

# Anthropometry and Nutritional Status of Primary School Children in a Sub-urban Region in Tanzania

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## Abstract

**Background:** Although undernutrition in children is widely recognized as a major health problem in Tanzania, region-specific prevalence data remain scarce. The objective of the present study was to determine the prevalence of stunting and thinness among primary-school-aged children in a village in the Arusha region in Tanzania, with the aim of developing a targeted nutritional support program.

**Methods:** In the present school-based cross-sectional study, anthropometric measurements were obtained for all children (n=1,379) who attended Baraa primary school in the Baraa village located at the transition between a rural and urban area in the Arusha region. The data were compared with the world health organization (WHO) 2007 growth reference data for individuals between the ages of 5 to 19. Continuous variables were compared using the t-test, while categorical variables were compared using Pearson's chi-square test. Spearman's correlation and  $\chi^2$  for trend were used to compare the trend of continuous and categorical variables, respectively.

**Results:** Basic anthropometric values of the study participants were significantly lower than those of the reference population. The mean values of z-scores significantly differed from zero. No gender differences in the prevalence of stunting and thinness were found. Three hundred and twenty-six children (23.7%) suffered from at least one form of undernutrition: 225 (16.3%) were stunted while 156 (11.3%) were thin. The prevalence of both stunting and thinness was at its lowest in the youngest children (5 - 9 years) and highest in the oldest children (14 - 19 years). Furthermore, 54 (16.5%) of the undernourished children suffered from multiple forms of undernutrition.

**Conclusions:** Undernutrition remains prevalent among primary-school-aged children in the Arusha region, Tanzania. Moreover, a high proportion of children suffer from a combination of different forms of undernutrition, with an increase in the prevalence of undernutrition with age.

**Keywords:** Prevalence, Anthropometry, School-Aged Children, Undernutrition, Tanzania

## 1. Background

Child undernutrition is common in the developing world, where 1 in 5 children is thought to suffer from at least one type of undernutrition. Indeed, half of all child deaths are associated with poor nutrition (1-3). According to the WHO (world health organization), the leading contributor to the global burden of disease (expressed in disease-adjusted life years) is an underweight childhood (4-6). Undernutrition during an individual's childhood is often caused by multiple factors and can cause lifetime-persistent disadvantages including low income, low offspring birth weight, and a higher likelihood of chronic diseases (7-9).

Tanzania was ranked 164 out of 187 countries on the international monetary fund list of 2013, which sorted countries based on their GDP (gross domestic product) and

PPP (purchasing power parity) per capita. While there is poor evidence for the inverse association between GDP per capita and child undernutrition (10-12), it has been indicated in multiple studies that the incidence and prevalence of child wasting, stunting, and being underweight in Tanzania exceeds the global average (13-16).

Arusha is one of the high-ranking regions in terms of GDP contribution in Tanzania. Important activities contributing to the GDP of the region include a) tourism to the vast national parks (Ngorongoro Crater, Serengeti, Lake Manyara, Tarangire) and mountain climbing (Mount Meru and Kilimanjaro); b) the presence of the International Criminal Tribunal of Rwanda of the United Nations; and c) various agricultural activities, including wheat production (17). Although these economic and financial advantages, especially compared to other regions, are well recognized, the presence of undernutrition remains high (18).

Several studies conducted in Tanzania have primarily involved pre-school-aged children (0 - 59 months). While this age group is presumed to be the most susceptible to undernutrition (14), the lack of data of older children (primary school age) can mask the rate and importance of undernutrition in this specific group. However, there is scarce information on the prevalence of undernutrition in children who attend primary school in the Arusha region in Tanzania.

Due to the wide variation of undernutrition prevalence between different countries and regions in Sub-Saharan Africa (19) as well as the need for group-specific interventions, the importance of region-specific prevalence data should not be underestimated.

The aim of the present study was to assess the prevalence of undernutrition (i.e., stunting and thinness) with the aim of developing a targeted nutritional support program for school-aged children in the Arusha region.

## 2. Methods

### 2.1. Study Design, Area and Subjects

A school-based cross-sectional study was conducted in the Baraa village located 10 km outside of the city of Arusha in Northern Tanzania. This village lies in the eponymous Baraa ward (sub-division of the Arusha district) and is located at the transition from rural to urban areas. Most of the children in this village attend Baraa primary school.

