

INVESTING IN ADOLESCENT GIRLS' NUTRITION: A SECOND WINDOW OF OPPORTUNITY

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OUTLINE :

I. Why is adolescent nutrition important?

- Background: Adolescent growth and developmental physiology and influence of nutrition

II. Nutritional and other drivers of menarche and linear growth

- Evidence and gaps

III. Adolescent pregnancy

IV. Nutrition interventions in adolescent girls: Data needs and research opportunities

PUBERTY : A TIME OF RAPID GROWTH AND MATURATION

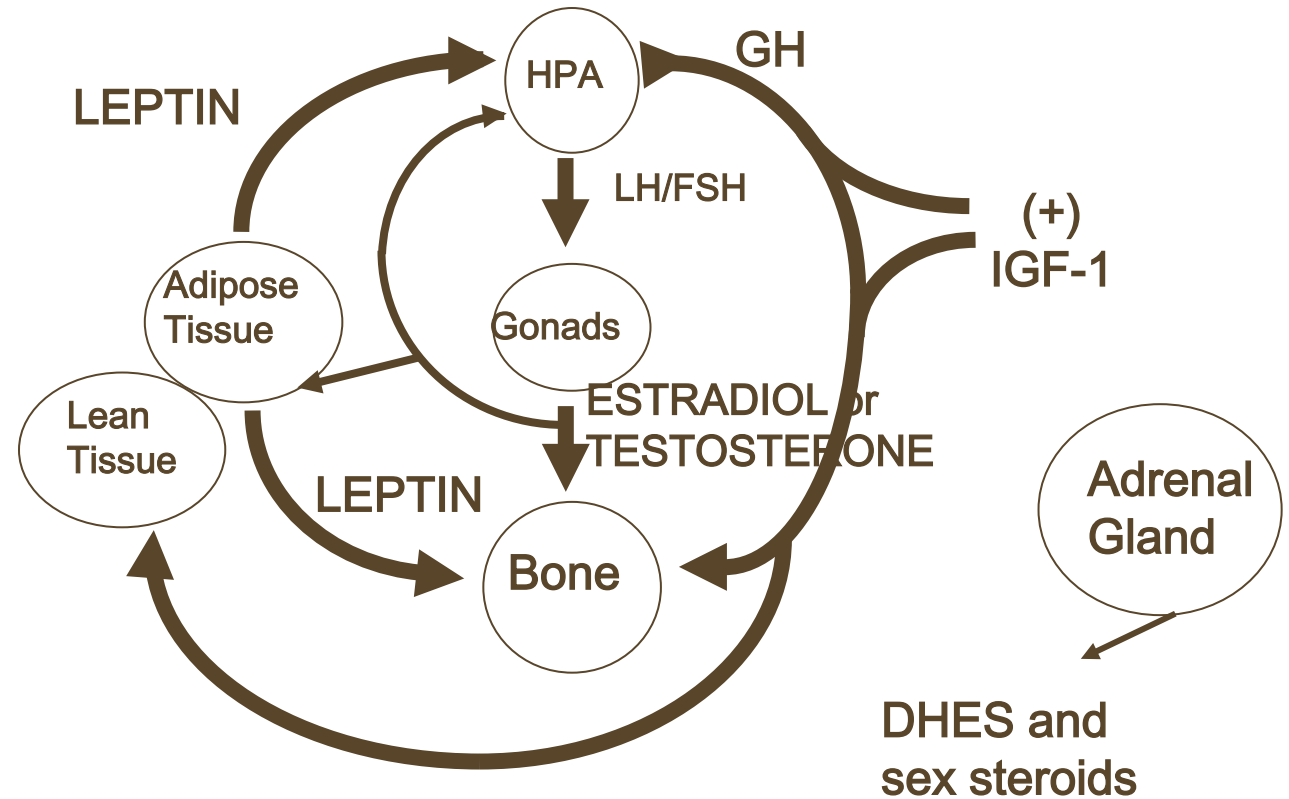
■ Gonadotrophic

- Sexual maturity (ovulation, spermatogenesis)

■ Somatotrophic

- Linear growth
- Body composition
 - Fat, lean, bone

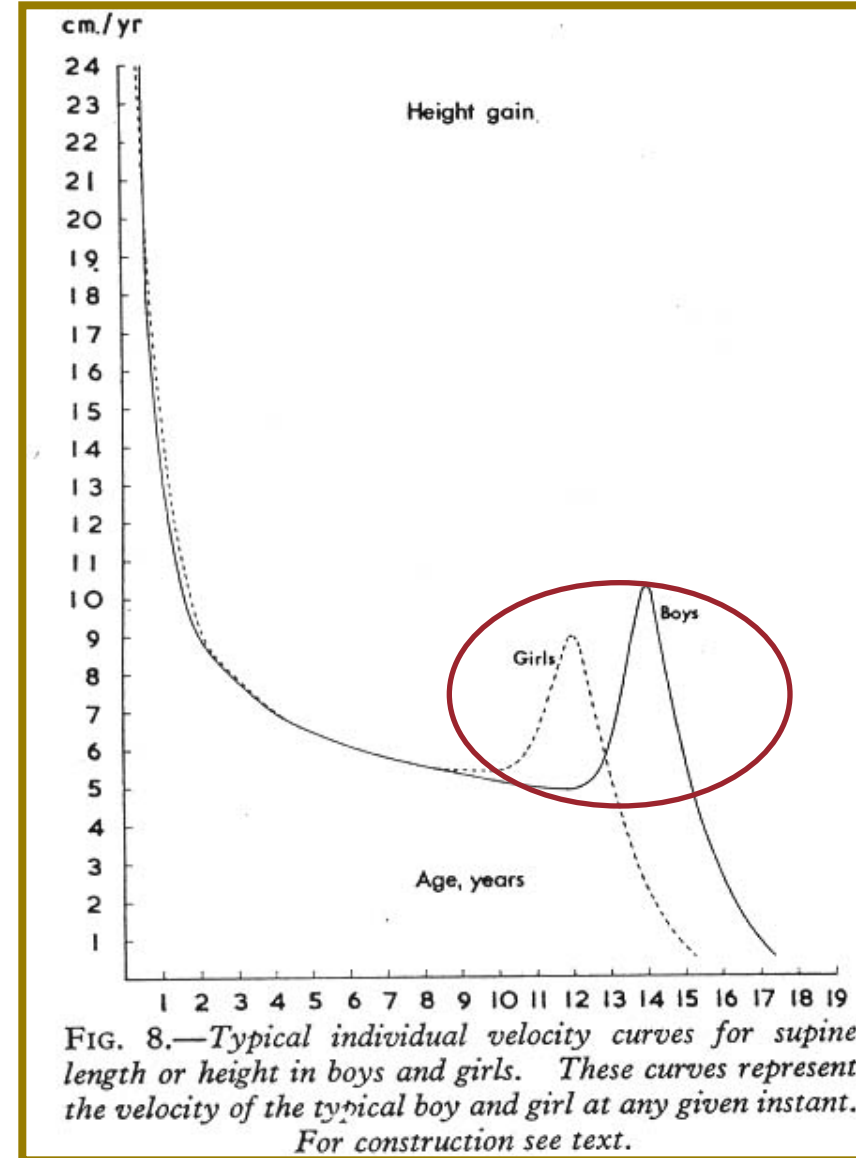
Undernutrition impacts these endocrine pathways



