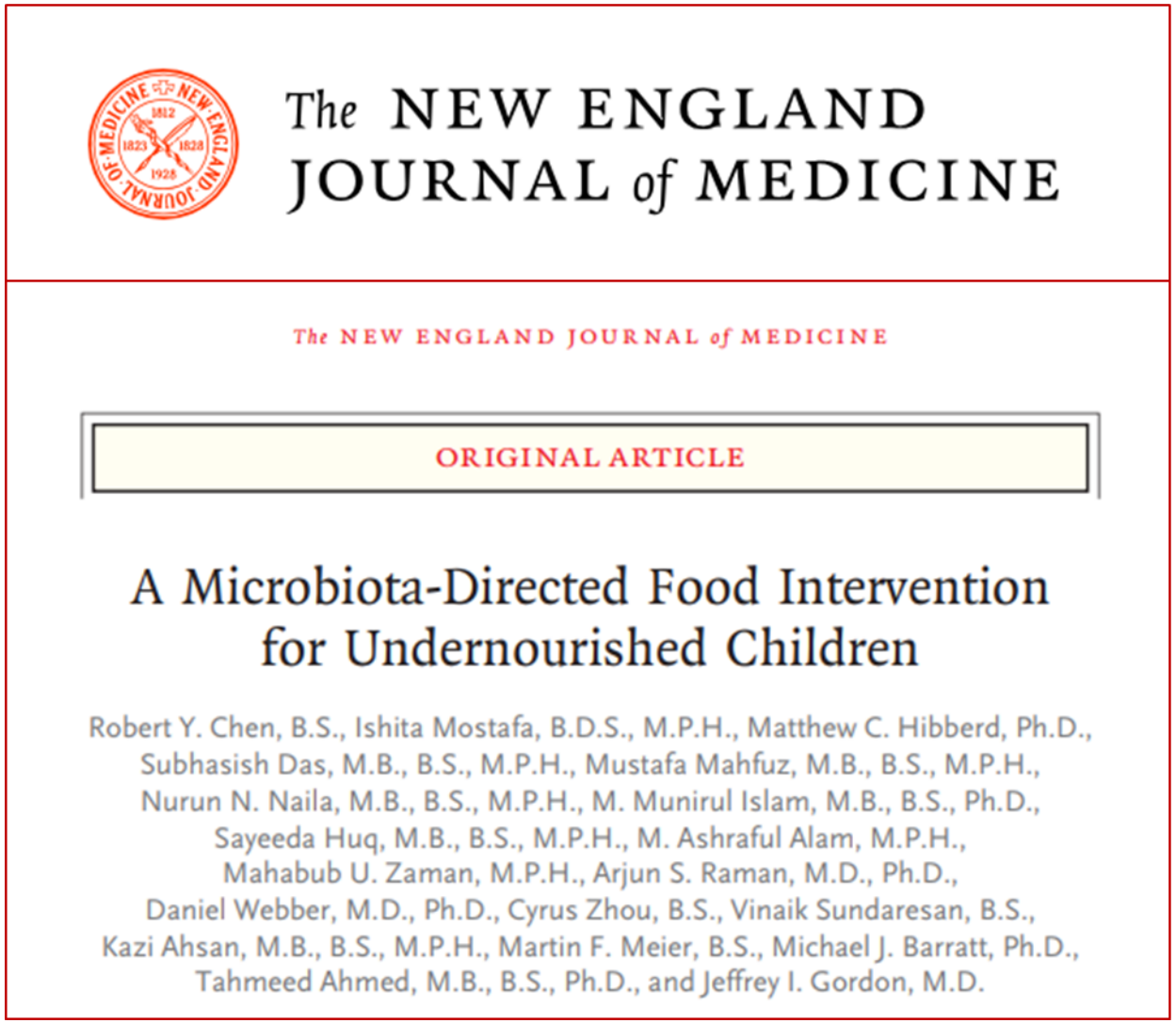
Microbiota Directed Complementary Food

- Chickpea
- Soybean
- Peanut
- Green banana
- Soybean Oil
- Sugar
- Micronutrient



