Life Course Factors, Nutrition and Body Composition

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Global Health Problems

Barker Hypothesis

Catch-up growth

Conclusions

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Europe: Secular Increase in Height

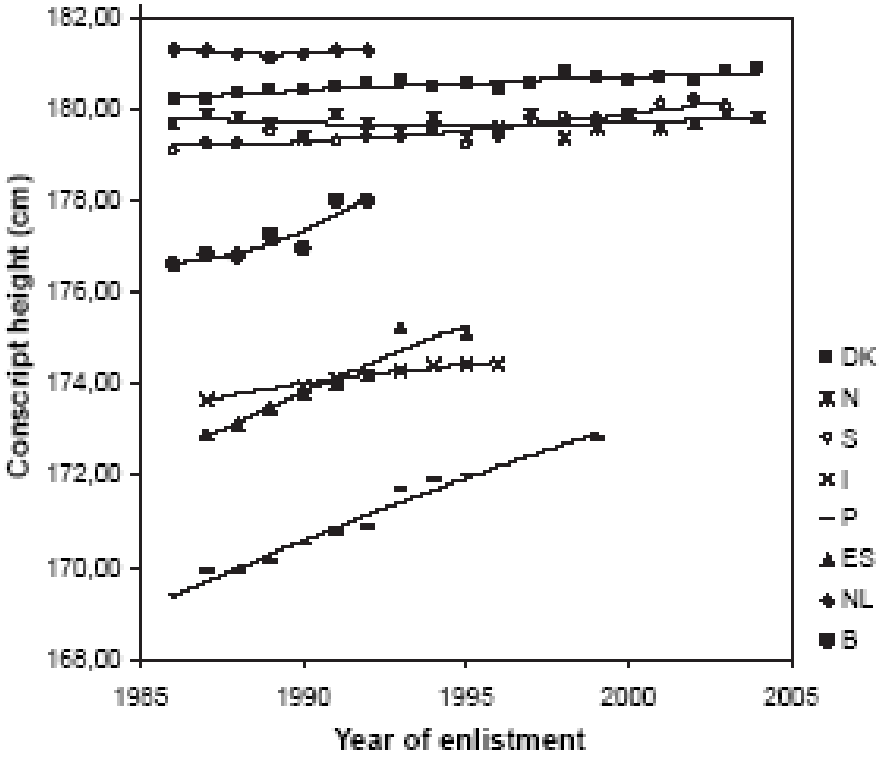


Figure 1. Mean conscript height in eight European countries according to year of enlistment. Previously published data from 1987 to 1990 have been included for comparison. B: Belgium; DK: Denmark; ES: Spain; I: Italy; N: Norway; NL: the Netherlands; P: Portugal; S: Sweden.

Larnkjaer et al Acta Paediatrica 2006

Plateau ~1.8 m:
Denmark, Sweden,
Norway, Netherlands
?genetic potential

Increasing:
Belgium, Spain,
Italy, Portugal

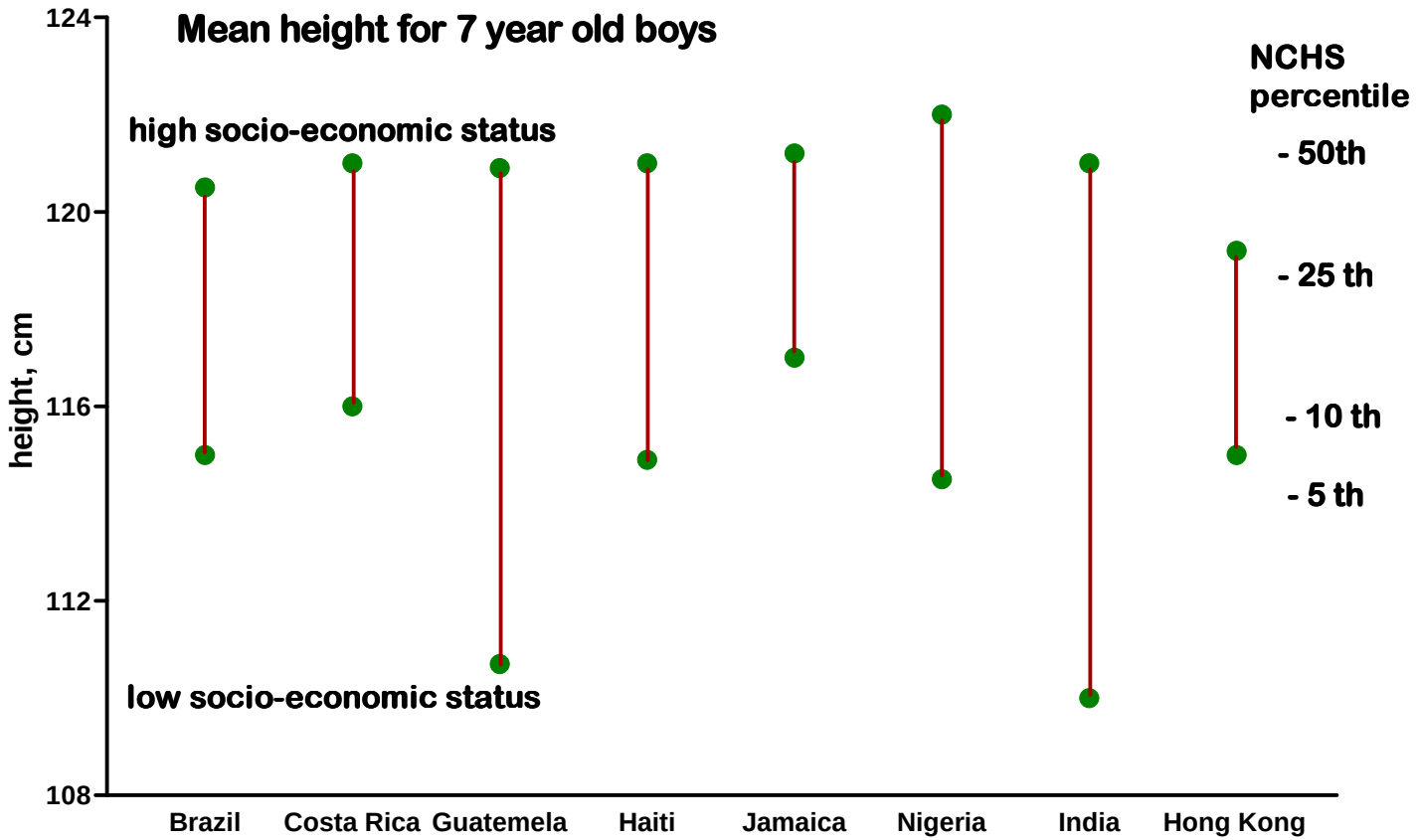
Europe: secular increase in height:

Stopped, 18 years following post-neonatal mortality around 4/1000 deliveries.

Improving socio-economic conditions

- better nutrition – healthier diet
- decrease in infectious diseases

Social Determinants of Length



Martorell, 1985

STUNTING: low height for age

More common than wasting
(thinness, severe acute malnutrition)
Obesity more common than wasting

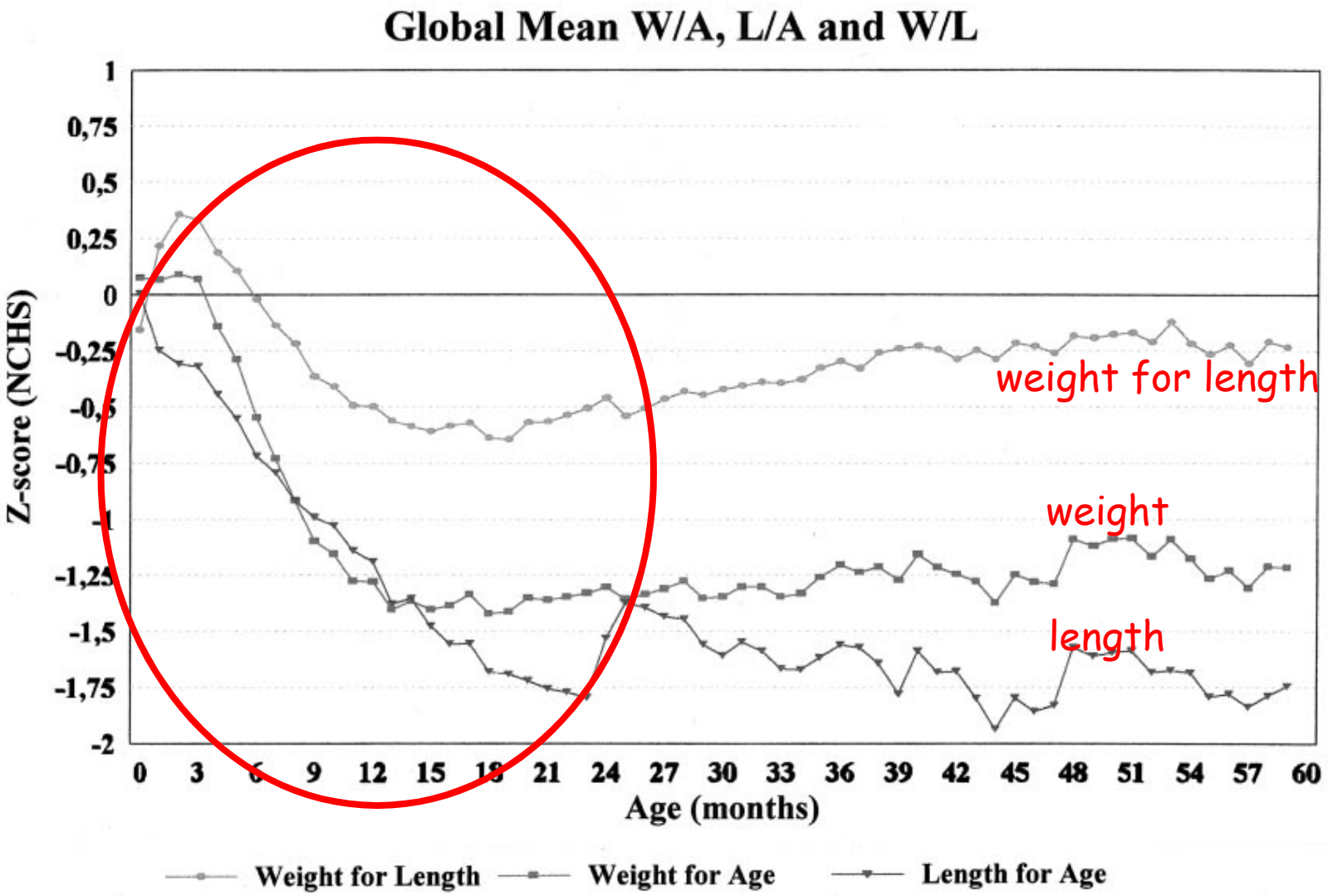
↑ mortality

↑ morbidity

↓ physical work performance

↓ intellectual function

↓ Lifelong earning capability



Stunting: by 2 years of age

Deprivation: poor neurocognitive development, obesity

Shrimpton 2001

Global epidemic of obesity

"The epidemic of obesity, with its attendant comorbidities --- heart disease, hypertension, stroke, and diabetes --- is not a problem limited to industrialized countries" – WHO TRS 916