GROWTH VELOCITY : OPPORTUNITY FOR INTERVENTION

Girls average PHV of 9 cm/y at age 12; Tanner 3

Boys average PHV of 10.3 cm/yr at age 14; Tanner 4



GAINS IN BONE LENGTH, SIZE, AND DENSITY

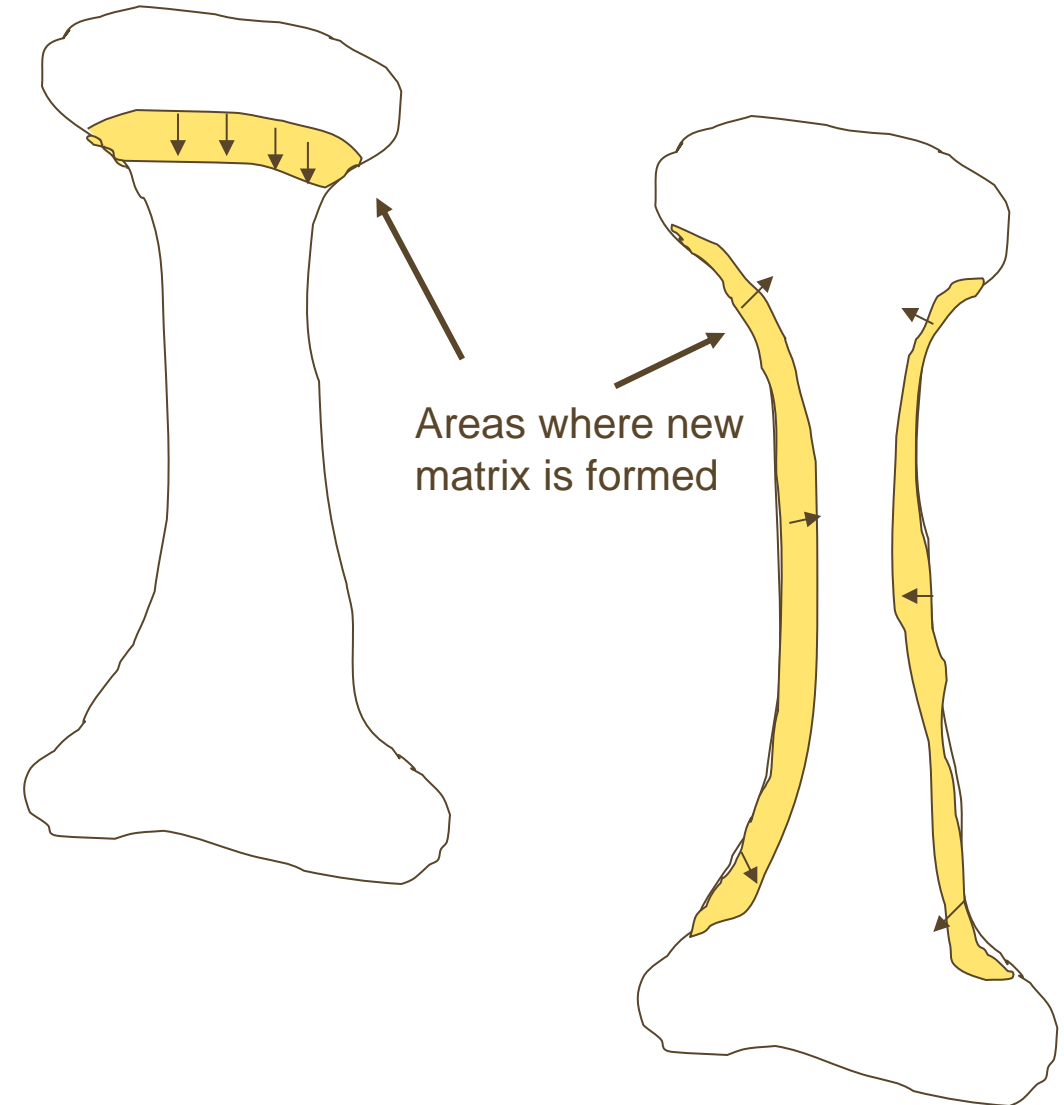
Lengthening of long bones occurs at growth plate

Nearly 40% of peak bone mass attained during puberty

Calcium comprises 1/3 of bone mineral

- Peak bone Ca deposition (*Bailey, 2001*)
 - Girls
 - 290 mg/d average

Bone mineralization depends on environmental (nutrition, exercise) & genetic influences



BODY COMPOSITION CHANGES

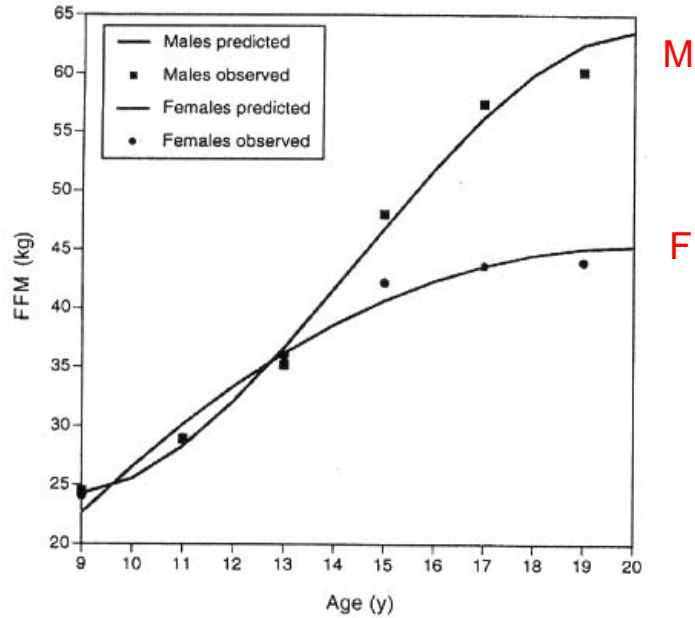


Figure 3 Average status values in fat-free mass (FFM) from age 8–20 y for males and females.

Fat Free Mass

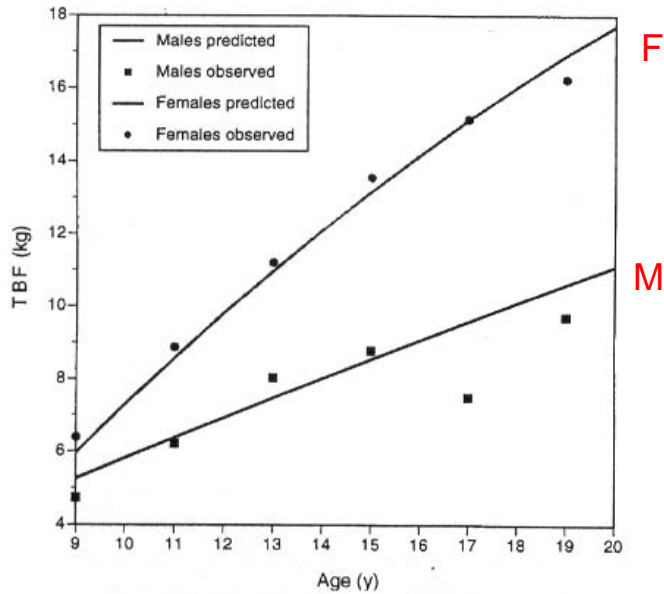


Figure 1 Average status values in total body fat (TBF) from age 8–20 y for males and females.

