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The growth of South African rural black children

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Abstract **The growth status of two samples of South African rural black children, from Ubombo, KwaZulu, and Vaalwater, northern Transvaal, was compared with that of samples of American black children and three other rural sub-Saharan groups. All the sub-Saharan black children were shorter, lighter and had less subcutaneous fat than the American children. Their growth curves demonstrated the well-recognised pattern of deviation from American means before adolescence so that, by the start of adolescence, approximately 50% of the children were below the 10th centile of American norms. Adolescence in all groups is delayed and the magnitude of peak velocity reduced. The adolescent growth spurt appears, however, to be extended along the time base so that pre- and post-peak velocities are raised; this leads to apparent catch-up growth in the late teenage years. While the Vaalwater sample demonstrated growth patterns very similar to those of other rural sub-Saharan black groups, the Ubombo children were consistently taller and heavier than all the others. These data are discussed in relation to the need for national norms that reflect the growth status of black South African children.**

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There have been relatively few studies of the growth and development of South African black children. Tobias,[1] in a characteristically comprehensive review of the history of physical anthropology in southern Africa, listed only 49 published studies from South Africa up to 1985. Almost all of these were cross-sectional in design and related to the growth of children under 5 years of age. Yet studies of the growth and development of children *over* 5 years of age are absolutely essential for the effective monitoring of environmental impact on the growth, and thus the health and well-being, of children.[2] In addition, there has been much debate in South Africa on the rationale underlying the use of 'international' as opposed to 'national' or 'local' growth standards or norms.[2,3] Regardless of the arguments for or against the use of national standards, the South African proponents of the 'international school of thought' have resisted the introduction of *national* norms, presumably from a belief that the international norms are clinically effective in the assessment of child growth. The result of this resistance is a relative paucity of growth studies on children over 5 years of age. However, in order effectively to reach some degree of consensus as to which growth norm is most appropriate, it is essential to have baseline data on the growth and development of South African black children.

In 1985 and 1986, in an effort to counteract this lack of information, the Human Growth Research Programme of the University of the Witwatersrand initiated two longitudinal studies of the growth and development of rural black children. Since then a number of publications have detailed the growth of these children in comparison with that of American and British children.[4-13] The majority of these have appeared in American or British human biology or anthropology journals that are not normally read by South African medical practitioners. This paper is intended to redress that situation and provide the current status of the growth of South African rural black children.

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Materials and methods

Samples

The samples consisted of two groups of rural children from Ubombo, KwaZulu, and Vaalwater, Northern Transvaal. The studies were initiated in 1985 (Ubombo) and 1986 (Vaalwater) and were mixed-longitudinal in design. Children were examined twice a year (January and July) in Vaalwater and once a year (September) in Ubombo. The logistical difficulties encountered in longitudinal growth research in rural areas entail problems of follow-up. Most of the time it was virtually impossible to be certain that the same children would be present for measurement on each occasion. Thus, once the site of the investigation had been selected, every child was measured, regardless of whether they had previously been involved in the study. Therefore some children were present on all occasions and others only on some occasions. Such a sample is referred to as a 'mixed-longitudinal' sample and can be analysed by means of a variety of *a priori* statistical strategies to overcome the problems of missing data. There were nine measurement occasions at Vaalwater and six at Ubombo. For the purposes of this paper, only those *cross-sectional* data from the second measurement occasion at both sites were used. These measurements were taken in July 1986 in Vaalwater and in late August 1986 in Ubombo. These examinations were chosen because of relatively large sample sizes and because the majority of both samples had already been measured on one occasion and were familiar with the measurement techniques. Both samples excluded subjects younger than 6 years of age. In addition, girls older than 17 years and boys older than 18 years were excluded from the Ubombo sample and all subjects older than 17 years from the Vaalwater sample. The samples for analysis consisted of 554 children (298 females; 256 males) from Ubombo and 269 children (140 females; 129 males) from Vaalwater (Table I).

Sites

Vaalwater is a farming community populated mainly by families from the Tswana/Pedi tribes. The farm where this study was undertaken was owned by a paediatrician who supplied medical care, basic foodstuffs and housing aid. Families were stable in that most had been resident on the farm for two or more generations. Income and food supply were not subjected to major seasonal fluctuation and earnings were roughly 60% above the local norm.

