EPI 2008

Sep 23, 2008

Birth cohorts in low- and middle-income countries: The catch-up dilemma?

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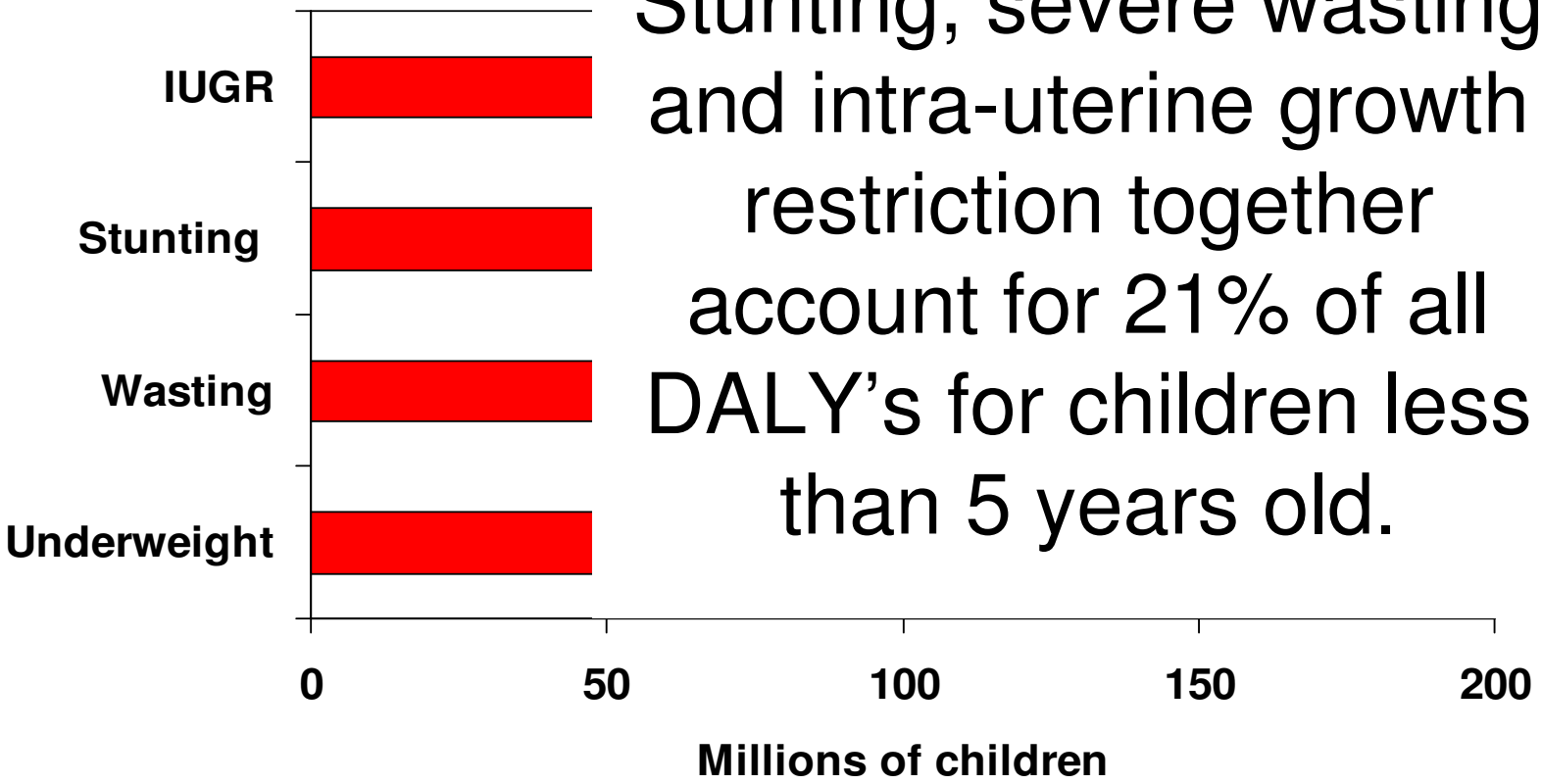
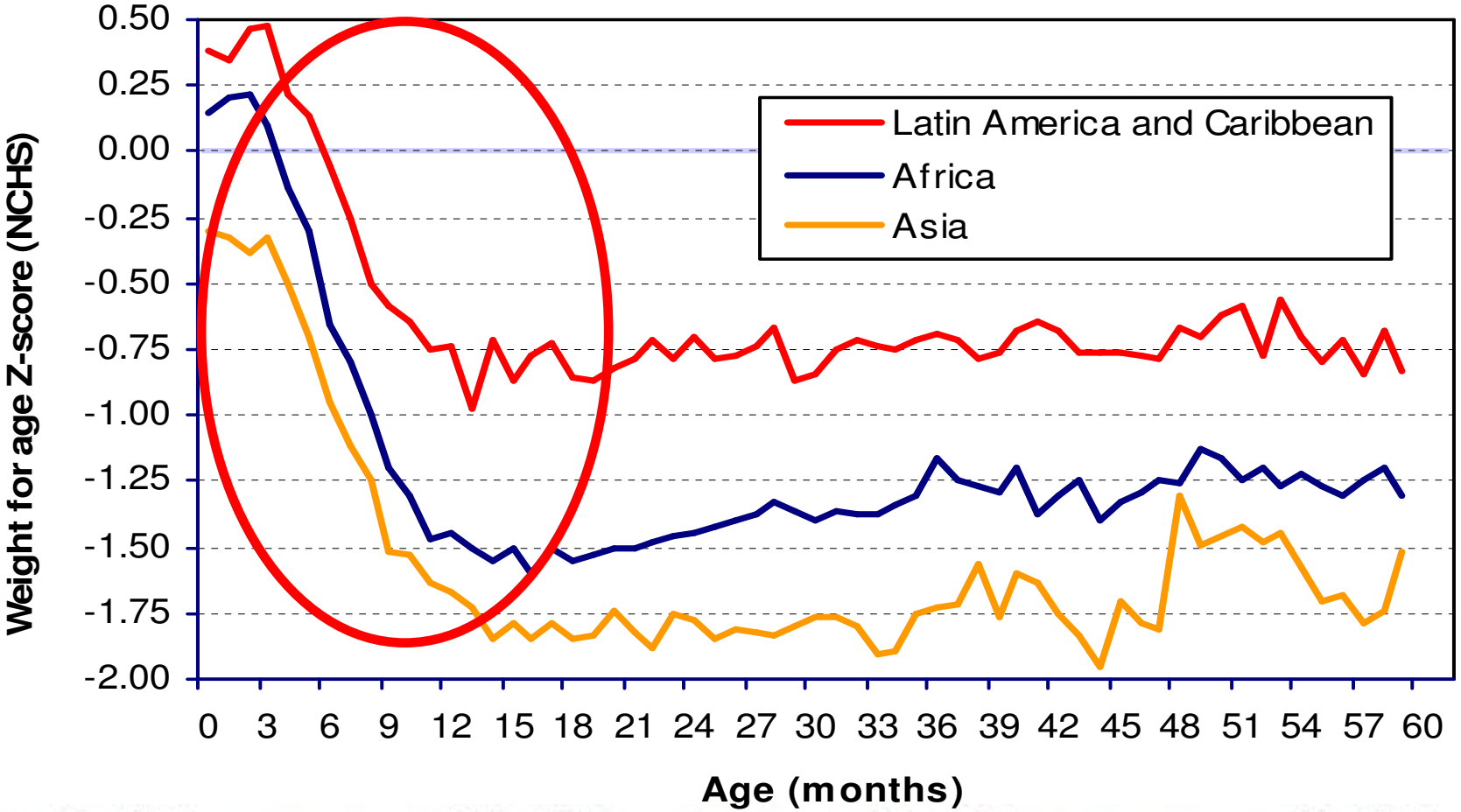
Child undernutrition today



