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INSTITUT FÜR STATISTIK
SONDERFORSCHUNGSBEREICH 386



Klasen, Moradi:

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Sonderforschungsbereich 386, Paper 217 (2000)

Online unter: <http://epub.ub.uni-muenchen.de/>

Projektpartner



The Nutritional Status of Elites in India, Kenya, and Zambia: An appropriate guide for developing reference standards for undernutrition?

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Abstract

Assessments of undernutrition are typically based on comparisons between anthropometric indicators of children and a reference standard from the US. Due to a number of problems associated with this reference standard, WHO is currently engaged in generating a new international reference standard for child growth based on well-to-do populations in a sample of poor and rich countries. The focus on socioeconomic elites is to ensure that the measured growth reflects their genetic potential (and not according their constrained environment). Based on an analysis of the Demographic and Health Surveys from Kenya, India, and Zambia, we identify a number of problems associated with using socioeconomic elites as representative of the genetic potential of a population. First, there are several, non-overlapping ways to identify elites. Second, the anthropometric status of elites appears to depend to a considerable degree on the nutrition and health status of non-elites. Third, there is a danger that the elites are not a random sample of the growth potential of the population. And lastly, it appears that the nutritional status of elites differs substantially between the three countries so that it is unclear how one can combine them to generate one international reference standard.

1. Introduction

Chronic and acute undernutrition among children is one of the most important problems afflicting developing countries. As adequate nutrition is an important aspect of human welfare, combating undernutrition is an intrinsically important concern (Sen, 1999). In addition, poor nutrition is associated with higher mortality and morbidity as well as poorer physical, emotional, and intellectual development (UNICEF, 1998; Sen, 1999). For these reasons, the reduction of undernutrition by 50% by the year 2015 has been included among the list of central development goals (OECD, 1996).

Nutritional status is most commonly determined using children's anthropometric status. In particular, the actual child's height for age, weight for height, and weight for age is considered in comparison with an international reference standard. If a child falls significantly short of the international reference standard in any of these three dimensions, it is called stunted, wasted, or underweight, respectively. The most commonly used indicator for that determination is the Z-score which is defined as:

$$Z_i = \frac{AI_i - MAI}{\sigma}$$

where AI_i refers to the individual's anthropometric indicator (weight at a certain height, height at a certain age, or weight at a certain age), MAI refers to the median of the reference population, and σ refers to the standard deviation of the reference population (see for example Gorstein et al., 1994, WHO, 1995). The share of children having a Z score of less than -2 (moderate wasting, stunting or underweight) or less than -3 (severe) is the most commonly used indicator for international comparisons of undernutrition. Indeed, it is this indicator which is being used to measure progress towards the international development goal of reducing undernutrition by 50% between 1990 and 2015 (OECD, 1996).

Up to now, the recommended international reference standard is the NCHS-CDC standard, which is based on linking the experience of two sets of US children. For children under 24 months, data from a study of white, largely bottle-fed middle-class children from the longitudinal Fels study from 1929-1974 were used, while for older children the standard is based from several nationally representative samples of children in the US in the 1960s and early 1970s (WHO, 1995).

The use of this international standard was justified by international comparisons of height and weight of elites in different developing countries where it was found that the differences between elites from different countries were very small up until age 6, certainly when compared to the differences between the elites and other sections of the population in the same country

(Graitcer et al., 1981; Habicht et al. 1974; Lancet, 1984; Gopalan, 1989). A second strand of support stems from the experience of developing country populations in rich countries (e.g. Asians in the US or Britain) which showed quick catch-up growth and, after some time, relatively small differences between them and the native population (Yip et al. 1992, Svedberg, 2000).¹

At the same time, this argument about the similarity of elites has never been fully accepted and examples have been found where the differences appear larger than commonly presumed (McFarlane, 1995).² Second, there have been persistent findings about the inability to explain the very rates of anthropometric shortfall in South Asia which led some observers to raise the question whether this may be related to the fact the US-based reference standard is not appropriate for international comparisons of undernutrition among developing countries.³ Moreover, the currently used US-based reference standard is beset with other problems. In particular, the splicing of two different data sets causes considerable discontinuity at age 2. A further problem is that the bottle-fed children that make up the data set until age 2 appear to have grown and put on weight more rapidly in the first six months than exclusively breast-fed children which erroneously suggests that exclusive breast-feeding for six months might contribute to undernutrition (WHO, 1995, de Onis and Habicht, 1996).

For these reasons, WHO decided in 1999 to develop a new international reference standard based on some 12000 children from Brazil, Ghana, India, China, Norway, Oman, and the US. The selection criteria for inclusion are: ‘absence of illness and socioeconomic constraints on growth, and nonsmoking mothers who are breastfeeding infants born at term (WHO, 1999:2).’ Thus the experience of socioeconomic elites is supposed to form the basis for the new international reference standard. While this approach appears promising, several key questions emerge which are the subject of this paper. First, will it be possible to actually select children in developing countries that are indeed free from any socioeconomic constraints on growth? How should such a selection be accomplished? Second, will the selection criteria ensure that the chosen children are representative of the genetic potential of the population at large, or could it be the case that the genetically taller or heavier are over-represented in the study? Third, is there evidence that there are some significant differences between the growth experience of elites in different countries which may create difficulties for merging the data from these countries to generate one international standard?

¹ Also, the large secular increases in height in rapidly developing Asian economies such as Japan seemed to support the claim that genetic differences are small. See Mosk (1996) for a discussion.

² See also Eveleth and Tanner (1990), van Loon et al (1986), among others.

³ For a discussion of these issues, see Klasen (1999), Smith and Haddad (1999), Osmani (1997), MacFarlane (1995) and Ramalingaswami et al. (1996).

In order to examine these questions, we analyze the Demographic and Health Surveys of Kenya, Zambia, and India to identify socioeconomic elites and then determine their nutritional status. We find that it is not straight-forward to identify socioeconomic elites, that the elites are apparently unable to shield themselves from the adverse socioeconomic conditions of their compatriots, and that the selection of elites may be subject to some selection biases which make them not fully representative of the genetic potential of the population from which they are drawn. Finally, we find that there appear to be considerable differences in the growth performance of elites in the three countries. The elites in India appearing significantly lighter than the Kenyan elites, and there are also significant differences between the elites in Zambia and Kenya.

2. Data and Methodology

We base our analysis on three Demographic and Health Surveys (Macroint, 1999). These are multi-purpose household surveys, undertaken by Macro International in association with local statistical offices, that ask detailed questions about fertility, health, contraception, nutrition, and mortality. It includes an anthropometric assessment (height, weight) of children below five years of age (and their mothers in some surveys) and has considerable information on the socioeconomic position of the household, the mother, and the partner. The surveys we use are from Zambia (1996), Kenya (1993), and India (1992/93). The Zambia and Kenya surveys are nationally representative while the Indian survey is representative at the state level, but only includes about 2/3 of Indian states. The sample sizes vary from some 6000 children in Kenya to over 30000 children in India. Table 1 provides some descriptive statistics on the three countries. While the countries exhibit some similarities in economic and demographic variables,⁴ the very high rates of undernutrition (determined using the method described above) and low birth weight in India are noteworthy, which are much higher than in the two African countries. On the other hand, under five mortality is the highest in Zambia, despite much lower rates of undernutrition. This is not only true of the two countries, but of the regions South Asia and Sub Saharan Africa as a whole. In the former high rates of anthropometric shortfall coexist with moderate rates of mortality, while in the latter, anthropometric shortfall is much smaller, yet under five mortality is much higher (see Klasen, 1999; Svedberg 2000).