Total body fat

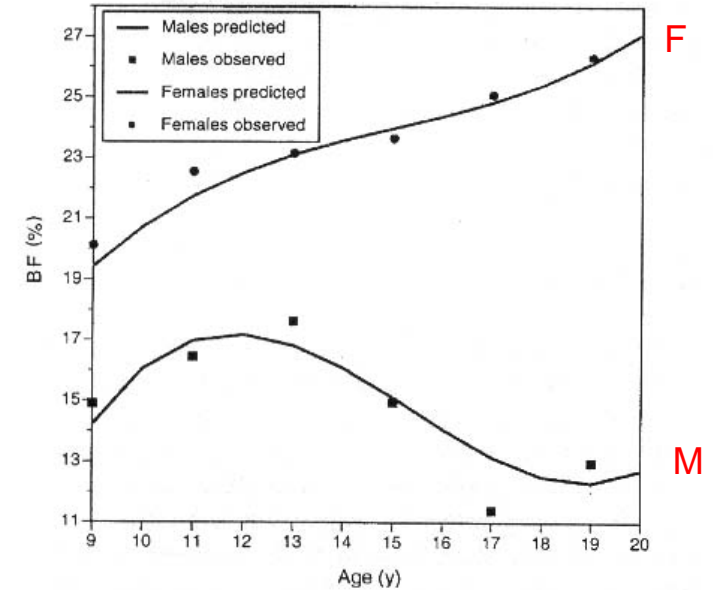


Figure 2 Average status values in percent body fat (%BF) from age 8–20 y for males and females.

% body fat

NUTRITIONAL REQUIREMENTS DURING PUBERTY

Energy

- At 1 yr of age, 3% of total energy requirement used to support growth
- During pubertal growth spurt, 4% of total energy requirement used to support growth

Calcium

- RDA of 700 mg for 1-3 y, 1000 mg for 4-8 y, 1300 mg for 9-18 y, 1000 mg in adulthood

Iron

- RDA of 7 mg for 1-3 y, 10 mg for 4-8 y
 - Females: 8 mg for 9-13 y, 15 mg for 14-18 y, 18 mg adulthood
-

CHALLENGES IN ASSESSING GROWTH DURING PUBERTY

“Historically, the rapid changes in somatic growth in adolescence, the problems of dealing with variation in maturation, and the difficulties involved in separating normal variations from those associated with health risks have all discouraged workers from developing a body of knowledge about adolescent anthropometry that would link it directly with health determinants and outcomes.”

Physical status: the use and interpretation of anthropometry, WHO, 1995

EVALUATING GROWTH DURING PUBERTY

WHO Growth Charts 2006

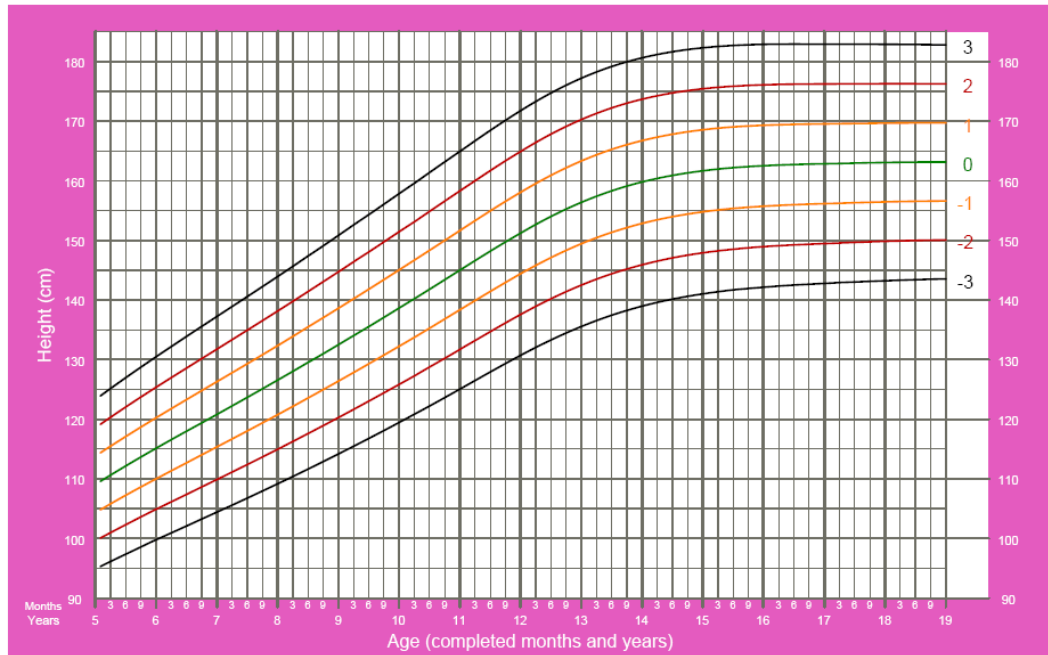
Original US growth charts (1977 NCHS, 1963-1970 data)

Combined with MGRS children through age 6 y

BMI data added

Height-for-age GIRLS

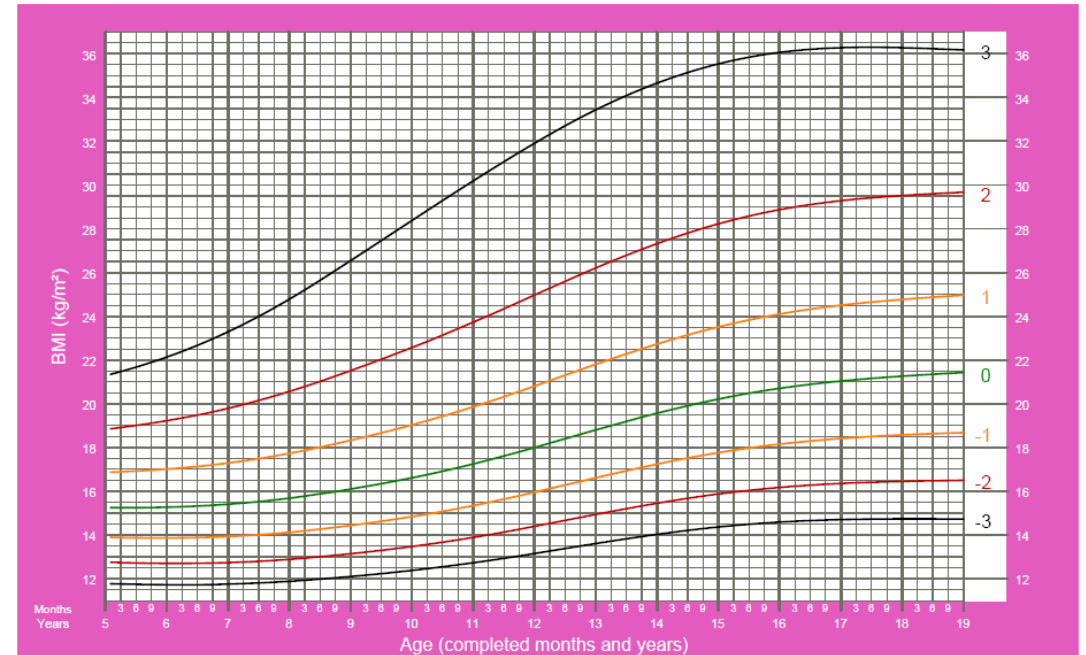
5 to 19 years (z-scores)