Stunting, severe wasting and intra-uterine growth restriction together account for 21% of all DALY's for children less than 5 years old.

Black R et al. Lancet 2008

When does growth falter?
Analyses of national surveys



Shrimpton, Victora, et al. Pediatrics 2001

Definitions

- **Catch-up: "Nutritional recovery following a period of growth restriction, after the latter is removed"** (Prader, Tanner, von Harnack 1963)
    - **Early catch-up**
        - **Rapid growth in early childhood among children who presented intrauterine growth restriction (IUGR)**
    - **Late catch-up**
        - **Rapid growth in later childhood among children who were previously malnourished**
- **Rapid growth: independent of previous growth faltering**

Note: in most studies, growth = weight gain

Underweight and subsequent mortality in 6-59 mo old children

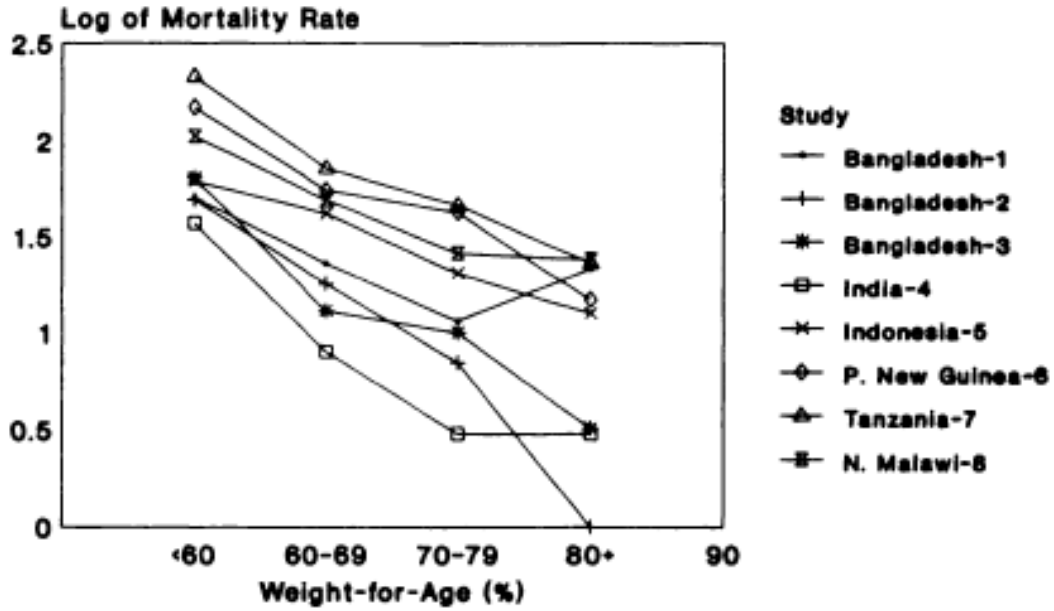


FIGURE 1 Relationship between log of mortality and weight-for-age in eight studies. Adapted from Coghill (1992), Bairagi (1981), Alam et al. (1989), Kielmann and McCord (1978), Katz et al. (1989), Heywood (1982), Yambi et al. (1993), Pelletier et al. (1993) and Chen et al. (1980).

