

Southampton Global Health Research Institute  
Exploring commonalities in Global Health Research 2 Workshop  
15 June 2016

# Holistic Approach to Nutrition and Development

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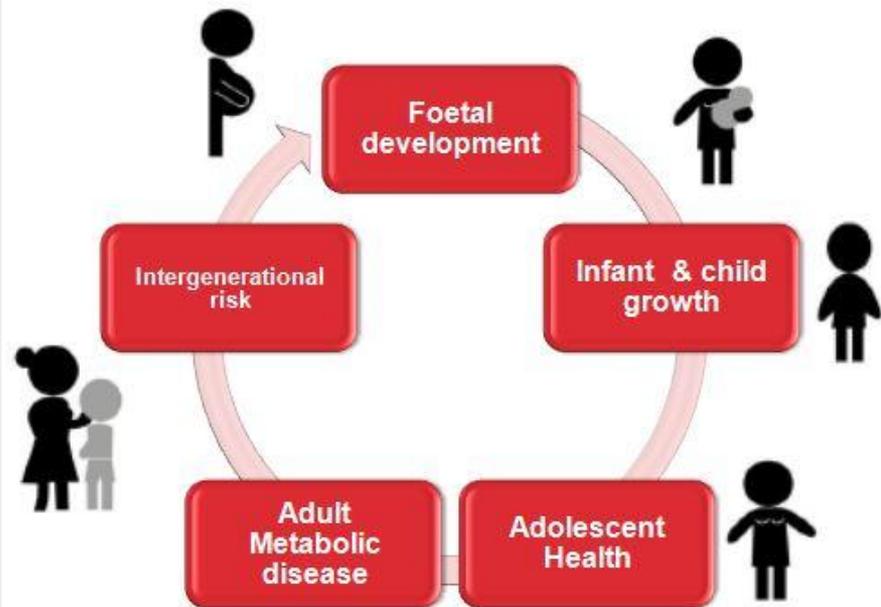
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# Concepts, empirical evidences and translation in the public health arena



## Life-course approach

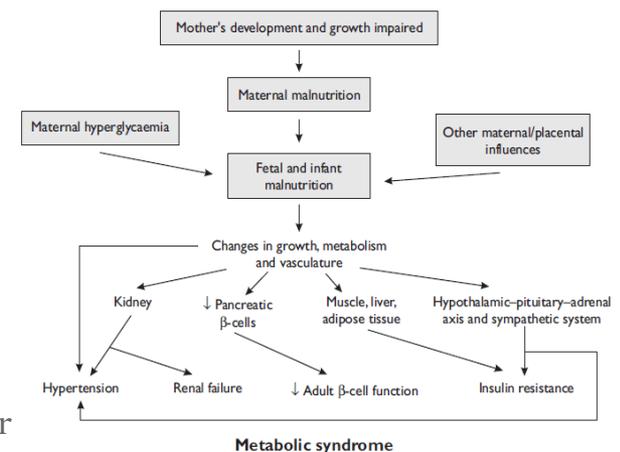


# Developmental Origins of Health and Diseases

- **Environmental** exposures (physical, pathogenic, social and cultural factors) during key periods of the **life course** (windows of **phenotypic plasticity**) affect **human development** including **mental and physical health outcomes**
  - Comprehensive ecological framework
  - Integrate epidemiology, biomedical, human biology, and evolutionary concepts
  - To understand pathways to health outcomes
  - Throughout the life-course

# Nutrition, Early Life and Intergenerational effect

- Thrifty Phenotype Hypothesis
- 30 years of empirical research (HICs, LMICs)
- Contributed to :
  - The recognition **of the intergenerational effect of maternal (and paternal) nutrition** (from pre-pregnancy)
  - The emergence of the concept of **the First 1000 Days of Life** (conception to 2 years of age)
  - The conception and implementation of novel **nutritional interventions programs**



# Nutritional Interventions to Improve Maternal and Child Nutrition

- Nutrition supplementation to improve birth weight, children height and weight
  - mixed results
  - modest effect of nutrition supplementation interventions programs targeting pregnant women or during infancy on birth weight, height and weight

*“To eliminate stunting in the longer term, these interventions should be supplemented by improvements in the underlying determinants of undernutrition, such as poverty, poor education, disease burden, and lack of women’s empowerment” Bhutta et al. Lancet 2008; 371: 417–40*