⁴ Of the three, Zambia should be considered the least developed given its lower income and education levels and higher fertility. Kenya and India, on the other hand, are quite similar.

Table 1: Descriptive Statistics

	India	Kenya	Zambia
Year	1992-1993	1993	1993
Population (m.)	891.0	25.3	8.9
Poverty Rate (%)	52.5	26.5	72.6
Share Rural (%)	74	73	56
GNP/capita (PPP)	1268	981	615
Total Fertility Rate	3.7	5.2	5.8
Female Literacy (%)	38	70	71
Under 5 Mortality (/1000)	124	90	202
Low Birth Weight (%)	33	16	13
Wasting (%)	17.5	5.9	4.2
Stunting (%)	52.0	33.3	42.4
Underweight (%)	53.4	22.6	23.5

Note: Poverty rate refers to the share of people living below \$1 a day. Wasting, stunting, and Underweight refers to the share of children below 6 with a Z-score smaller than -2. Low birth weight refers to the share of children with a birth weight below 2500g.
Source: World Bank (2000), UNICEF (1998).

The various studies that have examined the nutritional status of elites have differed in their definition of high socioeconomic class. Some have defined elites based on education of the parents (e.g. Janes, 1974; MacFarlane, 1995; Eksmyr, 1970), others have selected children from expensive private childcare institutions (Droomers et al. 1995; Quinn et al., 1995; Graitcer and Gentry, 1981)⁵, others combined enrolment in private hospitals, nurseries, and schools with observations by the researcher on indicators such as income, life-style, education and occupational status (Agarwal and Agarwal, 1994).

In this study, we base our selection on socioeconomic information available in the Demographic and Health Surveys. We use four different criteria selecting children of high socioeconomic status and then also consider combinations of them. In selecting the people of high socioeconomic status, a combination of absolute and relative criteria was used. Those of high status must have the a high enough absolute position to suggest that they are free from socioeconomic constraint. At the same time, we wanted to ensure that the elites selected would comprise some 5-15% of the population of the country. This was partly done to retain adequate sample sizes for the analysis but also based on the presumption that high socioeconomic status is partly a relative concept (see Sen, 1984; Klasen, 2000).

We always generated a stricter and a broader definition of high socioeconomic status. The strict definition is used if only this criteria is considered for the definition of an elite, while we used the more generous definition for combinations of criteria (see below).

⁵ In Graitcer and Gentry (1981), children from high ranking military and government officials were also included.

The first criteria for selecting elites is based on education. As shown in Table 2, both parents must have at least some secondary education, and, depending on the country and whether the definition is strict or broad, one partner must have completed secondary education. This is higher than the criteria used in earlier studies and selects the 10-15% best educated in the country. The second criteria is based on the place of delivery of the child. Birth in private hospitals are assumed to be a sign of high socioeconomic status in the strict definition; given the cost involved in using a private hospital, this selection criteria is somewhat similar to the ones based on private daycare facilities; the broad definition includes births in government hospitals as well (as opposed to births at home).⁶ A third criteria is based on the number of durable goods a household possesses from a predetermined list on the questionnaire. Finally, a fourth category is based on housing quality, which usually combines the quality of the structure, the size of the house, and the type of access to water or sanitation.⁷

Table 2 shows the share of children which are considered to belong to the socioeconomic elites by the various criteria. While the definitions are not always fully comparable across countries, for most criteria they should be roughly comparable. In the last column a combination of the four (broad) criteria was used to generate an elite that must do well in all (or at least 3) or them. This is in recognition that each individual category may be too narrow and thus a broader conception of elites is necessary.

⁶ This broad elite is very broad in Zambia and Kenya as the availability of government hospitals is quite extensive. Since access to a government hospital may as much on the public health policy of the government as on the well-being of the household, it is unclear whether this criteria is a useful way to identify a broad elite.

⁷ It should be pointed out that for the education, durable goods, and place of delivery definition, the strict elite is always a subset of the broad elite. In the housing variable, some households in the broad elite are not in the strict elite. This was done to ensure a similar share of the population among the elite as with the other definitions.

Table 2: Defining Elites based on four different Criteria

Criteria		Description	Share
1. Education			
Kenya	Strict	Mother at least 8 years, father at least 10 years	15.1
	Broad	Mother at least 7 years, father at least 10 years	20.7
Zambia	Strict	Mother at least 8 years, father at least 10 years	10.9
	Broad	Mother at least 7 years, father at least 10 years	18.4
India	Strict	Mother and Father completed high school	11.4
	Broad	Mother middle school, father high school completed	15.7
2. Place of Delivery			
Kenya	Strict	Private Hospitals	9.5
	Broad	Private or Government Hospitals	42.5
Zambia	Strict	Private Hospitals	9.8
	Broad	Private or Government Hospitals	43.2
India	Strict	Private Hospitals	12.2
	Broad	Private or Government Hospitals	28.5
3. Durables			
Kenya	Strict	At least two (TV, radio, electricity, refrigerator)	7.0
	Broad	At least one (TV, radio, electricity, refrigerator)	54.9
Zambia	Strict	At least three (TV, radio, electricity, fridge, car)	11.8
	Broad	At least two (TV, radio, electricity, fridge, car)	18.5
India	Strict	At least four (clock, radio, sofa set, TV, VCR, car)	10.8
	Broad	At least three (clock, radio, sofa set, TV, VCR, car)	21.5
4. Housing			
Kenya	Strict	Cement floor, piped water in residence, flush toilet or pit	14.1
	Broad*	Non-rudimentary*, piped water or well with pump, pit	13.4
Zambia	Strict	Cement floor, piped water in residence, flush toilet	11.1
	Broad	Cement floor, piped water in residence, flush toilet or pit	15.8
India	Strict	Pucca [#] or semi-pucca, piped water, electricity, >2 rooms	12.1
	Broad	Pucca or semi-pucca, piped water, elec., sep. kitchen	16.1
5. Combination			
Kenya	Strict	All four broad criteria met.	4.8
	Broad	Three or four broad criteria met.	15.9
Zambia	Strict	All four broad criteria met.	6.3
	Broad	Three or four broad criteria met.	13.7
India	Very strict	All four strict criteria met	2.1
	Strict	All four broad criteria met.	5.0
	Broad	Three or four broad criteria met.	12.1

*non-rudimentary means that at most two of the three parts of a house (floor, roof, walls) are made with rudimentary materials. Note that this definition is not so much broader as it is slightly different.

#pucca refers to a solid structure (i.e. no mud used), while semi-pucca refers to mixed structures that include mud among the materials used.

