Associations among anthropometric measures, food consumption, and quality of life in school-age children in Tanzania

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Abstract

Objectives: The factors associated with quality of life (QOL) and anthropometric measurements as outcomes of food consumption were examined among school-age children in Tanzania.

Methods: A cross-sectional study was undertaken in September 2013 in Tanzania. Anonymous self-administered questionnaire surveys were conducted in the Kiswahili language among primary school children in the fifth and/or sixth grade aged 10–14 years. The survey probed sociodemographic characteristics such as age, gender, living with family members, number of meals/snacks per day, food consumption in the previous 24 hours, and QOL, as well as anthropometric measurements (height and weight). The Rohrer index was calculated based on height and weight. After presenting the mean and standard deviation (SD) of height, weight, and the Rohrer index score by age and gender, the Rohrer index score was categorized into three groups (low weight, normal weight, and overweight) and analyzed according to sociodemographic characteristics and food consumption using the chi-square test. Furthermore, the QOL score was analyzed using the t-test. Multivariate linear regression analysis was used to analyze the associations between the QOL score and sociodemographic characteristics and food consumption.

Results: A total of 694 children (male: 312; female: 382) participated in this study. According to the Rohrer index, 273 (39.3%) children were classified as low weight, 353 (50.9%) were normal weight, and 68 (9.8%) were overweight. A total of 459 (66.1%) children reported having had three or more meals and/or snacks on the day before the study. In addition, 127 (18.3%) children had not eaten any protein-rich food on the day before the study, although almost all had eaten at least one carbohydrate-rich food per day. Regardless of region, location, gender, and age, living without parents was associated with short stature ($P = 0.010$). A high QOL score was associated with having three or more meals and/or snacks per day ($P < 0.001$).

Conclusions: The security of physiological needs such as a guarantee of three meals per day could contribute to higher QOL among underserved children.

Key words: anthropometric measures, food consumption, quality of life, school-age children

Introduction

The life and health of people within socially disadvantaged populations, particularly children, are vulnerable to the influences of various social determinants of health and susceptible to difficult and dangerous conditions such as housing insecurity1–3. A study in South Africa indicated that the levels of anxiety and depression, affability, and resilience did not differ significantly between orphans and non-orphans, but there were relationships between caregivers’ physical health, their caregiving capacities, and children’s psychosocial wellbeing regardless of “orphanhood” status4. Orphans’ health status is strongly dependent on their foster home environment, and there is evidence regarding the importance of developing and strengthening the health literacy...
Food security is a critical issue affecting the health conditions and wellbeing of orphans and their caregivers\(^5\). General self-rated health among orphans and vulnerable children was reported to be associated with increased access to food and medical health care, education, safe drinking water, and household income\(^7\). The consumption of three meals per day was associated with positive self-rated happiness among vulnerable children including orphans, as was no working activities such as being a street vendor or doing laundry by hand, good relationships with caregivers, and positive community attitudes towards orphans as a source of capacity for the community\(^8\). In addition, “living with mother” was one factor contributing to the frequency of consumption of carbohydrate-rich foods as staples among vulnerable children including orphans\(^9\).

Low nutritional status among children is a challenge in rural areas and populations with low socioeconomic status (SES)\(^10,12\). On the other hand, childhood obesity and overweight prevalence are becoming global public health concerns, even in the high-SES populations of developing countries and industrialized countries\(^13,15\). Recent rapid economic growth in Africa has been accompanied by increases in social deprivation, including food security disparities. SES is an important predictor of food security and nutritional status\(^16\). The impacts of economic growth and development on food security and consumption should be considered when evaluating nutritional outcomes in societies undergoing rapid economic growth.

There have been few studies regarding the interrelations between anthropometric measurements, food consumption, and quality of life (QOL) among school-age children including orphans and vulnerable children in Sub-Saharan Africa. Here, we investigated the relationships between sociodemographic factors, anthropometric measurements, food consumption, and QOL among school-age children in the Sub-Saharan African country, Tanzania.