Mirpur, Dhaka

Malnourished children between 12-18 months old of either sex



The NEW ENGLAND JOURNAL of MEDICINE

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

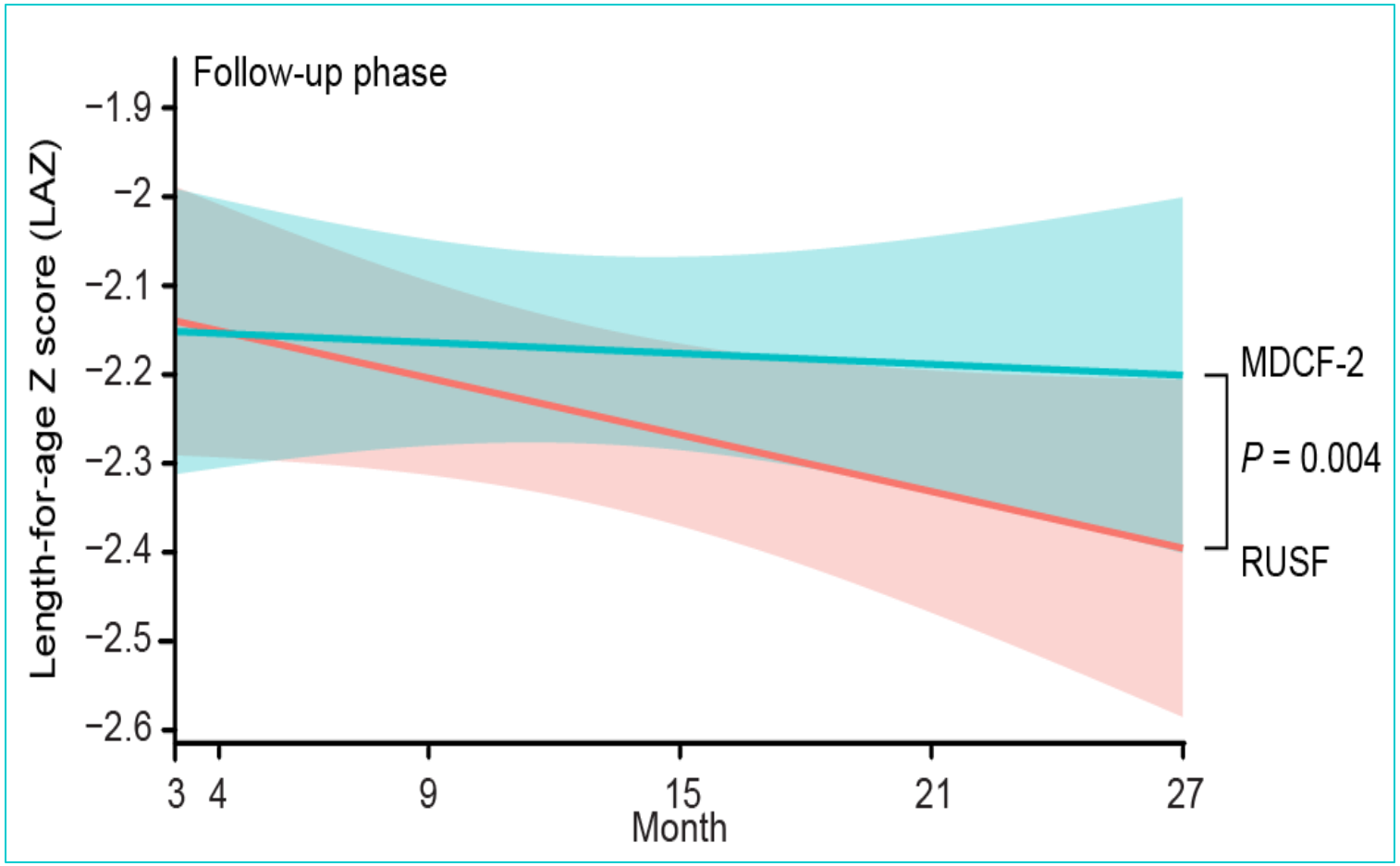
A Microbiota-Directed Food Intervention for Undernourished Children

Robert Y. Chen, B.S., Ishita Mostafa, B.D.S., M.P.H., Matthew C. Hibberd, Ph.D., Subhasish Das, M.B., B.S., M.P.H., Mustafa Mahfuz, M.B., B.S., M.P.H., Nurun N. Naila, M.B., B.S., M.P.H., M. Munirul Islam, M.B., B.S., Ph.D., Sayeeda Huq, M.B., B.S., M.P.H., M. Ashraful Alam, M.P.H., Mahabub U. Zaman, M.P.H., Arjun S. Raman, M.D., Ph.D., Daniel Webber, M.D., Ph.D., Cyrus Zhou, B.S., Vinaik Sundaresan, B.S., Kazi Ahsan, M.B., B.S., M.P.H., Martin F. Meier, B.S., Michael J. Barratt, Ph.D., Tahmeed Ahmed, M.B., B.S., Ph.D., and Jeffrey I. Gordon, M.D.