As already apparent from the surprisingly small share of the population that is included in the combined categories in Table 2, there appears to be relatively little overlap between the different types of elites. This is brought out more clearly in Table 3. While the share of the population of high socioeconomic status is about 10% for any given category, only 1-2% of the population would be considered to be among the elite by all four categories. Conversely, some 25% are among the elite in at least one category in the three countries. Correlation analysis (not

shown here) suggests that the overlap is particularly small between the place of delivery and the other three categories. The correlation between housing and durable goods, on the other hand, is particularly strong in all three countries, although also here the overlap is far from perfect.⁸

Given the large divergence between these criteria for defining elites, all of which consider important aspects of socioeconomic status, we focus our analysis on the group of people that have high status according to a combination of criteria as outlined in the bottom of Table 2.⁹ The results presented below do not depend on that; using any of the categories individually would not change the results significantly.

Table 3: Overlap among the Elites defined according to the four (strict) Categories

		Number	Share
Kenya	One Category	799	13.3%
	Two Categories	271	4.5%
	Three Categories	177	3.0%
	Four Categories	64	1.1%
	Total	5992	
Zambia	One Category	985	14.0%
	Two Categories	399	5.7%
	Three Categories	231	3.3%
	Four Categories	73	1.0%
	Total	7015	
India	One Category	4393	13.7%
	Two Categories	1668	5.2%
	Three Categories	866	2.7%
	Four Categories	674	2.1%
	Total	31999	

3. The Nutritional Status of Elites

We will use the Z-score described above as our measure of nutritional status and apply them for weight for height (wasting) and height for age (stunting). This allows us to note similarities and differences between the countries as well as between them and the currently used NCHS-CDC standard, upon which the Z-scores are based. Figures 1 through 6 show the Z-scores for wasting and stunting by age (averaged over three month intervals) in the three countries, differentiating between elites and the remaining population.¹⁰

⁸ The highest correlation coefficient observed is 0.6 between housing and durable goods in Zambia. It is considerably weaker in the other countries. In India, the highest correlation (0.51) is between education and durable goods.

⁹ Thus we will rely on defining elites by the number of broad criteria met by the population. Only in India, where the absolute number of people that have met all four strict criteria was sufficiently large, we will consider the intersection of the four strict elites which make up only some 2% of the population.

¹⁰ Since this is a cross-sectional analysis, there is considerable variability in each age bracket due to the genetic variance of children and the relatively small sample sizes at each age bracket. Since the elites are always much

One important observation to emerge from those figures is that elites are apparently not able to keep up with the NCHS-CDC standard for height and weight. In all countries, they appear to fall far behind the reference standard in the first two years.¹¹ Even the intersection of the four strict elites in India, which merely comprises the best-off 2% of the population, falls behind the NCHS-CDC standard in both height for age and weight for height, particularly in the first 18 months (Figures 1 and 2). Unless this means that all the populations in all three countries grow much slower for genetic reasons (which appears implausible),¹² it appears that the elites are unable to shield themselves from the influences of the overall health conditions in the country. Since the worsening of anthropometric status is typically closely associated with the weaning crisis when poor food and/or environmental conditions replace the complete reliance on mother's milk (UNICEF, 1998), this suggests that the elites are not able to escape this weaning crisis as their anthropometric status also rapidly deteriorates beginning at 4-6 months.

The inability of the elites to shield themselves from the rest of the population deserves some closer scrutiny. In particular, it might be worthwhile to examine this question at a more disaggregated level and see whether elites in one location are affected by the general state of undernutrition in that location. The Indian sample is large enough to allow for such an assessment by considering the nutritional status of elites in different Indian states and territories.

To do that, we estimate in Table 4 regression models of the Z-score for height for age among the (broad) elite in India.¹³ As independent variables we include an age polynomial to capture the age effects of anthropometric development, and a dummy variable for the switch in datasets at 24 months in the NCHS-CDC reference standard (and an interaction term with age), as well as dummy variables for the Indian states and territories. Column (1) shows the results. Compared to Uttar Pradesh (the omitted category), the height for age Z scores in Tripura, Kerala, and Goa are more than 1 standard deviation larger, suggesting that the elites there fare quite a lot better, in terms of nutritional status, than in UP.¹⁴ Column (2), which runs the same regression only using the 'non-elites' shows that there appears to be a very close relationship between the nutritional status of elites and non-elites in Indian States and Territories.¹⁵ In places where elites

smaller samples than the rest of the population, the variability is much greater. To reduce the variability, we combined the age groups to quarters (three months), but this only reduces but does not eliminate the problem.

¹¹ While the difference between elites and the rest of the population is usually sizeable, in Zambia it is surprisingly small when the indicator weight for height is considered.

¹² It is implausible given the fact that in all three countries (but particularly in Kenya and Zambia), the elite children have a birth length and weight not much below the NCHS-CDC standard and only fall off from that standard during the first two years. See also below.

¹³ The results for the strict or very strict elite are similar, but due to much smaller sample sizes, they are considerably less robust.

¹⁴ Part of the difference could also be due to genetic differences among the Indian population.

¹⁵ The same holds, to a lesser extent, for weight for height as well. The tables are available on request.

have higher height for age, the non-elites do as well. In addition, columns (3) through (6) suggest that indicators of education, health, and public food distribution are also correlated with the nutritional status of elites and non-elites in each state. In particular the contrast between Kerala on one hand, and Bihar and Uttar Pradesh on the other is instructive (see also Dreze and Sen, 1995). In the former, education and health levels are high and public services are expansive and this is associated with high Z scores for elites and non-elites, while in the latter states the reverse is the case. This provides further evidence that the anthropometric status of elites is highly dependent on the anthropometric status of the remaining population which in turn depends in part on the level of public services in health, education, and nutrition. Identifying elites based on individual or household characteristics ignores these important linkages and it is therefore uncertain whether the elites thus selected are indeed free from socioeconomic constraints on growth as required by the WHO criteria.

Table 4: Factors explaining the nutritional status of elites in Indian States

	(1) Height for Age Elites	(2) Height for Age Non-Elites	Female Literacy	Female Life Expectancy	Villages with Med. Facilities (%)	Public Food Aid per Capita (kg)
Constant	-0.43**	-0.38***				
Age (months)	-0.15***	-0.24***				
Age ² (/1000)	4.34***	6.36***				
Age ³ (/1000)	-0.04***	-0.05***				
Dummy Age=24 m.	0.97*	1.69***				
Age*Dummy Age=24	-0.03	-0.05***				
Assam	0.96***	0.47***	43.0			30.5
Bihar	0.28**	-0.03	22.9	58.3	13.8	6.5
Goa	1.02***	1.07***				
Gujarat	0.36***	0.46***	48.6	61.3	26.2	24.5
Haryana	0.60***	0.54***	40.5	63.6	57.1	6.2
Jammu	0.60***	0.73***			17.9	34.6
Karnataka	0.69***	0.52***	44.3	63.6	10.8	19.9
Kerala	1.10***	1.24***	86.2	74.4	96.3	60.2
Maharashtra	0.49***	0.51***	52.3	64.7	17.6	22.4
Manipur	0.82***	0.94***				
Meghalaya	0.95***	0.38***				
Mizoram	0.63***	0.77***				
Nagaland	0.83***	1.34***				
Orissa	1.05***	0.76***	34.7	54.8	10.6	7.1
Rajasthan	0.56***	1.29***	20.4	57.8	13.2	17.4
Dehli	0.53***	0.59***				
Aruna Pradesh	-0.40	0.44***				
Tripura	1.15***	0.61***				
Uttar Pradesh			25.3	54.6	9.6	2.9
Adj. R-Squared	0.09	0.17				
N	3783	27100				

Note: Data on female literacy refer to 1991, on life expectancy refer to 1990-92, on food aid for 1986-1987, and for medical facilities for 1981.