Ubombo is a traditional rural area in the so-called 'homeland' of KwaZulu, about 50 km south of the Mozambique border. The subjects lived in rural home-

TABLE I.
Sample size by age, sex and study

Age (yrs)	Vaalwater Girls	Vaalwater Boys	Ubombo Girls	Ubombo Boys	NHANES Girls	NHANES Boys
6	9	9	14	27	72	60
7	14	11	20	8	81	67
8	12	17	18	19	54	49
9	15	19	31	21	71	74
10	14	9	25	19	62	60
11	11	11	37	20	67	71
12	10	13	21	19	72	71
13	17	13	34	16	82	74
14	13	11	33	25	79	68
15	15	7	27	20	73	65
16	10	9	27	23	54	66
17	—	—	11	18	68	63
18	—	—	—	11	(474)*	(254)
19	—	—	—	10	—	—
Total, sex	140	129	298	256	835 (1 309)	788 (1 042)
Total, study	269		554		1 623 (2 351)	

*Numbers in brackets refer to the sample for the age range 18,0 - 24,9 years.
NHANES = US National Health and Nutrition Examination Survey.

steads (kraals) and were almost exclusively Zulus. Thirty per cent of the work force are employed by the KwaZulu government, 34% commute across local frontiers, 26% are farm labourers and 10% are unemployed.[14] The population thus relies mainly on subsistence farming and financial support from the men of the family who work as migrant labourers on cotton, sugar or corn plantations or within the major industrial areas near Johannesburg, 300 miles to the west. Supplies of both food and money are seasonal and migration to urban areas is common.

Anthropometric measurements

The same measurement protocols were used for all subjects, and followed the standard anthropometric measurements described by Cameron.[15] Measurements were made of height, weight, sitting height, bi-acromial and bi-iliac breadths, head and maximum arm circumferences and skinfold thicknesses of the triceps and biceps and at the subscapular and supra-iliac sites. All anthropometrists were trained and had participated in a test/retest reliability study before the field work was undertaken. Standard errors of measurement and standard deviations of differences had to fall within internationally acceptable limits to ensure accuracy and reliability.[15] For the purposes of this report only those data relating to height, weight, triceps and subscapular skinfold thickness and arm circumference are presented because these measurements are most often used in clinical settings to assess growth.

Comparative data

The data chosen for comparison were for American blacks and came from the US National Health and Nutrition Examination Survey (NHANES), published in 1990 by Frisancho.[16] These are the most recent survey data published in America and are based on a national sample of children. Data from studies of rural children in other areas of sub-Saharan Africa were also used for comparison; the rural samples from Kenya were those of Turkana pastoralists and Kamba children reported by Little and Johnson[17] and Kulin *et al.*[18] respectively. Data for rural Tswana children from Botswana were reported by Corlett and Woollard.[19]

Results

Figs 1 - 5 compare the Vaalwater, Ubombo and NHANES samples with regard to the measured variables of height, weight, arm circumference and the triceps and subscapular skinfold thicknesses (the NHANES survey did not measure biceps or supra-iliac skinfold thicknesses). Statistical tests of differences between mean values were carried out by means of Student's *t*-test. At virtually all ages, African children of both sexes were shorter, lighter, and had less subcutaneous fat than American black children of similar age. In addition the differences between the means of height and weight of the rural African samples and the American samples increased between the ages of 6,5 years and early adolescence, and 13,5 years. There are differences between the two samples of African children in that the Ubombo children of both sexes have consistently greater weights, arm circumferences and subcutaneous fat thicknesses than Vaalwater children. These differences, however, only reach statistical significance ($P < 0,05$) for mean weight in girls between 9 and 16 years. Height for both sexes, male weight, arm circumference and skinfold thickness and female subscapular and biceps skinfold thickness, while different, are not statistically so. Of the 154 possible age by sex by variable combinations ($11 \times 2 \times 7$), statistically significant differences were apparent in only 39 ($P < 0,05$). Previous mixed-longitudinal analyses of these data had realised significant differences ($P < 0,05$) in weight and most skinfold thicknesses between children from Ubombo and those from Vaalwater.[8] The diminished sample size as a result of the use of just one measurement occasion for analysis probably mitigates against the possibility of statistical significance. While tests of significance were not carried out to compare the NHANES sample to either African sample, the consistent differences are obviously of biological significance.

Comparisons with other samples of sub-Saharan rural black children used the variables of height, weight and triceps skinfold thickness (Figs 6 - 8).

