Sokoine University of Agriculture

MSc Dissertation

Influence of School Food Environment on Eating Behaviours and Nutritional Status of Primary School Children (6-13 years) in Dodoma

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May 2024

INFLUENCE OF SCHOOL FOOD ENVIRONMENT ON EATING BEHAVIOURS AND NUTRITIONAL STATUS OF PRIMARY SCHOOL CHILDREN (6-13 years) IN DODOMA

Dissertation Submitted to Sokoine University of Agriculture in Fulfilment of the Requirements for the Master Degree in Human Nutrition

By

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EXTENDED ABSTRACT

Malnutrition among school-aged children has significant consequences for their health, cognitive development, and overall educational achievement. Rapid shifts in the availability and affordability of less nutritious foods in food environments have contributed to the dual challenges of malnutrition. There is growing global interest in understanding how food environments contribute to this double burden of malnutrition. This study aimed to assess the impact of the school food environment on the eating habits and nutritional well-being of primary school children aged 6 to 13 years in Dodoma region. Specific objectives were first: to evaluate the nutritional status of school-age children and examine how socio-economic, demographic, and environmental factors influence their nutritional well-being; second, to investigate how the school food environments affect the eating behaviours of primary school children in both public and private schools in Dodoma region. A cross-sectional study involving 248 pupils was conducted in eight primary schools in Dodoma region. Four schools were chosen from Chamwino district (a rural setting), including two public and two private schools. The other four schools were located in Dodoma urban district (an urban setting), comprising of two government schools and two private schools. The study also involved eight head teachers and eight health/food teachers, who were purposefully selected from the eight participating primary schools. Anthropometric measurements were made following the World Health Organization (WHO) guidelines to assess stunting, thinness, underweight, and overweight/obesity. Socio-demographic data were collected from pupils using structured questionnaires. School administrators, including head teachers and health/food teachers, provided information on the physical, political, and socio-cultural aspects of the school food environment. Data on eating behaviours were obtained through structured questionnaires and food frequency questionnaires to assess students' dietary patterns over a period of seven days. Additionally, an observation checklist was used to

gather information on the availability and accessibility of foods consumed by the school children. Data analysis was performed by using the WHO AnthroPlus v1.0.4 software and IBM SPSS Statistics 26v. Descriptive statistics, such as frequencies and percentages, were calculated. Regression models were used to explore the determinants of nutritional status, reporting both crude (COR) and adjusted odds ratios (AOR). Multilevel modeling was employed to assess individual-level variance in eating behaviours and examine the association between the school food environment and dietary behaviours of children. Prevalence rates among surveyed pupils were as follows: stunting (10.5%), underweight (3.6%), thinness (2.8%), and overweight/obesity (10.1%). Stunting was more common in boys (13.2%) than in girls (8.2%), and it increased with age. Underweight was higher in public schools (8.2%) than in private schools (3.2%). Thinness was more prevalent in public schools (85.7%) than in private schools (14.3%), particularly in rural areas (57.1%) and among younger children (aged 6-9 years, 57.1%). Overweight/obesity was more common among girls (90.1%) than boys. Urban schools had a higher prevalence of overweight/obesity (90.3%) compared to rural schools (89.5%), and private schools had a higher prevalence (95.2%) than public schools (84.7%). Pupils in urban areas were more likely to be overweight/obese than those in rural settings. After adjusting for student characteristics, the school environment accounted for a small proportion of the variance in eating behaviours, ranging from 11.3% to 11.6% for carbohydrate-rich foods, 12.6% to 11.4% for protein-rich foods, 20.3% to 19.4% for vitamins and mineral-rich foods, and 11.0% to 10.1% for lipids and sugar-rich foods. In model 2, controlling for other factors, protein-rich and lipid and sugar-rich foods intake were significantly related to the death of a parent, while vitamins and mineral-rich foods intake were significantly related to the number of adults in the household. None of the investigated school food environmental factors were associated with the children's reported intake of carbohydrate-rich foods, protein-rich foods, vitamin and mineral-rich foods, or lipids and sugar-rich foods. These findings suggested that,

school-level factors do not strongly influence children's dietary behaviours. These results emphasize the need for interventions to improve the nutritional status of primary school pupils in Tanzania and recommend to conduct longitudinal studies on the school food environment.