Source: own calculations and Dreze and Sen (1995).

Given the rich data source, it is possible to say something more about some of the processes through which elites are apparently affected by the nutrition and health status of their surroundings. Mothers are being asked to recall whether their child had diarrhea in the past two weeks and it is well-known that the presence of diarrhea is a very good predictor of acute and chronic malnutrition (UNICEF, 1998; Moradi, 2000). This is not surprising given that the presence of diarrhea prevents the absorption of nutrients. Figures 7-9 show the prevalence of diarrhea in the previous three weeks among elites and the remaining population. In all three countries, the prevalence of diarrhea is quite similar for elites and non-elites. In fact, only in India is it possible to say that elites are considerably less affected by diarrhea than the remaining population, but also there the age profile of diarrhea among elites closely matches the age profile among non-elites.¹⁶

Also here, there are striking differences within India as shown in Table 5. Only 5% of elite children in Kerala are affected by diarrhea, in contrast to 8% of the elites elsewhere in India. This is closely related to the fact that non-elites in Kerala only have a prevalence of 9%, compared to a prevalence of 11% among non-elites elsewhere.

Table 5: Prevalence of Diarrhea by Elite Status, Kerala versus other Parts of India

		Prevalence of Diarrhea (%)#
Kerala	Elite	5.1
	Non-Elite	9.2
Rest of India	Elite	8.0
	Non-Elite	11.0
Average		10.0

refers to the share of children reported to have had an episode of diarrhea in the two weeks prior to the survey.

Clearly, it is very difficult to select elites that are free from socioeconomic constraints. This problems gets more difficult the poorer the country and the worse the state of public services. If it is at all possible to select elites that are free from socioeconomic constraints on growth, it would be best to select elites from areas where the overall level of public services, health, and nutrition is very high as well. Only in such areas can one be more certain that the people with high socioeconomic status indeed do not face major constraints on growth. In the Indian case, Kerala would be the obvious choice.¹⁷

Apart from the inability of elites to shield themselves from the remaining population, which is true in all three countries, a number of important differences emerge in the nutritional

¹⁶ There are also substantial level differences in the prevalence of diarrhea between India, Kenya, and Zambia. For a discussion, see Moradi (2000).

¹⁷ Alternatively, one may want to consider Indian populations in the US or Europe which are also more likely to be free of socioeconomic constraints on growth. On the other hand, it may be hard to argue that they are representative of populations living in India.

status of elites between the three countries. First, there are notable differences in the starting points in the three countries. At one extreme we have India where new-borns already start with a negative Z-score for weight for height, which is considerable for the rest of the population but also present for the elites. At another extreme, there is Kenya, where elites start with considerably higher weight for height than the reference standard. There is also a considerable difference between the starting points of elites and non-elites in all countries. This could be due to growth retardation in *utero* related to undernutrition or due to selection effects, i.e. that elites are not a random sample of the genetic growth variation of the population (see below).

Second, after 5 years, elites and non-elites converge in the weight for height Z-score. This is true for all three countries but the convergence takes place at different levels. While in Kenya it takes place at a Z-score of -0.3 , in Zambia it appears to be at a Z-score of about 0, and in India it happens at a Z-score of below -0.8 .¹⁸

Third, the growth paths for elites in India and Kenya, the two countries that are arguably most similar in socioeconomic characteristics (Table 1), differ considerably. As shown in Figures 10 and 11, elite children in India seem to develop mostly below elites in Kenya and always remain far below the reference standard. This is particularly true for wasting but also present for stunting.¹⁹

These last three findings support the suggestion that the reference standard might be too high for children in India (and South Asia more generally), which might be one reason for the high reported undernutrition in South Asia (see also MacFarlane, 1995; Klasen, 1999; WHO, 2000; Agarwal and Agarwal, 1994). This appears particularly to be the case for wasting which might therefore be overestimated in South Asia. To the extent that infant and child mortality depends more on acute undernutrition (wasting) than chronic undernutrition, this overestimate could contribute to the puzzle of comparatively low infant and child mortality in India (Klasen, 1999). In contrast, there is less reason to believe that the reference standard for undernutrition is particularly problematic for the African countries considered, although this would merit closer investigation.²⁰

¹⁸ A fifth interesting finding is that all populations in the three countries suddenly seem to improve at the age of 24 months. This is due to the switch of data sets in the reference standard

¹⁹ Elites in Zambia are somewhere in the middle between Kenya and India, but generally closer to India than to Kenya. Given that Zambia has experienced decades of economic decline and is considerably poorer than India, it is unclear whether this results just supports the notion that the anthropometric performance of the elite is closely correlated with remaining population, or whether there is substantial diversity in genetic growth potential within Africa with Zambia being more similar to India than Kenya.

4. Selection Issues

Since the number of people that are free from socioeconomic constraints on growth is limited in developing countries (and maybe be very small or even non-existing as suggested above), the question arises whether this group of people can be considered a random sample of the genetic growth potential of the population. In particular, the question arises whether people with a higher growth potential are over-represented among the elites of a developing country.

There is some literature supporting such a link so that one needs to worry about such selection effects. Several studies have found a positive impact of height on wages and thus socioeconomic status although it is difficult to separate people who are tall for genetic reasons from those who are tall for environmental reasons (e.g. Thomas and Strauss, 1997)

The considerably higher birth weights and heights of elites, shown in Figures 1-6, could be an indication of such selection effects although they could also be related to effects of maternal undernutrition *in utero*. One way to examine this question is to see whether maternal heights influence the likelihood of a child being among the elite, after controlling for the socioeconomic status of the parents (proxied by mother's and father's education, the BMI of the mother, and the location of the household). The results of the analysis are presented for Zambia in Table 6. It appears maternal height significantly influences the likelihood of being among the elite, even after controlling for other socioeconomic characteristics. This results is true in Zambia only; in Kenya (not reported here), maternal height did not have a significant influence.²¹ It suggests that in Zambia at least, selection effects may be present.²²

²⁰ In particular, the sizeable difference between Kenya and Zambia, countries that are not very far away from each other, could suggest that there the variability of growth potential in Africa is sizeable, as has been argued by others as well (Kidd et al. 1996, see also Klasen, 1999).

²¹ In India, maternal height and BMI are not recorded and this analysis cannot be performed.

²² This conclusion rests on the ability to separate the effects of paternal socioeconomic status from parental genetics. If mother's height reflects her socioeconomic status in ways that is not captured by the BMI, her education, or residence, then this correlation could be related to intergenerational transmission of socioeconomic status rather than selection effects.