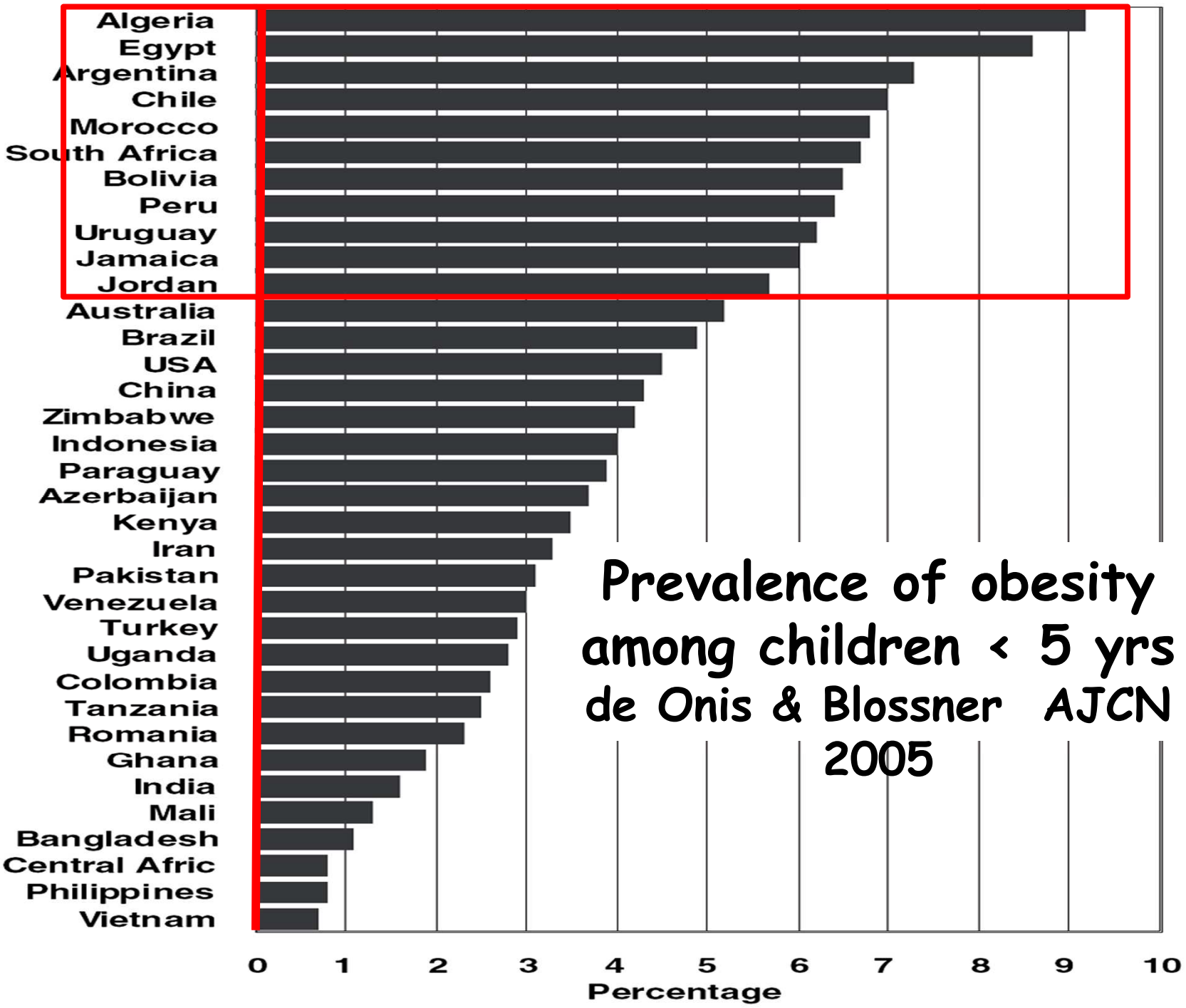
300 million BMI>30

1.5 billion BMI>25

1.7 billion BMI>23

200 m school-age children overweight

35 m under 5yrs overweight


Algeria
Egypt
Argentina
Chile
Morocco
South Africa
Bolivia
Peru
Uruguay
Jamaica
Jordan
Australia
Brazil
USA
China
Zimbabwe
Indonesia
Paraguay
Azerbaijan
Kenya
Iran
Pakistan
Venezuela
Turkey
Uganda
Colombia
Tanzania
Romania
Ghana
India
Mali
Bangladesh
Central Afric
Philippines
Vietnam
0
1
2
3
4
5
6
7
8
9
10
Percentage
Prevalence of obesity among children < 5 yrs
de Onis & Blossner AJCN 2005

Hillary Clinton Launches 1,000 Days Movement
September 2010

Double Burden of Malnutrition:

Malnutrition in All its Forms

Underweight, Overweight, Micronutrient Deficiencies

Global Action Plan for Scaling Up Nutrition (SUN)

Scaling up of evidence-based,
high priority nutrition interventions

Focusing primarily on the window of opportunity
conception to 24 months

Multisectoral: underlying socio-economic, intersectoral causes

Integrate: health systems,
agriculture and food security and social safety nets

United Nations A/66/L.1

General Assembly

Distr.: Limited
16 September 2011

Original: English

Sixty-sixth session
Agenda item 117
Follow-up to the outcome of the Millennium Summit

Draft resolution submitted by the President of the General Assembly

Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases

The General Assembly,

Adopts the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases annexed to the present resolution.

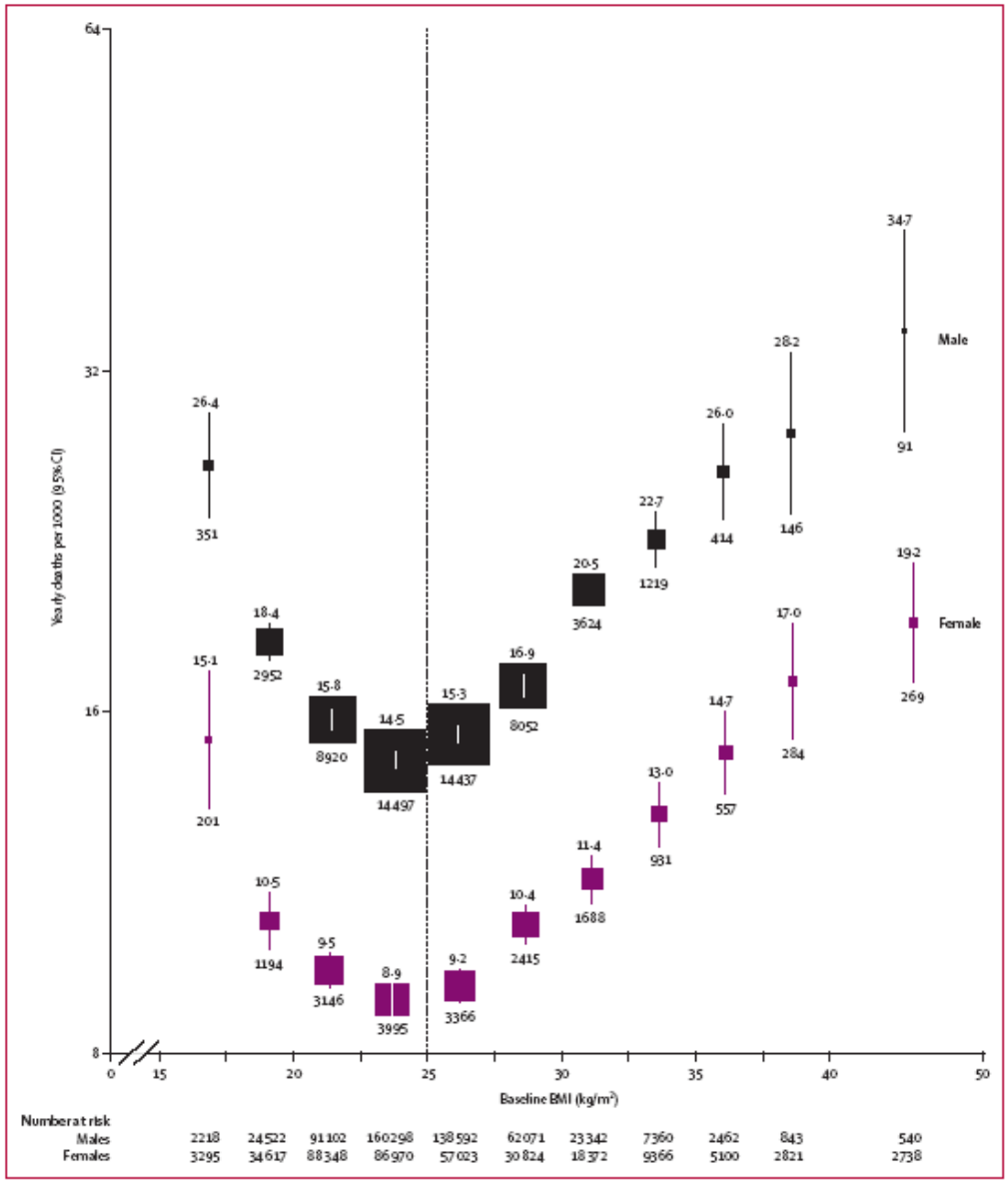


Figure 2: All-cause mortality versus BMI for each sex in the range 15–50 kg/m² (excluding the first 5 years of follow-up)
Relative risks at ages 35–89 years, adjusted for age at risk, smoking, and study, were multiplied by a common factor (ie, floated) to make the weighted average match the PSC mortality rate at ages 35–79 years. Floated mortality rates shown above each square and numbers of deaths below. Area of square is inversely proportional to the variance of the log risk. Boundaries of BMI groups are indicated by tick marks. 95% CIs for floated rates reflect uncertainty in the log risk for each single rate. Dotted vertical line indicates 25 kg/m² (boundary between upper and lower BMI ranges in this report).