While the mean heights, weights and triceps skinfold thicknesses of all African samples are consistently lower than those of American blacks, it is apparent that the Ubombo children of both sexes are consistently the tallest, heaviest and fattest of the African children at all ages. It is also remarkable how the between-study mean

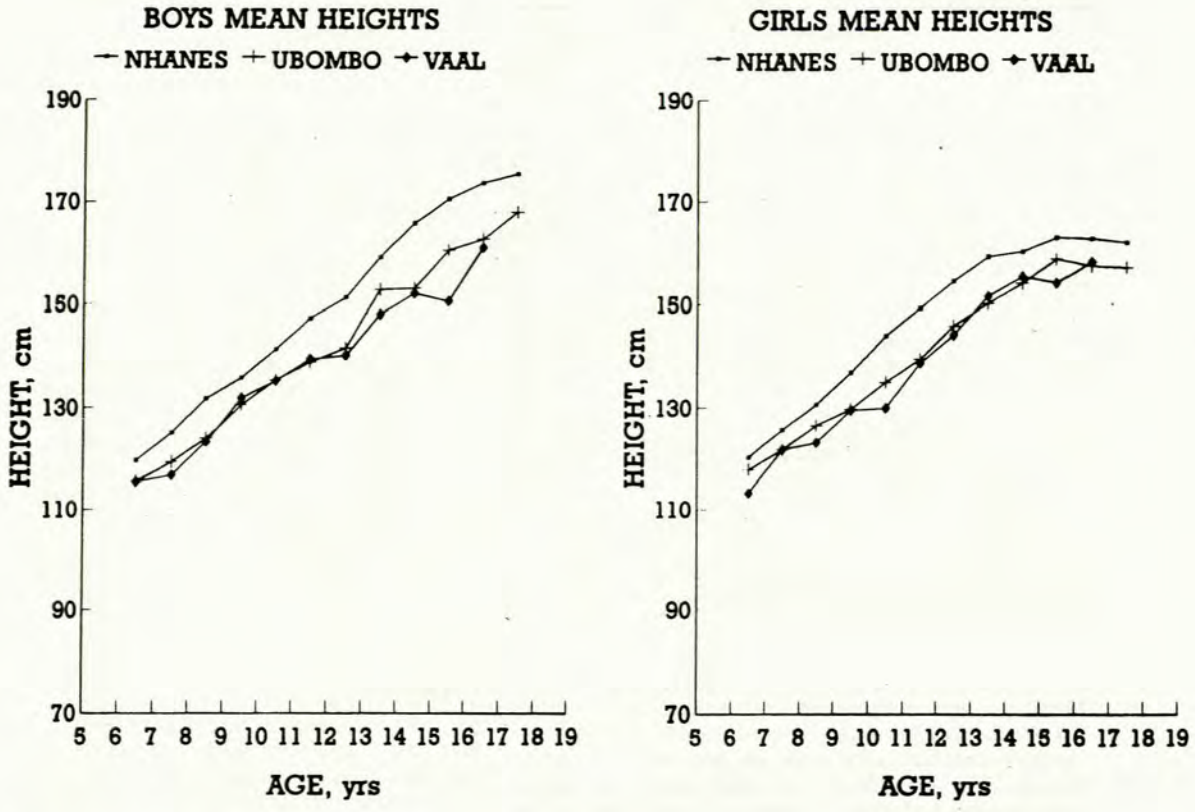

FIG. 1.
Boys' and girls' mean heights — NHANES, Ubombo and Vaalwater (VAAL) samples.