2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)



2007 WHO Reference

MENARCHE, STUNTING, AND ADOLESCENT PREGNANCY

TRENDS IN AGE AT MENARCHE IN EUROPE: THE EPIC STUDY

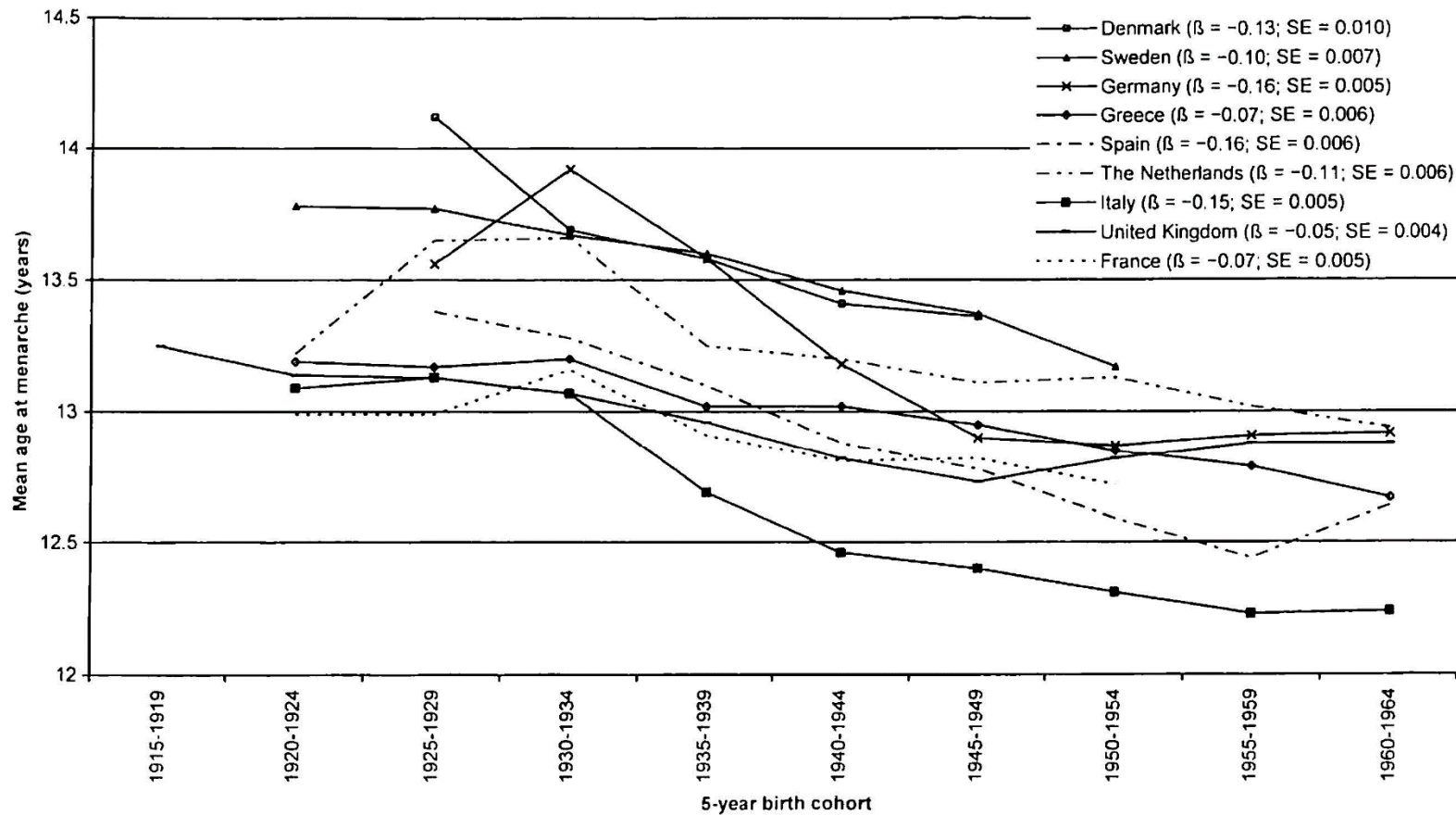


FIGURE 1. Mean age at menarche of women born between 1915 and 1964, adjusted for socioeconomic status, for 5-year birth cohorts for each participating country (Denmark, Sweden, Germany, Greece, Spain, the Netherlands, Italy, United Kingdom, and France). β is the country-specific regression coefficient from linear regression models, in which the independent variable is 5-year birth cohort and the dependent variable is age at menarche. $p_{trend} < 0.0001$ for all countries. SE, standard error.

