Childhood Malnutrition and Growth in a Rural Area of Western Kenya

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KEY WORDS health; nutritional status; stunting; overweight; East Africa

ABSTRACT An anthropometric survey was carried out on 1,383 school students aged 5–17 years in Suba district (a rural area of western Kenya). Body size and proportion were computed from height, weight, sitting height, arm circumference, and skinfolds. The aim of the study was to evaluate patterns of growth and nutritional status of the Luo population by assessment of the prevalence and trends of malnutrition among children and adolescents. Very few age-groups show significant sex differences for height, body weight, and arm muscle area. However, there are several differences in skinfold thicknesses and arm circumference, always with higher mean values in girls. Analysis of the nutritional status (weight-for-age, height-for-age, and BMI-for-age) shows significant differences among the age-groups in both sexes. Boys present lower Z-scores than girls and there are higher percentages of malnourished subjects (stunted and underweight) among the males. The Luo data were compared with those of other African populations. Their body dimensions, nutritional status, and growth are similar to those of the other sub-Saharan samples. In conclusion, the Luo children are generally undernourished at the older ages: adolescents (11–16 years of age) show the most severe undernutrition and the highest percentages of undernourished subjects. In addition to the higher risk of undernutrition in teenagers, an emerging problem of over-nutrition is evident among the younger age-groups, with a higher prevalence in females. These findings are discussed in light of sexual dimorphism in sensitivity to adverse environmental conditions. Am J Phys Anthropol 132:463–469, 2007. ©2007 Wiley-Liss, Inc.

Childhood malnutrition is still a serious global health problem (Food and Agricultural Organization, 2002). Recent studies in Africa have shown different trends, with increasing obesity in North Africa but persistent undernutrition in sub-Saharan populations (Mokhtar et al., 2001). In particular, there is both obesity (BMI ≥ 30 kg/m2) and undernutrition (BMI ≤ 18.5 kg/m2) in Morocco and Tunisia, with a higher prevalence of obesity in adult females. In these countries, overweight has been observed in adolescent girls around the age of 13. The data available for childhood refer only to children under 5 years of age.

The extent of overweight in sub-Saharan Africa remains unknown, since until the 1990s this type of malnutrition was not evaluated in these populations, not even in specific nutritional surveys (de Onis and Blossner, 1997). Subsequent nutritional surveys of preschool children have shown that undernutrition remains a major public health problem in Africa (de Onis and Blossner, 2000).

In Kenyan women (15–49 years), the prevalence of obesity is still low, with rates <5% (Demographic and Health Survey, 1997). A 1996 investigation by the Kenyan Ministry of Health indicated prevalences of 28% for stunted children, 43% for wasted children, and 22% for underweight children in the Suba district—our study area. Moreover, a 1999–2000 Kenyan survey (Food and Agricultural Organization, 2002) on anemia and the intake of micronutrients (vitamin A, iron, and zinc) found that micronutrient deficiencies were unacceptably high with respect to WHO recommended standards. It was also reported that 76.5% of children under 3 years of age were anemic and 10% died from micronutrient deficiency, illness, stunting, and wasting. In contrast, there is no information on the prevalence and pattern of childhood overweight.

The aim of this study was to evaluate the nutritional status and growth of children in a rural area of Kenya. Since relatively few studies have been published on African children older than 5 years of age (Cameron, 1991; Little et al., 1993; Sellen, 1999, 2000), we analyzed school-age children to determine if undernutrition is still a serious problem in Kenya and if there are also trends in overweight in this country, as in other developing nations. Specifically, we tested the hypothesis that changing food consumption practices have resulted in undernutrition and a tendency toward increasing obesity.

MATERIALS AND METHODS

Anthropometric data were collected in a rural population in Suba district, Nyanza province, Western Kenya, on the northeastern shore of Lake Victoria (see Fig. 1). The district is inhabited mainly by the Luo, a Nilotic tribe.

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Parental permission was requested for each student. The composition of the sample is reported in Table 1.