Anthropometric measurements were obtained for all 1,379 primary school children from Baraa Primary school, irrespective of their age (school-based study). Only 1 child in the entire school was excluded from recruitment due to "congenital talipes equinovarus" and the resulting difficulties in acquiring accurate measurements.

The study was conducted between the 15, July 2015 and 28, July 2015 in a secluded room of this school.

### 2.2. Anthropometric Measurements

Anthropometric measurements were performed conforming to the procedures outlined in the "centers for disease control and prevention" manual (20). Official UNICEF (united nations international children's emergency fund) MUAC (mid upper arm circumference) tape measures were used to assess MUAC. The midpoint between the acromion and the olecranon of the left arm (hanging at rest) was identified and used as a positional marker to slide an age-conform UNICEF MUAC-tape around the arm. The tape was gently tightened without pinching the skin. The results were noted in 2 ways: colour (green, yellow or red) and centimetres (to the nearest 5 mm). Both colour and metric cut-off values were age-group specific and conformed

to UNICEF guidelines. Weighing was performed on a digital weighing scale (Soehnle, Germany) without shoes. Underwear and shirts were worn when being weighed. Accuracy was set at 0.1 kg. Height was measured against a straight vertical wall with a sliding head board. Correct positioning was obtained by checking the contact between the wall and bilateral posterior surfaces of the calcaneal, gluteal, and scapular region. The head was brought in contact with the posterior wall and held in a vertical position while sliding the horizontal head board until it made contact with the head. Height was immediately documented to the nearest 5 mm and was re-checked by a second researcher.

### 2.3. Statistical Analysis

Basic anthropometric measurements, derived anthropometric measurements, and z-scores were used to determine the prevalence of undernutrition among the study population. Z-scores were calculated using the WHO 2007 growth reference data for individuals between the ages of 5 to 19 (21). Stunting and thinness were defined as height for age z-score (HAZ) and BMI for age z-score (BMIAZ) < -2 SD, respectively. Severe stunting and severe thinness were defined with a cut-off of HAZ and BMIAZ < -3 SD. Overweight was defined as BMIAZ > 1 SD and obese as BMIAZ > 2 SD. Wasting and severe wasting were defined as age-specific MUAC values within the yellow and red ranges, respectively. A MUAC value within the green range was considered "normal". Additionally, we added a classification category, "borderline normal", which was defined as a MUAC less than 2 mm off the cut-off value (defining the border between normal and wasting).

IBM® SPSS® Statistics version 22 (for Mac), Stata version 13 and R3.2.3 were used to perform statistical analyses. Mean values and standard deviations were calculated for weight, height, BMI, and MUAC. Z-scores (difference from zero) were tested for significance using a one-sample t-test. Categorical data were compared using Pearson's chi-square test. Spearman's correlation corrected for ties and  $\chi^2$  tests were used to assess the trend of continuous and categorical variables by age groups, respectively. A P-value < 0.05 was considered statistically significant.

### 2.4. Ethical Approval

The study was approved by the ethical committee of the University hospital of Antwerp (registration number: B300201627510). Only verbal informed consent of the parents/guardians for their children to participate in the study was obtained for this study, as there were no invasive procedures included in the study and it was considered that assessing the nutritional status of the children

was important to develop a targeted nutritional support program for this community. Permission to conduct the study was also obtained from both the Baraa village and Baraa primary school administrations.

### 3. Results

After data cleaning, one record was found to have spurious entry (height = 27.5 and BMI 317). Excluding this record from the analysis, the data set included the records of 1 378 children, of which 655 (47.5%) were male. The majority of the study participants were in the age group of 4 - 9 years (662 children; 48.1%) or 10 - 13 years (638 children; 46.3%). Only 78 (5.6%) of the children were aged 14 years or above.

The baseline characteristics of the study participants are shown in [Table 1](#). Age, weight, height, and MUAC were similar between males and females. Mean z-scores (WAZ, BMIAZ, and HAZ) were significantly lower than 0 ( $P < 0.001$ ) indicating that the study population had lower weight, height, and BMI for age than the reference population. There was no significant difference between the mean values of any anthropometric values between males and females ( $P > 0.05$ ; [Table 1](#)).