Table 6: Predicting Membership of the Broad Elite in Zambia

	Broad Elite
Constant	-7.17***
Mother's Education (years)	0.29***
Father's Education (years)	0.29***
Mother's BMI	0.09***
Mother's Height (Z-score)	0.09**
Rural	-3.11***
Cox-Snell R ²	0.35

Note: This table reports the results of a logistic regression predicting membership in the broad elite in Zambia.

In addition, some studies might artificially introduce selection effects. For example, some studies of children with high socioeconomic status (e.g. WHO, 2000) have omitted children with low birth weights from consideration. To the extent that birth weight is correlated with genetic growth potential, such a requirement would artificially restrict the genetic distribution of children and thus lead to an overestimate of height and weight of elites. To illustrate the magnitude of the problem, we considered the nutritional status of elites in India once with and without the restriction of low birth weights. Once the elite children with low birth weights are omitted, the average Z-score for height for age and weight for height rises by 0.1. This thus constitutes a small but significant bias introduced by this procedure. Fortunately, WHO is not conditioning on birth weights in its multicenter growth study (only on babies being born at term) so that this problem should not bias the resulting new reference standard.

5. Conclusion

Identifying elites from developing countries and using them as representative of the population in the country at large is a complicated undertaking that may introduce a number of biases. First, clarifying how one can determine whether a child is free from socioeconomic constraints on growth is a difficult question. We have shown above that four different ways to generate elites leads to surprisingly little overlap. Second, there are serious questions about whether elites are indeed able to shield themselves from the poorer socioeconomic situation of the remaining population. The data presented here suggests that they are affected by the state of nutrition and health, as well as the state of public services of the surrounding population. Third, due to selection effects, the elites may not represent the growth potential of the underlying population. Fourth, there appears to be considerable differences in the height and weight development of elites in Africa and South Asia. These differences may it very difficult to arrive at one reference

standard applicable to all regions of the world. The absolute magnitude of these differences looks small, especially when one examines a chart that traces age and absolute growth, the chart commonly shown in the literature that has examined growth differences among different population groups. Figure 12 shows such a chart for weight for height in Kenya and India. While this chart shows only modest differences between the two countries, especially in the range of 60 to 90 centimeters, when examining the same data using Z-scores, the differences appear very large indeed (Figure 11).

Moreover, these seemingly modest differences have a large impact on aggregate measures of undernutrition, such as the share of the population below two standard deviations from the reference median (the most commonly used measure for undernutrition). If the reference standard in South Asia for height at age 5 was reduced by a mere centimeter, the share of the South Asian population that was considered undernourished would fall by 8 percentage points (from 45 to 37%). Thus these small differences have a large impact on measured undernutrition and on the resulting public policy measures and development efforts in various regions of the world. This high sensitivity of aggregate measures of undernutrition to small differences in the growth standard points to the importance of generating a new international standard that is reliable and free from biases. This article has shown that this is not an easy task.

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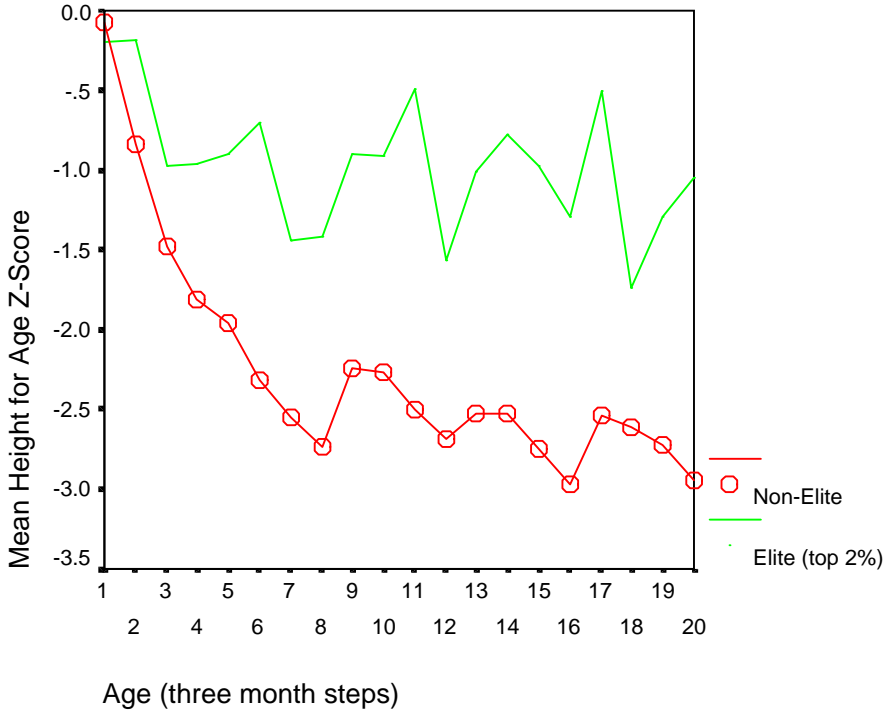
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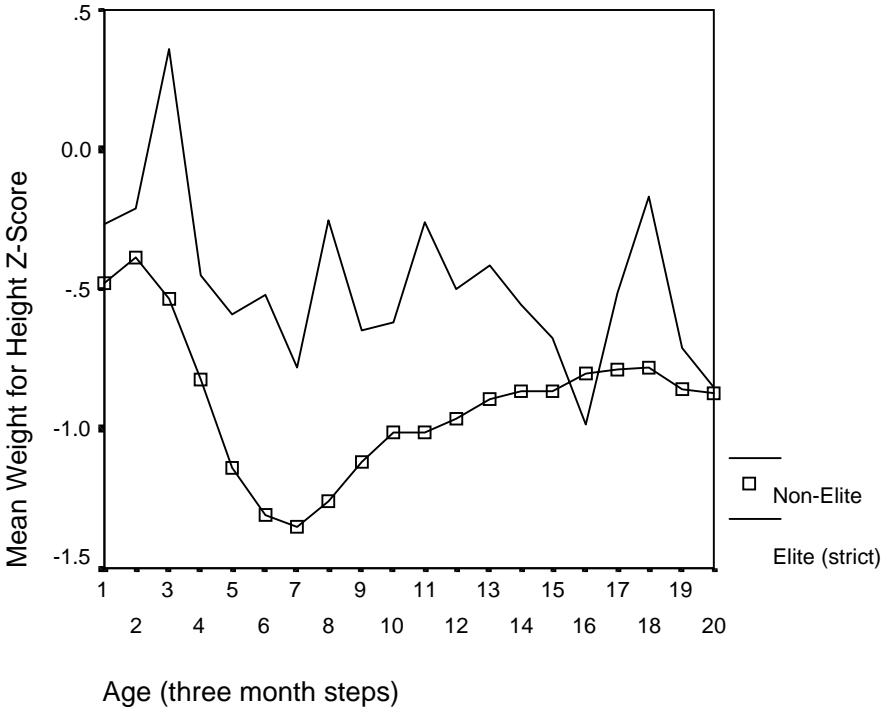
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Figure 1: Height for Age Z Score by Age and Elite Status in India



Note: Elite is defined to be the intersection of the four strict definitions of elite.