IKISIRI KUU

Ukosefu wa lishe bora kwa watoto wa umri wa shule una athari kubwa kwa afya zao, maendeleo ya kiakili, na mafanikio yao ya elimu kwa ujumla. Mabadiliko ya haraka katika upatikanaji na bei nafuu ya vyakula visivyo na lishe bora katika mazingira ya chakula yamechangia katika changamoto za utapiamlo. Kuna nia inayoongezeka ulimwenguni kote ya kuelewa jinsi mazingira ya chakula yanavyochangia matatizo ya utapiamlo. Utafiti huu ulilenga kutathmini athari ya mazingira ya chakula shuleni kwa tabia za kula na hali ya lishe wa watoto wa shule ya msingi wenye umri kati ya miaka 6 hadi 13 mkoani Dodoma. Malengo maalum yalikuwa mawili: kwanza, kutathmini hali ya lishe ya watoto wa shule za msingi na kuchunguza jinsi viashiria vya kijamii, kidemografia, na mazingira vinavyoathiri hali yao ya lishe; pili, kuchunguza jinsi mazingira ya chakula shuleni yanavyoathiri tabia za kula za watoto wa shule ya msingi katika shule za umma na za binafsi mkoani Dodoma. Utafiti wa huu ulifanyika kuanzia Januari hadi Aprili 2023, ukijumuisha wanafunzi 248 kutoka shule nane za msingi mkoani Dodoma. Shule nne zilitoka wilaya ya Chamwino (eneo la vijijini), ikiwa ni pamoja na shule mbili za umma na mbili za binafsi. Shule nyingine nne zilikuwa katika wilaya ya Dodoma (eneo la mjini), zikiwa na shule mbili za serikali na mbili za binafsi. Utafiti pia ulihusisha walimu wakuu nane na walimu wa afya/chakula nane, ambao walichaguliwa kwa makusudi kutoka shule za msingi nane zilizochaguliwa. Vipimo vya *anthropometric* vilichukuliwa kufuatia mwongozo wa Shirika la Afya Ulimwenguni *(WHO)* ili kutathmini udumavu, uzito pungufu, ukondefu, na uzito kupita kiasi/. Taarifa za kidemografia zilipatikana kutoka kwa wanafunzi kwa kutumia dodoso lililopangwa. Waendeshaji wa shule, ikiwa ni pamoja na walimu wakuu na walimu wa afya/chakula, walitoa taarifa kuhusu vipengele vya muonekano wa mazingira, sheria za upatikanaji wa chakula shuleni, na upatikanaji wa chakula kijamii shuleni. Taarifa za tabia za kula zilipatikana kupitia dodoso lililopangwa na maswali ya chakula kutokana na utumizi wa chakula ndani ya siku saba zilizopita. Aidha,

orodha ya uchunguzi ilitumika kukusanya taarifa kuhusu upatikanaji wa vyakula vilivyoliwa na watoto shuleni. Uchambuzi wa data ulifanywa kwa kutumia programu ya *WHO AnthroPlus v1.0.4* na Programu ya Takwimu kwa Jamii *(SPSS)* toleo la 26. Takwimu za maelezo, kama idadi ya Watoto na asilimia zao ziliripotiwa. Mifano ya uchambuzi wa regression ilitumika kutafiti viashiria vya hali ya lishe, na kutoa taarifa za uwiano kwa kuripoti *crude ratio (COR)* na uwiano wa kuripoti *adjusted odds ratio (AOR)* kwa kuzuia michango mingine ya taarifa. Uchambuzi wa mfano wa kiwango cha juu ulitumika kutathmini tofauti za mtu binafsi katika tabia za kula na kuchunguza uhusiano kati ya mazingira ya chakula shuleni na tabia za kula. Viwango vya kujitokeza miongoni mwa wanafunzi waliohojiwa vilikuwa kama ifuatavyo: utapiamlo wa kupungua kwa urefu (10.5%), uzito pungufu (3.6%), ukondefu (2.8%), na uzito kupita kiasi/sana (10.1%). Utapiamlo wa kupungua kwa urefu ulikuwa wa kiasi kikubwa zaidi kwa wavulana (13.2%) kuliko kwa wasichana (8.2%), na uliongezeka na umri. Uzito pungufu ulikuwa mkubwa zaidi katika shule za umma (8.2%) ikilinganishwa na shule za binafsi (3.2%). Ukondefu ulikuwa na uwiano mkubwa katika shule za umma (85.7%) ikilinganishwa na shule za binafsi (14.3%), hasa katika maeneo ya vijijini (57.1%) na kwa watoto wadogo (57.1%). Uzito kupita kiasi ulikuwa mkubwa zaidi kwa wasichana (90.1%) kuliko kwa wavulana. Shule za mijini zilikuwa na kiwango kikubwa cha uzito kupita kiasi/sana (90.3%) ikilinganishwa na shule za vijijini (89.5%), na shule za binafsi (95.2%) zilikuwa na kiwango kikubwa zaidi kuliko shule za umma (84.7%). Wanafunzi katika maeneo ya mijini walikuwa na uwezekano mkubwa wa kuwa na uzito kupita kiasi kuliko wenzao katika mazingira ya vijijini. Baada ya kurekebisha kwa sifa za wanafunzi, mazingira ya shule yalichangia kwa sehemu ndogo katika tofauti za tabia za kula, kwa kiasi kinachojumuisha kutoka 11.3% hadi 11.6% kwa vyakula vyenye wingi wa wanga, 12.6% hadi 11.4% kwa vyakula vyenye wingi wa protini, 20.3% hadi 19.4% kwa vyakula vyenye vitamini na madini, na 11.0% hadi 10.1% kwa vyakula vyenye lipidi na sukari nyingi. Katika “model 2”, kwa kuzingatia mambo mengine, ulaji wa vyakula

vyenye protini na mafuta na sukari nyingi ulihusishwa kwa kiasi kikubwa na kifo cha mzazi mmoja, wakati ulaji wa vyakula vyenye vitamini na madini ulihusishwa kwa kiasi kikubwa na idadi ya watu wazima katika kaya. Hakuna moja ya viashiria vya mazingira ya chakula shuleni vilivyochunguzwa vilivyopatikana kuwa na uhusiano na ulaji wa vyakula vyenye wanga, vyakula vyenye protini, vyakula vyenye vitamini na madini, au vyakula vyenye mafuta na sukari nyingi vilivyotajwa na watoto. Matokeo haya yanadokeza kwamba katika sampuli hii, viashiria vya ngazi ya shule havina athari kubwa katika tabia za lishe za watoto. Matokeo haya yanasisitiza umuhimu wa kuingilia kati ili kuboresha hali ya lishe ya wanafunzi wa shule ya msingi nchini Tanzania na kupendekeza kufanya tafiti za muda mrefu juu ya mazingira ya chakula shuleni.