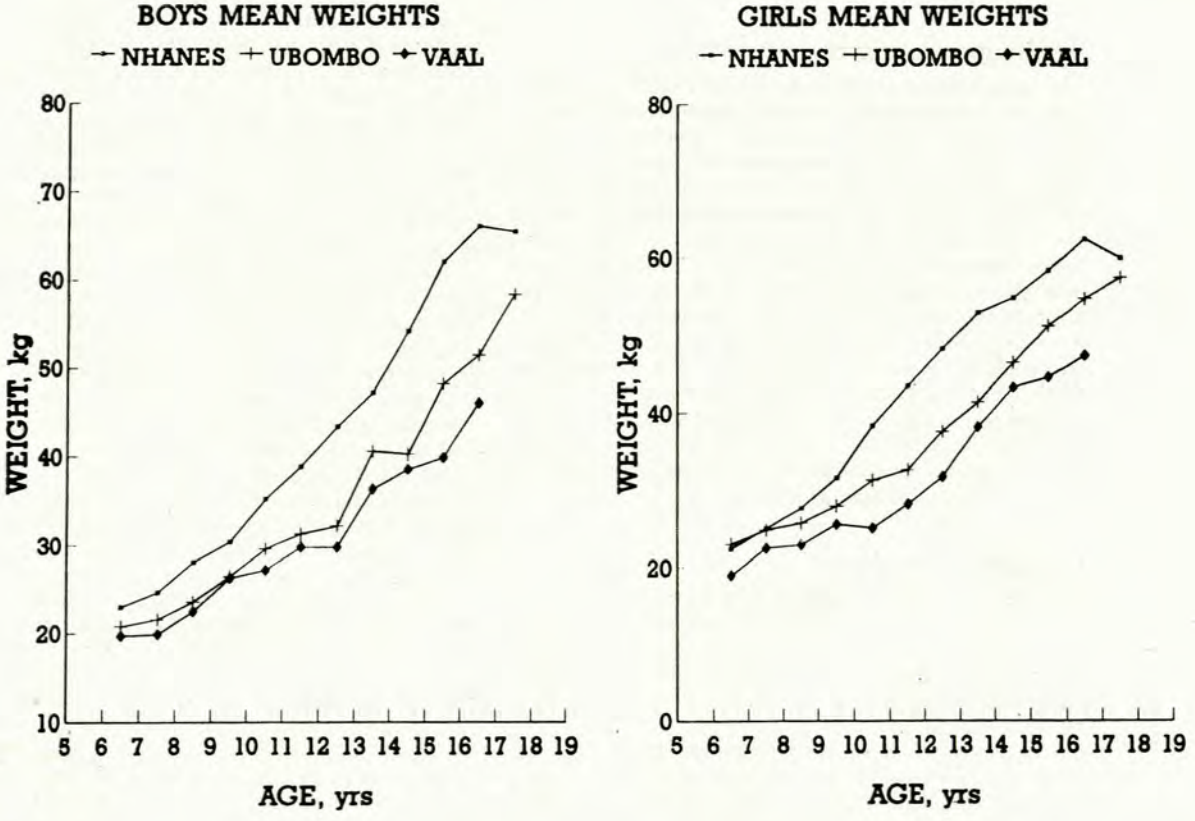

FIG. 2.
Boys' and girls' mean weights — NHANES, Ubombo and Vaalwater (VAAL) samples.

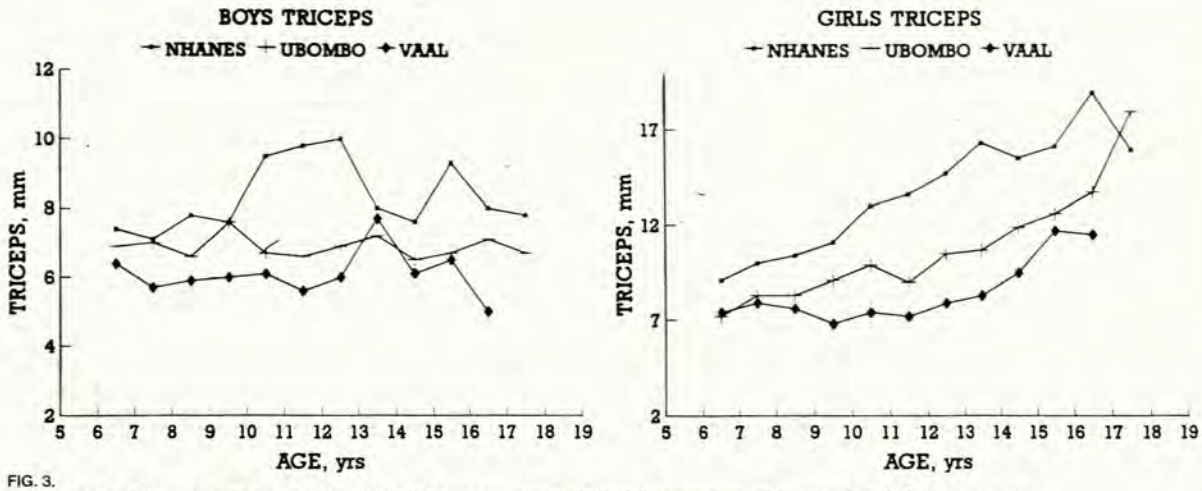

FIG. 3.
Boys' and girls' mean triceps skinfold thicknesses — NHANES, Ubombo and Vaalwater (VAAL) samples.