Pelletier DL et al. J Nutr 1994

Pelotas 1982 Birth Cohort

1982

1983

1984

1986

1997

2000

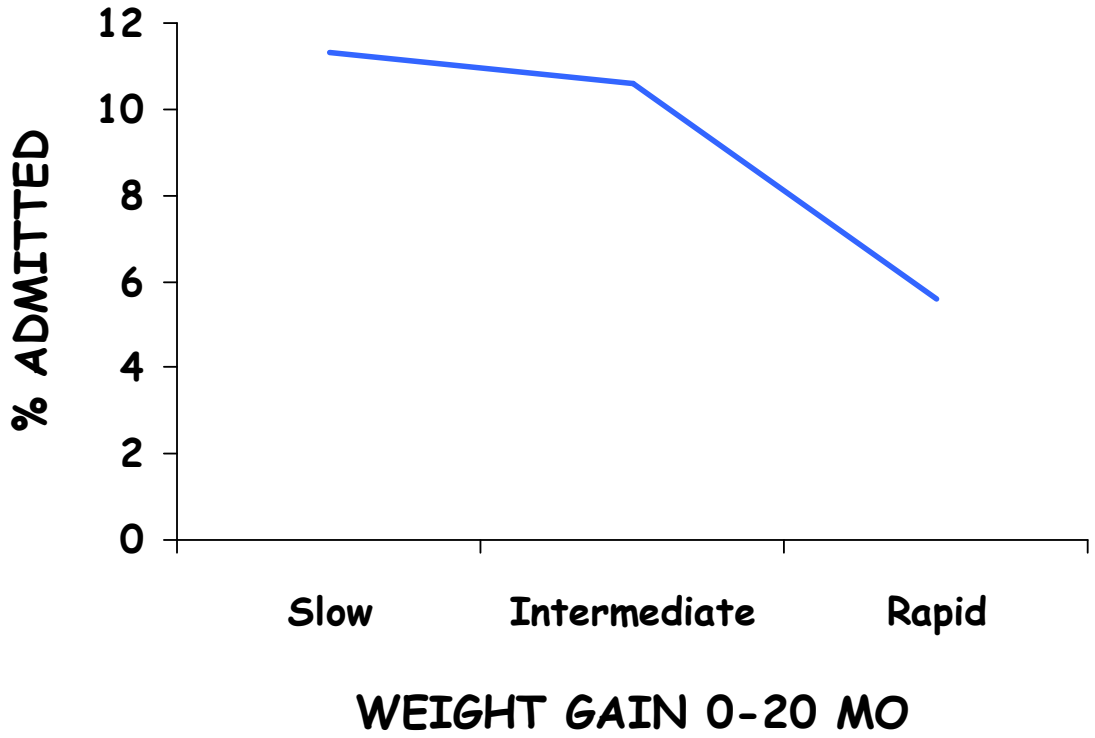
2001

2005

75% follow-up rate

Hospital admissions (1985) according to growth in 1982-84

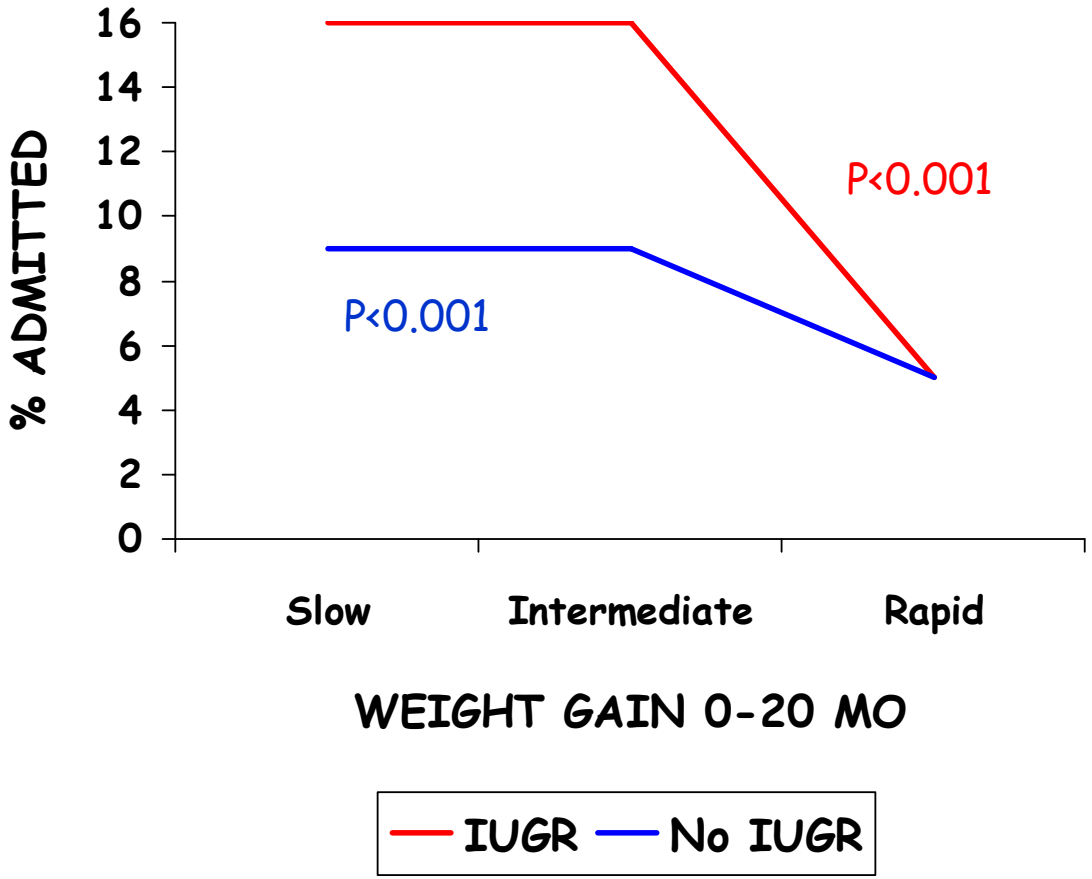
All children



P<=0.03

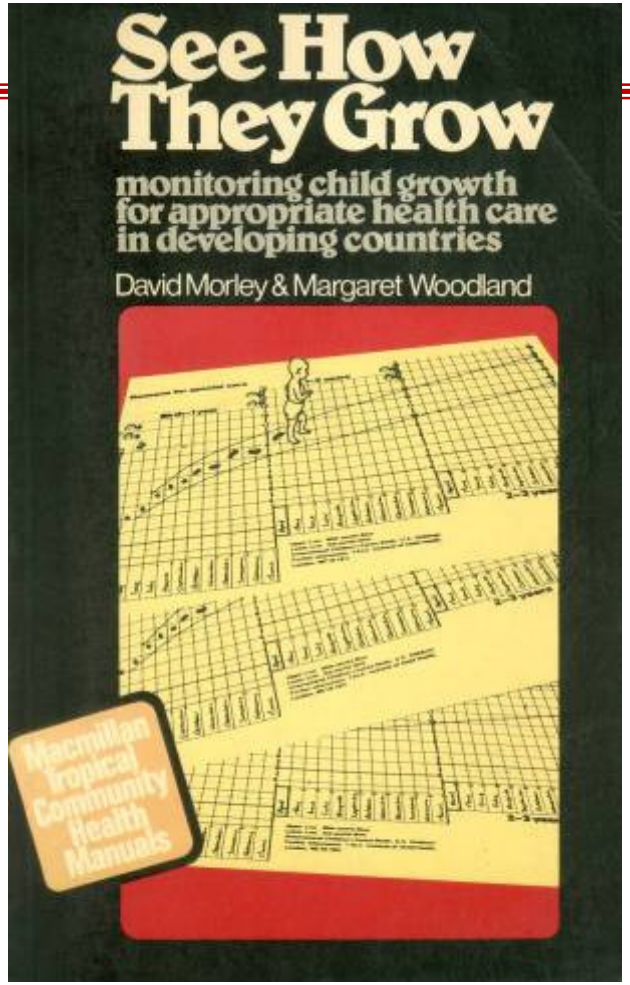
Victora, Barros et al. IJE 2001

Hospital admissions (1985) according to growth in 1982-84 Stratified by IUGR



Victora, Barros et al. IJE 2001

Growth monitoring and promotion



- Identification of children under 5 yr with low weight or growth faltering
- Promotion of catch-up weight gain through high-energy complementary feeding

Public Health Message

1. Children <5 yr who are underweight or faltering should put on weight rapidly

1902-2002 Celebrando 100 Años de Salud Pública Internacional en las Américas
PERSPECTIVAS de Salud
Volumen 7 Número 3 • 2002
La revista de la Organización Panamericana de la Salud
La nueva globesidad
www.paho.org

Dangers of rapid growth

BMJ

Being big or growing fast: systematic review of size and growth in infancy and later obesity

Janis Baird, David Fisher, Patricia Lucas, Jos Kleijnen, Helen Roberts and Catherine Law