A total of 326 (23.7%) children suffered from at least one form of undernutrition, for which the prevalence was similar between males (23.9%) and females (23.4%;  $P = 0.80$ ). Of 326 undernourished children, 169 (52.8%) were stunted, 102 (31.3%) were thin, and 55 (16.9%) were both stunted and thin. Of the stunted children ( $n = 224$ ), 192 (85.7%) were moderately stunted, while 32 (14.3%) were severely stunted ([Table 2](#)). The prevalence of stunting and severe stunting did not differ significantly between males (17.4%) and females (15.2%;  $P = 0.27$ ).

Thinness was present in 126 (9.1%), while 30 (2.2%) children showed severe thinness. Despite the rather prominent presence of undernutrition, 28 (2.0%) children were either overweight or obese ([Table 2](#)).

The prevalence of stunting was lowest in the age group of 4 - 9 years and highest in the age group of 14 - 19 years ([Table 2](#)). Of the children younger than 10 years, 43 (6.5%) were stunted or severely stunted, while in the age group of 14 - 19 years, this prevalence was 35.9% ( $n = 28$ ; [Table 2](#)).

A similar trend for an increased prevalence of thinness by age was also seen in this population. While the prevalence of thinness or severe thinness was 5% in the youngest age group, the prevalence was highest (26.9%) in the oldest age group (14 - 19 years; [Table 2](#)). Although the test statistics showed that that prevalence of undernutrition was similar between genders (23.9% in females vs. 23.4% in males,  $P = 0.80$ ), the prevalence was modified by the effect of age. [Figure 1A](#) shows that females in the age group of 4 - 9 years

had a higher prevalence of undernutrition than males ( $P = 0.01$ ), while in the oldest age group, males showed a slightly higher prevalence than females ( $P = 0.06$ ). This pattern is further demonstrated in [Figure 1B](#), which shows that the odds ratio of undernutrition substantially increased with age, and the risk was larger in males than in females.

MUAC was normal in 1,020 (73.9%) children, while 93 (6.7%) were classified as “borderline normal” and 227 (16.4%) children were classified as “wasted”. Severe wasting was present in 39 children (2.8%).

There was an association ( $P < 0.001$ ) between both stunting and thinness and an aberrant MUAC colour (yellow or red). One hundred and thirty-one children (58.5%) who were stunted and 124 children (78.9%) who were thin showed an aberrant MUAC colour.

### 4. Discussion

This study showed that 1/4 of all children attending a primary school in the Baraa village in Tanzania suffered from at least one type of undernutrition, with stunting observed more often than thinness. However, in the overall population, no gender differences in the prevalence of both types of undernutrition were found, although a significant difference was seen after stratification for age. In the youngest age group (4 - 9 years), undernutrition was more common in females, whereas in the oldest age group (14 - 19 years), undernutrition was more common in males. For both sexes, the prevalence of undernutrition increased with age, and this positive correlation between age and prevalence was seen in both types of undernutrition (stunting and thinness).

The prevalence of undernutrition found in this study was similar to that of other studies conducted in a similar population and is comparable to that of the region (22-25). Furthermore, the correlations between both age and sex and prevalence of under nutrition is as seen in other similar studies (26-28). A similar association of undernutrition and age has also been seen in regions less comparable to the East African regions (29, 30). One of the leading contributing factors to the positive correlation between age and prevalence of undernutrition is thought to be the delay in the start of the growth spurt. The delay in the start of the growth spurt is multifactorial and can be affected by many factors such as helminth infection, micronutrient deficiency, and energy intake deficiency (31). The growth spurt in boys is slightly delayed compared with that of girls, which may explain the higher rates of stunting in older age groups as well as sexual differences. Another contributing factor that leads to a higher prevalence of stunting in older children is that stunting, a chronic type of un-