DECLARATION

I, **VIVIAN RICHARD KILANDEKA**, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

Vivian Richard Kilandeka (MSc Candidate)	Date

The above declaration is confirmed by

Prof. T.C.E Mosha (Supervisor)	Date
Dr. Victoria Gowele (Supervisor)	Date

LIST OF MANUSCRIPTS

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I am sincerely grateful to my beloved parents, who have consistently showered me with love, moral support, and material assistance throughout my education. They laid the groundwork for my academic journey, and I will forever be grateful and indebted to them.

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Thank you all.

DEDICATION

I dedicate this work to my cherished family, including my mother Daphrosa Jerome Shayo, my brother Vitalis Richard Kilandeka, and my sister Irene Richard Kilandeka.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
FAO	Food and Agriculture Organization
LMICs	Low- and Middle-Income Countries
NBS	National Bureau of Statistics
NCDs	Non-Communicable Diseases
SAC	School Aged Children
SPSS	Statistical Package for Social Sciences
TAMISEMI	Tawala za Mikoa na Serikali za Mitaa
TDHS	Tanzania Demographic and Health Survey
UNICEF	United Nations International Children's Emergency Fund (UNICEF)
WHO	World Health Organization

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background Information

Food environment may be defined in terms of geographic access to food in a community or neighborhood, consumer experiences inside food outlets, services, and infrastructure in institutional settings, or the information available about food (Downs *et al.*, 2020). The framework for children and adolescents' food environment is comprised of two domains: external and personal. The external domain consists of all the physical places where individuals go to purchase or consume food. It reflects exogenous dimensions related to food price, availability, marketing and advertisements, and product properties. The personal domain includes a set of individual-level dimensions, namely food accessibility, affordability, convenience, and desirability (UNICEF, 2019).

Different reviews have suggested that much of a child's eating behaviours occurs in and around the home, in the neighborhood, and at school which have potential impact on children's diet or obesity-related outcomes (Williams *et al.,* 2015). Home food environment predictors model include the physical environment, such as food and beverage availability, socio-cultural environment, including parenting styles, practices, and rules and child/parent characteristics i.e., child age, child sex, child race, parent BMI and parent education (Jang *et al.,* 2021). Neighbor food environment refers to mixture of retail outlets as well as restaurants and take always in which may also act as potential risk factor for diets of school going children (Lake, 2018). The school food environment refers to all the spaces, infrastructure and conditions inside and around the school premises where food is available, obtained, purchased and/or consumed (for example tuck shops, kiosks, canteens, food vendors and, vending machines (FAO, 2022).

School food environments are an important alternative environmental exposure for diet outcomes in children and adolescents. The availability, sources, purchase, and consumption of foods within the school setting constitutes the school food environment. The school food environment is important because it is a known driver of dietary behaviours among children and adolescents in school (Smith *et al.,* 2013). Providing healthy food options at school is linked with learning of appropriate dietary preferences as well as capacity to overcome barriers to sub-optimal dietary practices (Hawkes *et al.,* 2015). During the school day, most students are purchasing food for consumption elsewhere. This may be from vending machines within schools, choosing alternative options in school canteens, or sourcing food during the commute to and from school. Conversely, vending unhealthy food can expose children to malnutrition and other diet-related non-communicable diseases (NCDs) (Mukanu *et al.,* 2022).

For school-aged children and adolescents, food environment in or surrounding schools play a significant role in their food choices and consumption by the types of foods and beverages available and accessible (Carducci *et al.,* 2020). Considering that almost all children attain some years of schooling, health promotion efforts in schools could positively impact eating behaviours and reduce future disease risk (Micha *et al.,* 2018). The effectiveness of proper food environment policies in schools to improve children's diet and food choices have been reported. Such approaches are proposed as the most cost-effective diet-related approaches to prevent non-communicable diseases (Micha *et al.,* 2018).

School food environment plays an essential role in students' dietary patterns. Studies have shown that the variety and quality of food available around schools can influence this population's health and nutrition outcomes (Leite *et al.,* 2021). Characteristics of the school food environment contribute to the obesogenic school environment, which influences the nutritional status of children (Carmo *et al.,*

2018; Saavedra-Garcia *et al.,* 2021). School are generally surrounded by canteens, grocery stores, restaurants, fast food and snack bars. This can determine the type of food that this target audience consumes, limiting the offer of healthy possibilities of choice, either by availability (Fabiana *et al.,* 2022). Poor food consumption patterns, which include intake of extremely processed meals is a key component of the high weight epidemic (Monteiro *et al.,* 2013), Therefore, this study aimed at assessing influence of school food environment on eating behaviours and nutritional status of primary school children (6-13 years) in Dodoma. With an assumption that the school surroundings contribute to young's people food consumption habits.