Ten anthropometric variables were collected for each subject: body weight, height, sitting height, and arm circumference; triceps (TRCP), biceps (BCP), subscapular (SSCP), suprailiac (SPIL), abdominal (ABD), and calf (Calf) skinfolds. Height and sitting height were measured in centimeters with a portable anthropometer, whereas skinfold thickness was recorded in millimeters with a Lange caliper on the left side. Arm circumference was measured in centimeters with a nonstretchable plastic-coated measuring tape on the left side. All anthropometric measurements were taken according to standard procedures (Weiner and Lourie, 1981; Lohman et al., 1997) at fixed measurement stations. The same researcher (S.S.) performed all the measurements during the 3-month study period. The cross-sectional muscle area of the upper arm (UMA) was estimated from mid-upper arm circumference (c) and triceps skinfold (TRCP) according to Frisancho (1990): UMA (cm$^2$) = $\frac{c^2}{4\pi}$. The body mass index was calculated by the equation: BMI = weight (kg)/height (m$^2$), and the sitting height/height ratio was computed.

The prevalence of childhood malnutrition, defined as “an abnormal physiological condition caused by deficiencies, excesses, or imbalances in energy, protein, and/or other nutrients,” (Food and Agricultural Organization, 2000) can be evaluated with the following anthropometric indices: weight-for-age (WTAGE), weight-for-height (WTHT), height-for-age (HTAGE), and BMI-for-age. The height and weight of the rural Kenyan children were compared (as Z-scores of HTAGE, WTAGE, and WTHT) to the CDC Growth Chart/NHANES III reference data (Kuczmarsky et al., 2000) according to World Health Organization suggestions (1986) for international use. To evaluate the nutritional status, cut-off points of $-2$ SD and $+2$ SD from the mean value of the reference population (Keller, 1991) were used to separate the malnourished population from the well-nourished one. Undernourished children (Z-score $<$ $-2$ SD) were considered wasted (low weight-for-height), underweight (low weight-for-age), or stunted (low height-for-age) (Waterlow, 1972). A Z-score $<$ cut-off of $>2$ SD (de Onis and Blossner, 1997) was used to classify high weight-for-height as overweight in children aged $<$10 years. We chose to use WTHT for malnutrition only for children aged $<$10 years, as recommended by the WHO Expert Committee (1995).

For older children (≥10 years), we preferred BMI-for-age. In particular, we used the BMI 5th percentile to define undernourished adolescents and new international reference age- and sex-specific BMI cut-offs to define overweight adolescents on the basis of centile curves passing through the adult cut off point of 25 kg/m$^2$ at age 18 (Cole et al., 2000).

Ages were computed at 1-year intervals. The first two age-groups considered in both sexes (5, 6 years) and the last (17 years) were under-represented. Therefore, we combined the first two and last two age-groups to calculate the prevalence of malnutrition.

All the data were normalized when independent t-tests (two-tailed) with unequal sample size were used to compare boys and girls in each age-group. For each parameter, ANOVA was applied to detect the variability among age-groups. Statistical tests were considered significant at the 95% confidence level. The statistical analysis was carried out with “Statistica” for Windows, Version 5 (StatSoft Italia srl, Vigonza, Padua, Italy).
RESULTS

Tables 2 and 3 report the means and standard deviations for height, weight, body mass index, sitting height/height ratio, skinfolds (triceps, biceps, subscapular, suprailliac, abdominal, and calf), arm circumference, and arm muscle area (UMA) for the Kenyan girls and boys, respectively. F values for the growth effects are also presented. Significant differences were found for all traits and indices, with the exception of BMI in males. There are no sex differences in height, body weight, body mass index, and UMA within the same age-groups (t-test), except for the 8, 11, 14, 15-year-olds, in which girls (Table 2) have significantly greater weight, height, and arm muscle area ($P < 0.05$) than boys (Table 3).

The sitting height/height ratio and BMI means follow the normal growth model (Malina et al., 2004). However, there are several sex differences in skinfolds (TRCP, BCP, ABD, CALF, SPIL, and SSCP) and arm circumference. For all these parameters, girls show significantly higher values than their male counterparts (Tables 2 and 3).