Body Mass Index

U-shaped relationship
all cause mortality

Preferred range 22-25 kg/m^2

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Barker hypothesis:
Fetal Origins of Chronic Disease:

Coronary heart disease,

Stroke,

Type 2 diabetes

Hypertension

Developmental Model for Disorders

Fetal Origins Hypothesis of Chronic Disease

Disorders originate through **Developmental Plasticity**

Poor nutrient exposure: early life (fetus, infant, early childhood)

Permanent change in structure and function:

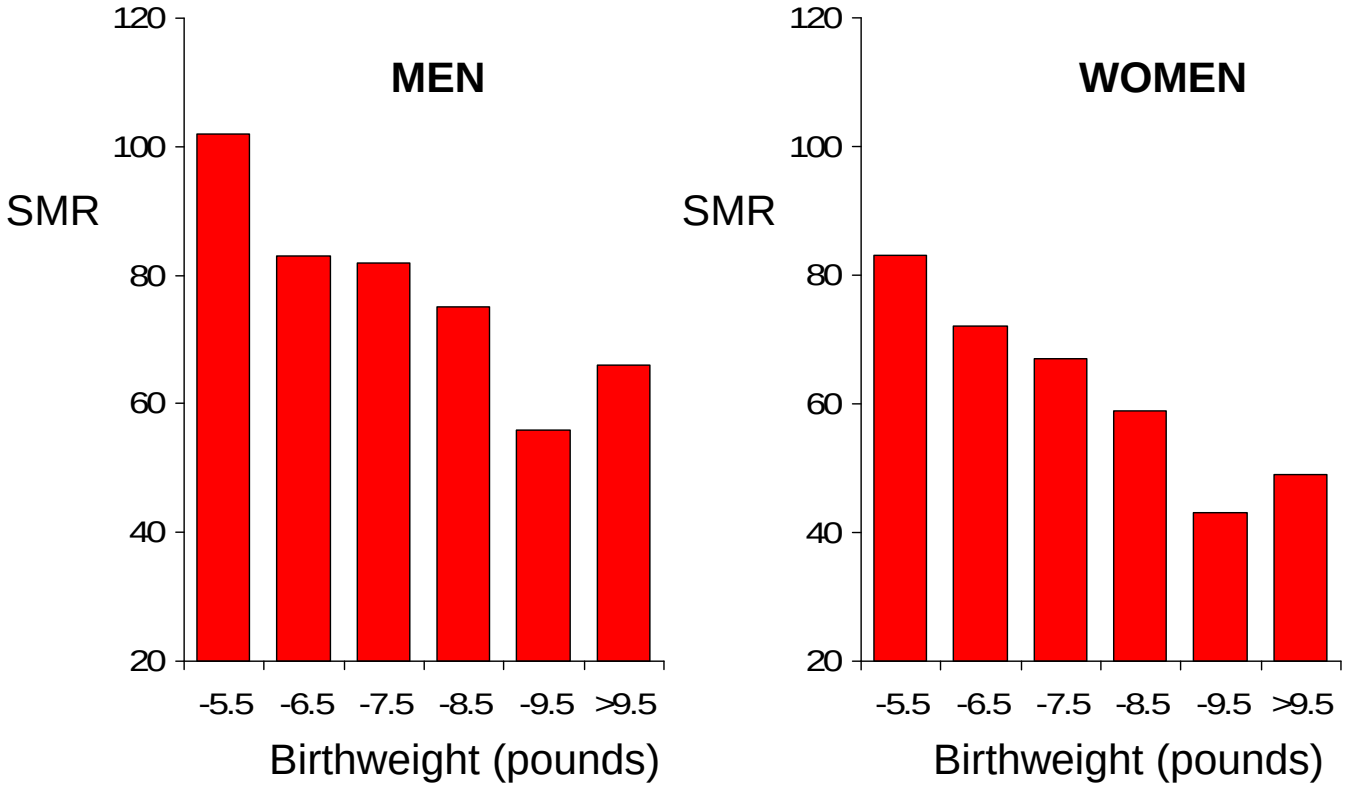
- tissues and organs

Vulnerable period: timing, intensity, duration

Barker Hypothesis

Coronary heart disease

Standardised mortality ratios (SMR) in 10141 men & 5585 women

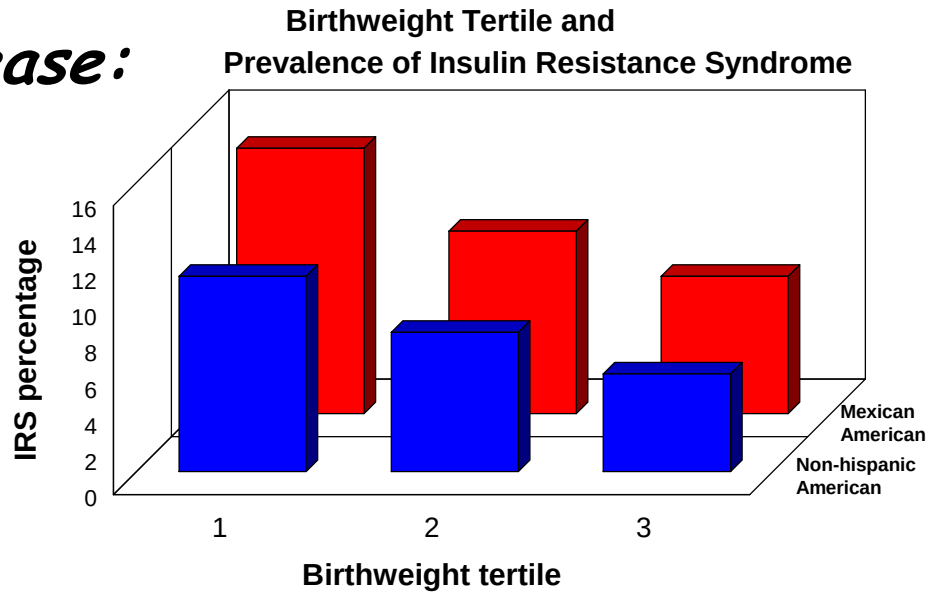


BMJ 1993;307:1519-24

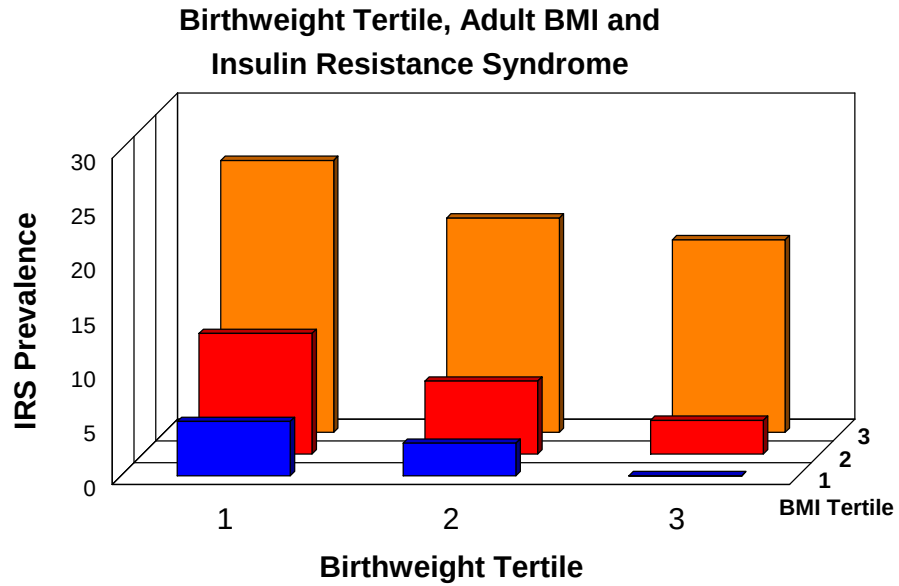
Variable risk <u>across the range</u> of weight at birth & at age one year, which is not a feature of the extremes of the ranges, very low or very high.

Early Life origins of disease:

Evidence from wide range of international studies



Valdez et al, Diabetologia 1992



Valdez at al, Diabetologia 1994

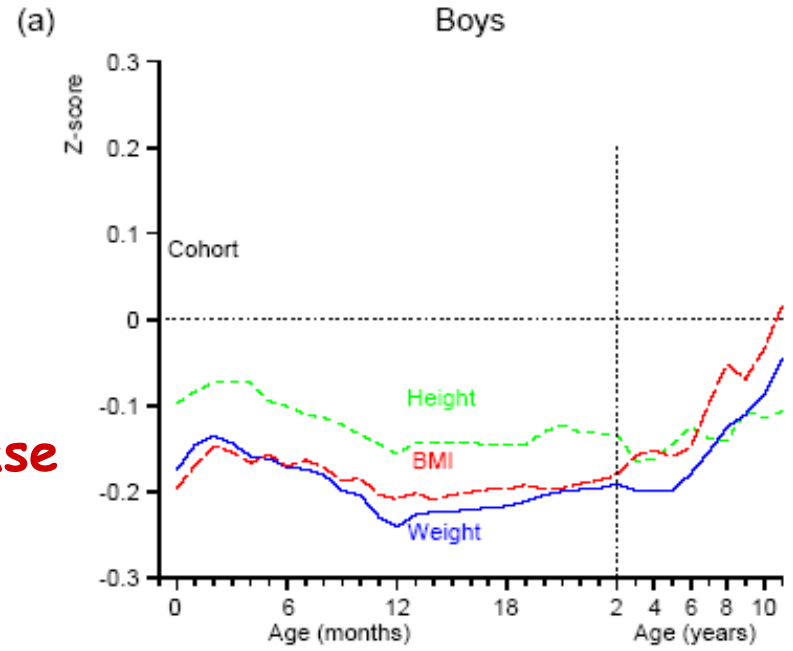
Metabolic changes already evident in childhood by 5 years of age