1.2. Problem Statement and Justification of the Study

1.2.1. Problem statement

Nutrition-related health problems of school children include growth retardation, micronutrient deficiencies like iron-deficiency anemia being most prevalent (Mosha *et al.,* 2010), dental caries and conditions like as obesity. Globally, there are about 42 million overweight children with over 35 million living in developing countries (Sanyaolu *et al.,* 2019). In Africa, despite high levels of undernutrition among children, overweight and obesity are on the rise with a prevalence of more than 10% among School Aged Children in countries such as; South Africa, Ethiopia, Cameroon, Nigeria, Kenya, and Tanzania (Mekonnen *et al.,* 2018). In Tanzania, the 2019 School Malaria and Nutrition survey reported that, prevalence of stunting, thinness, overweight and obesity was 25%, 11% and 5%, respectively (John *et al.,* 2019).

Healthful eating habits are essential to reducing children's risk of immediate and long-term health problems. School children require adequate nutrient and energy inputs for growth, development, and good academic performance (El-Kassas and Ziade, 2017). Appropriate dietary choices and dietary intake are crucial for building good eating habits early in life (Ochola and Masibo, 2014). Eating

habits during childhood may have long term implications; therefore, environments associated with children's food choices need to be studied for modification and to reinforce healthy choices. Foods that are high in sugar and/or fat, which are globally available in school environments are associated with increased risk of obesity and their consumption is reported to increase at the highest rates ever (Negash *et al.,* 2017).

Escalating overweight and obesity rates in school children necessitate consideration of school food environment as potential contributors (Lytle and Sokol, 2017). The consumption of readily available, high-energy food items is a major contributing factor to the rise in overweight and obesity as well as non-communicable diseases in Tanzania and the region.

Most studies on nutrition situation focus on children under the age of five years, leaving a gap among children older than five years. Therefore, the present study is designed to examine the influence of school food environments on eating behaviours and nutritional status of primary school children (aged 6-13 years) in urban and rural Dodoma region.

1.2.2. Justification of the study

The local food vendors, home and school food environments may act as a potential risk factor for unhealthy diets of school going children. In Tanzania, there is limited data describing the school food environments. The purpose of this study is to examine influence of school food environments on eating behaviours and nutritional status of primary school children (aged 6-13 years) in urban and rural areas of Dodoma region. Results are expected to inform the development of interventions that address a variety of physical (availability and accessibility) of food at school environment, economies of school food environment, socio-cultural aspects in terms of attitudes and perceptions of children with regards to school

food environment as well as policy or rules with regards to provision of food in school environment.

1.3. Study Objectives

1.3.1. General objective

To examine the influence of school food environment on eating behaviours and nutritional status of primary school children (6-13 years) in urban and rural areas of Dodoma region.

1.3.2. Specific objectives

1. To characterize the school food environments of primary school children (6-13 years)
2. To assess the eating behaviours of primary school children (6-13 years)
3. To determine the anthropometric status of primary school children (6-13 years)

1.4. Research Methodology

1.4.1. Description of the study area

The study was conducted in Dodoma Region since it was among the regions with a higher prevalence of undernutrition for children less than five years of age (TDHS, 2022). Additionally, Dodoma is a fast-growing city with rapidly changing lifestyles, modernization, and socio-economic transition. Furthermore, urban and rural districts were selected to provide the basis for comparison between schools in these two settings. At the time of the study, the region had a total land area of 41.311 sq. km. and an average population of 3,085,625 based on 2022 population census. The administrative districts in Dodoma Region are Dodoma City Council, Bahi, Chamwino, Chemba, Kondoa Town Council, Kondoa District Council, Kongwa, and Mpwapwa. The region is served by two referral hospitals, as well as several health centers and dispensaries. In terms of education, the region had 757 government primary schools. The economy of the region is primarily dependent on agriculture and animal husbandry, which were practiced at a subsistence level in

rural areas. The main food crops grown in Dodoma region include sorghum, maize, paddy, beans, bulrush millet, groundnuts, and finger millet. Cash crops grown in the region include sunflower and simsim. Additionally, Dodoma is known for its large numbers of livestock, including cattle, goats, sheep, poultry, and pigs (TAMISEMI, 2016; NBS,2022).

1.4.2. Study design

A cross-sectional design was used for this study whereby data were collected once among the primary school-aged children. This design was employed so that it could allow collection of data from a large sample of individuals at a single point in time.

1.4.3. Study population (Inclusion and exclusion criteria)

Primary school children (aged 6-13 years) from selected public and private day schools within urban and rural districts of Dodoma participated in the study. According to the National educational guideline, children typically start primary education at the age of 6 years and complete it after 7 years. Therefore, the selected age range aimed to cover children from when they joined primary school to completion of standard seven. The study encompassed two strata of children; the younger stratum included pupils from standard I to standard III, while the older stratum consisted of pupils from standard V and VI. Pupils from Standard IV and VII were exempted from participation because they were preparing for standard four national assessment (SFNA) and Primary School Leaving Examination (PSLE). Additionally, children on a special diet, those taking medication that restricted their usual food consumption, individuals with disabilities, and pupils outside the specified age range were also excluded from the study. Other participants in the study included at least two school staff members, school principal and health/food & nutrition teachers.