Figure 2: Weight for Height Z-Score by Age and Elite Status in India



Note: Elite is defined to be the intersection of the four strict definitions of elite.

Figure 3: Height-for Age Z Score by Age and Elite Status in Kenya

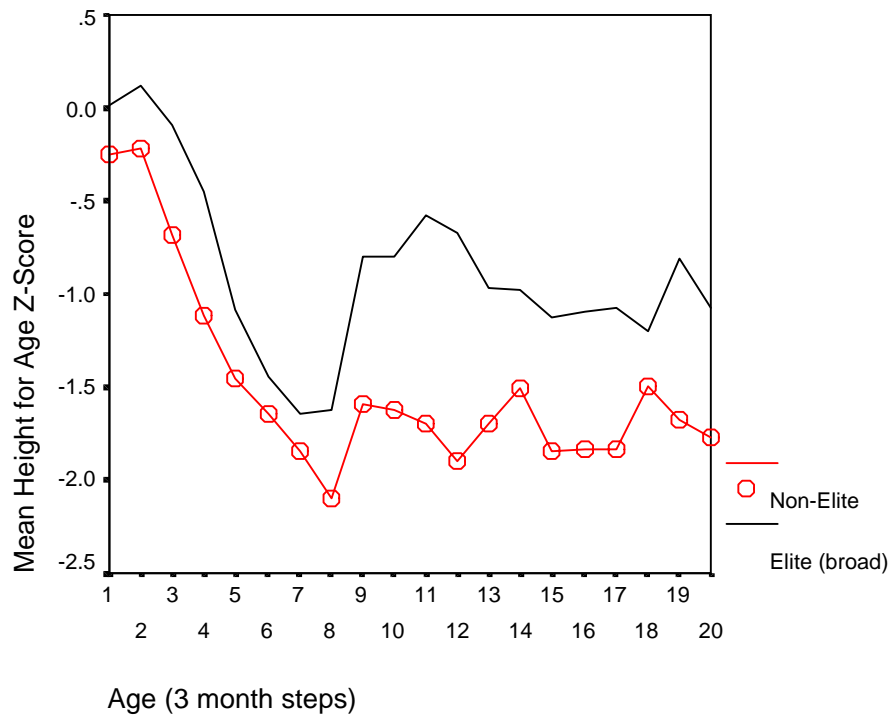


Figure 4: Weight for Height Z Score by Age and Elite Status in Kenya

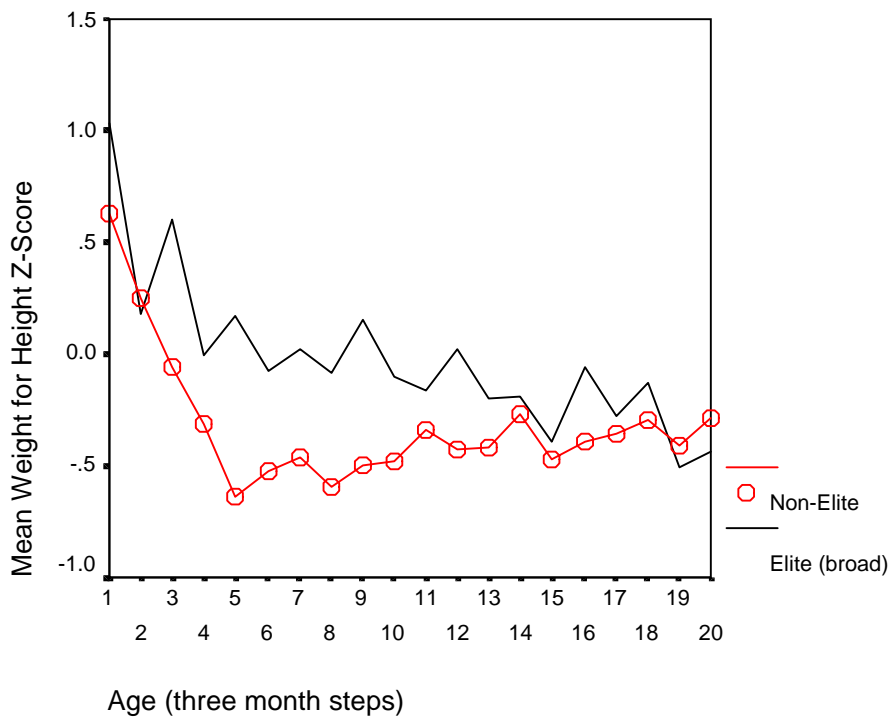


Figure 5: Height for Age Z-Score by Age and Elite Status in Zambia

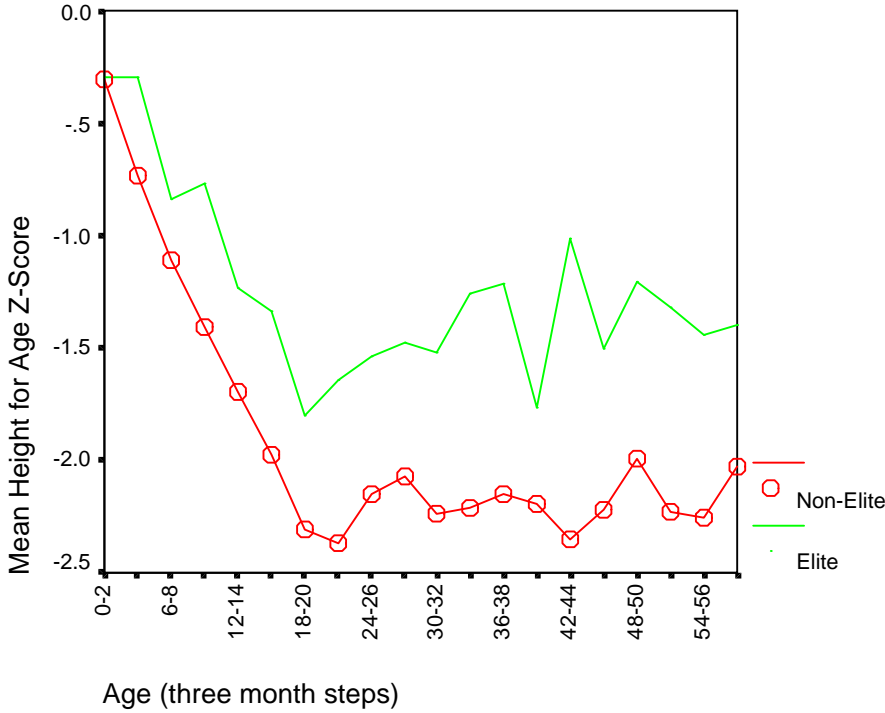