Finnish Studies

Adults who had coronary heart disease

Growth in childhood – to 11 years

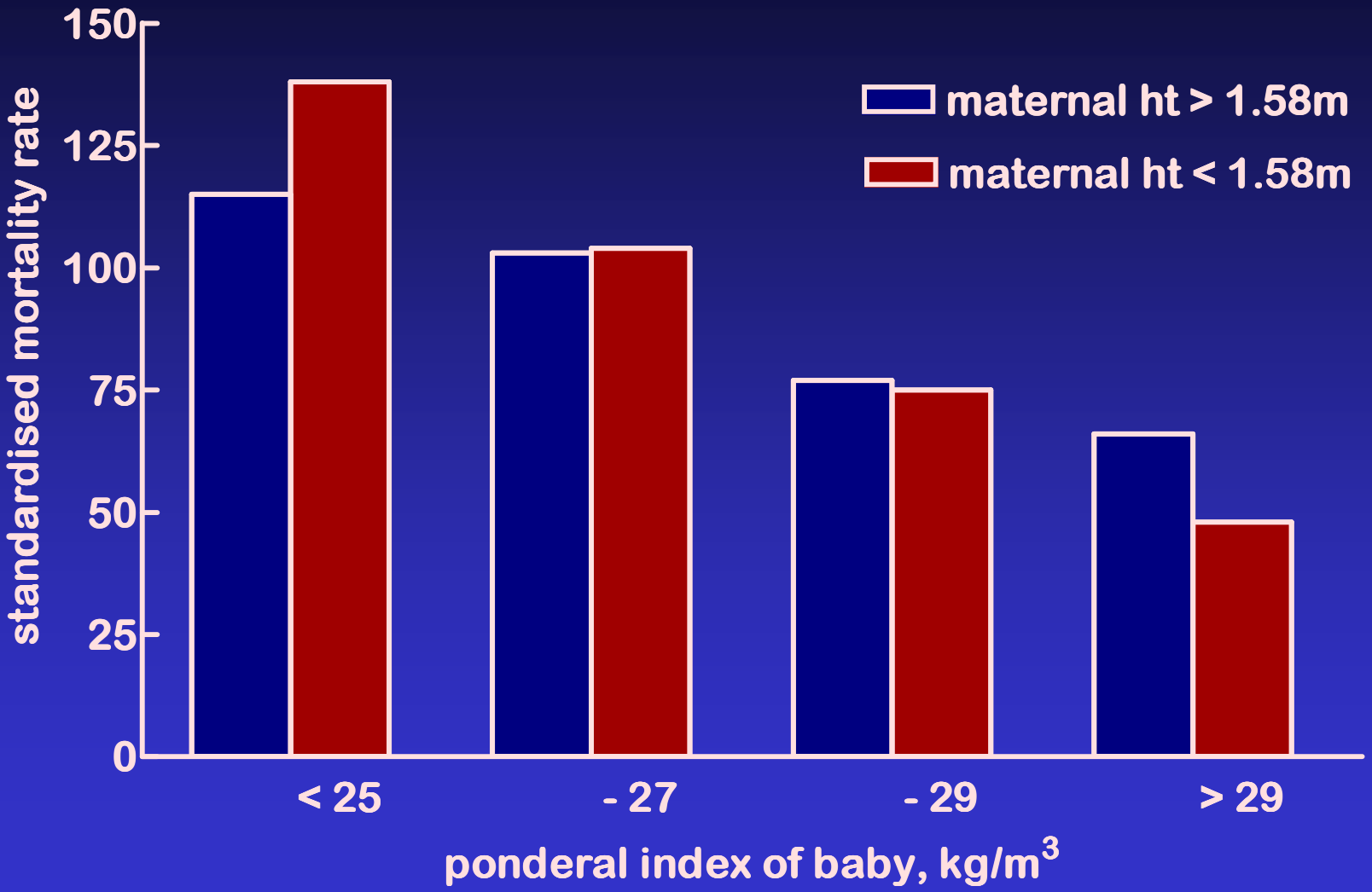
Mean z scores for height, weight and body mass index

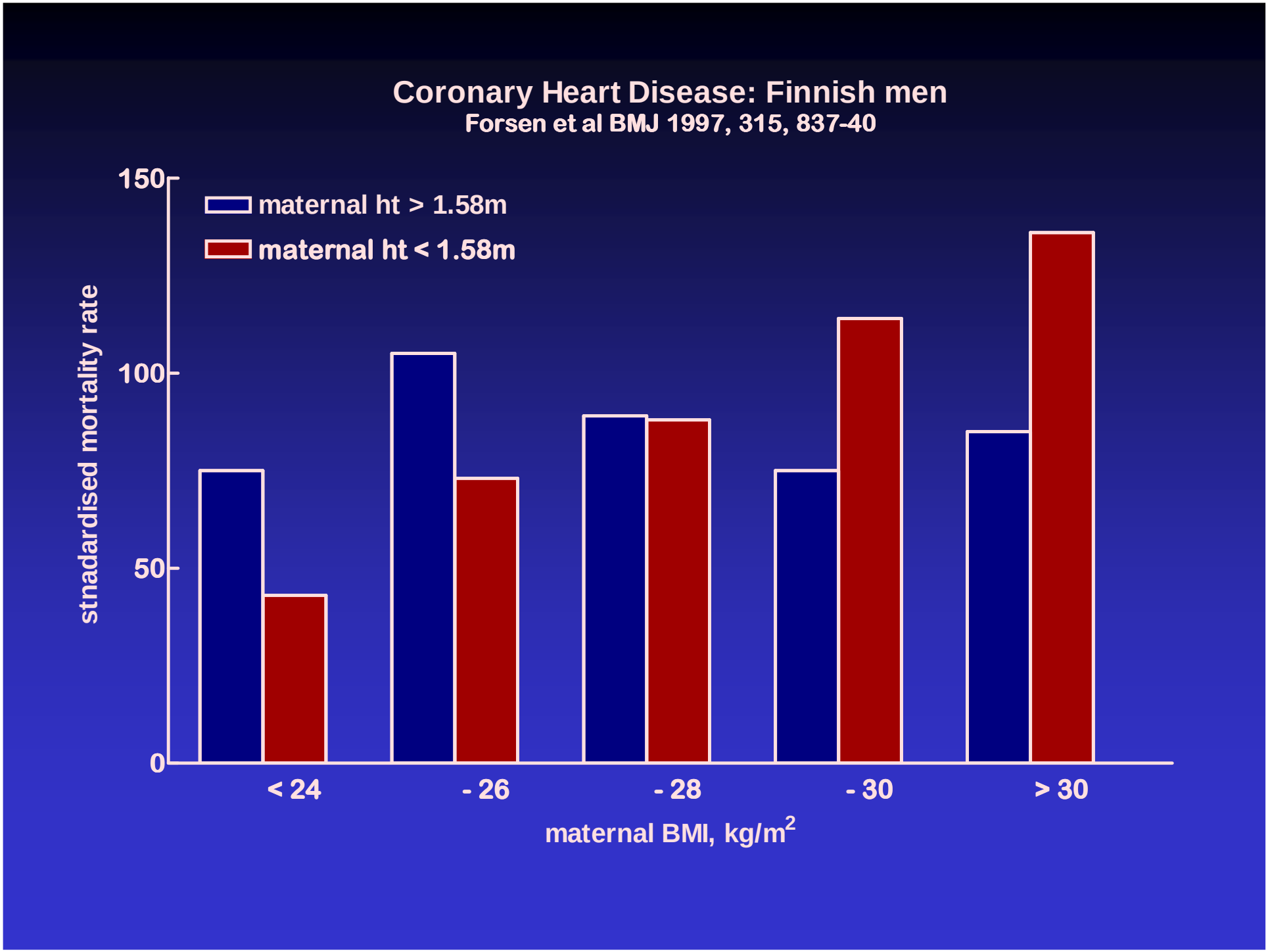


Barker et al Ann Hum Biol 2009;36:445-458

Coronary Heart Disease: Finnish men

Forsen et al, BMJ 1997, 315, 837-40




Coronary Heart Disease: Finnish men
Forsen et al BMJ 1997, 315, 837-40
maternal ht > 1.58m
maternal ht < 1.58m
stnadardised mortality rate
150
100
50
0
< 24
- 26
- 28
- 30
> 30
maternal BMI, kg/m2

Coronary heart disease: mother < 1.58 m

standardised mortality rate

Ponderal index of baby	BMI of mother					
	< 24	-26	-28	-30	> 30	All
<25	55	106	168	170	224	131
-27	55	70	146	113	134	104
-29	26	54	31	137	149	75
> 29	0	63	26	55	75	48
All	43	73	88	114	136	90

Forsen et al, BMJ 1997; 315: 837-840

Stunting and overweight in children
Countries in transition

Popkin, Public Health Nutrition 1998, 1, 5-21

High rates of lower birth weights

High rates of stunting in childhood (15-35%)

Increased prevalence of obesity

Changes in dietary habits

Reduced levels of activity associated with urbanization

Increased prevalence of heart disease and type 2 diabetes

Global trend towards increase weight and height:

generally desirable:

BUT

increase in weight achieved
- before increase in height

Increase in childhood overweight and adiposity

Increased risk of shortness/stunting and obesity

The Thin-Fat Indian Baby

Pune: newborn baby

Weight 2,800g

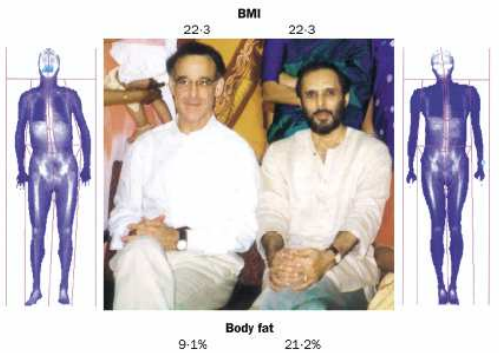
Thin: reduced lean mass.