# Multisectoral approach to intervention for nutrition and development

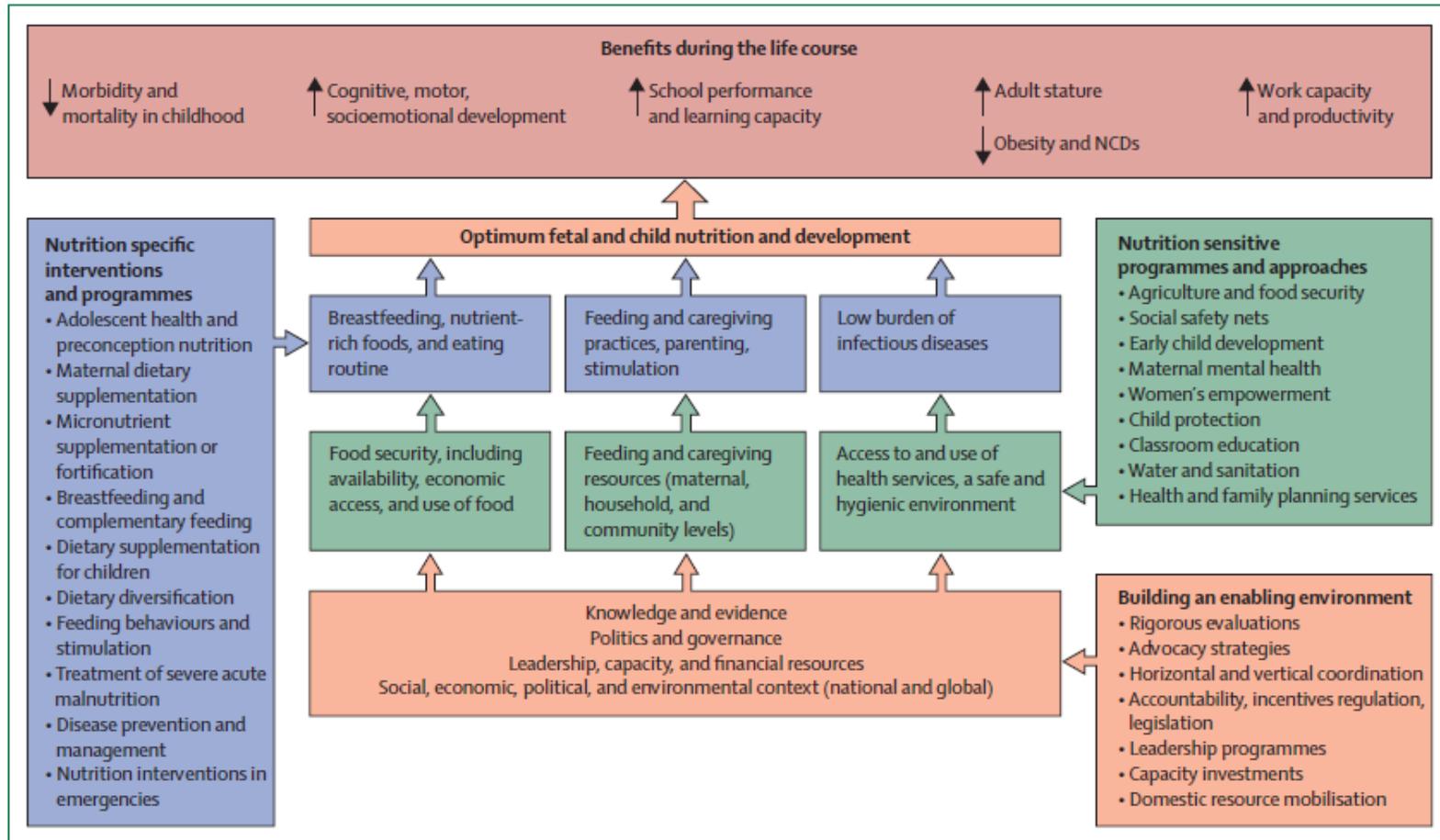
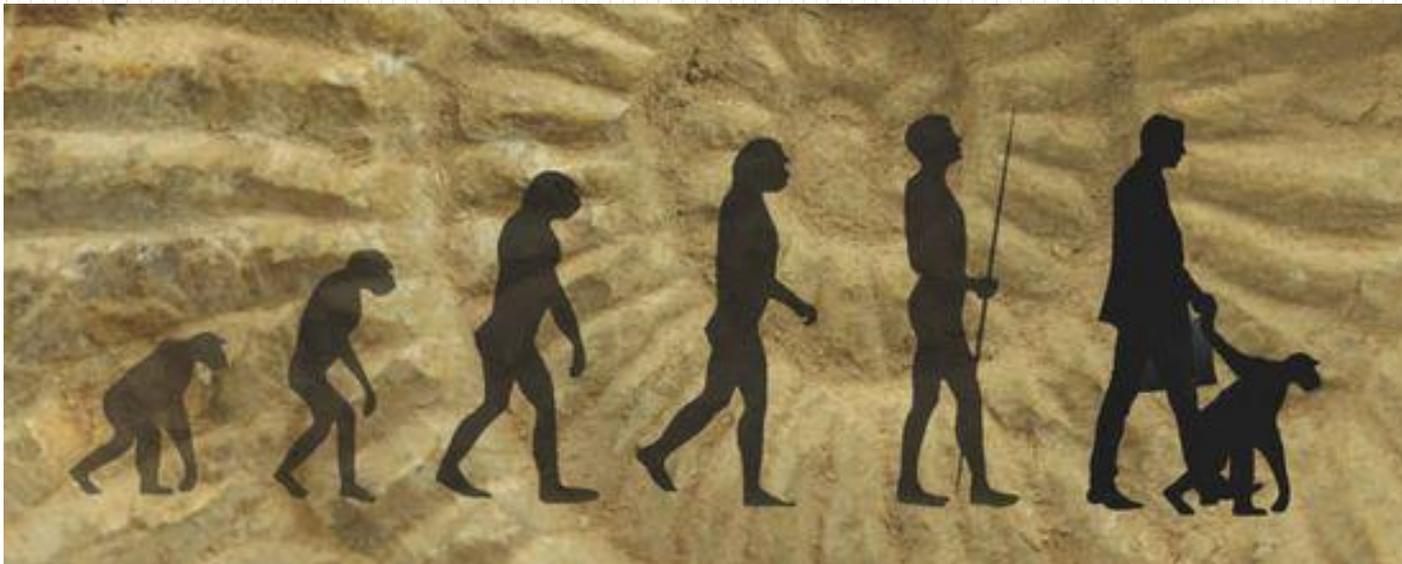