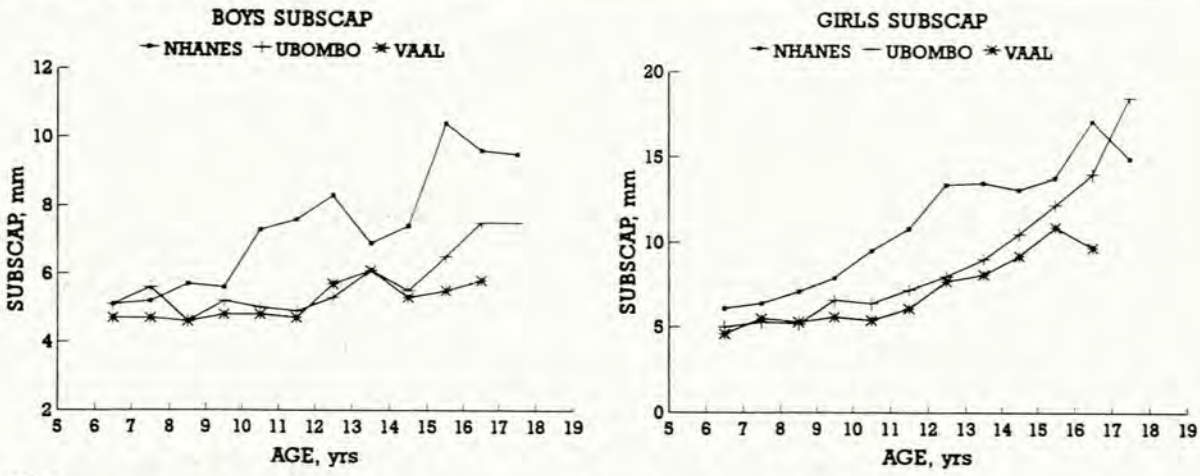

FIG. 4.
Boys' and girls' mean subscapular skinfold thicknesses — NHANES, Ubombo and Vaalwater (VAAL) samples.

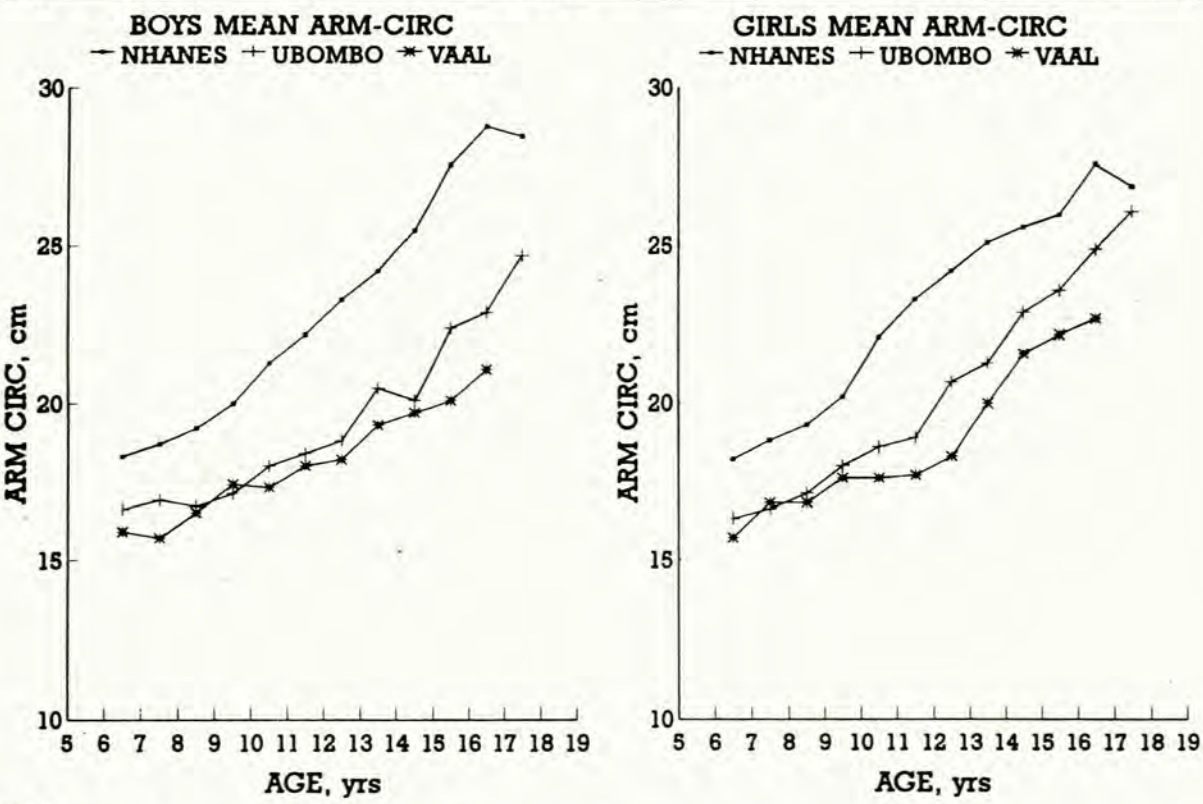

FIG. 5.
Boys' and girls' mean arm circumference values — NHANES, Ubombo and Vaalwater samples.