1.4.4. Sampling procedure and sample size determination

1.4.4.1 Sampling procedure

Multistage sampling was employed for this study. Firstly, within the Dodoma region, one urban district and one rural district were selected purposively. This was done to facilitate a comparison between schools in urban and rural areas. Secondly, random sampling technique was used to select schools from wards that had at least two private and two government school. In each district, a total of four schools were selected, resulting in a combined total of eight schools. Stratified sampling was used to select pupils. Two strata were identified: young children (standard I to III) and older children (standard V and VI). From the two strata, a total of 31 students were randomly selected per school, taking into consideration class size or streams. It should be noted that, all students in the selected classes or streams were included in the study.

1.4.4.2. Sample size determination

The sample size was determined using a formula by Kothari (2004).
The formula:

$$\mathrm{n} = \frac{z^2 p\,(1-p)}{d^2}$$

Whereby;
n = desired sample size
z = standard normal deviation, set at 1.96 corresponding to 95% confidence interval
P = Expected prevalence of overweight and obesity among school-aged children in Dodoma Tanzania was 18.6% (Mosha and Fundo, 2010).
q = (1-p) proportion of the individual: 1-0.226=0.774
d = degree of accuracy desired (0.05)
Therefore;
$n = (1.96)^2 \times 0.186\ (1-0.186)/0.05^2$
n = 223.25 plus attrition of 10% of n is 22.33
Hence, the sample size of school-aged children obtained was 248

1.5. Data Collection

Various methods were used to collect primary data from school children, school staff, food vendors around eight radius from the center of the school, and shop owners in close proximity to the schools. Information regarding the school environment was obtained through the input of children, school staff, food vendors, and nearby shop owners. The questionnaire was divided in sections based on objectives. The first section solicited information about socio-demographic and socio-economic characteristics of the children. The second section solicited information on the characteristics of the school food environment based on the internal dimension of the school food environment together with Semi structure interviews conducted with school staff members, including the school principal and the school health teacher. These interviews provided valuable insights into various aspects related to the study.

The third section collected information concerning the eating behaviours of the school-aged children using a food frequency questionnaire (FFQ) to collect their eating habits within the past seven days. Were data were grouped according to the food groups from 62 food items from FFQ to find the mean intake for the participants, were food groups created were cereals, starchy, roots, tubers, plantains and green bananas, animal source foods (i.e., meat, poultry, fish), pulses, nuts, oily seeds, vegetables, fruits, fats and oil, snacks/confectionary and beverages. The fourth section solicited anthropometric measurements of the primary school children. Structured observations of the schools and their surroundings were carried out for a duration of two to three days to minimize any potential observer effect. These observations aimed to gather objective information about the school's physical environment and its immediate surroundings. It is important to note that, all interviews were conducted in Kiswahili, ensuring effective communication with the participants, and field notes during interviews were taken whenever necessary. All questionnaires and

interviews were used to gather data and were pretested to obtain the feasibility of the collection process and test the validity of the data.

1.5.1 Data management and statistical analysis

In this study, data were managed by using IBM SPSS 26v, Microsoft Excel software and WHO AnthroPlus. Descriptive analysis was done were frequencies, percentages, means, and standard deviation, were obtained to describe the characteristics of the study population. Statistical analysis was performed and results were said to have a significant difference when ($p < 0.05$).

1.5.2 Characterization of the school food environments

Descriptive analyses of the school food environment were conducted, categorized into political aspects (presence of nutritional guidelines, existence of nutritional committees), socio-cultural elements (responsibility of staff for student meals, prioritizing nutritious foods for students), and physical factors (presence of canteens, availability of water sources, presence of outlets for fruits and vegetables). These analyses were expressed in terms of frequencies. To investigate the influence of factors in the school food environment on the dietary behaviours of the children, a multi-level linear mixed model was utilized. Initially, a null multilevel model was employed to test selected dietary behaviours as response variables with no predictor variables, thereby examining the between-school variance. Subsequently, a model with individual-level covariates (such as age, gender, education level of parents, etc.) was conducted to assess whether the between-school variance was simply due to a compositional effect.

1.5.3. Assessing eating behaviours of primary school children

Descriptive analyses of the eating behaviours were conducted, categorized into Carbohydrate-rich foods (i.e., cereals-based products and roots, tubers, banana), Protein-rich foods (pulse, seeds, nuts, and meat, poultry, fish), Vitamins and minerals-rich foods (i.e., vegetables and fruits) and lipids and sugar-rich foods (oil

and fats, snacks/confectionery and beverages). These analyses were expressed in terms of frequencies for assessing the frequency of food consumption and the analysis of the variance (ANOVA) test for comparison of intake of various food groups between boys and girls. To investigate the influence of factors on the dietary behaviours of the children, a multi-level linear mixed model was utilized. Initially, a null multilevel model was employed to test selected dietary behaviours as response variables with no predictor variables, thereby examining the between-school variance. Subsequently, a model with individual-level covariates (such as age, gender, education level of parents, etc.) was conducted to assess whether the between-school variance was simply due to a compositional effect.