TRENDS IN HEIGHT OF WOMEN IN EUROPE

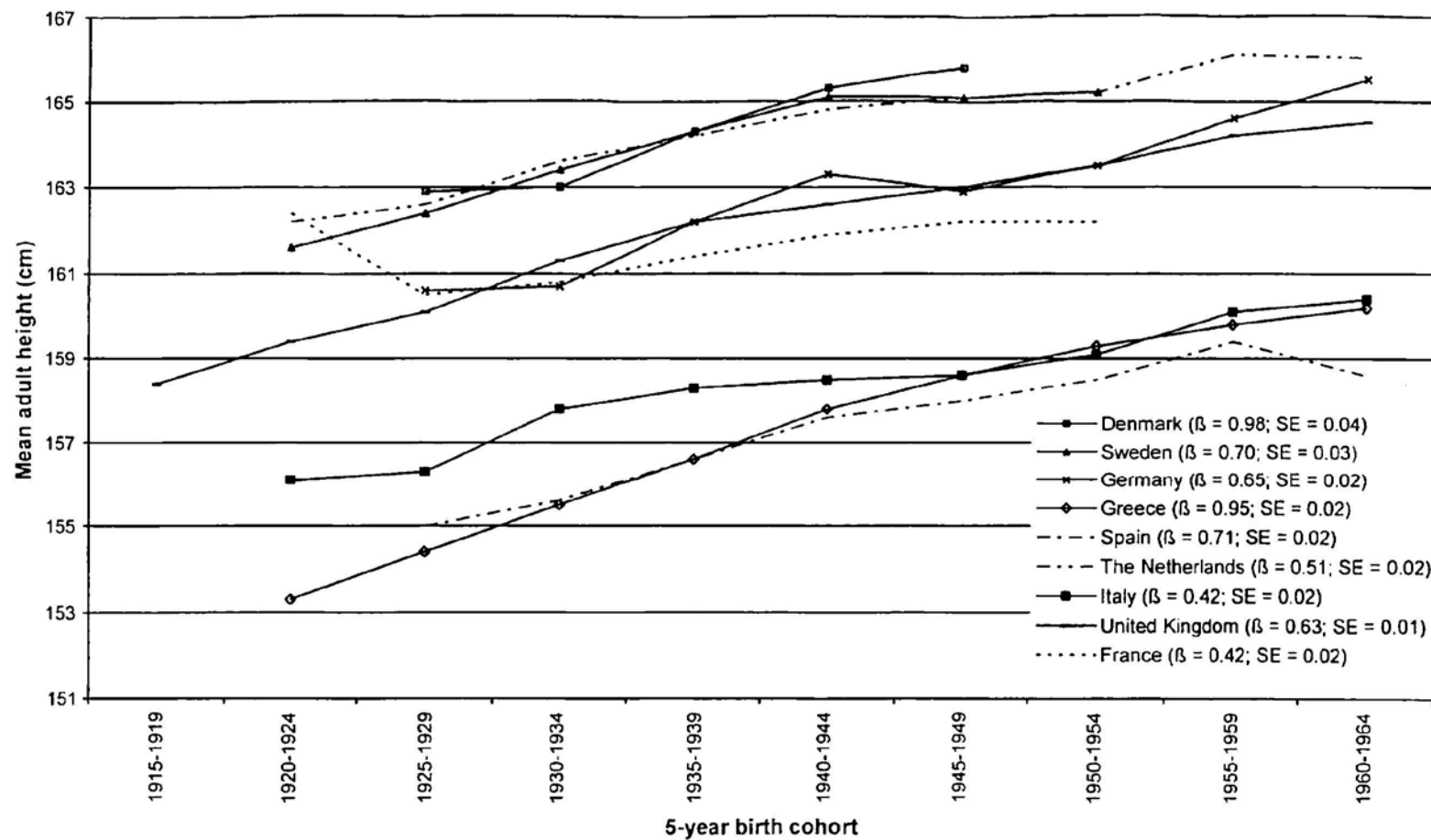
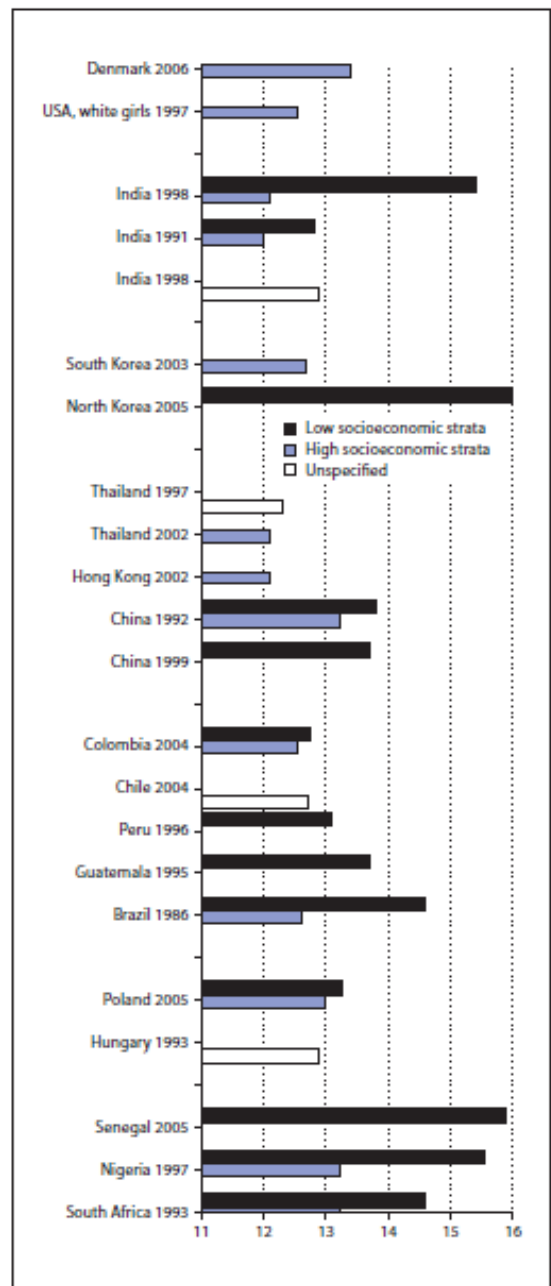


FIGURE 2. Mean height of women born between 1915 and 1964, adjusted for socioeconomic status, for 5-year birth cohorts for each participating country (Denmark, Sweden, Germany, Greece, Spain, the Netherlands, Italy, United Kingdom, and France). β is the country-specific regression coefficient from linear regression models, in which the independent variable is 5-year birth cohort and the dependent variable is height. $p_{\text{trend}} < 0.0001$ for all countries. SE, standard error.

AGE OF MENARCHE— BY INCOME STRATA



Teilmann, Horm Res, 2009

Fig. 5. Studies of age at menarche in different regions of the world and in different socioeconomic settings according to socioeconomic strata.

Height of Nations: A Socioeconomic Analysis of Cohort Differences and Patterns among Women in 54 Low- to Middle-Income Countries