**Methods**

This study was conducted in Dar es Salaam (population in 2012: 4,364,541) and Moshi (population in 2012: 184,292), Tanzania, in September 2013. One of the three districts in Dar es Salaam was randomly selected. The selected district contained 140 governmental primary schools (81 from urban areas and 59 from rural areas). Moshi had 34 governmental primary schools (20 from urban areas and 14 from rural areas). Two primary schools from urban areas and two primary schools from rural areas in both cities were selected for this study. Urban and rural areas were defined according to the classification of the governmental school list provided by the municipal offices. The numbers of study participants and subjects for analysis from each school are shown in Table 1.

Anonymous self-administered questionnaire surveys were conducted in the Kiswahili language among fifth and/or sixth grade primary school-age children to gather data on sociodemographic characteristics (age, gender, and family members living together), daily life conditions (working status and number of meals/snacks per day), food consumption in the previous 24 hours, QOL, and anthropometric measurements (height and weight). The height and weight of all questionnaire survey participants were measured by the authors and research assistants, all of whom were Muhimbili University nursing graduates and nursing teachers from Kilimanjaro Medical Training College. The Rohrer index score was calculated from height and weight, and scores of \(< 115\) were classified as low weight, \(115–145\) as normal weight, and \(> 145\) as overweight. The Rohrer index score was calculated as shown below\(^17\).

\[
\text{Rohrer index score} = \frac{\text{weight (kg)}}{\text{height (cm)}} \times 10^7
\]

A list of common breakfast, lunch, and supper foods in the study areas was formulated based on our previous interviews with school-age children who visited anti-retroviral treatment clinics, including 30 children in Dar es Salaam and 30 children in Moshi (unpublished). The participants completed the hard copy questionnaire by selecting options from the list illustrating their food consumption in the past 24 hours. If the list included no food that they had eaten, they provided the name of the food in the “others” section of the questionnaire. The reported foods consumed were categorized as carbohydrate-rich or protein-rich foods, and vegetables or others for analysis by identifying the main nutritional contents of each food mentioned by the participants (Table 2).

Table 1: Numbers of study participants and subjects for analysis from each school

| Region         | Location | Participants | Subjects for analysis |
|----------------|----------|--------------|-----------------------|
| School 1 Dar es Salaam | Urban    | 120          | 118                   |
| School 2 Dar es Salaam | Urban    | 126          | 119                   |
| School 3 Dar es Salaam | Rural    | 148          | 144                   |
| School 4 Dar es Salaam | Rural    | 99           | 95                    |
| School 5 Moshi        | Urban    | 59           | 58                    |
| School 6 Moshi        | Urban    | 23           | 23                    |
| School 7 Moshi        | Rural    | 73           | 73                    |
| School 8 Moshi        | Rural    | 64           | 64                    |
| Total               |          | 712          | 694                   |

QOL was evaluated based on seven questions from the WHOQOL-BREF\(^18\), adapted by the authors for the condi-
The mean and standard deviation (SD) of height, weight, and Rohrer index score by age and gender were calculated. The Rohrer index score was categorized into three groups (low weight, normal weight, and overweight) and analyzed according to sociodemographic characteristics and food consumption using the chi-square test. The QOL score was also analyzed according to sociodemographic characteristics and food consumption using the t test. Multivariate linear regression analysis was used to analyze the associations between QOL score and sociodemographic characteristics and food consumption. IBM SPSS statistics 22.0 was employed for statistical analysis. In all analyses, P < 0.05 was taken to indicate statistical significance.

This study was approved by the educational sectors of local government and the leaders of selected schools after being informed of the procedures and ethical issues prior to survey distribution. An oral explanation regarding study participation including ethical considerations, the voluntary nature of participation, and right to refusal if they did not wish to answer was provided to the participants before the survey. Privacy and confidentiality were protected during both survey distribution and data analysis processes, and participants were not asked to give their name or any information that would allow household identification. In addition, all data obtained were anonymized to ensure confidentiality. This study was approved by the Ethics Committee of the National Institute of Medical Research (NIMR) in Tanzania (approval number MINR/HQ/R.8c/Vol. II/149).