Figure 1: Framework for actions to achieve optimum fetal and child nutrition and development

# Contribution of evolutionary concepts to the holistic approach

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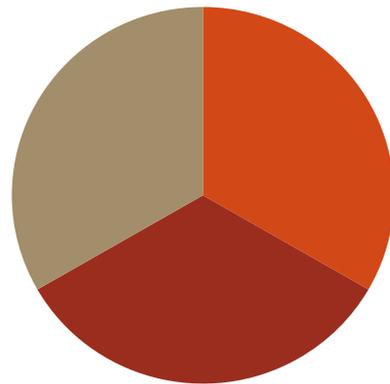
# And evolutionary aspects...

- **“Why should fetal responses to undernutrition lead to disease in later life? The general answer is clear. ‘Life history theory’,** which [...] states that, during development, increased allocation of energy to one trait such as brain growth, necessarily reduces allocation to one or more other traits, such as tissue repair processes. [...] An undernourished baby may establish a “thrifty” way of handling food. **Insulin resistance**, which is associated with low birthweight, **may be viewed as persistence of a fetal response by which blood glucose concentrations were maintained for the benefit of the brain, but at the expense of glucose transport into the muscles and muscle growth.”**

Barker DJP. Journal of the American College of Nutrition. 2004;23(6):588S–595S

# Life History Theory (LHT)

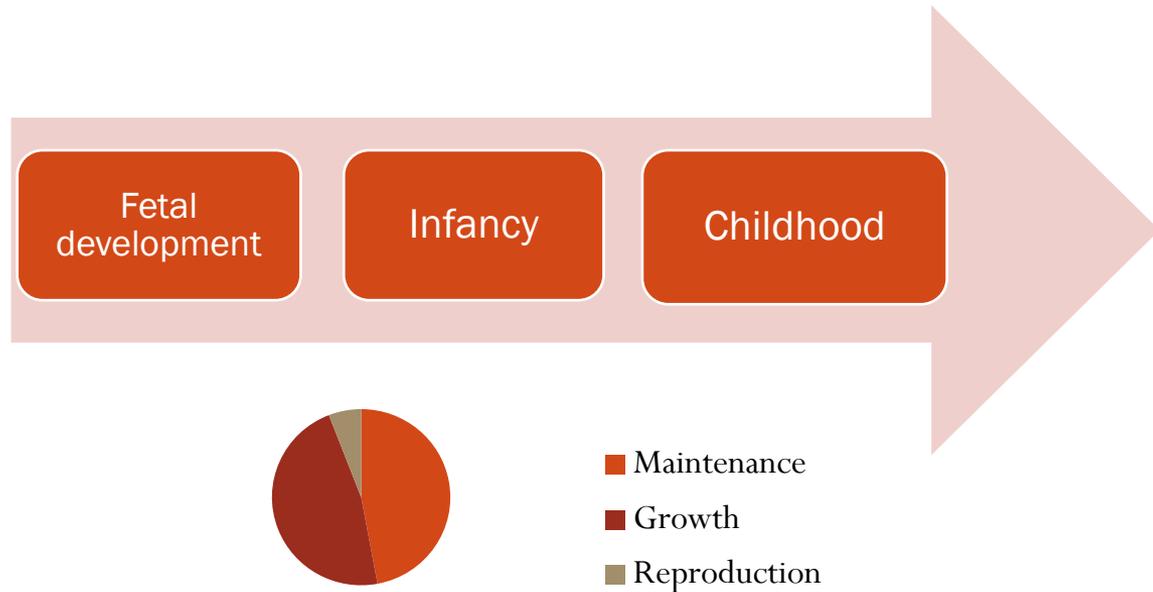
- Evolutionary strategies for organisms to optimize survival and reproduction
- Allocation Principle of LHT: **energy and time are limited resources that have to be allocated between three main life history traits: growth, reproduction and maintenance**
- The principle of trade-offs: **increased allocation of resources to one of these traits at a given stage of the life course is made at the expense of the other trait(s)**



- MAINTENANCE  
(functions involved in cellular and molecular repair including immune functions)
- GROWTH  
(physical growth, brain growth and development)
- REPRODUCTION  
(reproductive functions and organs)

# Different stages of development

## Different priorities



# First Thousand Days in LMICs

- Direct challenges to optimal growth:
  - Maternal health: co-morbidities
  - Malnutrition: nutritional deficiencies (quantity and quality)
  - Infectious diseases/parasitism
  - Social violence
  - Psycho-social issues