BMJ 2005;331;929-; originally published online 14 Oct 2005;
doi:10.1136/bmj.38586.411273.E0

What this study adds

Infants who are in the highest end of the distribution for weight or body mass index, or who grow rapidly during infancy, are at increased risk of subsequent obesity

Strategies for prevention of childhood and adult obesity may need to address factors during or before infancy that are related to infant growth

bmj.com

Catch-up growth in childhood and death from coronary heart disease: longitudinal study

J G Eriksson, T Forsén, J Tuomilehto, P D Winter, C Osmond and D J P Barker

BMJ 1999;318;427-431

Key messages

- Men who had low birth weight or were thin at birth have high death rates from coronary heart disease
- Death rates are even higher if weight "catches up" in early childhood
- Death from coronary heart disease may be a consequence of prenatal undernutrition followed by improved postnatal nutrition
- Programmes to reduce obesity among boys may need to focus on those who had low birth weight or who were thin at birth

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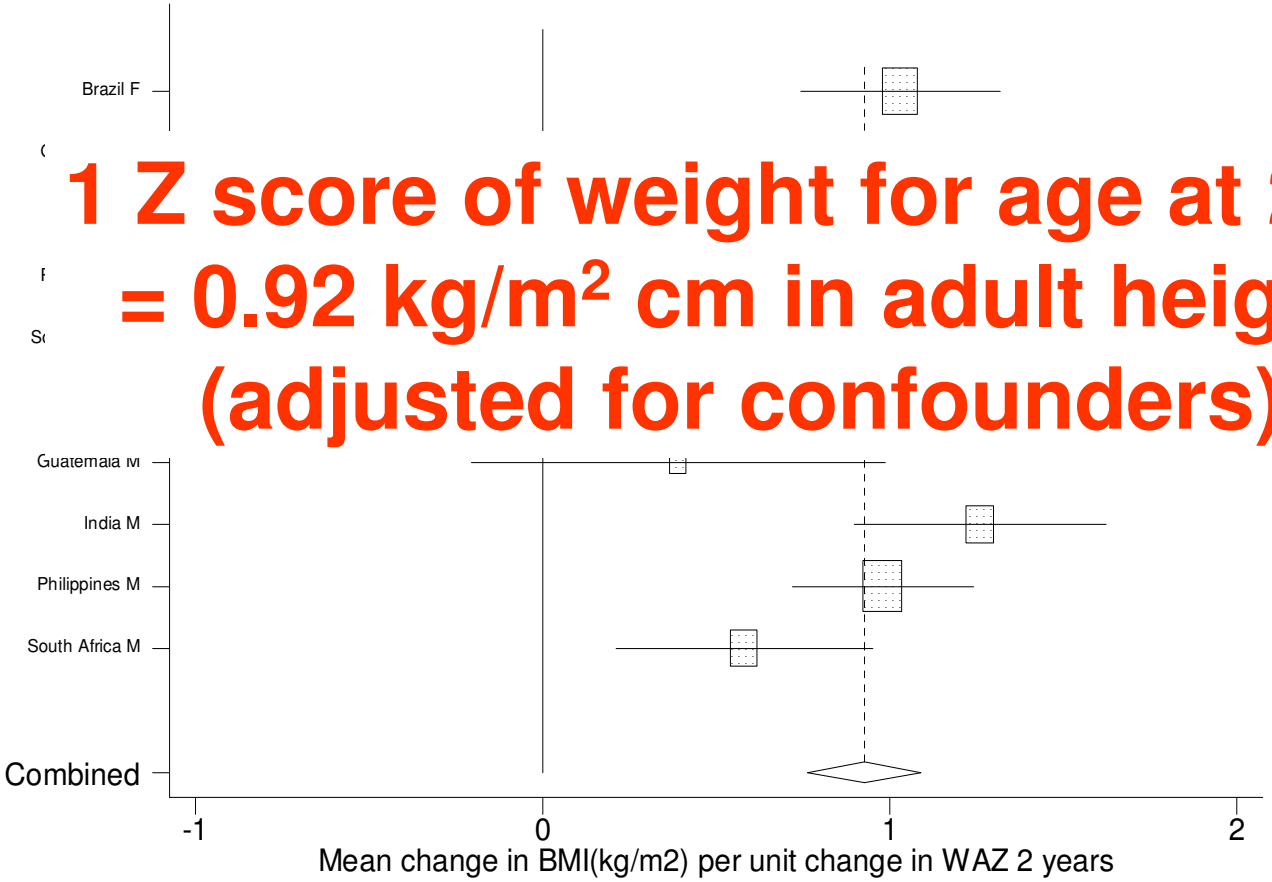
COHORTS

Consortium of Health Orientated Research in Transitioning Societies

Brazil Guatemala India Philippines South Africa

The COHORTS group

COHORTS pooled analyses
Wt/age at 2 yr and adult BMI



1 Z score of weight for age at 2 yr = 0.92 kg/m^2 cm in adult height (adjusted for confounders)

COHORTS team, Lancet 2008

Public Health Messages

1. Children <5 yr who are underweight or faltering should put on weight rapidly
2. Fat children tend to become fat adults at higher risk of chronic diseases