**Results**

A total of 694 school-age children (male: 312; female: 382) aged 10–14 years participated in this survey, which gathered information about sociodemographic characteristics, food consumption in the previous 24 hours, QOL, and anthropometric measurements (height and weight).

Table 3 shows the children’s height (cm) and weight (kg) by age. Females exceeded males in both average height and weight in all age groups except weight for the 10-year-olds.

Table 4 shows children’s sociodemographic characteristics, Rohrer index score, and QOL score. Based on the Rohrer index score, 273 (39.3%) children were classified as low weight, 353 (50.9%) as normal weight, and 68 (9.8%) as overweight. Other than gender, there were no significant differences encountered by Tanzanian school children (Box 1), and evaluated on a five-point scale (1–5). The QOL score was calculated by totaling the number of points for the seven questions (maximum 35 points).

The mean and standard deviation (SD) of height, weight, and Rohrer index score by age and gender were calculated. The Rohrer index score was categorized into three groups (low weight, normal weight, and overweight) and analyzed according to sociodemographic characteristics and food consumption using the chi-square test. The QOL score was also analyzed according to sociodemographic characteristics and food consumption using the t test. Multivariate linear regression analysis was used to analyze the associations between QOL score and sociodemographic characteristics and food consumption. IBM SPSS statistics 22.0 was employed for statistical analysis. In all analyses, P < 0.05 was taken to indicate statistical significance.

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### Box 1 Questions to evaluate the QOL of school-aged children

1. How would you rate your quality of life?
2. How satisfied are you with your health?
3. How satisfied are you with the support you get from your family and/or caregiver?
4. How satisfied are you with the support you get from your friends?
5. Do you have enough energy for everyday life?
6. Have you enough money to meet your needs?
7. How often do you have negative feelings such as unhappiness, despair, anxiety, or depression?
differences in the distribution of the Rohrer index score by region, location, living status with parent(s), current working status, or food consumption. Children in Dar es Salaam were more likely to be low weight or overweight compared to those in Moshi, although the differences were not significant (chi-square test, $P = 0.114$).

As shown in Table 4, 459 (66.1%) children reported having three or more meals and/or snacks in the day before the survey. Only two children (0.3%) reported that they did not eat any carbohydrate-rich foods as staples on the day before the survey; they were both orphans that had lost both parents. A significant difference was observed in the consumption of carbohydrate-rich food at least once per day between children living with and without parent(s) (Fisher’s exact test, $P = 0.027$, data not shown in tables). As shown in Table 4, 127 (18.3%) children had not eaten any protein-rich food on the day before the survey. There was no significant difference in the consumption of protein-rich food at least once

### Table 3  Height and weight of school-age children in Dar es Salaam and Moshi, Tanzania ($n = 694$)

|          | Male                       | Female                      |
|----------|----------------------------|-----------------------------|
|          | Height Mean ± SD           | Weight Mean ± SD            | Rohrer index score Mean ± SD |
|          | n                          | n                           | n                          |
| 10 years | 15                         | 136.9 ± 5.3                 | 31.7 ± 5.0                 | 123.2 ± 17.2 | 137.3 ± 5.4 | 30.9 ± 5.0 | 119.6 ± 17.2 |
| 11 years | 80                         | 138.4 ± 5.7                 | 32.3 ± 6.9                 | 120.9 ± 16.8 | 157          | 140.4 ± 6.9 | 34.7 ± 7.1 | 125.0 ± 21.5 |
| 12 years | 101                        | 141.5 ± 6.3                 | 33.2 ± 5.3                 | 117.2 ± 17.5 | 117          | 145.1 ± 6.8 | 37.3 ± 8.9 | 121.4 ± 22.2 |
| 13 years | 91                         | 145.4 ± 8.5                 | 36.3 ± 8.4                 | 117.2 ± 17.3 | 69           | 148.1 ± 8.2 | 41.7 ± 9.0 | 128.1 ± 21.7 |
| 14 years | 25                         | 151.1 ± 7.6                 | 39.7 ± 6.1                 | 114.9 ± 13.1 | 7            | 154.1 ± 7.1 | 47.8 ± 4.9 | 131.8 ± 20.2 |