1.5.4. Determining the nutritional status of primary school children (6-13 years)

Chi-square and Fisher's exact tests were utilized to examine the relationships between anthropometric indices and the socio-demographic characteristics of the respondents. These statistical tests were employed to determine the associations and dependencies between the variables of interest. Additionally, all variables with p value less than 0.05 from the chi-square test was included in a multivariate logistic regression analysis. This multivariable model was used to adjust for confounding and explore the associations between factors (independent variables) and the nutritional status of children (dependent variable-a binary variable indicating whether or not children were undernourished or over-nourished).

1.6 Ethical Consideration

All the required ethical procedures were followed including getting approval to carry out the research from Sokoine University of Agriculture. Ethical permission was requested from the National Institute of Medical Research (NIMR) - NIMR/HQ/R.8a/Vol. IX/4250. Other permissions were sought from administrative authorities at

regional, district, and ward levels. The recruitment process was done after introducing the study to the school's administrations involved, followed by a selection of students, and then permission was sought from the teachers. Research objectives and procedures were explained to the school teacher and those who agreed to participate were asked to sign informed consent.

1.7. Study Limitations

This study encountered challenges in controlling for confounding factors that could influence eating behaviours and nutritional status of pupils. Variables such as home food environment, socio-economic status, cultural background, or individual characteristics may have independently impacted on the outcomes of the study and their influence may not have fully accounted for in the analysis.

1.8. Organization of the Dissertation

There are five chapters in this dissertation. Two chapters (chapters two and three) are organized in publishable manuscripts. Chapter one covers the general introduction of the study that gives context and provides justification for conducting the study. Chapter two presents the first manuscript that addressed the third specific objective on "Factors Associated with Nutritional status of Primary School Children in Dodoma region, Tanzania". In chapter three, the second manuscript addressed the first and second specific objectives that determined the "Influence of school food environment on eating behaviours of primary school children in Dodoma region: A Cross-Sectional Study". Chapter four has the general discussion synthesized from all findings of the study. Chapter five gives conclusions and recommendations based on the research findings.

CHAPTER TWO

MANUSCRIPT ONE

2.0 Factors Associated with Anthropometric Status of Primary School Children in Dodoma, Tanzania

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Abstract

Background: Malnutrition in school-age children has significant implications for their health, cognitive development and overall educational attainment. This study aimed at assessing the nutritional status of school age children and the influence of socioeconomic, demographic, and environmental factors on their nutritional well-being. This study focused on primary school children in Dodoma. It sought to assess the nutritional status of children and identify who could be at risk of malnutrition. The study intended to establish baseline data regarding the nutritional status of school children that could contribute to comprehensive understanding of the nutritional landscape among primary school children in Dodoma. This information could subsequently inform nutritionists and policy makers to plan interventions aimed at improving the nutritional status of these children.

Methods: A cross-sectional study involving 248 pupils aged 6-13 years was conducted in eight primary schools in Dodoma. Four schools were selected from Champion and Dodoma urban district respectively whereby two government schools and two private schools were selected from each district. The other four schools were situated in the urban district of Dodoma, comprising two government schools and two private schools. The study took place between January 2023 and April, 2023. Anthropometric measurements were taken, weight was measured using weight scale to the nearest 0.01kg, and height was measured using WHO height board to the nearest 0.01cm. Nutrition status was categorized based on the World Health Organization (WHO) cut-off points. The study assessed the prevalence of stunting, thinness, underweight, and overweight/obesity among primary school children. Data were analyzed using the WHO AnthroPlus v1.0.4 software and IBM SPSS v26

Results: Prevalence of malnutrition among the surveyed pupils were as follow: stunting (10.5%), underweight (3.6%), thinness (2.8%), and overweight/obesity (10.1%). Stunting was more prevalent in boys (13.2%) than in girls (8.2%), and it exhibited an upward trend with increasing age. Prevalence of underweight was higher in public schools (8.2%) compared to the private schools (3.2%). Thinness was more prevalent in rural areas (57.1%) and among younger children (57.1%). Overweight/obesity was more prevalent among girls (91.0%) compared to boys (88.6%). Schools situated in urban areas showed a higher prevalence of overweight/obesity (90.3%) than those in rural areas (89.5%). Private schools (95.2%) had a higher prevalence of overweight/obesity pupils compared to public schools (84.7%). There was association between stunted pupils and whose age is 10-13 years, who schooling in public school, who have birth order of greater than four, who lost their mothers and living in the household with children number greater than three (p 0.05). There was association between being overweight/obesity with children who live in the household with number of children less than four and

attending private schools (p 0.05). Multiple regression analysis showed that children aged 10-13 (AOR 0.26; 95% CL: 0.09-0.73) were independently predictive of stunting while children attending public school (AOR 0.313; 95% CL: 0.102-0.957) were independently predictive of overweight or obesity

Conclusion: Significant rates of stunting, thinness, underweight, and overweight/obesity were observed among primary schoolchildren in Dodoma, Tanzania. These findings underlined the necessity to enhance nutrition interventions aimed at improving the nutritional status of both public and private primary school pupils in Tanzania.