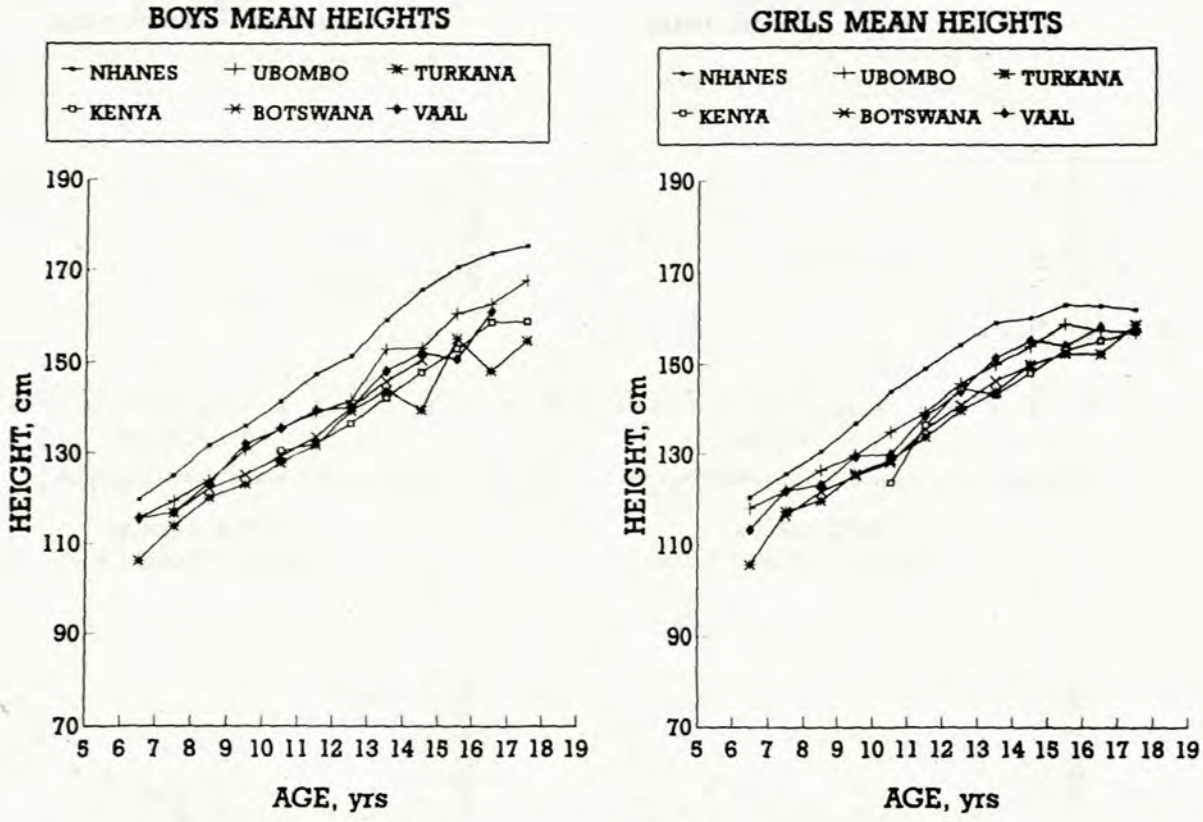

FIG. 6.
Boys' and girls' mean heights — American (NHANES) and rural sub-Saharan samples.