### Table 4  Sociodemographic characteristics, Rohrer index score, and QOL score of the study participants ($n = 694$)

| Region           | Region           | n    | %    | n    | %    | n    | %    | n    | %    | n    | %    | n    | %    | n    | %    | Mean ± SD   | P-value (Chi-square test) | P-value (t test) |
|------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------------|--------------------------|------------------|
| Dar es Salaam    | Moshi            | 476  | 68.6 | 191  | 40.1 | 231  | 48.7 | 53   | 11.1 | 0.114 | 23.5 ± 3.8 | 0.001 | 24.5 ± 3.6 | 0.001 | 23.9 ± 3.3 | 0.065                |
| Location         | Urban            | 318  | 45.8 | 133  | 41.8 | 153  | 48.1 | 32   | 10.1 | 0.399 | 23.8 ± 4.1 | 0.001 | 24.2 ± 3.3 | 0.057 | 23.6 ± 4.0 | 0.001                |
| Dar es Salaam    | Moshi            | 218  | 31.4 | 82   | 37.6 | 121  | 55.5 | 15   | 6.9  | 0.691 | 23.9 ± 3.6 | 0.001 | 24.2 ± 3.3 | 0.057 | 23.6 ± 4.0 | 0.001                |
| Female           | Male             | 312  | 45.0 | 137  | 43.9 | 162  | 51.9 | 13   | 4.2  | < 0.001 | 24.2 ± 3.3 | 0.001 | 23.6 ± 4.0 | 0.001 | 24.2 ± 3.3 | 0.057                |
| Female           | Female           | 382  | 55.0 | 136  | 35.6 | 191  | 50.0 | 55   | 14.4 | 0.691 | 23.9 ± 3.6 | 0.001 | 24.2 ± 3.3 | 0.057 | 23.6 ± 4.0 | 0.001                |
| Age group        | 10–12 years old  | 502  | 72.3 | 188  | 37.5 | 268  | 54.3 | 46   | 9.2  | 0.097 | 23.9 ± 3.8 | 0.031 | 23.6 ± 3.6 | 0.001 | 24.2 ± 3.3 | 0.057                |
| ≥ 13 years old   | 192              | 27.7 | 85   | 44.3 | 85   | 44.3 | 22   | 11.5 | 0.097 | 23.9 ± 3.6 | 0.031 | 23.6 ± 3.6 | 0.001 | 24.2 ± 3.3 | 0.057                |
| Living with parent(s) | Living without parents | 115  | 16.6 | 41   | 35.7 | 62   | 53.9 | 12   | 10.4 | 0.691 | 23.2 ± 4.5 | 0.112 | 23.8 ± 3.7 | 0.001 | 24.1 ± 3.5 | 0.001                |
| Living with parent(s) | Living with one parent | 203  | 29.3 | 86   | 42.4 | 101  | 49.8 | 16   | 7.9  | 0.691 | 23.2 ± 4.5 | 0.112 | 23.8 ± 3.7 | 0.001 | 24.1 ± 3.5 | 0.001                |
| Living with parent(s) | Living with parents | 376  | 54.2 | 146  | 38.8 | 190  | 50.5 | 40   | 10.6 | 0.691 | 23.2 ± 4.5 | 0.112 | 23.8 ± 3.7 | 0.001 | 24.1 ± 3.5 | 0.001                |
| Working status   | Not working      | 645  | 92.9 | 253  | 39.2 | 329  | 51.0 | 63   | 9.8  | 0.943 | 23.9 ± 3.7 | 0.150 | 23.1 ± 3.8 | 0.001 | 24.5 ± 3.4 | 0.001                |
| Working          | 44               | 6.3  | 17   | 38.6 | 22   | 50.0 | 5    | 11.4 | 0.943 | 23.9 ± 3.7 | 0.150 | 23.1 ± 3.8 | 0.001 | 24.5 ± 3.4 | 0.001                |
| Number of meals on the day before the survey | Number of meals on the day before the survey | 235  | 33.9 | 84   | 35.7 | 124  | 52.8 | 27   | 11.5 | 0.293 | 22.6 ± 4.1 | < 0.001 | 24.5 ± 3.4 | 0.001 | 24.5 ± 3.4 | 0.001                |
| ≥ 3              | 459              | 66.1 | 189  | 41.2 | 229  | 49.9 | 41   | 8.9  | 0.293 | 22.6 ± 4.1 | < 0.001 | 24.5 ± 3.4 | 0.001 | 24.5 ± 3.4 | 0.001                |
| Consumption of protein-rich food on the day before the survey | Yes (at least once) | 567  | 81.7 | 223  | 39.3 | 291  | 51.3 | 53   | 9.3  | 0.680 | 23.1 ± 4.0 | 0.014 | 24.0 ± 3.7 | 0.014 | 23.1 ± 4.0 | 0.014                |