Keywords: Anthropometric status, Primary school children, Nutritional status, Socioeconomic Factors and Dodoma, Tanzania

2.1 Introduction

Malnutrition encompasses insufficient or excessive nutrient intake, as well as imbalances or impaired utilization of essential nutrients. The double burden of malnutrition encompasses both undernutrition (i.e., stunting, underweight and thinness) and overnutrition (i.e., overweight and obesity) (WHO, 2021). Malnutrition is a prevalent public health issue across the globe that is rapidly increasing in low and middle-income countries. Various manifestations of child malnutrition have been consistently demonstrated, and in turn result in serious health problems that affect growth and development of children and adolescents. Undernutrition may lead to underweight, poor performance at school, poor general health and less economic productivity (Smith *et al.,* 2018). While overnutrition may contribute to non-communicable diseases such as hypertension, heart diseases, diabetes and cancer. In most LMICs, the distribution of childhood nutritional diseases is shifting from a predominance of

undernutrition to a dual burden of under and over nutrition such as overweight and obesity (Said *et al.,* 2023).

Children are the backbone of society, and their health status serves as a foundation for the health of the entire society. Research has demonstrated that growth delays among school-aged children can impede their learning, cognitive development, and academic progress(Mohammadi *et al.,* 2022). Undernutrition remains a major contributor to disease susceptibility, morbidity, and mortality among school-aged children, especially in resource-constrained countries. This issue is responsible for about half of all deaths in this population globally(Assemie *et al.,* 2020). School-aged children, similar to under-five children, are considered one of the most susceptible groups to undernutrition in Sub-Saharan Africa (Appleby *et al.,* 2019). In Ethiopia, Berheto et al. (2015) found significantly lower BMI for Age Z score and Lower HAZ score and higher rates of stunting among rural versus urban adolescent girls. Similarly, Hadley et al. 2011 reported lower weight for age Z score, BMI, HAZ and BAZ among Ethiopian rural compared to urban school children after controlling for income, age, sex and workload. Determinates of rural-urban health disparities can inform programmatic option to mitigate health consequences associated with migration and rapid urbanization, especially given that the nutritional status of the lowest quartiles of poor urban youth are on par with or worse than rural inhabitants (Lorraine *et al.,* 2021).

Urban children are highly susceptible to growth and nutritional deficiencies due to various factors, such as overcrowding, inadequate sanitation, unclean drinking water supply in residential areas, and other conditions that are often associated with lower socioeconomic status(Amare *et al.,* 2020; Mohammadi *et al.*, 2022). Parental education serves as a crucial proxy indicator of socioeconomic status, with a lack of proper hygiene and poor food habits being other reasons for nutritional deficiencies that are directly linked to parental education (Alderman & Haeday 2017). In

urban areas, poor eating habits, lack of dietary diversity, and excessive consumption of energy-dense, nutrient-poor junk foods and sweetened beverages contribute to overnutrition among children(Bhattacharyya *et al.,* 2021).

Malnutrition problem of school age children is of foremost importance to all nations as this group forms future generation (Yeasmin & Islam, 2016). In Africa, despite high levels of undernutrition, overweight and obesity rates in children are increasing. The prevalence of overweight and obesity among school aged children (SAC) is more than 10% in many countries such as; South Africa, Ethiopia, Cameroon, Nigeria, Kenya, and Tanzania (Mekonnen *et al.,* 2018). In Kenya it was 47.1%, in Ghana 33%, and in Ethiopia 48.5%. According to previous studies, undernutrition is a common problem among school-aged children, especially those in public schools who are more vulnerable to undernutrition due to socioeconomic-related variations (Agbozo *et al.,* 2016; Ali *et al.,* 2022; Endris *et al.,* 2017) The existence of triple burden of malnutrition among school-aged children and adolescents in Tanzania poses a growing health challenge. In Tanzania, the 2019 School Malaria and Nutrition survey reported that, prevalence of stunting, thinness, overweight and obesity were 25%, 11% and 5%, respectively (John *et al.,* 2019). However, there is an increasing body of evidence that childhood obesity often persists throughout adulthood and higher possibility of lifestyle modification in children as opposed to adults, interventions aiming at modifying risk factors to prevent childhood obesity should be a top priority(Hlaing *et al.,* 2012).

This paper focuses on undernutrition and overnutrition in line with the Tanzania National Multisectoral Nutrition Action Plan which provides an important opportunity to improve the nutrition and health status among this demographic (NMNAP 2021/22-2025/26). The present study was conducted to find out the nutritional status of school children and explore socioeconomic, demographic, and

environmental factors associated with nutritional status among primary school children so that a basis for planning strategic intervention program can be undertaken from the result of this study, which will improve their health, physical growth and development, school academic performance and progress in whole life.