Figure 6: Weight-for-Height Z-Score by Age and Elite Status in Zambia

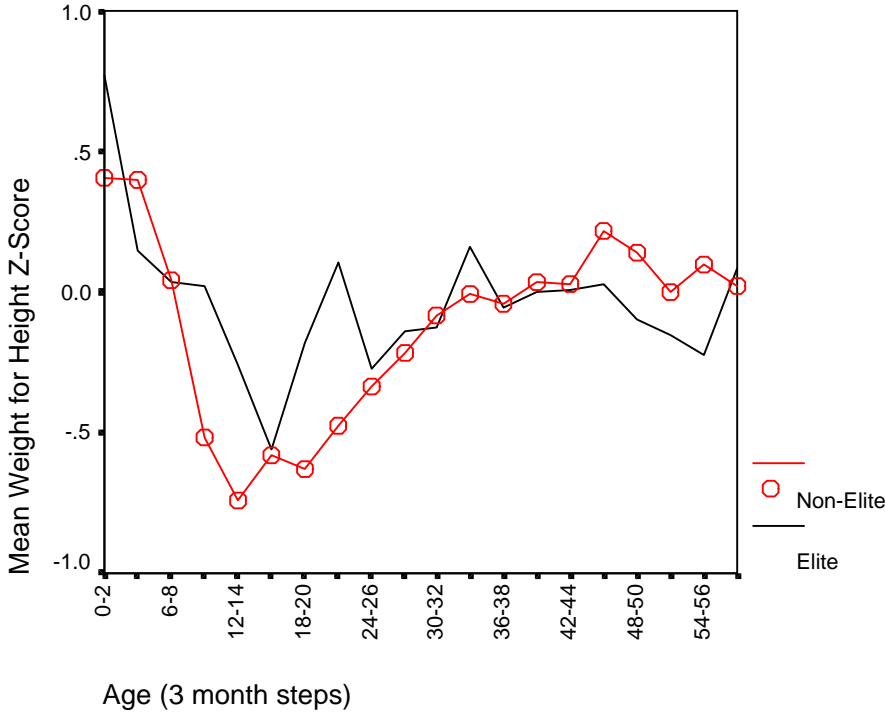


Figure 7: Prevalence of Diarrhea among Elites and Non-Elites in India

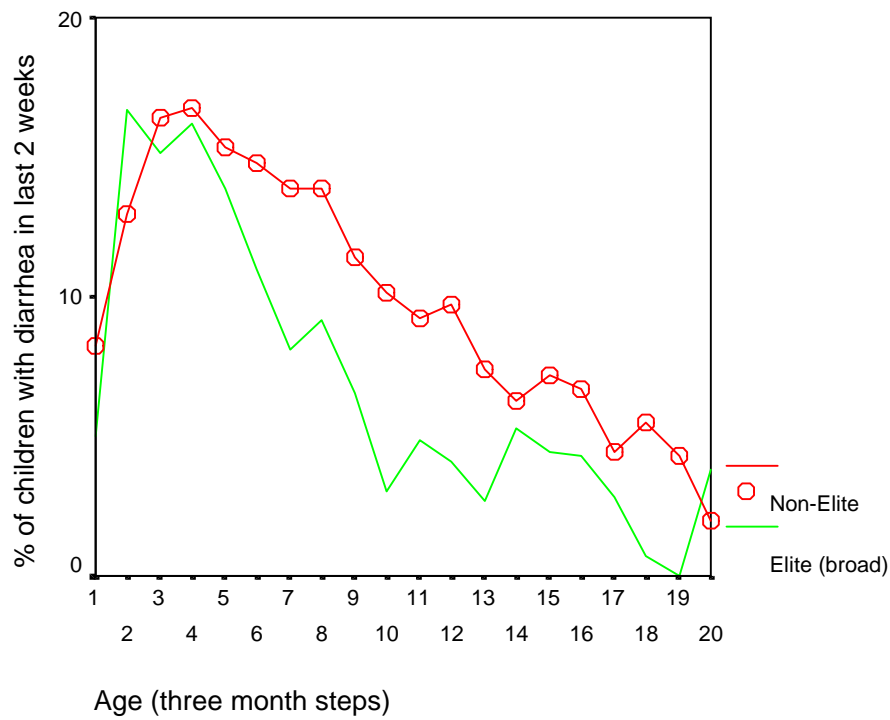


Figure 8: Prevalence of Diarrhea among Elites and Non-Elites in Kenya

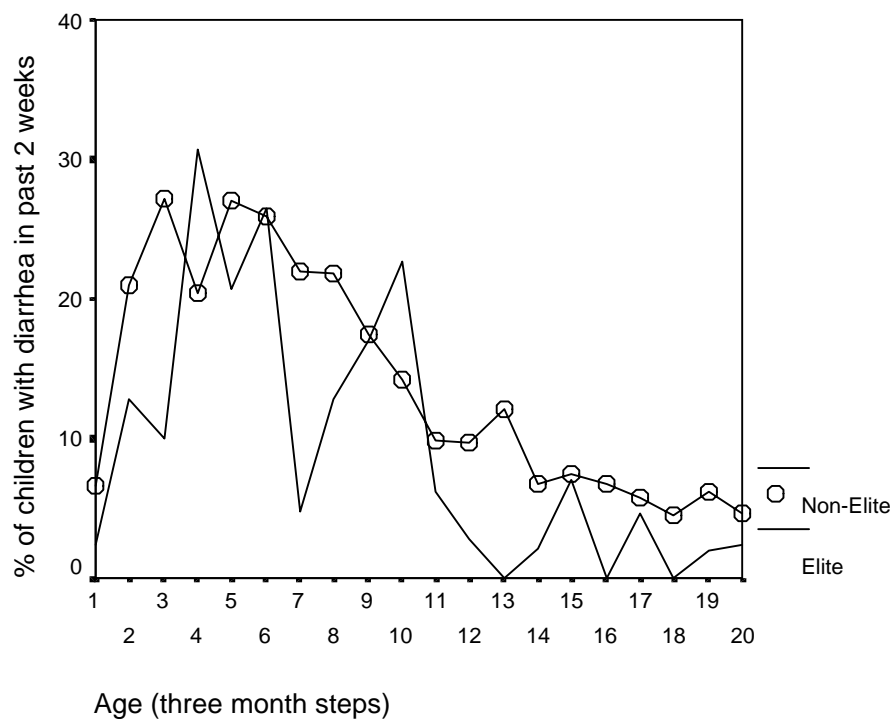


Figure 9: Prevalence of Diarrhea among Elites and Non-Elites in Zambia

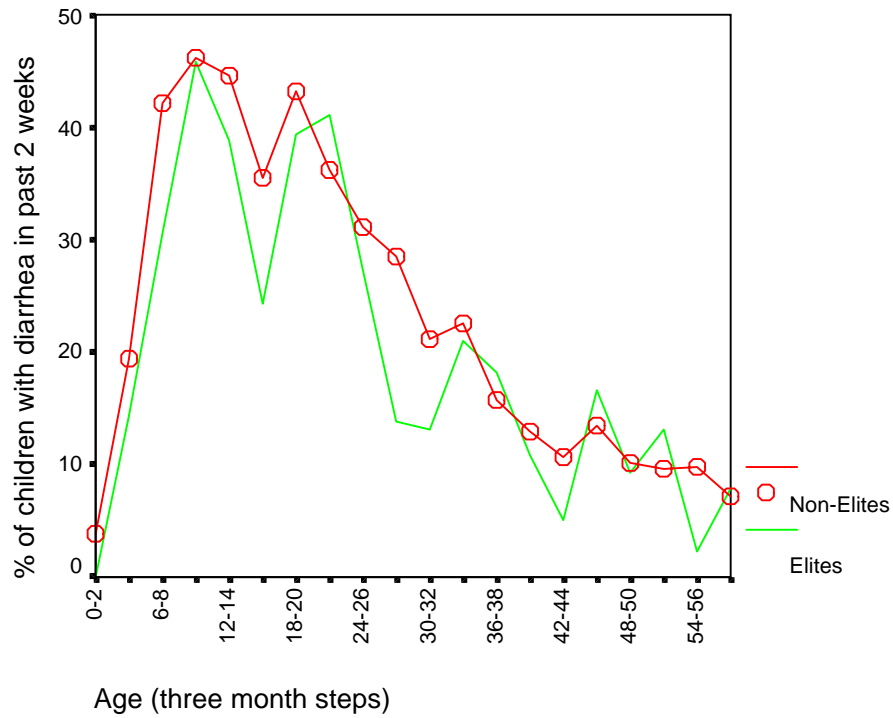
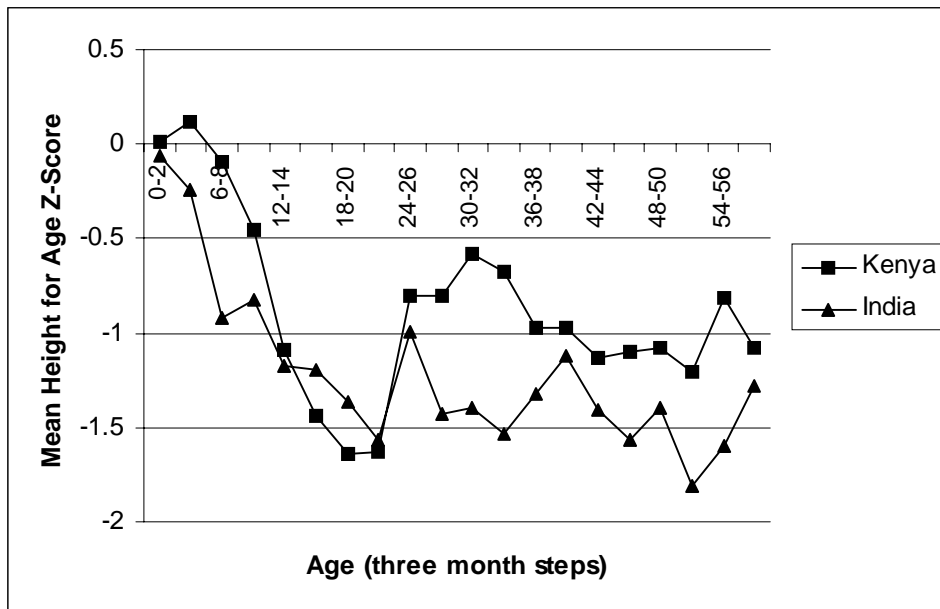