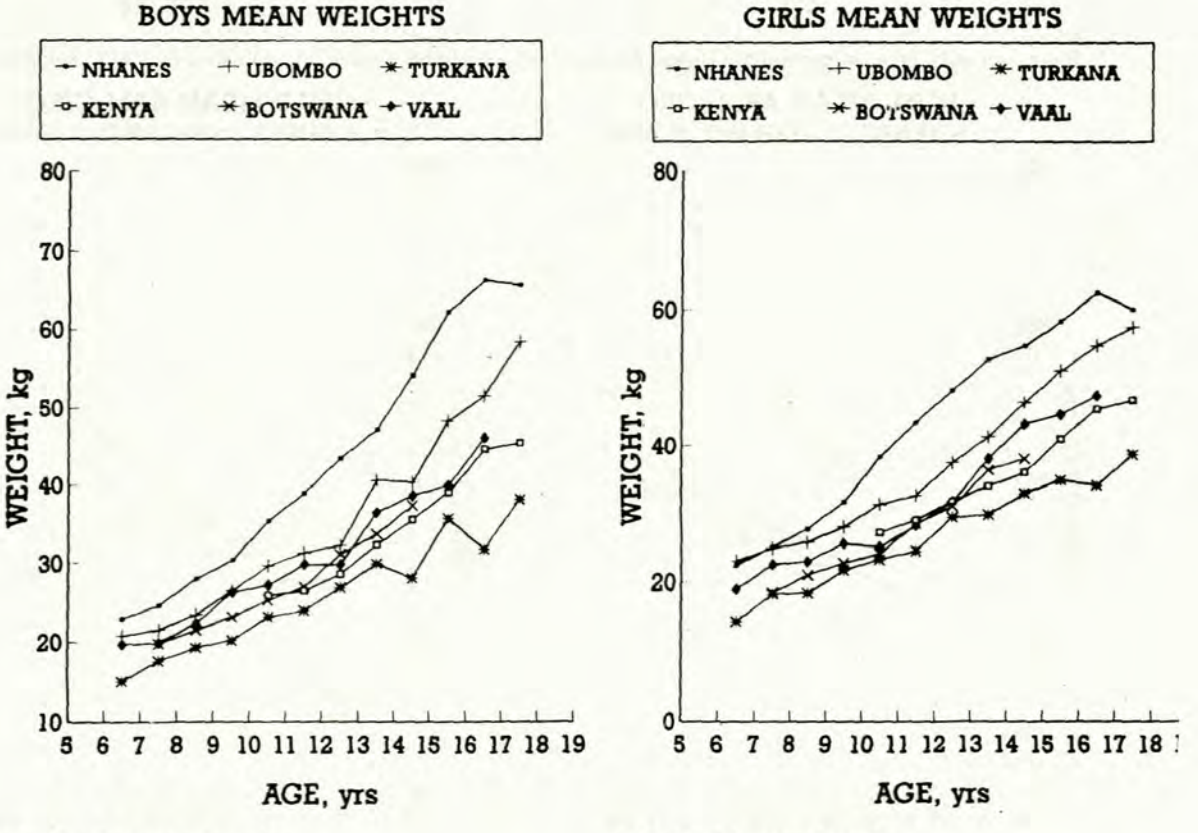

FIG. 7.
Boys' and girls' mean weights — American (NHANES) and rural sub-Saharan samples.

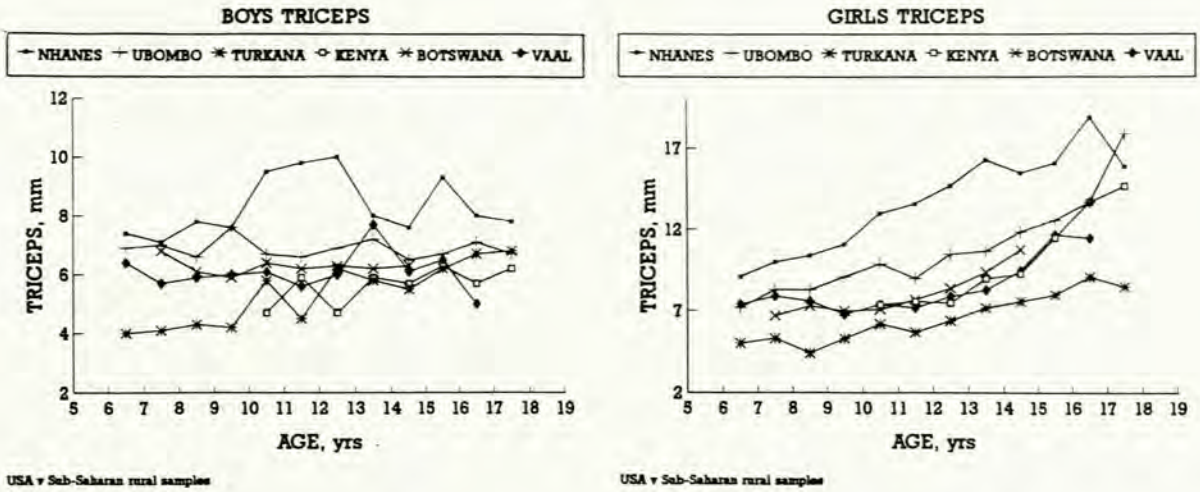

FIG. 8.
Boys' and girls' mean triceps skinfold thicknesses — American (NHANES) and rural sub-Saharan samples.

weights and skinfold thicknesses vary to a greater degree than do mean heights. At 17,5 years, for example, female mean heights for all rural samples are almost identical, with a range of 1,6 cm, compared with mean weights which vary widely and have a range of 18,2 kg. In other words mean weights at 17,5 years vary by almost 30% from the NHANES value. The same is true of the boys who have a mean weight range at 17,5 years of 20,3 kg compared with a mean height range of 13,2 cm, less than 10% of the NHANES value.