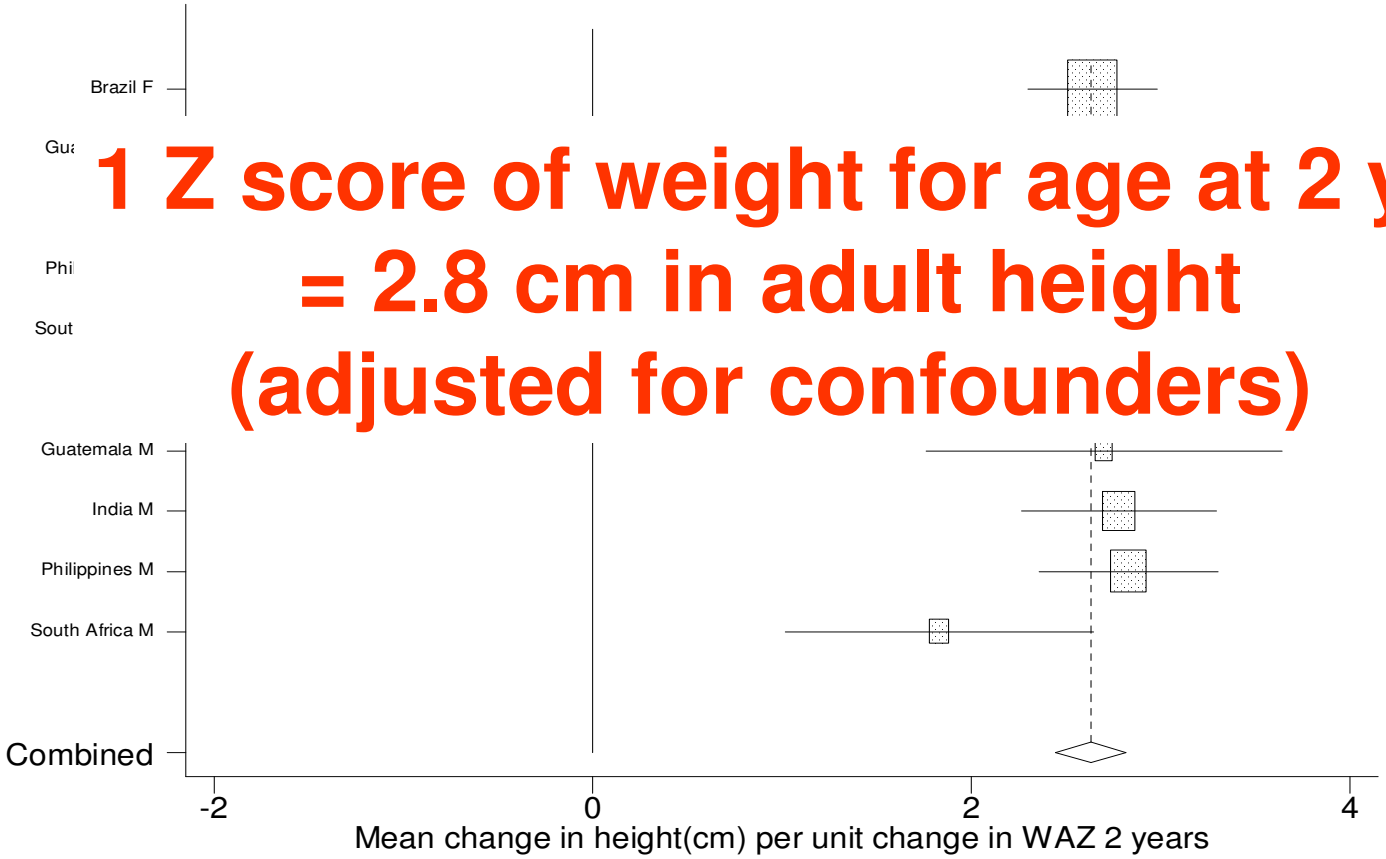
Should we prevent catch up growth among infants who are born small?

COHORTS
Consortium of Health Orientated Research in Transitioning Societies
Brazil Guatemala India Philippines South Africa

Human capital findings

- Birthweight, length for age, weight for age and to a lesser extent BMI for age are associated with improved human capital
  - Adult height
  - Achieved schooling
  - Income/wealth
  - Offspring birthweight

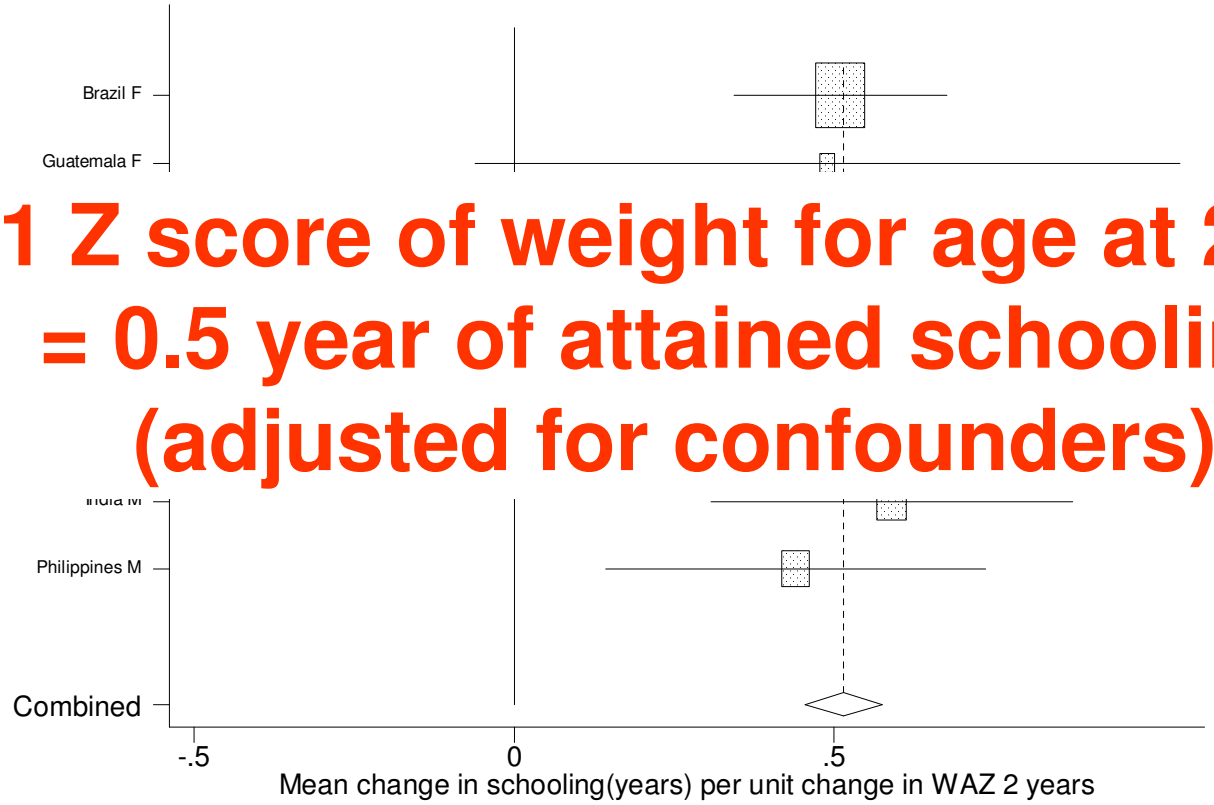
COHORTS pooled analyses



1 Z score of weight for age at 2 yr = 2.8 cm in adult height (adjusted for confounders)

COHORTS team, Lancet 2008

COHORTS pooled analyses



1 Z score of weight for age at 2 yr = 0.5 year of attained schooling (adjusted for confounders)

COHORTS team, Lancet 2008

Guatemala trial confirms observational results

"The Impact of Nutrition during Early Childhood on Education among Guatemalan Adults"

John A. Maluccio, John Hoddinott, Jere R. Behrman, Reynaldo Martorell, Agnes R. Quisumbing, and Aryeh D. Stein

our results indicate significantly positive, and fairly substantial, effects of the randomized nutrition intervention a quarter century after it ended.

Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults

John Hoddinott, John A Maluccio, Jere R Behrman, Rafael Flores, Reynaldo Martorell

Findings Exposure to atole before, but not after, age 3 years was associated with higher hourly wages, but only for men. For exposure to atole from 0 to 2 years, the increase was US$0·67 per hour (95% CI 0·16–1·17), which meant a 46% increase in average wages. There was a non-significant tendency for hours worked to be reduced and for annual incomes to be greater for those exposed to atole from 0 to 2 years.

Public Health Messages

1. Children <5 yr who are underweight or faltering should put on weight rapidly
2. Fat children tend to become fat adults at higher risk of chronic diseases
3. Small and thin children have lower human capital as adults

Period of weight gain and body composition in 18 yr old males

1982 Pelotas Birth Cohort – regression coefficients

Wt gain Z scores	BMI	Height (cm)	$FM/LM^{2.3}$
BW	0.44	1.29	-0.02
0-1 y	0.63	0.70	0.01
1-2 y	0.71	0.17	0.01
2-4 y	1.29	0.15	0.02
4-15 y	1.48	-0.44	0.05

Source: Victora CG et al. Acta Paediatr 2006

Period of weight gain and body composition in 9 yr olds

1993 Pelotas Birth Cohort – Q4-Q1 difference

Wt gain Z scores	BMI	Height (cm)	$FM/LM^{2.7}$
BW	1.5	0.07	-0.8
0-6 mo	1.6	0.06	-0.3
6-12 mo	0.1	0.03	-0.8
1-4 y	2.7	0.05	1.9
4-9 y	1.7	-0.02	4.1

Source: Wells J et al. Int J Obes 2003

Early weight gain is associated with lean mass in adults

- Rogers I. The influence of birthweight and intrauterine environment on adiposity and fat distribution in later life. *Int J Obes Relat Metab Disord* 2003;**27:**755-77.

- Victora CG, Sibbritt D, Horta BL, Lima RC, Cole TJ, Wells J. Weight gain in childhood and body composition at 18 years of age in Brazilian males. *Acta Paediatrica* 2007;**96:**296-300.

- Sachdev HS, Fall CH, Osmond C, et al. Anthropometric indicators of body composition in young adults: relation to size at birth and serial measurements of body mass index in childhood in the New Delhi birth cohort. *Am J Clin Nutr* 2005;**82**(2)**:**456-66.

- Wells JC, Hallal PC, Wright A, Singhal A, Victora CG. Fetal, infant and childhood growth: relationships with body composition in Brazilian boys aged 9 years. *Int J Obes (Lond)* 2005;**29**(10)**:**1192-8.

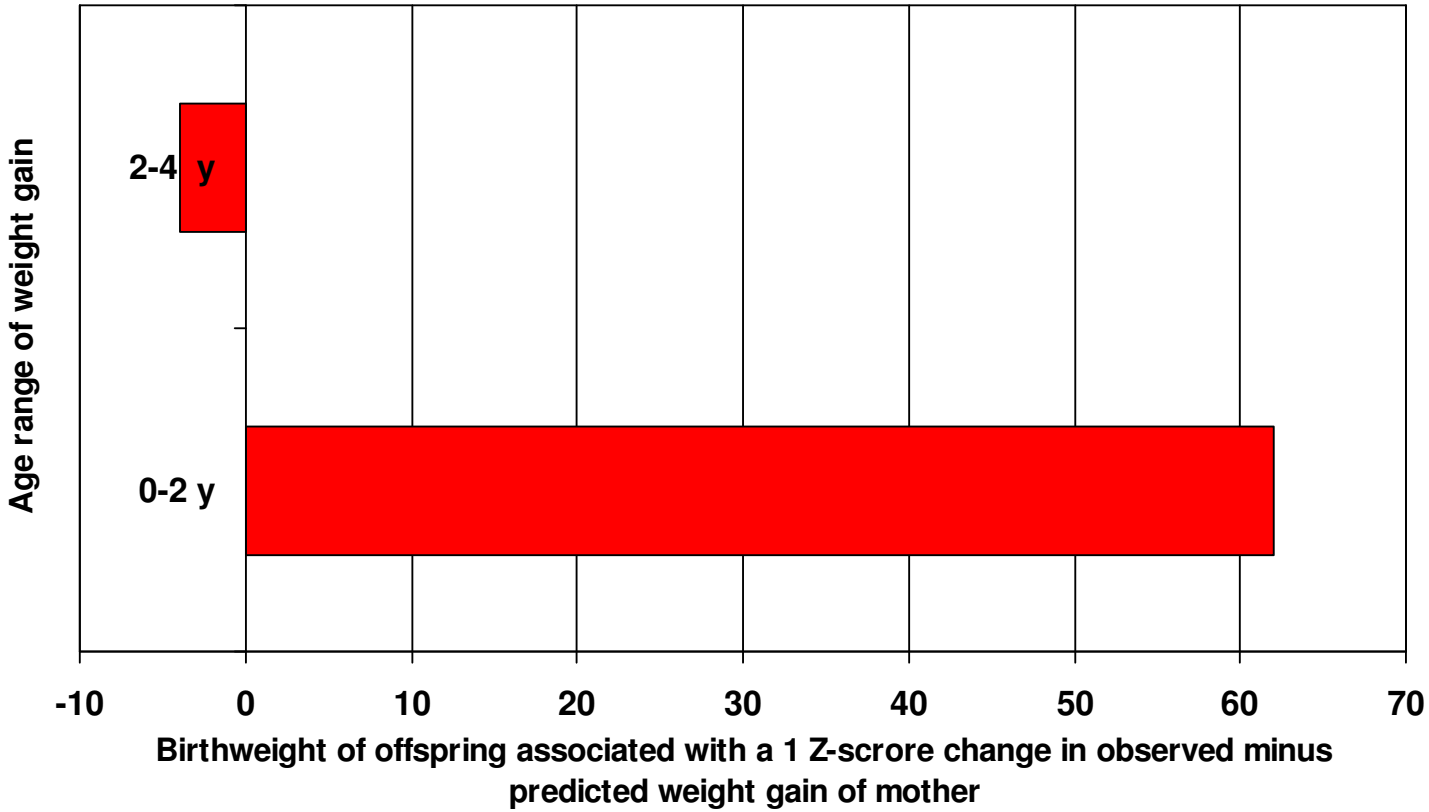
- Li H, Stein AD, Barnhart HX, Ramakrishnan U, Martorell R. Associations between prenatal and postnatal growth and adult body size and composition. *Am J Clin Nutr* 2003;**77:**1498-505.