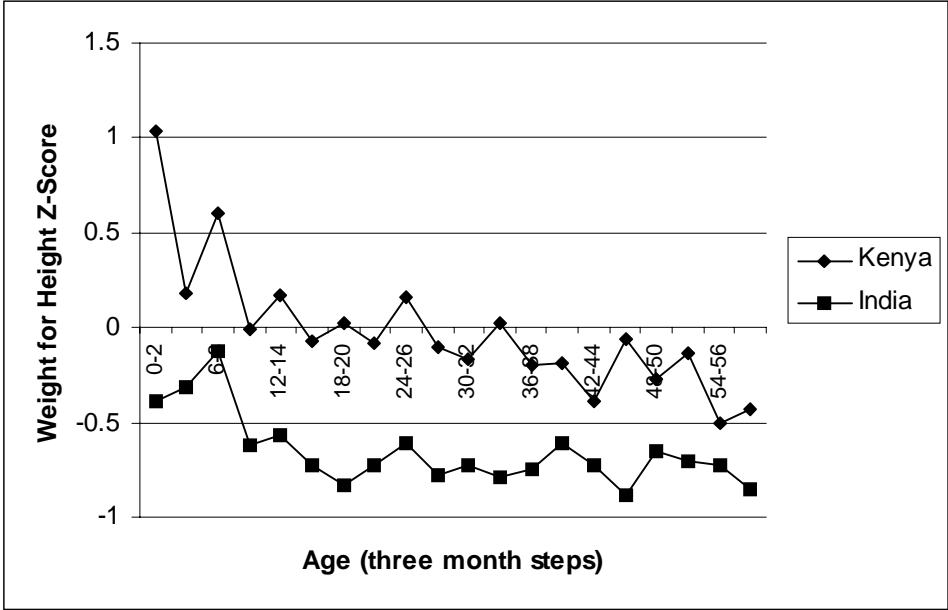


Figure 10: Height for Age Z-Score by Age among Elites in Kenya and India



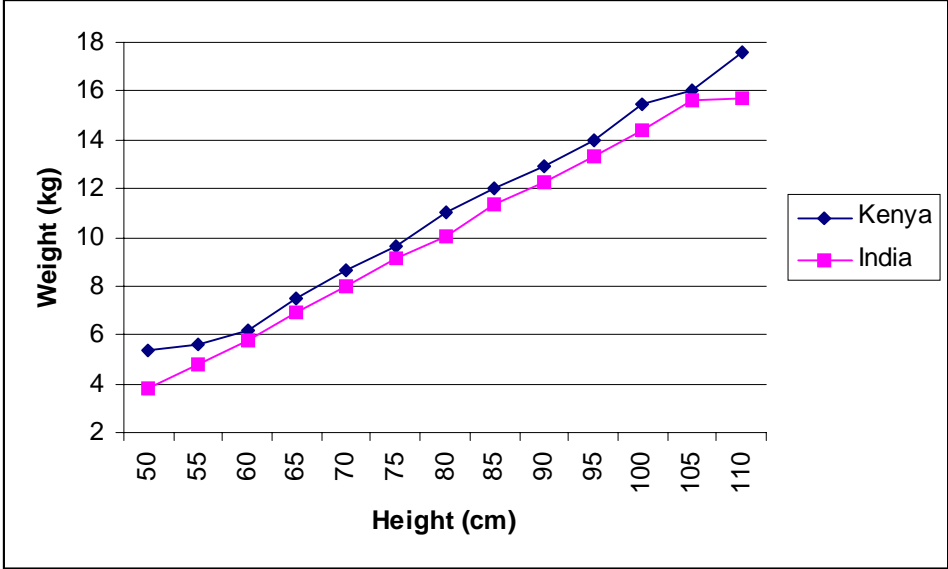
Note: the figure compared the broad elites in the two countries.

Figure 11: Weight for Height Z-Score by Age among Elites in Kenya and India



Note: the figure compared the broad elites in the two countries.

Figure 12: Weight for Height Development, Kenya and India



Note: The figure compared the broad elites in the two countries.