# 1. Maternal co-morbidities in the Soweto First Thousand days cohort

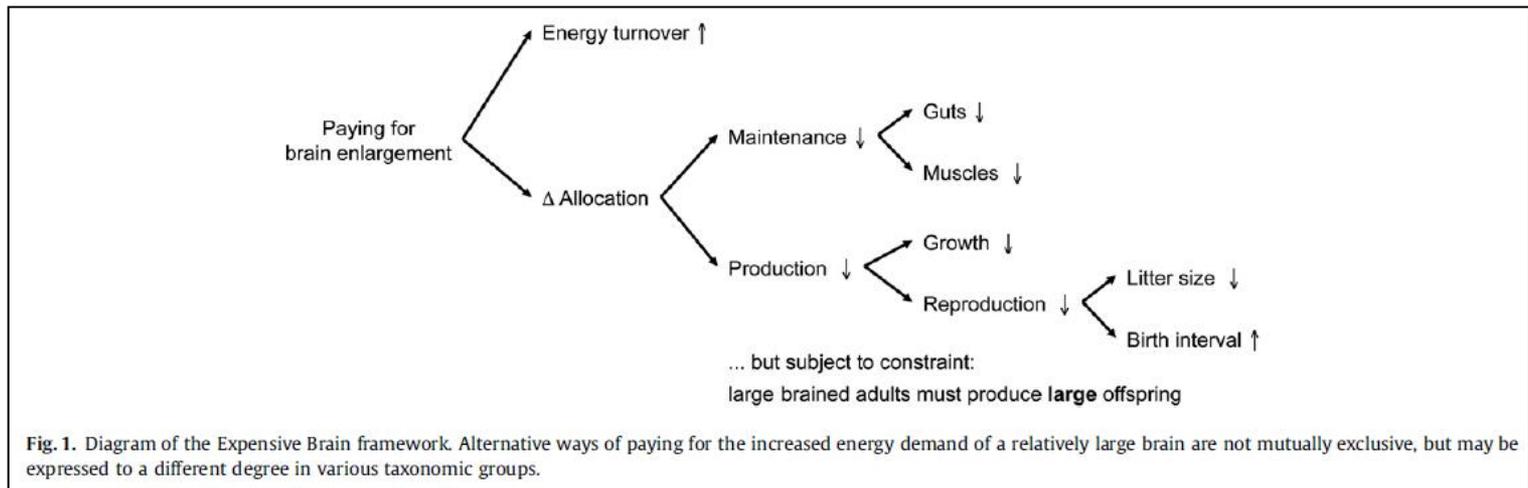
- Maternal pre-pregnancy weight (67% overweight or obese; 0% underweight)
- Gestational weight gain (9kg)
- Gestational diabetes (14%)
- Pre-eclampsia (6%)
- Anaemia (31%)
- HIV (30%)
- Maternal stress and depression risk (high >30%)
- 25% had no discernible morbidity

# Maternal diseases and fetal growth: case of infectious diseases

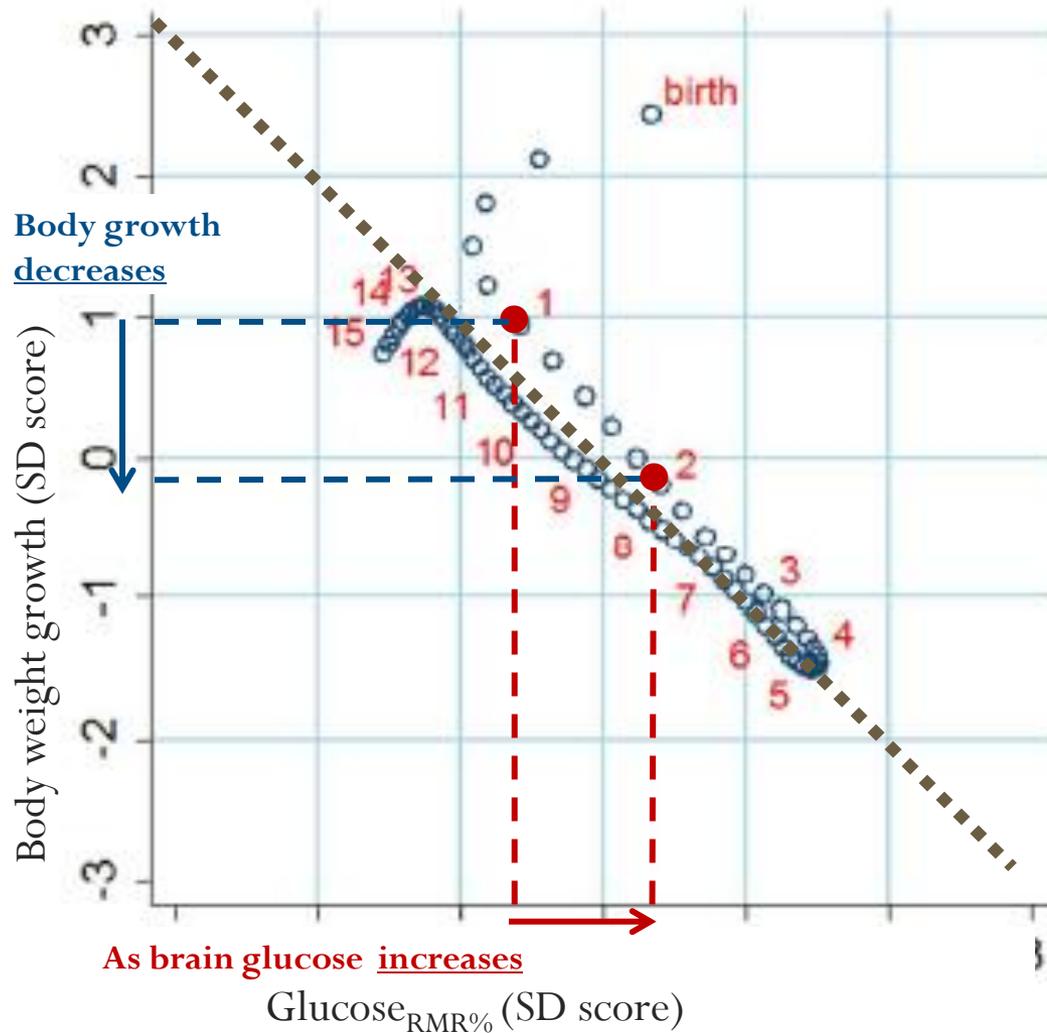
- Mothers with HIV / AIDS or malaria have more risks to give birth to low birth weight babies
- Hypothesis: Women reproductive strategy may vary by altering or re-prioritizing the allocation of the available metabolic energy, involving trade-offs for energy between their reproduction and their maintenance i.e. between maternal investments in fetal growth and investments in her own survival and future offspring
- A “tug-of-war” for energy between maternal immune function and pregnancy requirement (including fetal growth)?