The mean triceps and subscapular skinfold thicknesses of the Suba children are similar to the 50th percentile for the Black Americans (Frisancho, 1990) until 15 years in males and 11 years in females. Moreover, to evaluate the nutritional status of the sample, the means of boys and girls were descriptively compared with the NHANES III data. One-way ANOVA of the $Z$-scores for WTAGE and HTAGE in the different age-groups revealed significant differences ($P < 0.01$) for both indicators in both sexes. No significant differences were found in age-groups from 5 to 9 years for WTHT. Figure 2 shows that HTAGE is distinctly lower in boys than in girls from age 14 to 17, with mean $Z$-scores closer to $-2$. Nevertheless, the mean values of boys and girls are closer to the NHANES III values at earlier ages. In particular, there are different patterns in boys and girls during growth (see Fig. 2): the mean $Z$-scores increase toward 0 after 13 years in girls but not in boys. The mean values of WTAGE in boys and girls are not significantly different until 13 years. Both sexes start from high $Z$-scores at 5 years (1.13 and 1.56, respectively for boys and girls) and approach 0 at 9 years of age. The mean $Z$-scores then continue to decrease and become negative at 11 years. The girls show an increase from 14 to 17 years while the mean $Z$-scores in boys continue to decrease to $-1.12$ at age 17. WTHT shows similar patterns in both sexes, with slightly lower values in girls than in boys (although always above 0 in both sexes). The Kenyan sample has high $Z$-scores of WTHT, which approach +2 at 6 years in boys and +1.5 in girls of the same age. The high values of WTHT are mainly due to the low height with respect to age.

Table 4 and Figure 3 show a high percentage of malnourished children, especially during adolescence. This trend is more evident in boys, with a high prevalence of underweight and stunting after 13–14 years: the percentage of stunted subjects approaches 40–50% after 14 years. The girls show lower percentages of stunting, with values close to 35% only at 13 years, after which the prevalence declines markedly from 15 to 16–17 years. The prevalence of underweight is lower in girls than in boys, with a maximum of 11% at 14 years in females (more than 20% in males after 14 years). From 5 to 9 years, wasting is absent in females and shows low percentages in males (except for the 5-year-olds). After 10 years of age, the prevalence of adolescents with BMI less than the 5th percentile tends to increase with age, with higher percentages in females at 16 years and in males after 14 years. The prevalence of overweight (defined as the combined prevalence of overweight and obesity) is considerably higher in children under 8 years than in those above this age. Overweight was completely absent in boys from 11 to 16–17 years, except for the 13-year-olds.

DISCUSSION

This study provides anthropometric data on the nutritional and growth status of rural Kenyan children from 5 to 17 years of age.

In light of our effort to examine numerous anthropometric characters in a large sample of children, this study has several limitations that should be considered when interpreting the results. The risk of confusing the effects of environmental changes with the effects of age (inherent in the cross-sectional design) is increased by the precarious living conditions of these children. Moreover, as we did not assess puberty, our observations on changes due to development are only hypothetical. Although our methodological choices allow better comparison of our findings on the prevalence of overweight with international data, they constitute a limitation due to the different methodologies used for the cut-offs and the reference standards. In fact, we used the US reference data (NHANES III) for the comparisons of all the nutritional indicators (WTAGE, HTAGE, WTHT, 5th percentile of BMI-for-age), except BMI-for-age in the assessment of overweight. This dishomogeneity is justified by the need to use international reference data to obtain information about populations of developing countries and to adequately insert the information into a pattern of general global changes and trends.

De Onis and Blossner (1997) emphasized the importance of identifying prevalence ranges to assess the severity of malnutrition in a population to provide indications about public health and to establish appropriate interventions. By extending the classification valid for children under 5 years of age (de Onis and Blossner, 1997) to higher ages, we can classify the severity of malnutrition in Kenyan children as “medium-high” stunting prevalence in females 12–14 years old and “high-very high” stunting prevalence in males 15–16 years old. The prevalence of WTAGE below the cut-off increases with age but remains “low” in girls; in males, the prevalence of underweight is “low-medium” until 13 years and “high” thereafter. Consistent with this trend, wasting is absent or “low” in girls, “low-medium” in boys till 13 years, and “high” after that age. Although the mean prevalence

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**Table 1. Sample composition by sex and age**

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### Table 2. Descriptive statistics for females in Suba sample

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<th>TRCP (mm)</th>
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* ANOVA significant values (P < 0.05) among ages.

### Table 3. Descriptive statistics for males in Suba sample

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<td>17</td>
<td>57.1*</td>
<td>163.5</td>
<td>9.6</td>
<td>24.51*</td>
<td>3.05</td>
<td>0.47</td>
<td>0.02</td>
<td>21.5</td>
<td>2.1</td>
<td>31.21</td>
<td>6.48</td>
</tr>
</tbody>
</table>

* ANOVA significant values (P < 0.05) among ages.