Relatively adipose: central fat

Clinical picture

The Y-Y paradox

Chittaranjan S Yajnik, John S Yudkin



The two authors share a near identical body-mass index (BMI), but as dual X-ray absorptiometry imagery shows that is where the similarity ends. The first author (figure, right) has substantially more body fat than the second author (figure, left). Lifestyle may be relevant: the second author runs marathons whereas the first author's main exercise is running to beat the closing doors of the elevator in the hospital every morning. The contribution of genes to such adiposity is yet to be determined, although the possible relevance of intrauterine undernutrition is supported by the first author's low birthweight. The image is a useful reminder of the limitations of BMI as a measure of adiposity across populations.

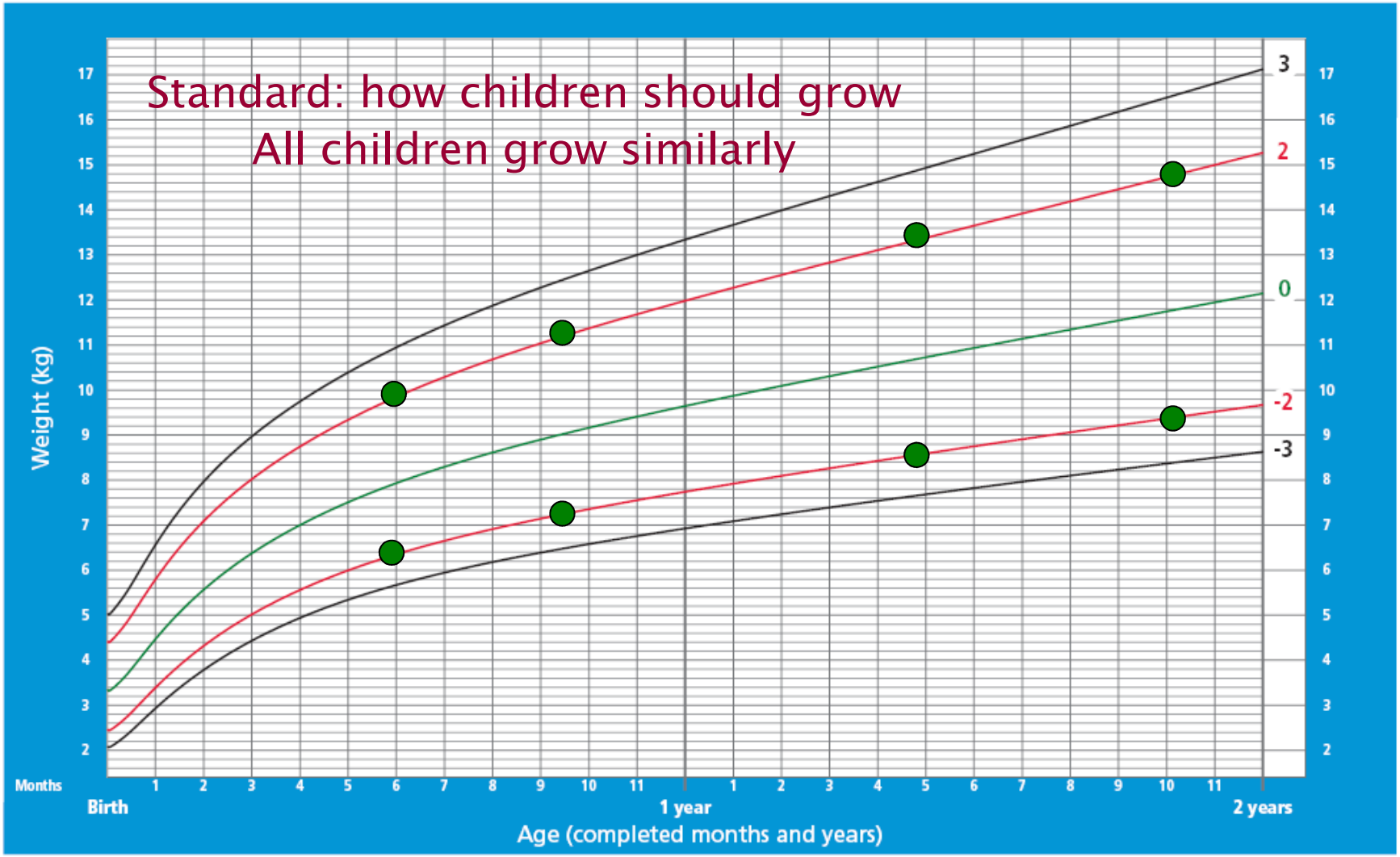
Diabetes Unit, KEM Hospital Research Centre, Rasta Peth, Pune 411011, India (C S Yajnik MD); **International Health and Medical Education Centre, University College London, UK** (J S Yudkin FRCP)

Small Baby: shortness and fatness
Increased risk type 2 diabetes

Weight-for-age BOYS

Birth to 2 years (z-scores)