## 2. The energy demanding human brain from conception to childhood

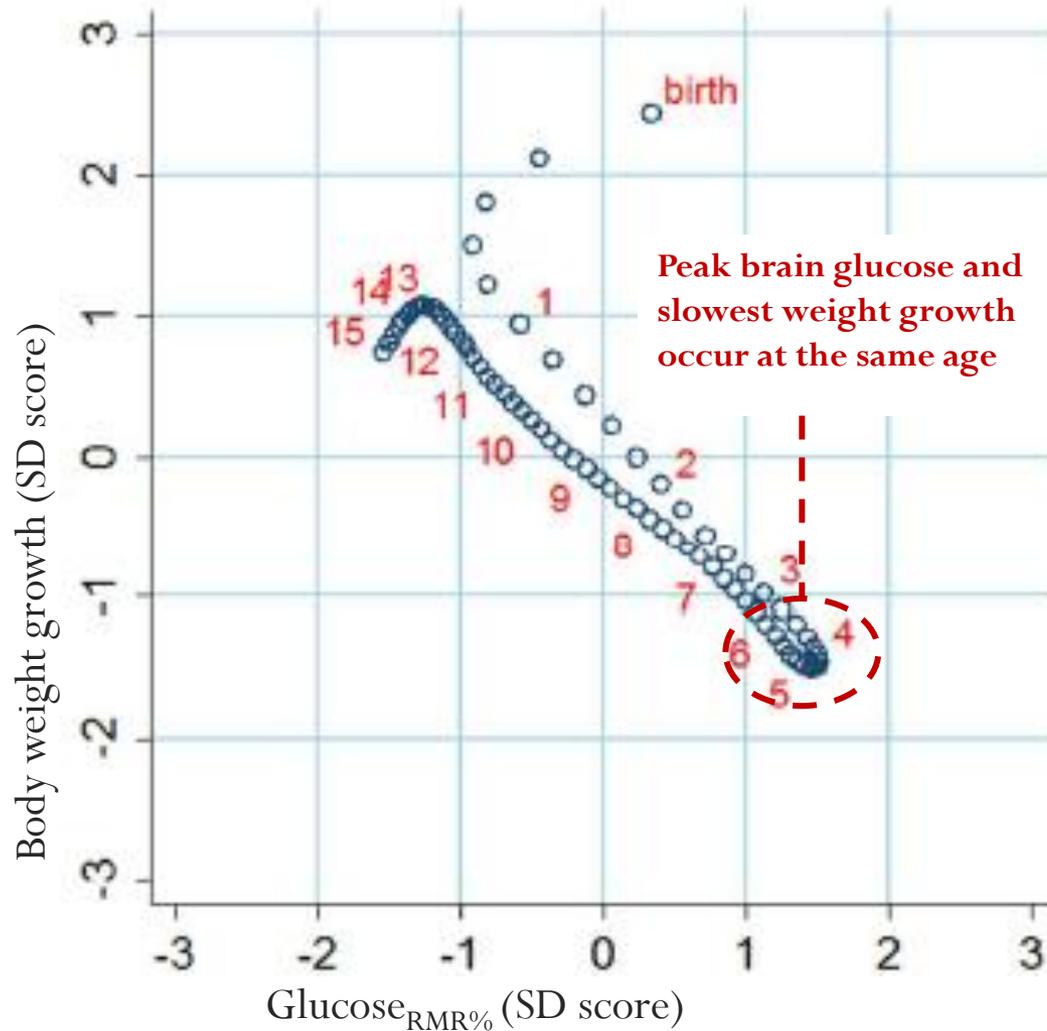
- 87 to 44% of infant and childhood resting metabolic rates
- Hypothesis: ensuring brain related energy costs during childhood require a decrease in growth related (stature and weight) energy costs: trade-off