*ANOVA.*
Table 5  Factors associated with a higher QOL score among school-age children in Dar es Salaam and Moshi, Tanzania (n = 694)

|                      | Height          | Weight         | Rohrer index score | QOL score       |
|----------------------|-----------------|----------------|-------------------|-----------------|
|                      | β               | P-value        | β                | P-value        | β              | P-value        |
| Region (Dar es Salaam / Moshi) | 0.014           | 0.675          | 0.016            | 0.665          | -0.006         | 0.887          | 0.083           | 0.029          |
| Location (Urban / Rural)          | -0.077          | 0.031          | -0.049           | 0.194          | 0.018          | 0.647          | 0.001           | 0.971          |
| Gender (Male / Female)                | 0.146           | < 0.001        | 0.225            | < 0.001        | 0.156          | < 0.001        | -0.083          | 0.033          |
| Age                           | 0.452           | < 0.001        | 0.342            | < 0.001        | 0.005          | 0.895          | -0.055          | 0.165          |
| Living with parent(s)           | -0.089          | 0.010          | -0.046           | 0.204          | 0.034          | 0.379          | 0.035           | 0.364          |
| (Living without parents / With one parent / With parents) | -0.027          | 0.431          | 0.004            | 0.921          | 0.014          | 0.716          | -0.033          | 0.382          |
| Number of meals on the day before the survey (≤ 2 / ≥ 3) | -0.015          | 0.418          | -0.058           | 0.119          | -0.074         | 0.065          | 0.172           | < 0.001        |
| Consumption of protein-rich food on the day before the survey (No / Yes, at least once) | 0.009           | 0.787          | 0.013            | 0.720          | -0.008         | 0.831          | 0.062           | 0.102          |

Table 5 continues...
of stunting due to chronic lack of nutrition and is associated with low SES\(^2\). Having the father and/or both parents in the household may reduce negative impacts on children’s wellbeing and life conditions, because the income status of men is generally higher than that of women\(^2\). For example, the father’s presence contributed to better schooling of children, although the same association was not observed for the mother’s presence\(^2\). The father’s absence may influence household income and/or food security, and adversely affect long-term aspects of children’s growth such as height.

Previous studies indicated that the number of children in the household was related to children’s nutritional and growth status such as stunting\(^3\), but no such differences were observed in this study. Although some participants reported living in homes where there were numerous children, > 75% of the participants lived with three or fewer children in this study. Therefore, the number of children in the household did not affect children’s food consumption or anthropometric measurements in this study.