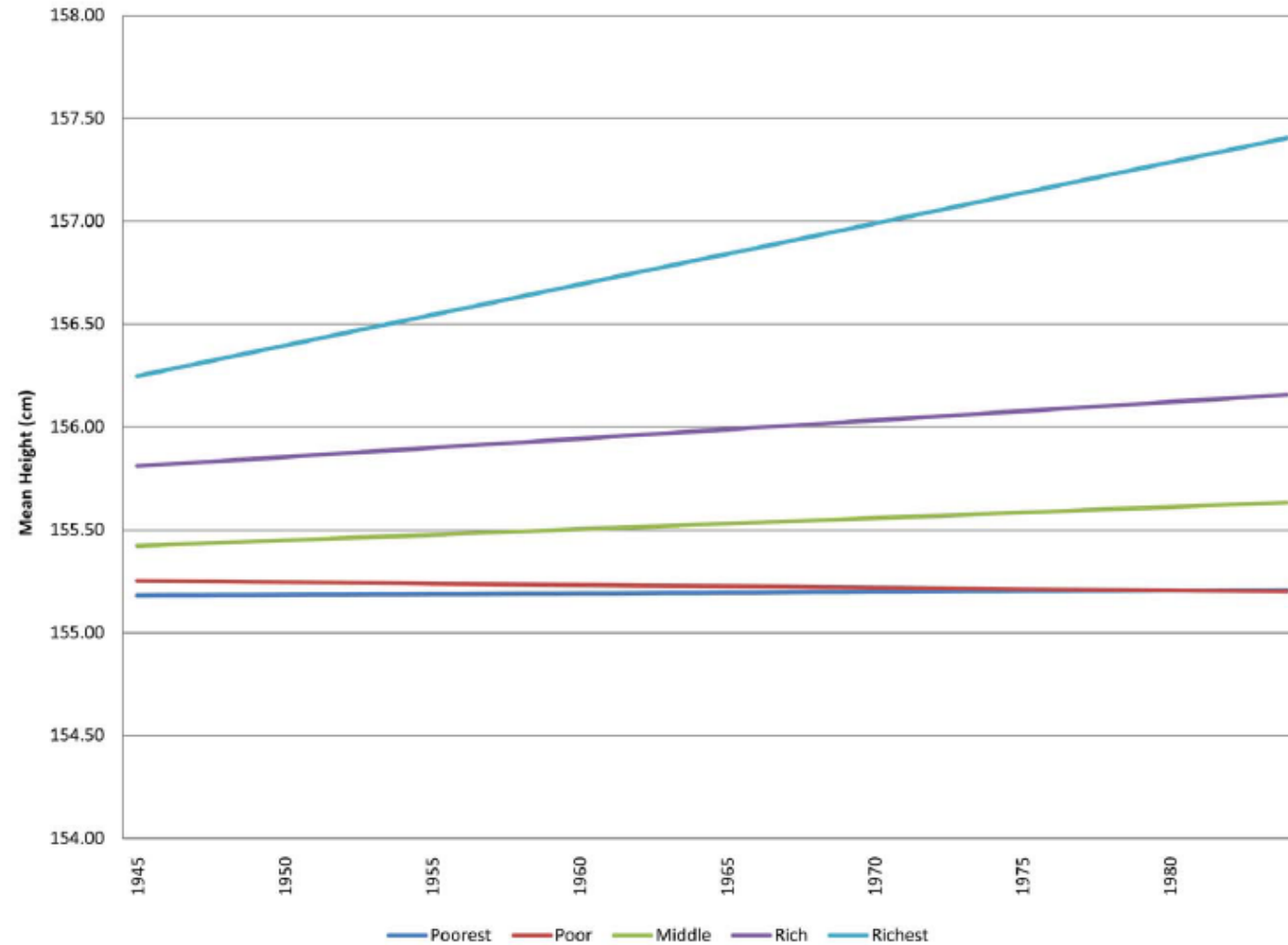
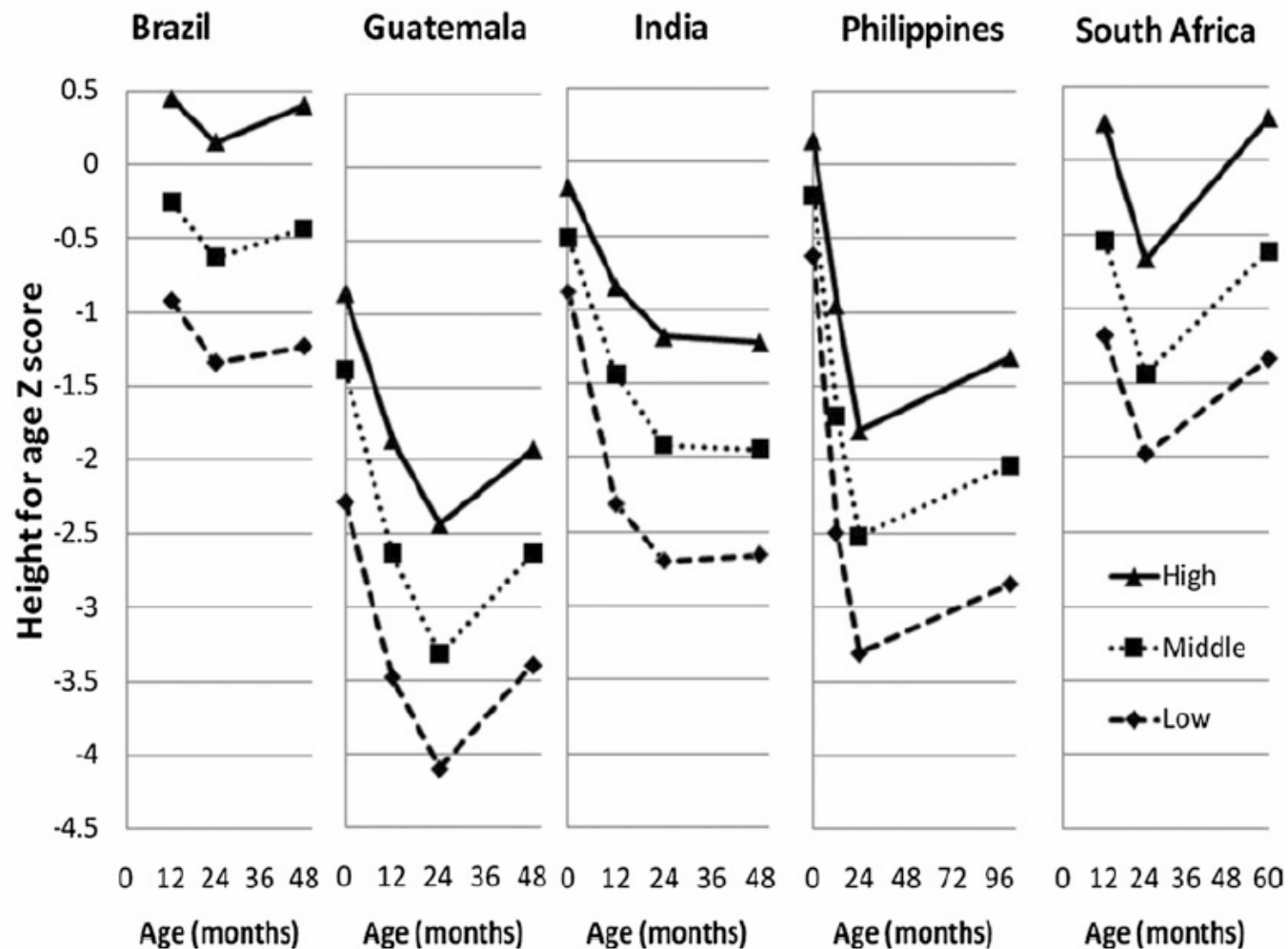
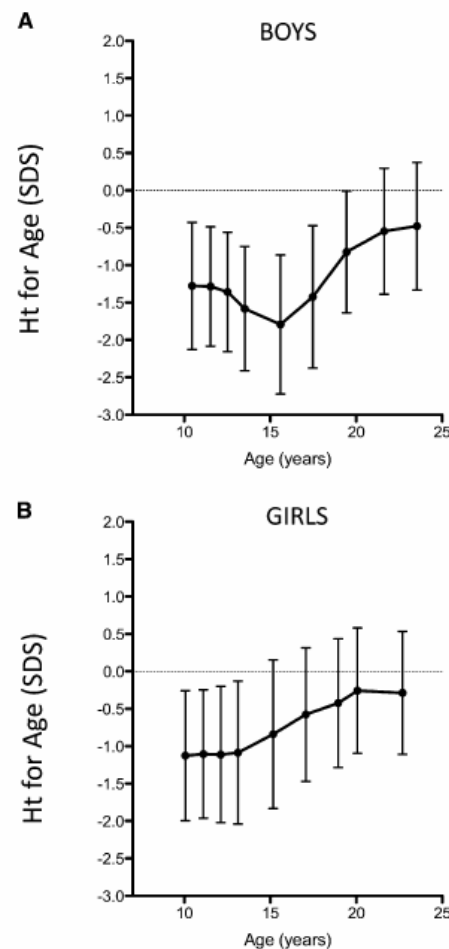