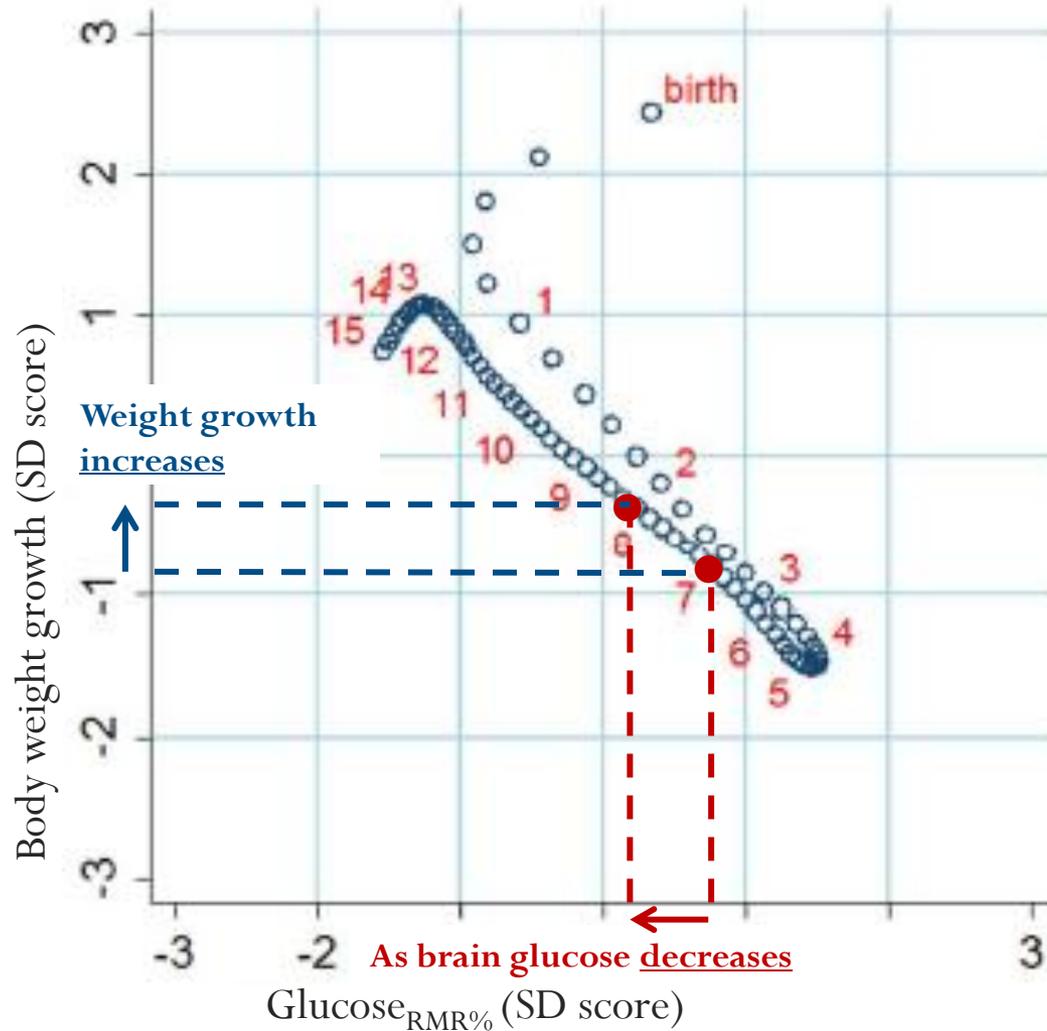
# Trade-off between brain energetic and body weight growth rate