Discussion

These results clearly demonstrate that sub-Saharan rural black children are consistently smaller, lighter and thinner than American blacks and that differences exist between sub-Saharan samples. The South African samples do not differ in terms of mean height even though they experience different rural environments. Those environments would appear to affect only weight and subcutaneous fat, as demonstrated by the greater variability of between-study mean weights and skinfold thicknesses. Such data demonstrate the greater ecosensitivity of weight; not only are mean values absolutely lower but they vary between samples to a greater degree. That same ecosensitivity may be seen in the measurements of triceps skinfold thickness; while the hierarchical order of NHANES followed by Ubombo and the other studies is maintained, the spread of mean values is far greater than for mean height.

Although it is often assumed that morphological differences between South African 'tribes' have a major genetic basis this is unlikely to be the case. Professor Trefor Jenkins (personal communication) asserts that the genetic distance between these two groups is negligible and that differences between them are mainly cultural.

While differences exist in the absolute amount of fat, the pattern of fat distribution is not affected by the environment. Cameron *et al.*[20] demonstrated that fat patterning in African black children, specifically children from Ubombo and Vaalwater, was no different from that in American blacks. Both African and American black children showed similar degrees of centralisation of body fat even though their nutritional and health environments were vastly different.

Discussions about the use of international, as opposed to 'local' or 'national', norms or standards for the assessment of human growth in developing countries, have developed into arguments about whether such norms should reflect *actual* growth or *potential* growth.[2,21] In the former case, international norms are seen to reflect the genetic potential for growth in the environment of a developed country. The difference between a child's *actual* growth status and *potential* growth status, as reflected in the normal centiles, is therefore interpreted as being the result of an impoverished environment, disease and malnutrition. Conversely, in the latter case, national or local norms accept the fact that in many developed countries *actual* growth status differs, possibly because of genetic differences, and local norms thus allow a more sensitive interpretation of a child's growth. That sensitivity relies on the fact that the source sample, and the child/sample under investigation, share a common environment. So widespread is the acceptance of the advantage to be gained from national norms that most European countries, and some developing countries, e.g. Venezuela, Cuba and India, have their own growth standards. However, the decision as to whether international or national norms should be used clinically is actually determined by whether the clinician wishes to examine the mean growth status of a *sample* or the absolute growth status of an *individual* child. If the study involves the comparison of a *sample* of children to normal values, then international norms seem more appropriate. There is little doubt that secular trends toward greater heights and weights and earlier pubertal development are the result of improved socio-economic environments and that these improvements can *only* be assessed by the comparison of mean values from samples of children to international norms. Thus the *monitoring* of child growth to assess the effect of the environment should be done by comparison of the mean values of a sample of such children with the international norms. If, on the other hand, the purpose of the comparison is to monitor the health of an *individual* child compared with his peers, a local or national chart will provide a more sensitive assessment of the individual. It will, in effect, allow for the comparison of that child with others of the same age and sex living within the same, or a similar, environment. In essence, the clinician will be able to answer the question: 'Given the impoverished environment of this

child, is he/she growing normally relative to his/her peers?'

The data presented in this paper demonstrate that the growth of sub-Saharan black rural children is consistently lower than the international norms for all measured variables even though they grow at reasonably normal rates. The only investigations of adolescent growth rates have been in the Ubombo and Turkana samples,[4,17] and both demonstrated remarkably similar patterns in that they show similar pre- and post-peak increased rates. A comparison of mean adult heights and weights of black African samples compared with European samples reveals that an adolescent 'catch-up' effect may be operating through these raised rates. Eveleth and Tanner's[22] comparison of African adult heights and weights with those of European urban, rural and national samples, showed that all of the 19 means of black African male height, with the obvious exception of Pygmy and Bushman data, fell within, or above, the range of means from comparative European samples. Ten of the 13 black African female height means were also within the European range. Weight means, on the other hand, exhibited a different pattern with only 3 of 17 male weight means and 12 of 14 female weight means falling within the European range.[11] This evidence of a narrowing of the differences between mean values for height and weight as children approach adulthood must be taken into account when a judgement is made about the biological/health significance of differences in mean height and/or weight. Ample evidence is available of delayed secondary sexual development, and thus adolescent growth, in black African children.[10,23] That delay is responsible for the apparent slowing of growth as these children approach adolescent age. But this pattern, common to *all* sub-Saharan groups so far studied, should not necessarily be taken as sinister and detrimental to the health and well-being of the child. Rather, in the absence of reliable information about the association between growth status and educational/social achievement, the pattern should be viewed as characteristic of the growth of children in developing countries that may be adaptive to the impoverished environment in which they live.

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