Figure 2. Predicted association between height and year of birth across wealth quintiles among adult women.
doi:10.1371/journal.pone.0018962.g002

Catch-up Growth between 24 mo and Mid-childhood



Catch-up Growth between Mid-childhood and Adulthood



Gambian boys and girls compared with a UK population

EVIDENCE FROM ADOPTION STUDIES

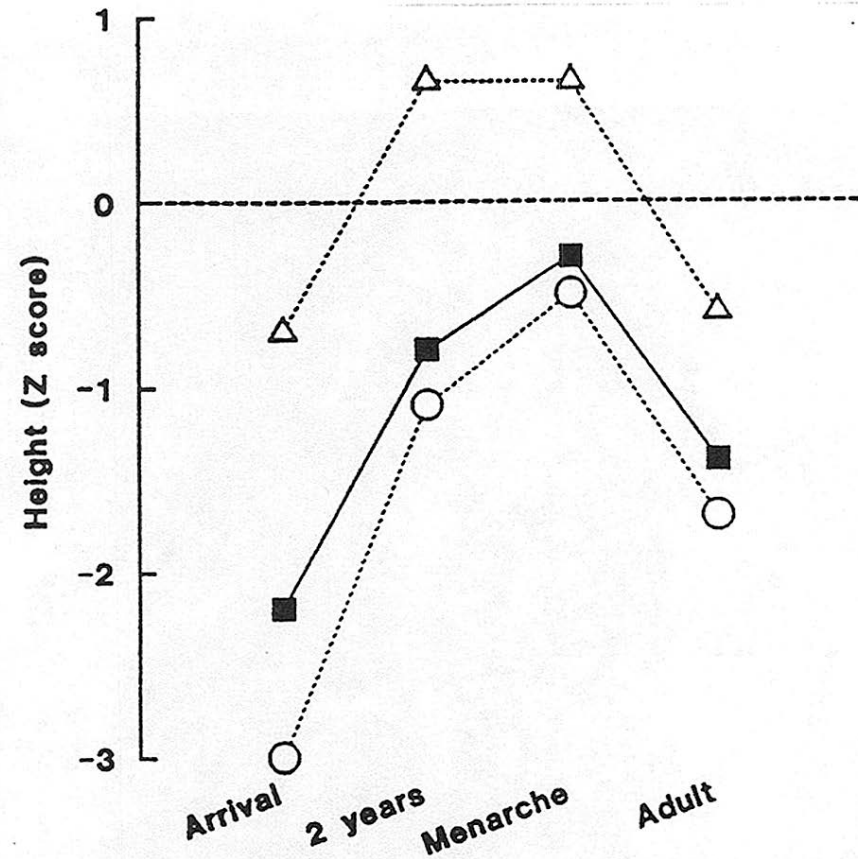
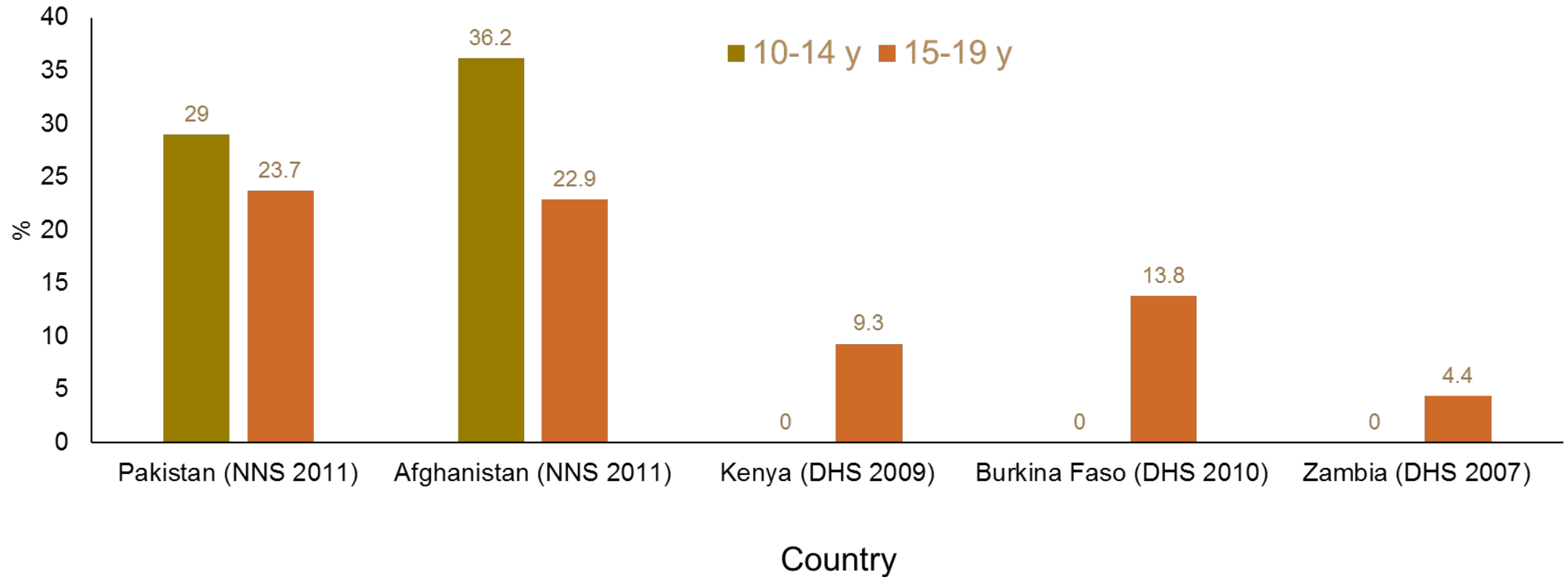


Fig. 5. Heights (Z scores, NCHS standard) of Indian girls adopted in Sweden, upon arrival, two years after arrival in Sweden, at menarche (11.6 years), and when they had attained their final adult height. The filled squares are the whole group of children; the triangles represent only those children who were not stunted at adoption; the circles represent those children who were stunted at adoption (below -2 Z). Data of Proos, Hofvander & Tuvemo (1991b).