# Trade-off between brain energetic and body weight growth rate



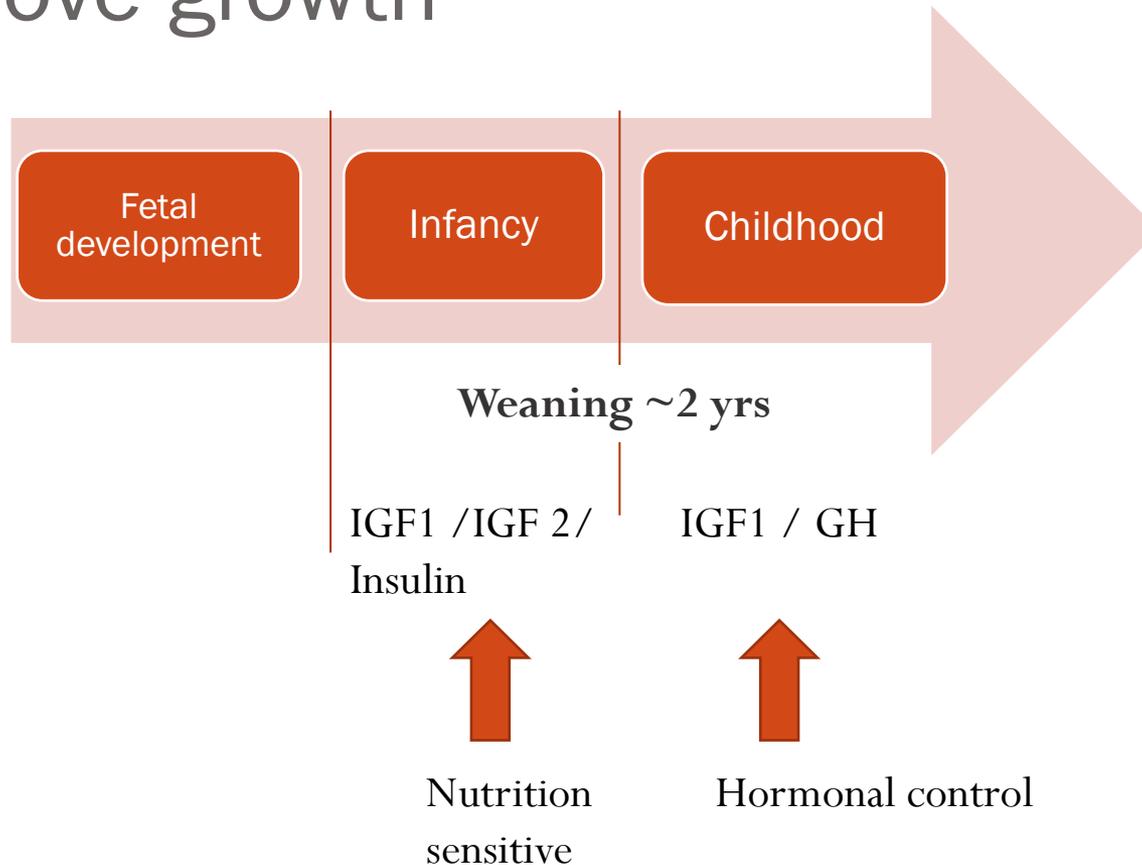
# Trade-off between brain energetics and body weight growth rate



# Growth-brain trade-off in undernourished populations

- May impact on:
  - **physical growth and the risk of stunting**
  - **cognitive development**
  - **metabolic and vascular functions**
    - Is insulin sensitivity during childhood a mechanism to divert energy from body growth to brain development?
- **Inform the optimal timing for nutritional intervention to improve cognitive development**

### 3. The window of opportunity to improve growth



**Inform the optimal timing for nutritional intervention to improve linear growth**

## 4. Trade-off between offspring immunity, physical growth and brain development?

- Stunting is prevalent in infants with high of parasites or infectious diseases burden
- Immunity (maintenance and survival) versus physical growth
- What is happening to the brain?

# Hypothesis on the possible immunity, growth and brain trade-offs in populations with undernutrition and high burden of infection

Published in final edited form as:

*Nutr Rev*. 2012 November; 70(11): 642–653. doi:10.1111/j.1753-4887.2012.00543.x.

## Early childhood growth failure and the developmental origins of adult disease: Do enteric infections and malnutrition increase risk for the metabolic syndrome?

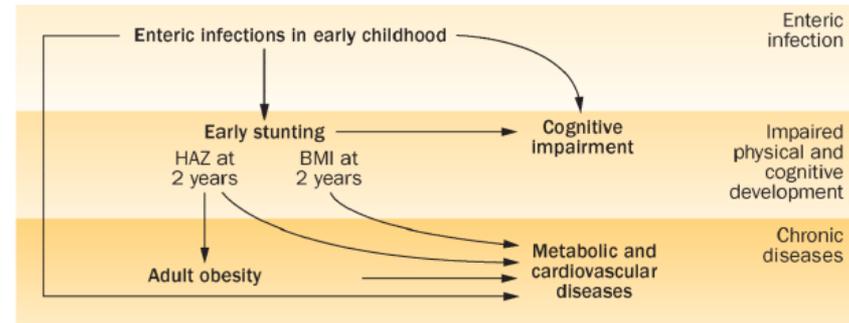
Mark D. DeBoer, MD, MSc., MCR<sup>1,7</sup>, Aldo A. M. Lima, MD, Ph.D.<sup>2</sup>, Reinaldo B. Oria, MD<sup>2</sup>, Rebecca J. Scharf, MD, MPH<sup>3,4</sup>, Sean R. Moore, MD, MS<sup>5</sup>, Max A. Luna, MD<sup>6</sup>, and Richard L. Guerrant, MD<sup>5</sup>

Published in final edited form as:

*Nat Rev Gastroenterol Hepatol*. 2013 April; 10(4): 220–229. doi:10.1038/nrgastro.2012.239.