* P < 0.05 between girls and boys (t-test).

b df: 12, 665.
of wasting in our sample of rural Kenyan children (3.3%) is less than that previously recorded in preschool Kenyan children (the figure given by de Onis and Blossner (2000) indicates a prevalence slightly higher than 5%), the prevalence of overweight (3.2%) is similar (3.5%, as given by de Onis and Blossner (2000)). However, it should be underlined that our results for wasting and overweight show different patterns in boys and girls and in the different agegroups. In addition to a higher prevalence of wasting in males and of overweight in females, there is the problem of emerging overnutrition in the younger age-groups of both sexes. The latter trend, which must be confirmed and carefully followed in time, may indicate the first signs in this sub-Saharan country of health problems related to overweight, as observed in North Africa and in some Latin American countries where famine and food sufficiency, and thus undernutrition and obesity coexist (Demographic and Health Survey, 1997).

Our data suggest that the Kenyan children exhibit a chronic condition of protein energy malnutrition and/or a probable developmental delay. Environmental influences (particularly nutritional factors) may be responsible for a pubertal delay in growth, as found in other African populations (Kulin et al., 1982; Cameron, 1991; Olivieri, 1995). Because of this slow growth rate, the differences between the Kenyan and Western children progressively increase as they approach adolescence, as observed in samples from South Africa (Cameron et al., 1992) and Malawi (Zverev and Gondwe, 2001). The mean weight-for-age and especially BMI-for-age are close to the 50th
percentile of NHANES III, even when height-for-age shows stunted growth. Stunted height associated with appropriate weight-for-height indicates a sufficient energy intake but chronic poor-quality nutrition (Keller, 1991).

The pattern of poor growth performance of the Kenyan children, probably related to malnutrition, is similar to that recorded in other African populations (Dellaportas, 1969; Gallo and Mestriner, 1980; Bénéfice, 1993; Olivieri, 1995; Monyeki et al., 2000; Zverev and Gondwe, 2001; Pawloski, 2002). Our results concerning sex differences in anthropometric characters, with a more favorable growth status in girls than in boys, agree with other studies conducted in sub-Saharan Africa (Corlett, 1986; Bénéfice and Malina, 1996; Simondon et al., 1998). This pattern is probably related to a generally higher resistance of girls to adverse environmental conditions, as observed in other studies (Hiernaux, 1964; Corlett, 1986; Bénéfice and Malina, 1996; Zverev and Gondwe, 2001), as well as to the greater access to food of Suba girls because they help with the cooking. On the other hand, since Suba boys are more involved in heavy work activities (and thus with greater energy expenditure), their higher prevalence of malnutrition indicators can be interpreted in terms of a "work activity hypothesis," proposed in a previous study on an African pastoral community (Sellen, 2000).

The nutritional status of the Suba boys and girls, assessed by anthropometric indicators, had improved substantially with respect to the incidence of malnutrition in 1996. Since 1996, several nongovernmental organizations have been working in the study area to improve the living conditions of the population. Some policies have also been implemented to decrease the drop-out rate of school children (especially girls) and to delay the age of child bearing. Since education is highly valued by the Luo ethnic group, families have responded well to the policies and have made sacrifices to allow their children to attend school, e.g. paying their maintenance fees (books, uniforms) and reducing their daily workload in the household.

Many volunteers from Western countries have traveled to Suba to help develop public structures (building schools, renovating medical clinics). Thus, traditions have also started to change rapidly because of the external influence, the growing number of educated people, and the new requirements dictated by progressive modernization. Some of these changes involve eating habits: previously men and boys sat and consumed most of the meal, but now women and girls take part in the meal and mothers can make sure that the youngest children eat well.

The decreased prevalence of wasting in younger children could reflect responses to these recent changes. However, the increased prevalence of overweight in the same age-groups indicates a significant negative consequence in terms of inappropriate dietary patterns. As in North Africa, where changes in lifestyle and food availability have contributed to a significant health problem due to overweight (especially among females), there seems to be a tendency toward this situation in Kenya and in other sub-Saharan populations, which are experiencing very rapid sociodemographic changes that may lead to sudden nutritional transitions (Popkin, 1993).

The results presented here provide a clearer picture of anthropometric indicators in school-age children of a specific rural Kenyan population, where the persistence of undernutrition and an emerging pattern of overweight coexist. These findings can help identify the most urgent needs of intervention programs, focusing on the most sensitive age/sex groups (adolescent males for undernutrition and younger children of both sexes for overweight) to help all subjects increase their growth potential and work capacity and reduce their susceptibility to disease.

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LITERATURE CITED