On the other hand, regardless of region and location of residence, about 10% of the participants was overweight according to the Rohrer index score. As mentioned in the introduction, childhood obesity and overweight prevalence have been observed even in high-SES populations in developing and industrialized countries\(^4\). There is an inverse association between SES and childhood obesity in industrialized countries, especially in low-SES populations\(^5\), because of greater access to energy-dense diets among low-SES populations in industrialized countries\(^6\). Further studies are required to identify background factors and mechanisms underlying the relations between region and location of residence and anthropometric measurements of school-age children in Tanzania. However, low-SES populations should be considered at risk of poor nutritional status, irregular child growth, and unbalanced food consumption such as high dependence on energy-dense diets, resulting in higher levels of overweight and obesity.

Limited access and/or not consuming three meals and/or snacks per day were associated with low QOL in this study, suggesting the importance of determining the mechanisms underlying the relationships between a healthy life, including food security and a high QOL. A previous study performed in South Africa indicated associations of food security and access to medical services with better emotional wellbeing of orphans, although SES such as the household asset index and monthly household expenditure showed no such associations\(^7\). Experiences in Canada indicated that a small monthly income supplementation for each child aged under six years significantly reduced food insecurity among vulnerable households such as low-income and single-parent families\(^8\). Physiological needs including food are defined as the most fundamental human needs in Maslow’s hierarchy of needs, followed by safety—including financial security, health, and wellbeing—and needs of belonging including family and intimacy. The results of this and previous studies explain the importance of food security including number of meals per day as physiological needs rather than orphanhood status, and household income and/or poverty level as safety and belonging needs. Caregivers’ condition and caregiving capacity as safety needs are more likely to be related to children’s wellbeing and/or QOL than orphanhood status as a belonging need.

Consumption of carbohydrate-rich foods was not analyzed in this study, because almost all participants ate carbohydrate-rich foods at least once per day. Bivariate analysis showed statistically significant relations between protein-rich food consumption and QOL in this study, although multivariate linear regression analysis did not show statistical significance. When carbohydrate-rich food consumption needs are satisfied, we estimated that children may expect consumption of quality foods such as protein-rich foods, although further studies are required to clarify the relationship between children’s QOL and consumption of quality foods. As carbohydrate-rich foods including bread, rice, plantain, and taro are usually staples in the study areas, they are likely to be the first choice of food under conditions with insufficient options and capacity for survival. On the other hand, there was no clear difference in quality food consumption, such as of protein-rich foods, between children living with or without parent(s), although previous studies indicated that food security is dependent on household economic status\(^9\), which is in turn associated with the presence of the father in the household and his support\(^8\).

This study had several limitations. Only the number of meals per day and variations in consumption of carbohydrate-rich foods and protein-rich foods were assessed, while quantity of food and nutritional intake were not included in the analyses. We did not assess the consumption of tea, milk, and/or other types of drinks containing sugar. This study also did not rigorously evaluate children’s growth using the Z-score of height for age and weight for age according to Tanzanian standards for school-age children that were not appropriate, although the Rohrer index score is a means of assessing weight for height among school-age children. This is because the objectives of this study were to evaluate the relationships between factors related to anthropometric measurements, food consumption, and QOL in general in Tanzania, not to assess the details of school-age children’s growth monitoring through multi-dimensional measurements. As this study had a cross-sectional design, it was not possible to evaluate the long-term influence of SES and food consumption on children’s growth and anthropometric
measures to determine the relationships between these factors on children’s self-rated QOL.

Measures to avoid deaths such as reducing deaths among young people are needed in low-SES populations. In addition, this study suggested the need to improve the living environments and conditions of vulnerable children, such that they can receive the continued and stable support necessary to lead a safe and healthy life. It is especially important to ensure food security, defined as three meals per day, to satisfy their physiological needs. In addition, under socially disadvantaged conditions, it is important to improve not only individual capacity, but also family and community capacities to secure positive development for health promotion.

Conflict of Interest: None declared.

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