## The impoverished gut—a triple burden of diarrhoea, stunting and chronic disease

Richard L. Guerrant, Mark D. DeBoer, Sean R. Moore, Rebecca J. Scharf, and Aldo A. M. Lima  
Center for Global Health, Division of Infectious Diseases and International Health (R. L. Guerrant), Department of Pediatrics (M. D. DeBoer, R. J. Scharf), University of Virginia School of Medicine, 1400 West Main Street, Charlottesville, VA 22908, USA, Division of Gastroenterology, Hepatology and Nutrition, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229, USA (S. R. Moore), Institute of Biomedicine and Clinical Research Unit, Federal University of Ceará, Fortaleza, CE 60430-270, Brazil (A. A. M. Lima).



**Figure 3.**

Chronic consequences of early childhood enteric infections and stunting. The triple burden of enteric infections, impaired physical development (including low HAZ-2, or stunting and BMI-2) and cognitive development, and later life risk of obesity and its comorbidities are shown. Abbreviation: HAZ-2, height-for-age z-score at age 2 years.

## Public health importance for sub-Saharan populations

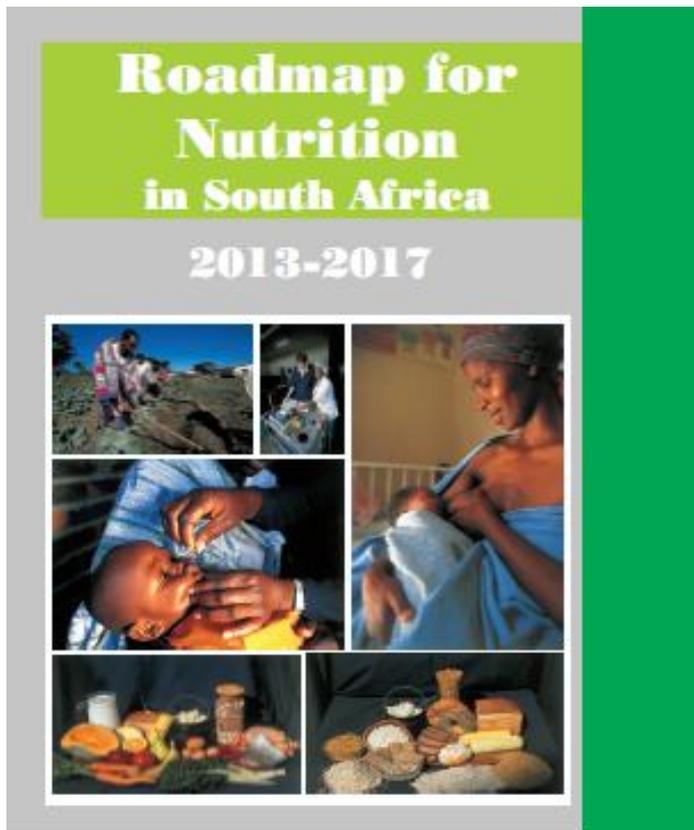
considering that the two first causes of children under 5 years of age death are lower respiratory infections and diarrhoea

# Conclusion: holistic approach

- The success in identifying the underlying biological, social cultural pathways to health and in designing the optimal interventions necessitate:
  - Synergies
  - An approach multi-:
    - Disciplinary: human biology, evolution, biomedical, epidemiology, public health, health economists, humanities
    - Sectorial: researchers, policy makers of various sectors, medical practitioners
    - Scalar: individual, family, household, different community levels
  - A holistic approach but context specific i.e. socially and culturally calibrated

# Translation to Policies and Intervention Programs in South Africa

- Landscape analysis (2009)



Research published in the Lancet Nutrition Series of 2008 showed that maternal and child malnutrition are responsible, globally, for more than one third of all deaths of children under 5 years old. This shows the importance of early and integrated intervention strategies targeted at malnutrition in pregnant women and children under two years old for healthy development. Missing the “*window of opportunity*” – the thousand-day period from conception to two years of age – to improve nutrition can result in long-term permanent damage. There is a clear window of opportunity for addressing nutrition, and after age two, this window closes rapidly and the effects of undernutrition are largely irreversible. It is therefore critical that interventions to prevent undernutrition reach mothers and young children during this period. In addition, it is more effective to prevent child undernutrition than to treat it, and therefore investments aimed at improving nutrition should focus on the thousand-day period.

## 7 OVERALL GOALS

In line with the four outputs of the NSDA, for 2010 to 2014 which are: increasing life expectancy; combating HIV and AIDS; decreasing the burden of disease from Tuberculosis and improving health systems effectiveness, the goals set out by the Nutrition Roadmap are:

- To contribute to increased life expectancy of the entire population by improving the quality, coverage and intensity of specific nutrition interventions that support reduction in mortality rates, especially maternal, neonatal, infant and child mortality;
- To promote optimal growth of children and prevent overweight and obesity later in life, by focusing on optimal infant and young child nutrition;
- To contribute to the prevention, control and treatment of HIV and Tuberculosis through targeted nutritional care and support strategies;
- To contribute to the effective functioning of the health sector, by reducing the demand for curative services and improving recovery rates from diseases, thus freeing up resources for preventive and promotive services
- To empower families and communities to make informed nutrition-related decisions, through advocacy regarding household food security, multisectoral collaboration and effective nutrition education.

THANK YOU !