**Table 1.** Baseline Characteristics of Study Participants

Characteristic	All Participants (n = 1,378)	Male (n = 655)	Female (n = 723)	Test Statistic, P Value
Sex (%)	1,378 (100)	655 (47.5)	723 (52.5)	
Age, y, median (IQR)	10 (7-12)	10 (7-12)	10 (7-12)	Z = -0.13, P = 0.90 <sup>a</sup>
Weight, mean (SD)	27.7 (7.7)	27.6 (6.9)	27.8 (8.3)	t = 0.59, P = 0.55
Height, mean (SD)	132.4 (13.5)	132.2 (13.0)	132.6 (13.9)	t = 0.62, P = 0.54
MUAC, mean (SD)	17.9 (2.2)	17.8 (1.9)	18.0 (2.3)	t = 1.63, P = 0.10

<sup>a</sup>Sign rank test, MUAC = mid-upper arm circumference.

**Table 2.** Distribution of Anthropometric Scores, Stunting and Thinness of Study Participants by Age Group

Variable	All Participants		Age Group		Trend Test ( $\chi^2$ Trend (P Value))
	(n = 1,378)	4 - 9 (n = 662), y	10 - 13 (n = 638), y	14 - 19 (n = 78), y	
Male, n (%)	665 (47.5)	307 (46.4)	305 (47.8)	43 (55.1)	0.53 (0.467)
BMI, mean (SD)	15.5 (1.7)	14.9 (1.31)	15.9 (1.8)	17.2 (2.1)	0.37 (< 0.001) <sup>a</sup>
BMI-for-age, mean (SD)	-0.88 (1.73)	-0.605 (0.91)	-1.106 (1.02)	-1.392 (1.04)	-0.28 (< 0.001) <sup>a</sup>
Height-for-age, mean (SD)	-0.96 (1.10)	-0.575 (1.02)	-1.278 (1.00)	-1.702 (1.20)	-0.35 (< 0.001) <sup>a</sup>
Weight-for-age, mean (SD)	-0.49 (0.95)	-0.373 (0.92)	-0.920 (0.94)		-0.23 (< 0.001) <sup>b</sup>
Stunted <sup>c</sup>	224 (16.25)	43 (6.49)	153 (23.98)	28 (35.89)	67.0 (< 0.001)
Moderate stunted <sup>c</sup>	192 (13.93)	42 (6.34)	134 (21.0)	16 (20.51)	39.2 (< 0.001)
Severe stunted <sup>c</sup>	32 (2.32)	1 (0.15)	19 (2.98)	12 (15.38)	50.0 (< 0.001)
Thinness and overweight <sup>c</sup>	184 (13.35)	52 (7.85)	110 (17.24)	22 (28.21)	30.1 (< 0.001)
Thinness <sup>c</sup>	126 (9.14)	27 (4.08)	82 (12.85)	17 (21.79)	37.5 (< 0.001)
Severe thinness <sup>c</sup>	30 (2.18)	6 (0.91)	20 (3.13)	4 (5.13)	10.4 (0.001)
Overweight and obese <sup>c</sup>	28 (2.03)	19 (2.87)	8 (1.25)	1 (1.28)	3.69 (0.055)
Undernutrition <sup>c</sup>	326 (23.66)	71 (10.73)	219 (34.33)	36 (46.15)	72.3 (< 0.001)

<sup>a</sup>Spearman correlation coefficient (P values).

<sup>b</sup>Computed for children below 10 years only.