MDCF-2 was able to

- Repair immature microbiota
- Promote weight gain
- Increase plasma biomarkers related to bone formation, neurodevelopment, and immune function

MDCF-2 resulted in long term increase in linear growth



Children who had received MDCF-2 were significantly less stunted during follow-up than those who received RUSF (p=0.004)

Malnutrition

Gut reactions

A special diet made from cheap ingredients treats childhood malnutrition by encouraging the growth of the right intestinal bacteria

THE BEST treatment for childhood malnutrition might seem obvious: more, and more nutritious, food. And the standard approach is indeed just that. Over the years, formulae for ready-to-use supplementary food (RUSF)—bars and packets of paste intended for moderate cases and made from rice, lentils, sugar, soya oil and milk powder—and similar therapeutic food (RUTF), a nut-based treatment for more severe instances, have been developed. These work. But Tahmeed Ahmed, executive director of the awkwardly named icddr,b, a research institute in Dhaka, Bangladesh, and his team think they have come up with something better.

In collaboration with Jeffrey Gordon and his colleagues at Washington University in St Louis, Missouri, Dr Ahmed's team have produced a new mixture for the treatment of malnutrition. Besides providing nutrients, this formulation also enhances gut health. That brings benefits to the malnourished which the conventional approach does not. Now, the World Health Organisation (WHO) is testing the result, dubbed MDCF-2, in Bangladesh, India, Mali, Pakistan and Tanzania.

The bugs in the system

Until recently, little attention was paid to the role in digestion played by the trillions of microbes, known collectively as the microbiota or microbiome, which live in the human gut. That changed in 2013 when Dr Gordon compared the gut floras of pairs of twin children in Malawi. He did so assuming that, since they are born together and raised in the same households, twins' nutritional histories will be identical.

He nevertheless came across a number of cases in which one twin of a pair had a form of malnutrition called kwashiorkor while the other remained healthy. And when this happened, he also found that their microbiomes differed in systematic ways. On top of this he discovered that when the bugs in question were transplanted into laboratory mice which had been raised in a germ-free environment, those animals receiving transplants from a twin with kwashiorkor went on to develop the murine equivalent of that illness.

It thus looked likely that, while the underlying cause of kwashiorkor is unquestionably an insufficiency of nutrients, undernourished individuals who might otherwise remain free of its symptoms (a bloated belly, loss of muscle mass, stunted growth and brittle hair) may be tipped over the edge by an unbalanced microbiome.

In 2014, in a follow up to this work, Dr Ahmed, Dr Gordon and their respective teams compared the gut microbiomes of healthy children living in the slums of Dhaka with those of children being treated for forms of severe acute malnutrition

→ Also in this section

64 Fatherhood shrinks the brain

65 Keeping track of trains

66 Protecting Earth from asteroids

66 A better way to recycle polyethylene

The Economist

For many malnourished children in the future, MDF could make all the difference

Summary

- Prevalence of stunting in Bangladesh has decreased significantly over the past two decades

- Annual gross domestic product, household access to electricity, improved WASH, facility-based deliveries, antenatal and postnatal visits associated with reduced stunting prevalence

Summary

- Poverty, poor WASH, ARI, fever, early marriage, less birth spacing, maternal illiteracy, maternal underweight associated with increased chance of stunting

What can and should be done?

Governance

Judicious spending

Have more grass-root community health workers

Care of adolescent girls: dietary diversity, weekly IFA, menstrual health

Multiple MN supplement during pregnancy

Mothers' club to talk about breastfeeding, complementary feeding

Hand hygiene

"Real" Growth Monitoring & Promotion

Food security for the vulnerable

Use of novel interventions such as the Microbiome-directed Food

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Thank you

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for their on-going support

Government of the People's
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Canada