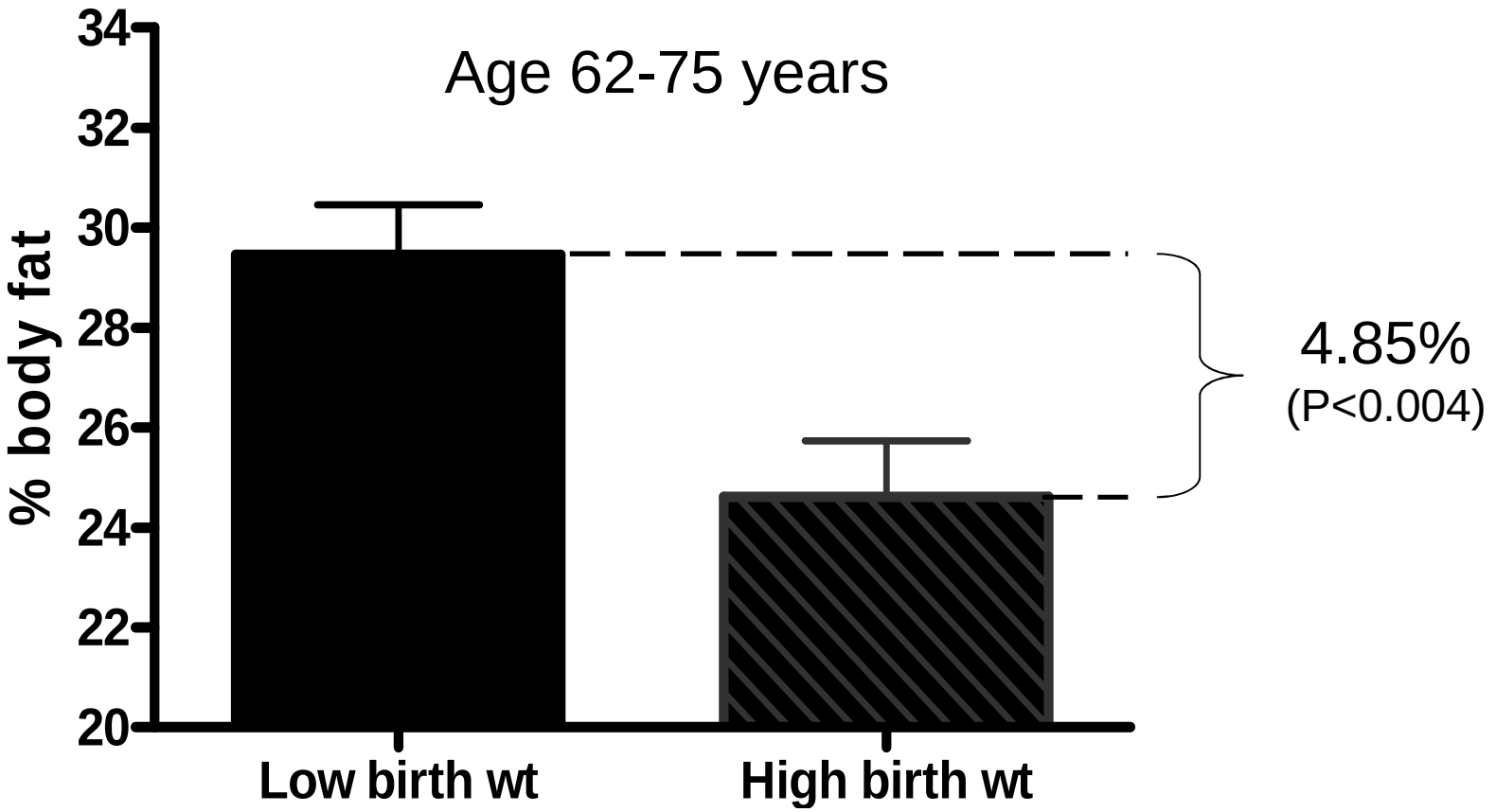
World Health Organization



WHO Child Growth Standards

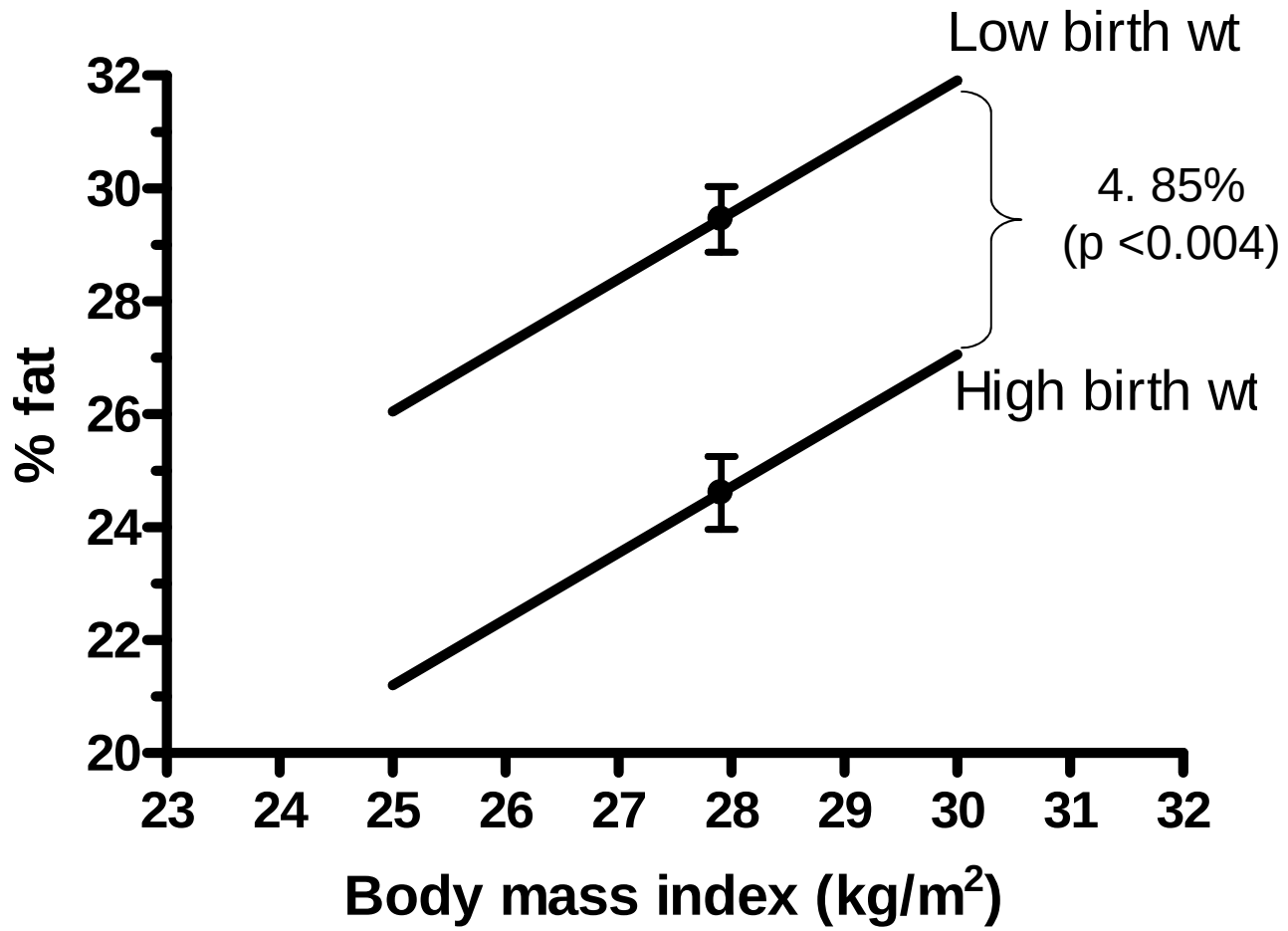
% fat in low and high birth weight groups

(mean ± sem), adjusted for BMI (27.9 kg/m^2)



Kensara et al, 2005

ANCOVA BMI v % fat (r = 0.67; p <0.001)



Kensara et al, 2005

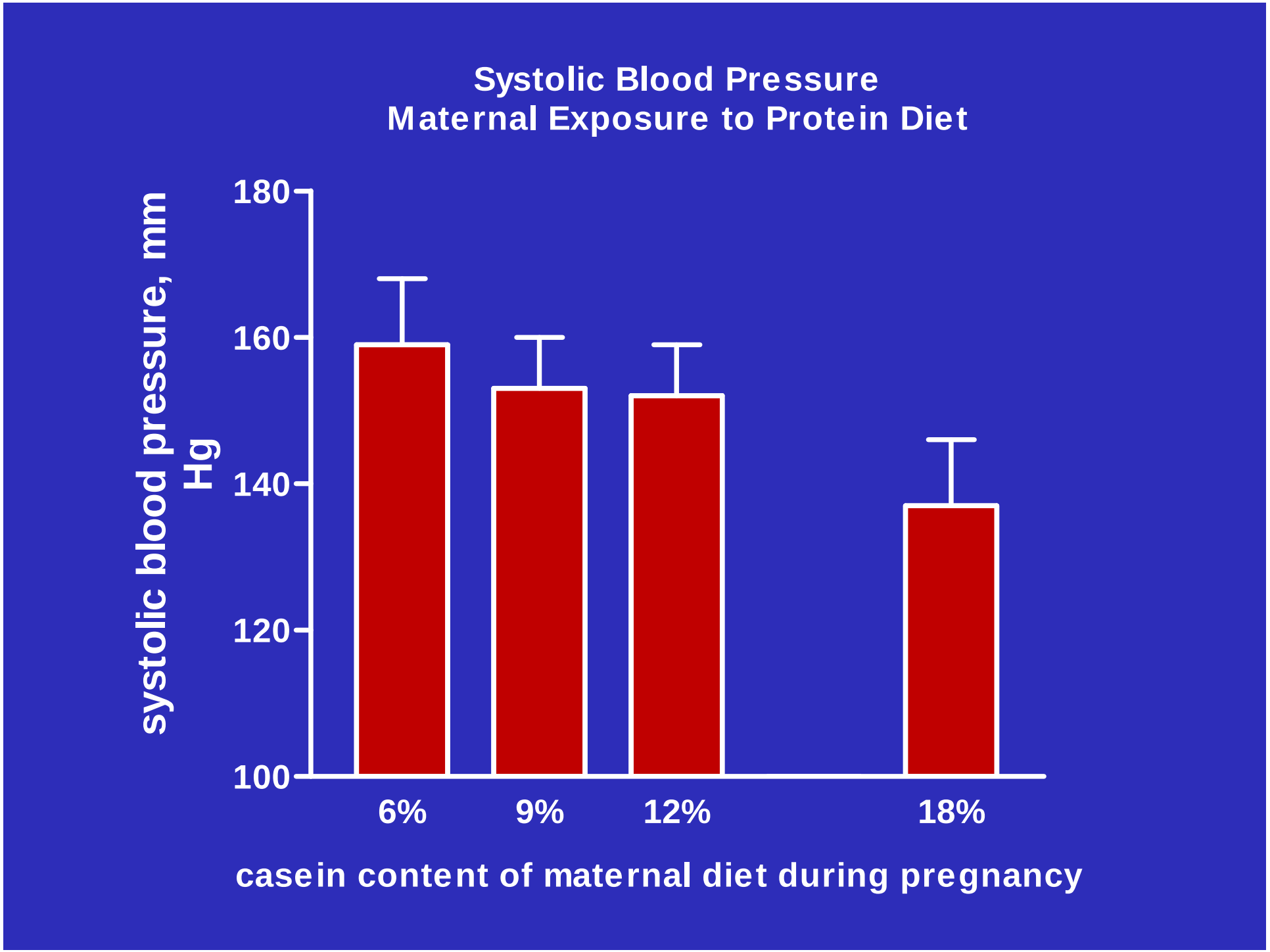
For the same weight or BMI at 70 years of age

Lower birth weight

- less muscle
- more fat
- more central fat

- function difference

- altered cellular nutrient environment


Systolic Blood Pressure
Maternal Exposure to Protein Diet
systolic blood pressure, mm Hg
180
160
140
120
100
6%
9%
12%
18%
casein content of maternal diet during pregnancy

Fetus:

reset of central set-point for key hormonal axes

hypothalamo - pituitary-adrenal

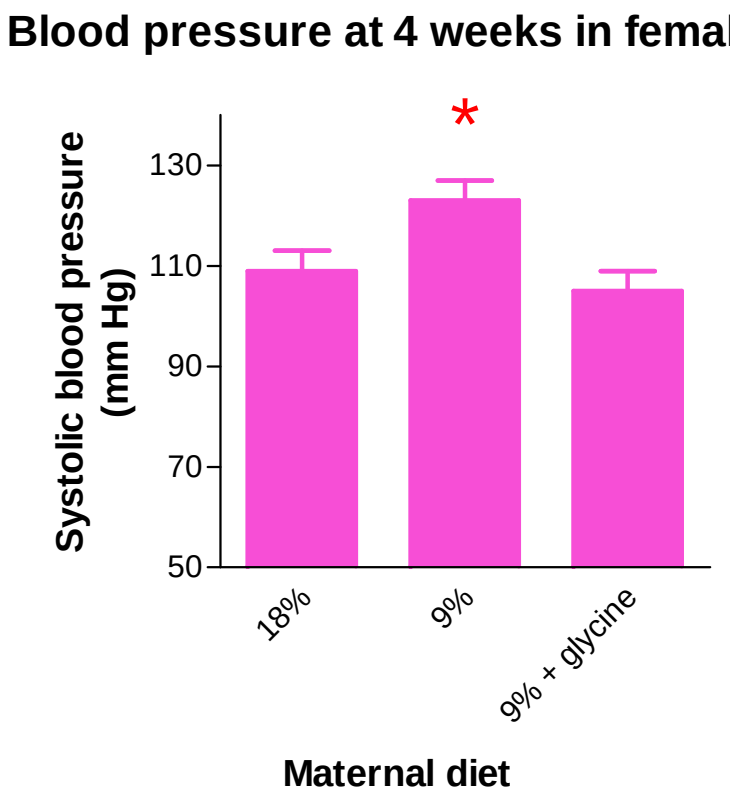
growth hormone – IGF – insulin

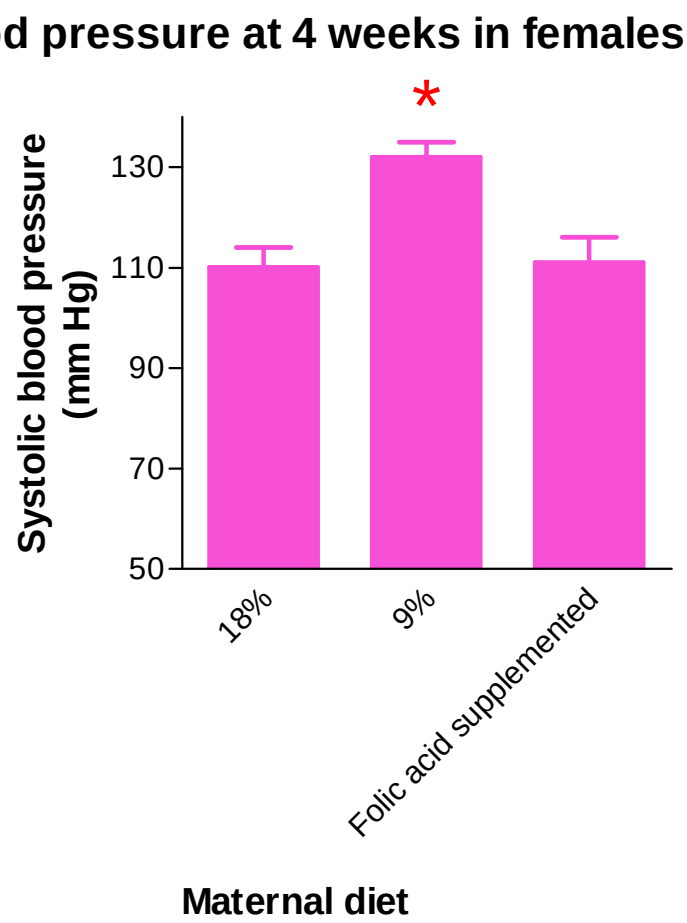
thyroid axis

sex steroid axis

- response to diet
- response to stressors

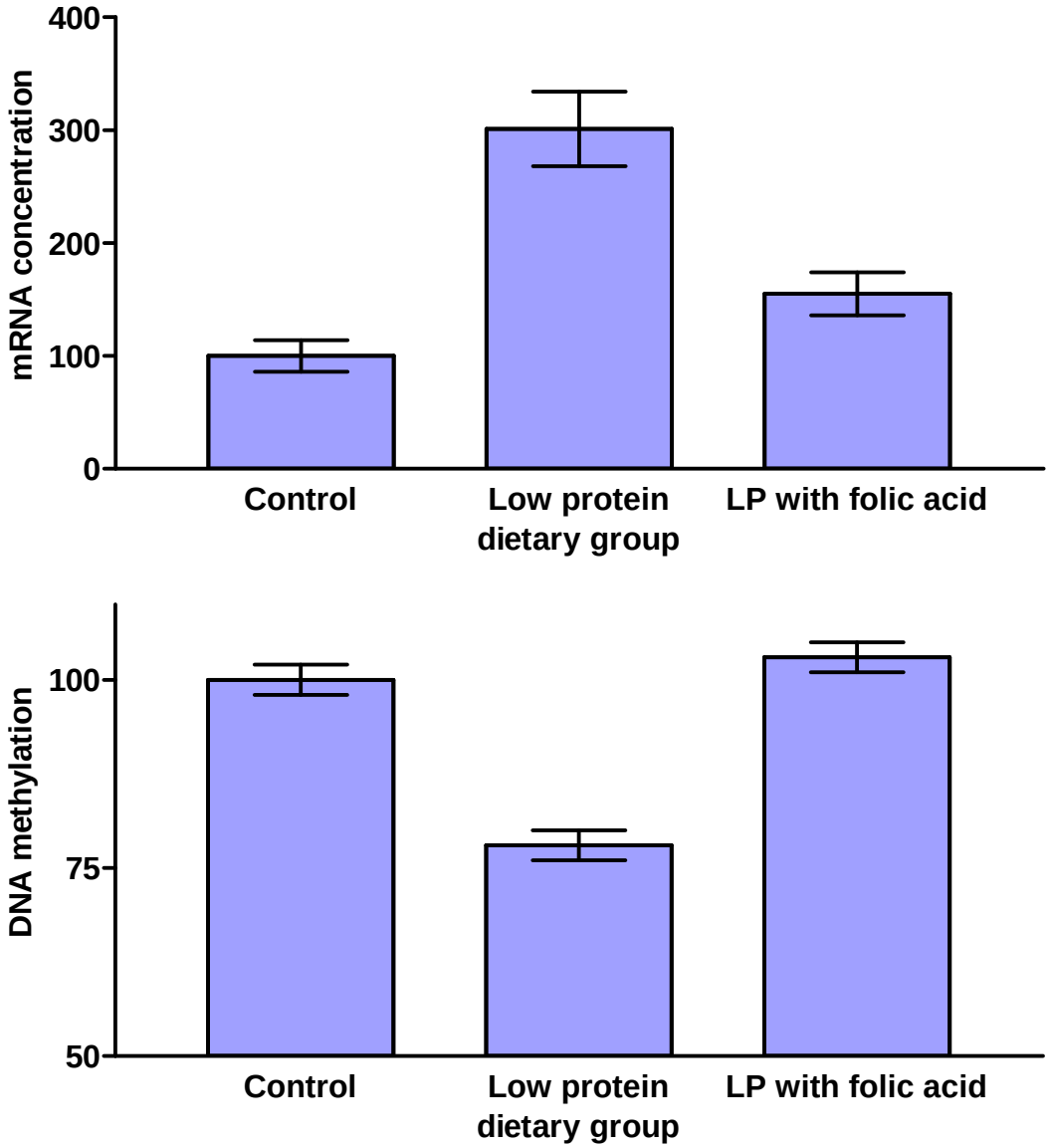
Glycine and folic acid supplementation prevent hypertension





Jackson et al. 2002, Torrens et al. 2006

Hepatic Glucocorticoid Receptor: methylation of promoter region of gene and gene expression



Epigenetics

Stable change in DNA structure

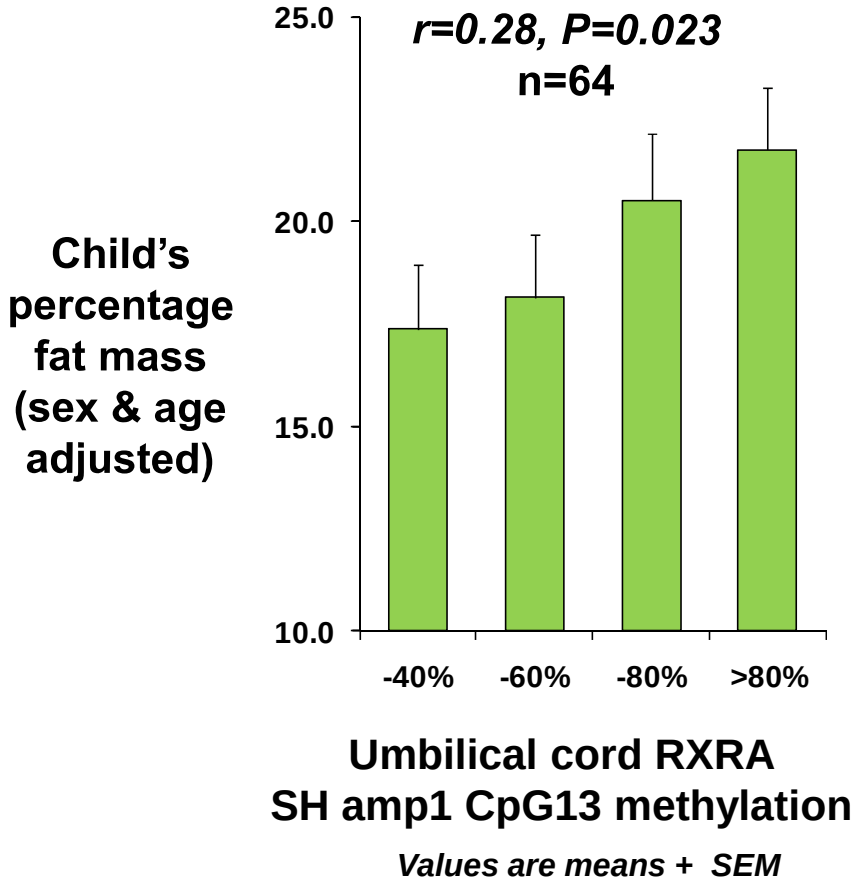
Modifies expression

Carried between generations

Variable methylation (protein and folate)

Selective methylation of promoter region

Methylation promoter RETINOIC ACID RECEPTOR gene umbilical cord
Association adiposity 9 years of age: 'explains' >25% of later adiposity;



Godfrey, et al. Diabetes 2011

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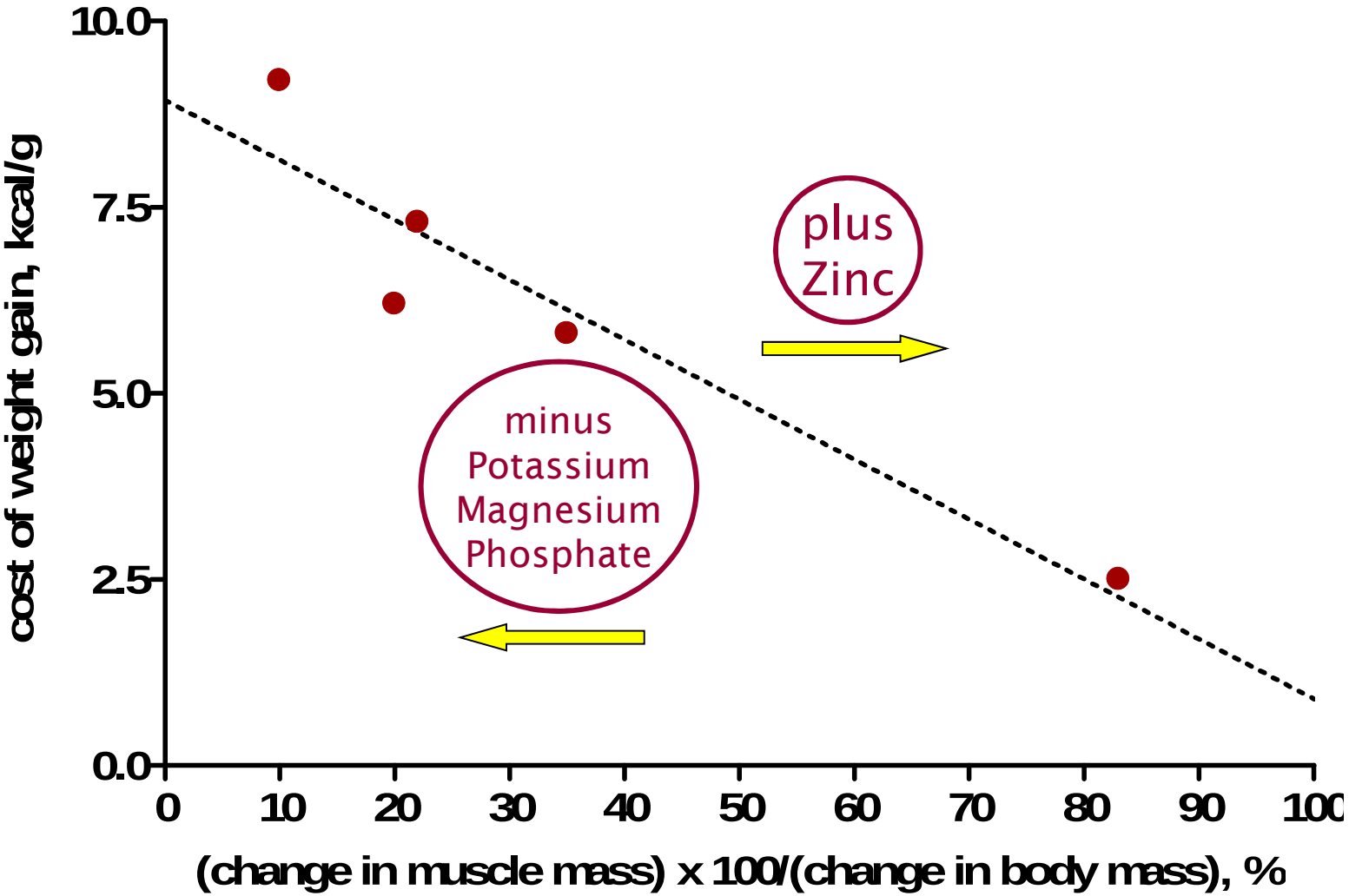
Catch-up growth