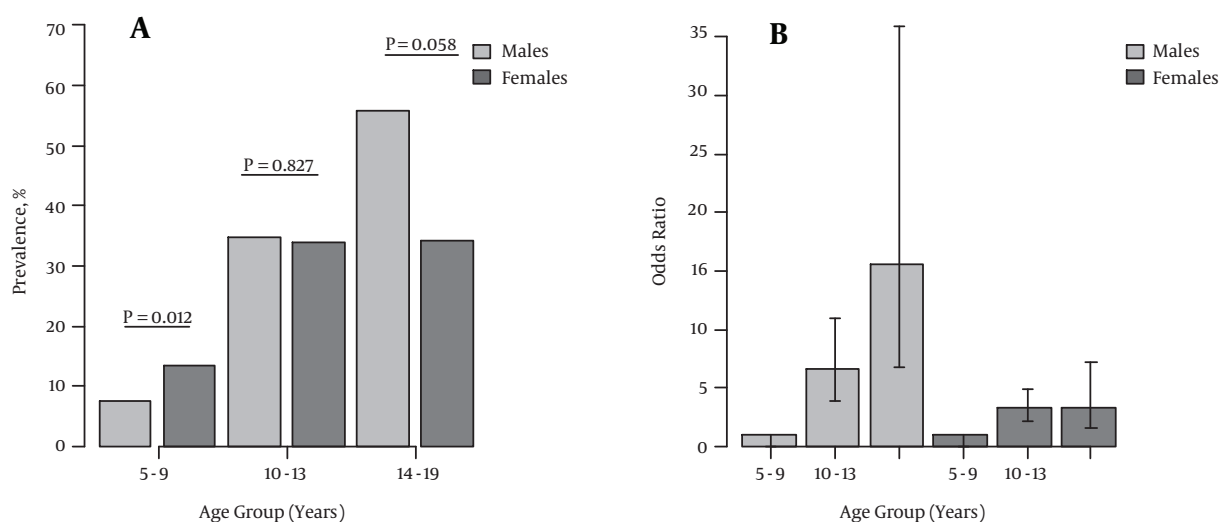
<sup>c</sup>Values are expressed as No. (%).

dernutrition, is maintained by prolonged exposure and is difficult to reverse in late childhood (8, 25).

One sixth of the undernourished children in our study appeared to be both stunted and thin. A strong overlap in risk factors, such as a poor socio-economic environment, low (parental) cultural status and income level, poor feeding practices and quality of food for both types of undernutrition, is thought to explain this coincidence of both types of undernutrition in one person (32). Although some studies claim the overlap of risk factors between different types of undernutrition is rather minimal (33), different types of undernutrition often co-exist and lead to a compounded risk of morbidity and mortality (34). Furthermore, a very early or delayed transition from exclusively breastfeeding to complementary food is thought to be harmful for children and can lead to undernutrition (35). Poor quality of

food is one of the major risk factors for undernutrition. The lack of good-quality food in Tanzania, which is caused by bacterial and faecal contamination, poor storage conditions, and also the presence of flies and other animals, may have also contributed to this finding (15).

To improve the nutritional status of children in the Arusha region of Tanzania, a non-profit organization started a targeted nutritional support program. Our data were used by this organization to identify the age groups at highest risk of morbidity and mortality due to undernutrition. This program will consist of health education for all children included in the present study. Furthermore, all children suffering from stunting or thinness will be included in a nutritional program that consists of providing a healthy lunch at school. The financial costs of the entire program will be covered by a Belgian non-profit organiza-



**Figure 1.** Distribution of the prevalence (A) and odds ratio (B) of undernutrition by age group and sex. In Figure 1B, the baseline age group is 5-9 years

tion.

Both interventions are well known as cost-effective interventions to augment education and health (36, 37). Health education lessons will be given to all children of the Baraa Primary School, and nutritional support will consist of providing balanced lunch meals prepared using resources harvested from an adjacent cropland.

In addition to height and weight, a 3rd parameter, the MUAC, was examined. Due to its simplicity and ease of use, it is being increasingly recognized as a tool to screen for poor nutritional status in adults (38, 39). However, the use of this tool in older children and adults remains rather limited because of the lack of a consensus regarding the cut-off values to be used in individuals above the age of 5 years (40-42).

Despite the potential contribution of the present study regarding the prevalence of undernutrition in the Arusha region, the study had some major limitations that are important to mention. First, the study did not assess factors (dietary intake, family size, and mean income of caregivers, etc.) associated with undernutrition in this population, which could further provide insight into the types of interventions to be implemented in this population. Furthermore, the study was only conducted in one village, which makes it impossible to generalize the findings for the entire region.

#### 4.1. Conclusion

Our study population, consisting of primary school children living in a Tanzanian village, was significantly smaller and thinner than the global reference population.

With an overall prevalence of 23.7%, undernutrition remains prevalent among children attending Baraa primary school in the Arusha region. Furthermore, 1/6 of the students who were undernourished were both stunted and thin, and the oldest children were the most affected.

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#### Footnotes

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