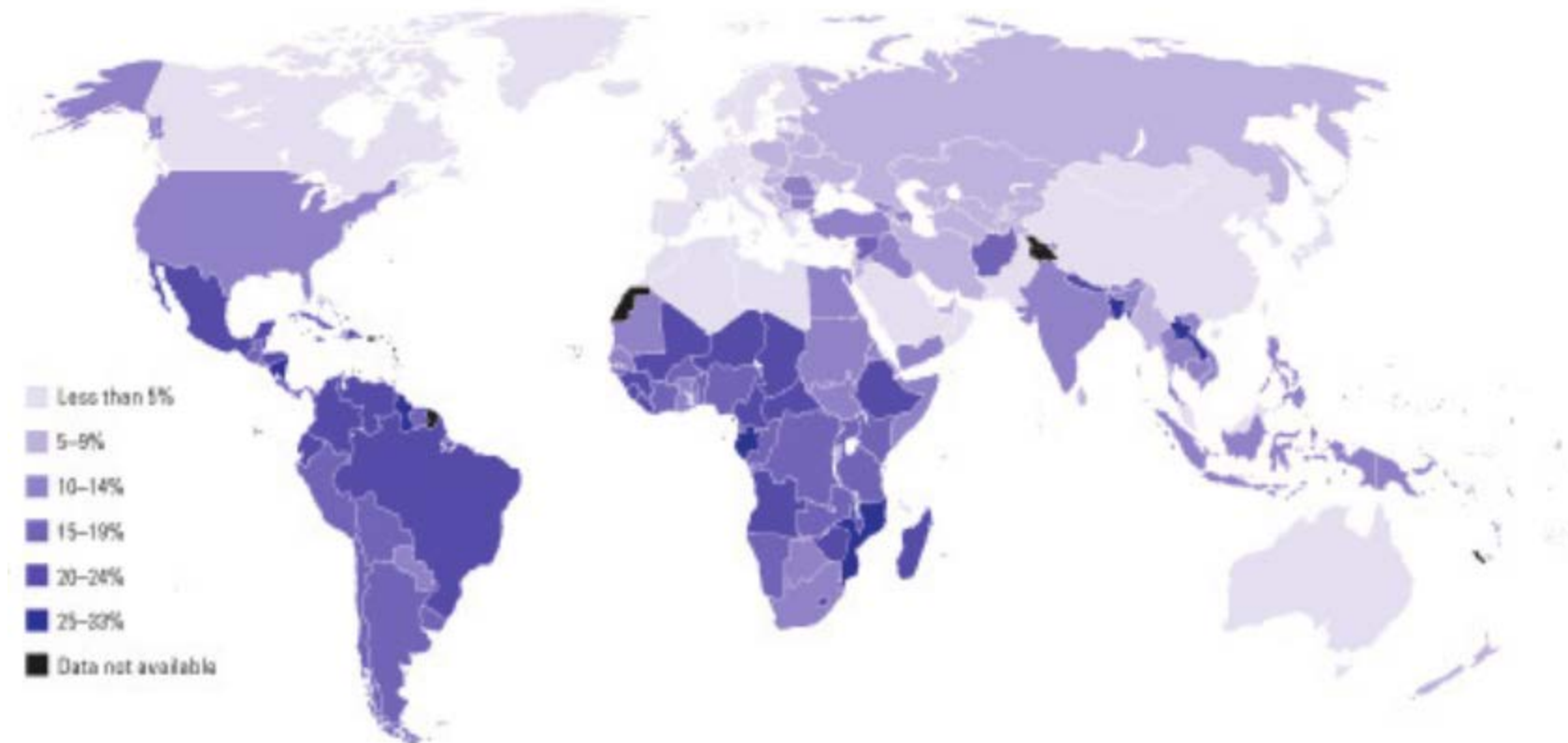
STUNTING (HAZ < -2) AMONG ADOLESCENT GIRLS

Regional differences exist



ADOLESCENT PREGNANCY AND CHILDBIRTH

Births among adolescent girls 15–19 years old as a percentage of total births, 2000–2010



Note: This map is stylized and not to scale. It does not reflect a position by UNICEF on the legal status of any country or territory or the delimitation of any frontiers. The dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the Parties. The final boundary between the Republic of the Sudan and the Republic of South Sudan has not yet been determined. The final status of the Abyei area has not yet been determined.

Source: United Nations Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2010 revision*, CD-ROM edition, 2011, and '2011 Update for the MDG Database: Adolescent Birth Rate' (POP/DB/Fert/A/MDG2011), reanalysed by UNICEF.

ADVERSE BIRTH OUTCOMES IN <18 Y OLD NULLIPAROUS GIRLS

Using data from 14 birth cohorts, adolescent pregnancy (compared to adults) had:

- 1.5 – fold higher risk of preterm birth
- 1.8 – fold higher risk of SGA
- 2.0 – fold higher risk of neonatal mortality
- 1.5 – fold higher risk of infant mortality



PREGNANCY IN ADOLESCENCE STOPS LINEAR GROWTH – RURAL BANGLADESH

		Height (cm)	BMI (kg/m ²)	MUAC (cm)
		<i>Mean ± SD</i>		
Preg	Baseline	149.2 ± 5.4	19.3 ± 1.7	23.4 ± 1.8
	1y follow-up	149.2 ± 5.3	19.0 ± 1.7	22.7 ± 1.8
	(Δ)	-0.05 ± 0.72	-0.35 ± 1.17^a	-0.65 ± 1.11^a
Non-preg	Baseline	149.4 ± 5.1	19.0 ± 2.0	23.2 ± 2.0
	1y follow-up	149.7 ± 5.0	19.3 ± 2.0	23.5 ± 2.0
	(Δ)	0.29 ± 0.82^a	0.29 ± 0.98^a	0.28 ± 0.90^a

a. Baseline and follow-up measurements being significantly different with $p < 0.001$ using a paired t-test; Between group difference in Δ , p -value < 0.001

NUTRITION INTERVENTIONS IN ADOLESCENTS

- Drivers of healthy growth and development in adolescence are not well understood
- Few known nutritional interventions for LIC contexts; school-based iron-folic acid (IFA) supplementation done in some settings
- Only 10 out of 53 programs examined targeted adolescent girls (USAID/SPRING REPORT 2015)
 - And they promoted largely –
 - Consumption of a diverse diet
 - Use of IFA
- Antenatal supplementation with IFA, multiple micronutrients, balanced protein and energy, and calcium, known to benefit pregnancy outcomes, also benefit adolescent pregnancies, but lower ANC utilization may be an issue
 - Current WHO guidelines only exist for IFA and Ca

RESEARCH AGENDA : ADOLESCENT GIRLS IN LMIC

- Fill the “data gap”
 - Elucidate patterns and drivers of pubertal growth and development
 - Conduct rigorous studies testing efficacy of nutritional and other interventions
 - Type, dose, timing and duration
 - Promote linear growth while preventing overweight
 - Behavior change strategies
 - Promote delay in first pregnancy combined with support for preconception nutrition
 - Several preconception trials underway or planned
 - Develop nutrition and dietary guidelines (boys and girls)
 - Design and evaluate integrated approaches and delivery platforms
-

THANK YOU