Public Health Messages

1. Children <5 yr who are underweight or faltering should put on weight rapidly
2. Fat children tend to become fat adults
3. Small and thin children have lower human capital as adults
4. Weight gain in the first 1-2 years of life mainly contributes to lean body mass; later weight gain builds up fat – particularly among men

Period of weight gain and offspring birthweight

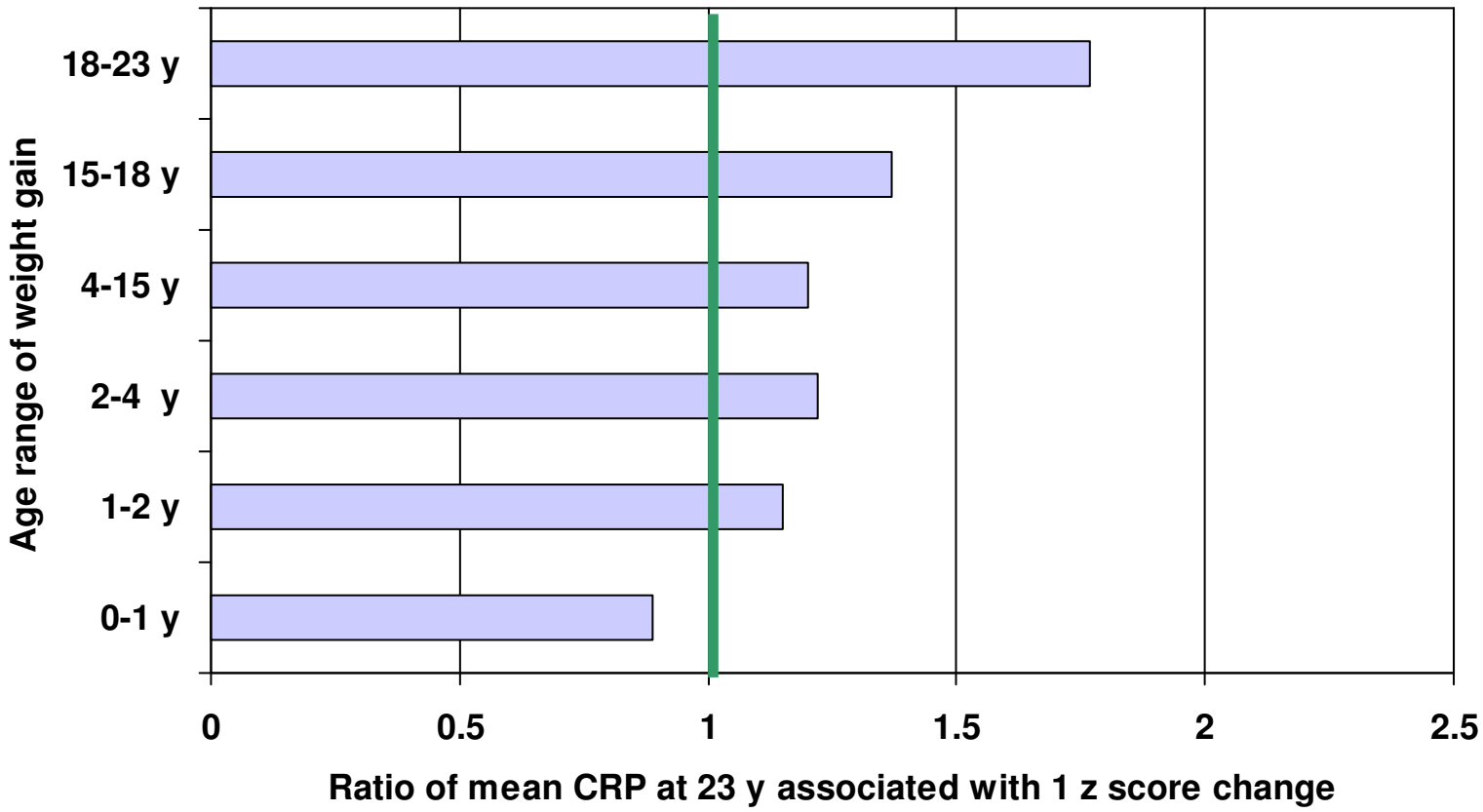
1982 Pelotas Birth Cohort
(adjusted analyses)



Horta BL, Victora CG (unpublished)

Period of weight gain and C-reactive protein in 23-yr-olds

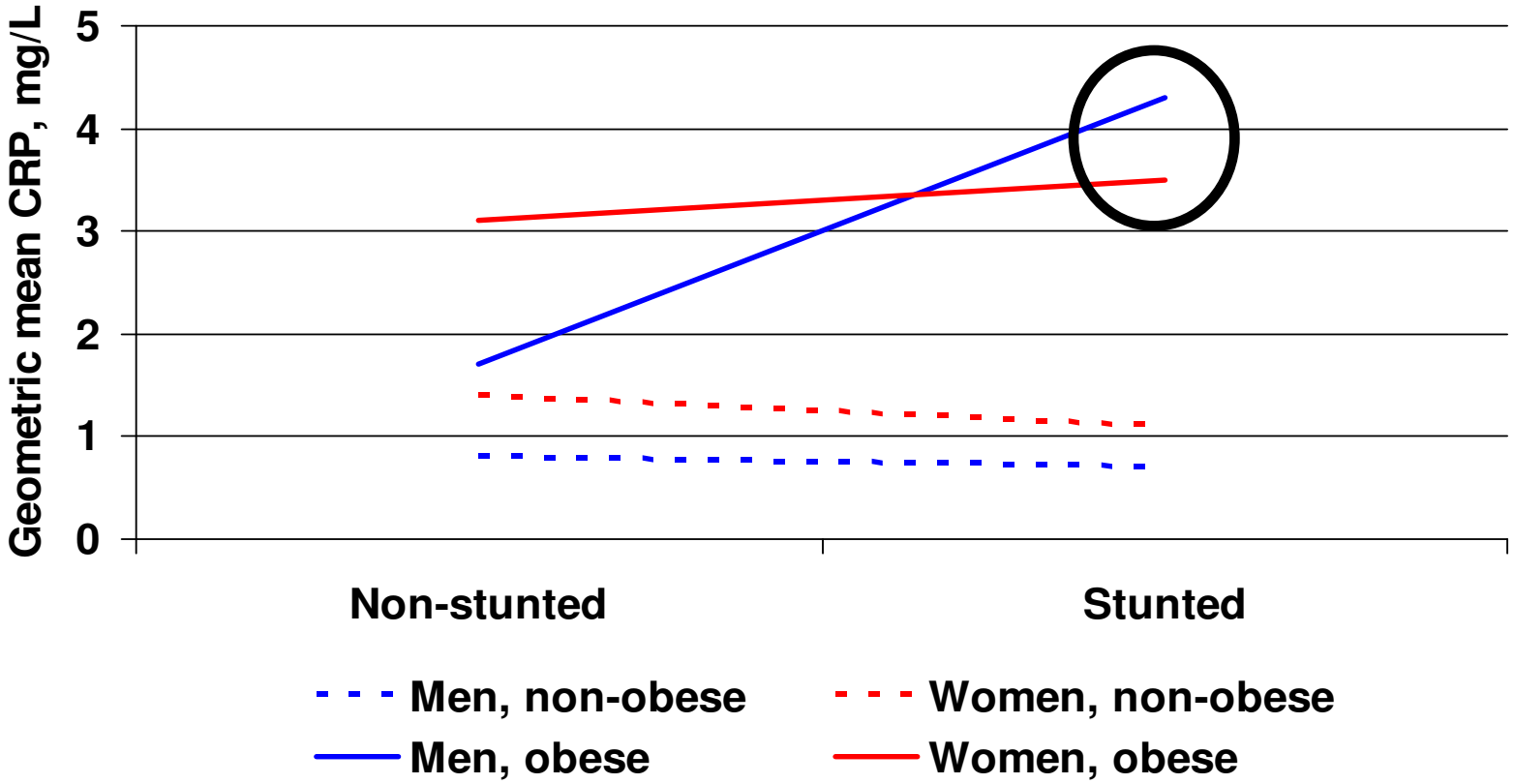
1982 Pelotas Birth Cohort – geometric mean ratios