- rapid growth, rate greater than normal

- altered efficiency of growth
  greater tissue gain per unit energy

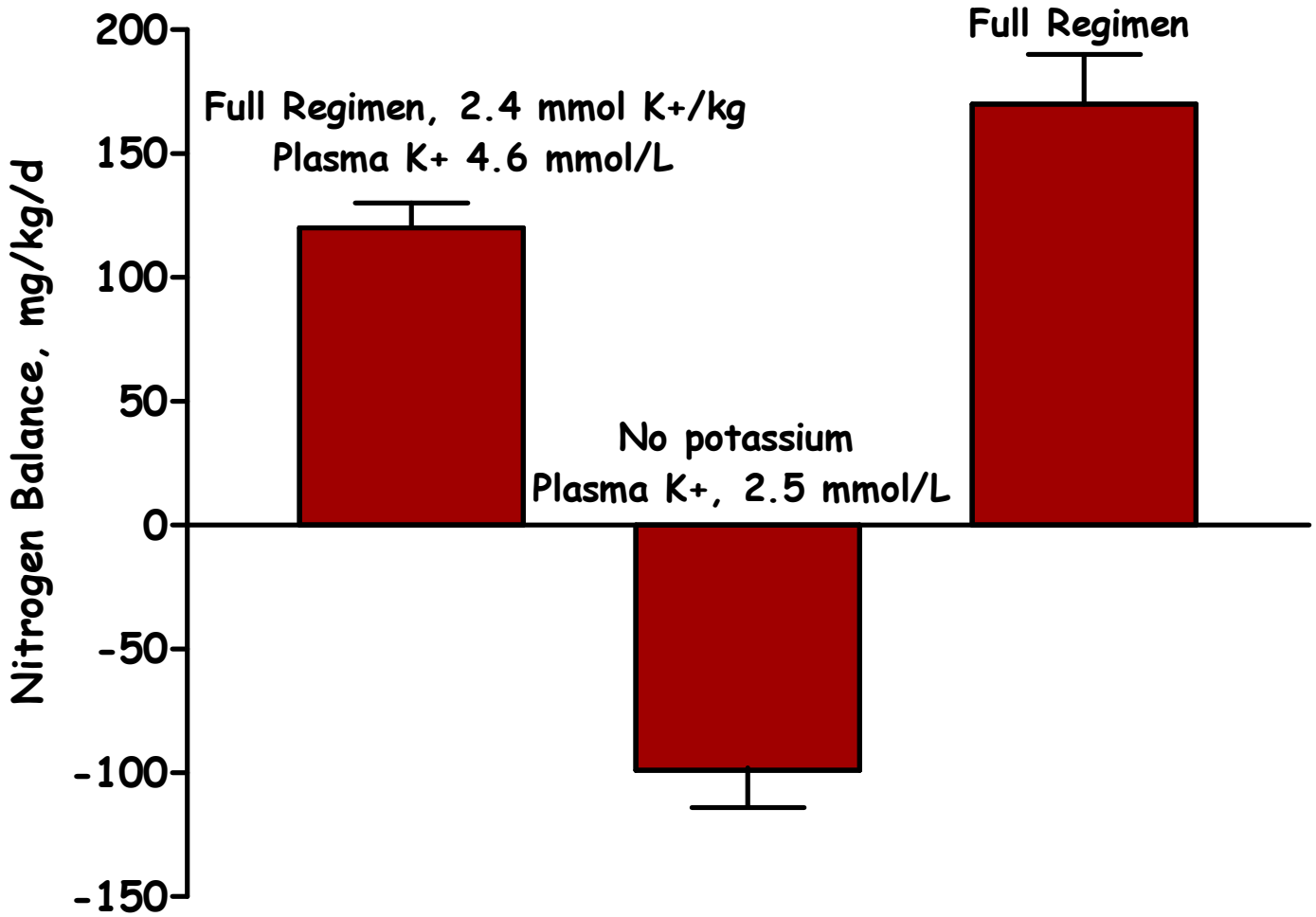
- Altered pattern of tissue deposition

Cost of Growth in relation to Change in Body Composition during recovery from severe malnutrition
Jackson, 1977



Effect of removing potassium from parenteral nutrition on nitrogen balance

Rudman et al, 1975



Pattern of nutrients retained
Nutrient requirements for net deposition:

- bone
- lean tissue
- adipose (by default)

Nutrient availability – altered pattern tissue deposition:

- energy
- macronutrients
  dietarily essential, conditionally essential
- micronutrients

Non-essential or conditionally essential Nutrients:
- do not have to be provided preformed in diet.

Required for metabolism
- formed from precursors usually readily available in diet.

Amino acids

Longer chain polyunsaturated Fatty acids

High rates of formation

Regulated rates of formation

FOOD/NUTRIENT INSECURITY

Diet:

Quantity:

energy
[macronutrients, carbohydrate, lipid (fat), protein]

Quality:

Nutrients
[CHO, lipid (essential fatty acids), amino acids,
minerals, vitamins, trace elements
water, oxygen]

Activity: Inflammation

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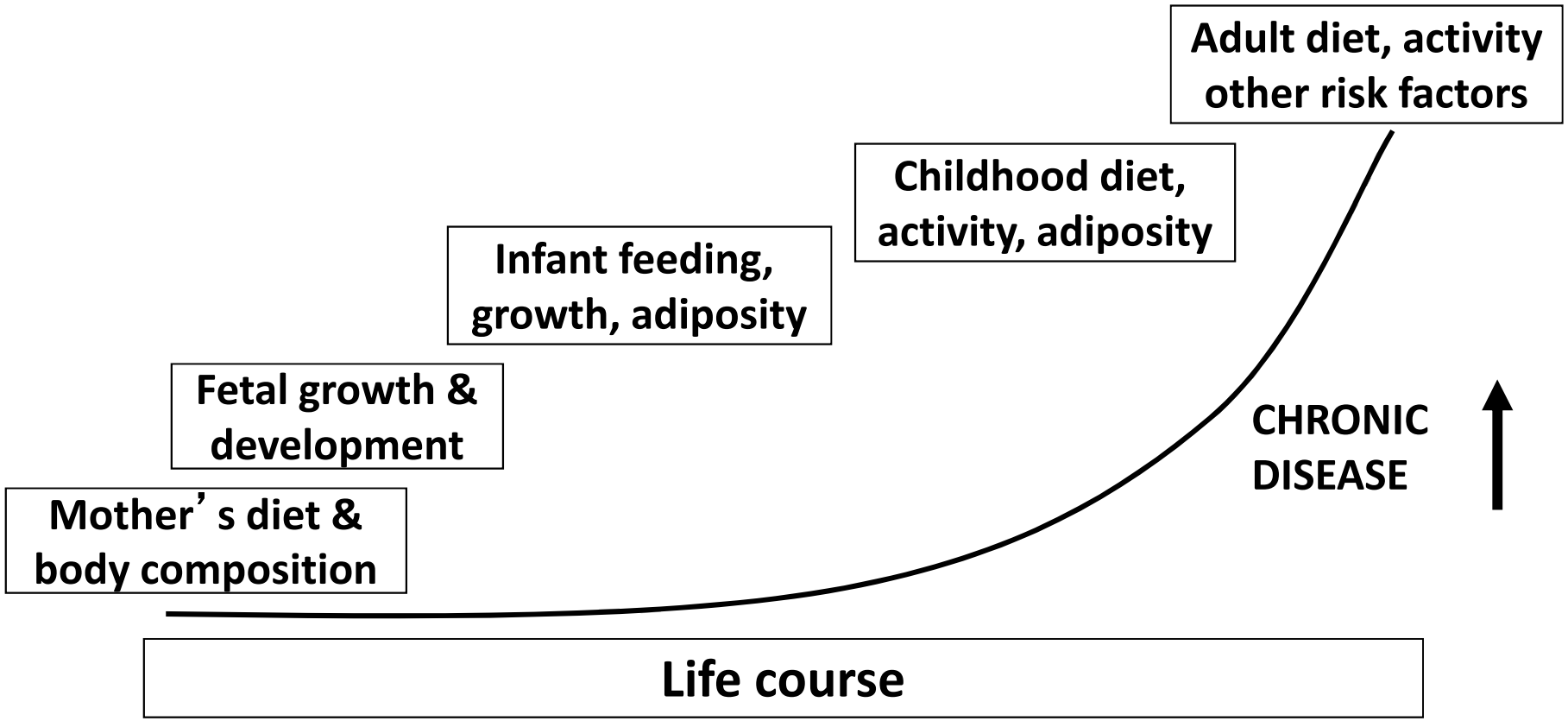
What happens in the short term matters in the long term

Life course approach to chronic disease



Standing Committee on Nutrition, United Nations System:
Chronic disease: impending global burden of ill-health
Window of vulnerability: preconception to 2 years of age

Structure and function inextricably linked

Molecular:

genetic, epigentic

Cellular:

membrane structure and function
receptor function
signalling, replication, differentiation

Tissue, organ

Head circumference: brain
Renal size:nephron number
Abdominal circumference: hepatic architecture

Body shape:

height, lean, adipose

Structure /function

Quantity and Quality

Widdowson - "Harmony of Growth"

pace and proportion, partitioning of nutrients