Nazmi A, Victora CG (unpublished)

Stunting at 2 y and central obesity at 23 y

1982 Pelotas Birth Cohort – mean CRP levels



Public Health Messages

1. Children <5 yr who are underweight or faltering should put on weight rapidly
2. Fat children tend to become fat adults
3. Small and thin children have lower human capital as adults
4. Weight gain in the first 1-2 years of life mainly contributes to lean body mass; later weight gain builds up fat – particularly among men
5. The worst-case scenario is early undernutrition followed by rapid weight gain in late childhood (≥4 years ?)

The Public Health challenges

Interventions in low and middle-income countries

- Growth monitoring: promotion of weight gain in children up to 5 or 6 years of age
  - No evidence of efficacy

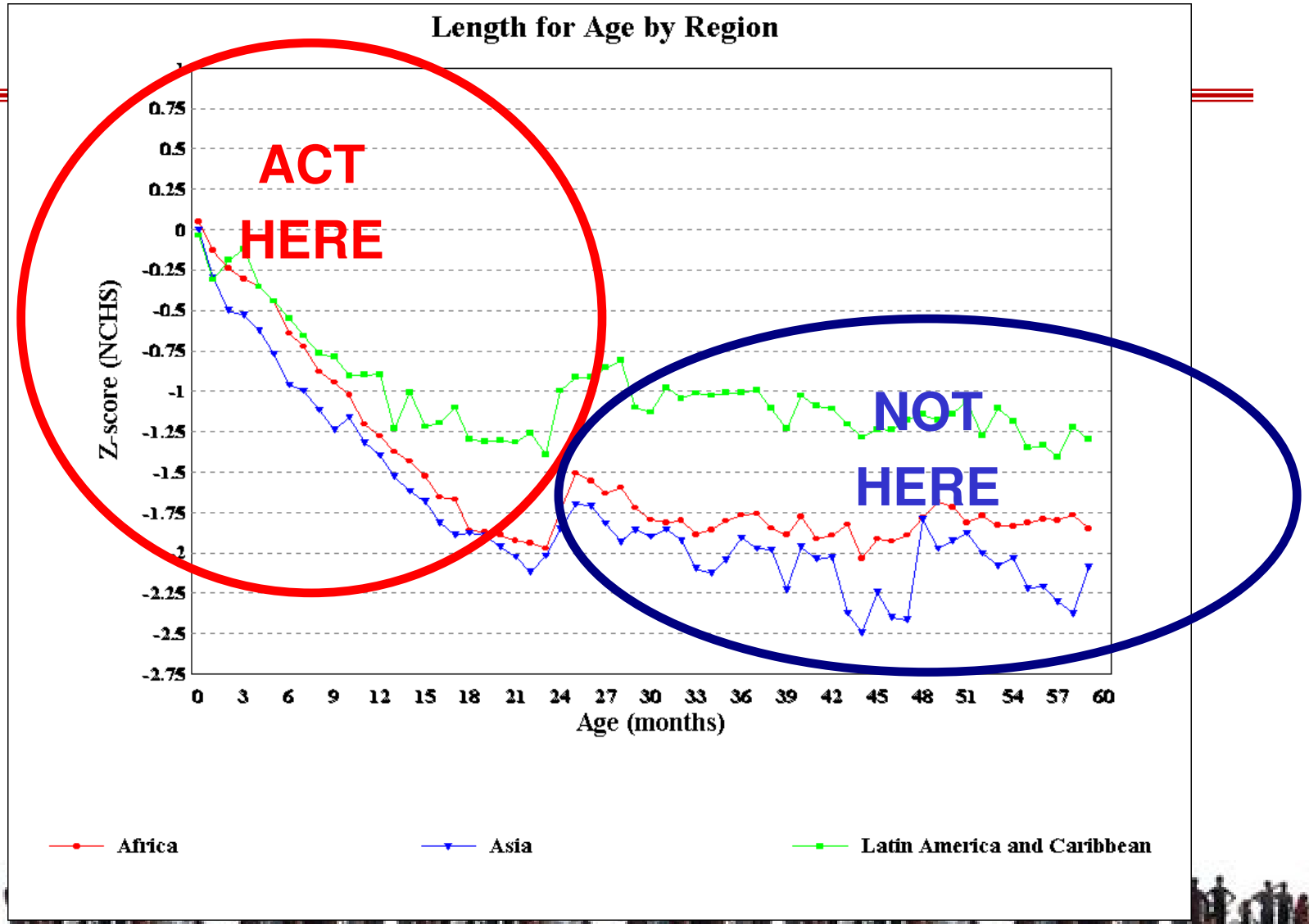
Bhutta Z et al. Lancet 2008

Interventions in low and middle-income countries

- School feeding programs
  - Net effect on 5-9 yr olds
    - 2.7% increase in weight and 0.7% on height
    - BMI increase 0.2 kg/m^2 per year

Bhutta Z et al. Lancet 2008

Public Health Messages

- Prevent low birthweight
- Promote rapid weight gain for children <2 yr in low and middle-income settings
  - Particularly those with IUGR, underweight or faltering
- Do not promote rapid weight gain for children >2 yr (>4 yr?) unless they are severely wasted
- Discontinue or modify interventions that promote weight gain among school children

Is there really a "catch-up dilemma"?