2.2. Methodology

2.2.1. Description of study area

This research was carried out in Dodoma and Chamwino district in Dodoma region, Tanzania. Dodoma is one of the regions with higher prevalence of undernutrition among children less than five years (TDHS, 2022). Dodoma is a fast-growing city with rapidly changing lifestyles, modernization and socio-economic transition with population of approximately 3,085,625 (NBS, 2022). The two districts namely Dodoma Urban district and Chamwino Rural districts were selected purposely to allow comparison in the nutrition status of primary schools in the two districts Chamwino districts was in rural setting while Dodoma Urban district was in urban setting.

2.2.2. Study design

A cross-sectional study design was employed for this research.

2.2.2.1. Sampling frame (Population) and eligibility (Exclusion and Inclusion Criteria)

The study included all children aged between 6 to 13 years studying in primary schools in the selected districts since the National educational guideline requires that children start primary education at 6 years and ends after 7 years, it is expected that the selected age range will cover children when they join and complete primary school. Exclusion criteria was children with physical or mental impairments, chronic illnesses, and those enrolled in boarding schools or participating in special school programs.

2.2.2.2. Sampling techniques

Selection of private and public schools was carried by purposive sampling technique for acknowledges the diversity within the education system and enhances the applicability of the results to a broader audience. Pupils were randomly selected into the sample to ensure fairness, boys and girls were given an equal opportunity to be included in the sample. A total of eight schools, with four from private and four others from public schools were randomly selected into the sample. Within each class, a representative sample of children was chosen using a random selection process.

2.2.3. Sample size

The sample size was calculated based on Kothari (2004) formula:

$$n = \frac{z^2 p(1-p)}{d^2}$$

Where n = sample size, z = 1.96 for a confidence limit of 95%, p = expected prevalence of overweight and obesity (18.6%), d = degree of desired precision (in this study was 0.05) and q = 1 – p.

n = (1.96^2). 0.186. (1- 0. 186)/ (0.05^2)

By using the formula and assuming an expected prevalence rate of 18.6% for overweight and obesity based on a previous study by (Mosha & Fungo, 2010), and a desired degree of precision of 0.05, the sample size of 248 pupils was selected. To obtain the sample, a random sampling technique using a table of random numbers was employed, and 31 children were randomly selected from each of the 8 schools.

2.2.3. Data collection

2.2.3.1. Construction of a questionnaire

A questionnaire which was self-reported was formulated to solicit information from the participants. Questionnaire was divided into three sections. Section A established rapport with the participants, section B solicited information about socio-demographic information such as the child's age and sex, school type, child's place of residence, grade level, parents' occupations, birth order, occurrences of parental death, and the number of people living in the household. Section C solicited information related to weight,

height, and other health details, including instances of illness in the past four weeks, treatment for the illness, using mosquito nets while sleeping at night, and the frequency of hand washing before meals and after visiting restrooms.

2.2.3.2. Pre-testing the questionnaire

The questionnaire was pre-tested outside the study area. Subsequent to pre-testing the questionnaire, necessary adjustments were made based on the feedback and insights gathered from the respondents.

2.2.3.3. Administration of the questionnaire

Before administration of the questionnaire the enumerators were trained to acquaint themselves with the questionnaire proper procedure to ask the questions and proper recording of the responses. The pre-tested questionnaire was then administered to the study subjects through face-to-face interviews. These interviews were conducted within the school premises during the mid-morning or lunch break hours of the day.

2.2.3.4. Measurements taken

Anthropometric measurements involving weight, height, and age were taken according to standardized protocols outlined by the World Health Organization (WHO, 2007). Heights were taken using a length board, while weights were taken by using a digital weighing scale. These measurements were taken while participants were standing on a flat surface, without footwear, and their heels, buttocks, shoulders, and the back of their head touching the wall. Heights were recorded to the nearest 0.1 cm, while weights were recorded to the nearest 0.1 kg. Demographic information, such as sex and date of birth were documented.

2.2.4. Data analysis

Data were compiled, coded, cleaned and analyzed using SPSS software version 26.0 for Windows and the WHO AnthroPlus tool.

Data collected were entered into the WHO Anthro-Plus software (version 1.0.4), which facilitated computation of Z-score indices in line with the WHO's 2006 growth references for children aged 5-19 years (de Onis *et al.,* 2007). The indices used were height-for-age (HAZ), weight-for-age (WAZ), and body mass index-for-age Z-scores (BAZ). The categorization of HAZ, WAZ, and BAZ were as follows: <-3SD severe underweight or stunting or thinness, ≥-2SD to <-2.9SD moderate underweight or stunting or thinness, -1SD to -1.9SD mild underweight or stunting or thinness, ≥-1SD to ≤+1.9SD normal, +2SD to +3SD overweight or tall, and >+3SD obese or over tall slender. Within the SPSS software, demographic characteristics of primary school children were succinctly summarized and presented as frequencies and percentages. Nutritional status of primary school children was condensed into frequencies and percentages, depicting the number of children falling into each nutritional status category (underweight, normal, overweight, and obese). The correlations between various factors (treated as independent variables) and the nutritional status of children were analyzed using the Chi-square (X^2) test. Fisher's exact test was employed when at least one expected value was below 5. Subsequently, all variables that exhibited p-values < 0.05 from the Chi-square test were incorporated into a multivariable logistic regression analysis. This multivariable model helped to account for confounding variables by entering all the factors that shows significance difference in the university analysis and elucidated the associations between these factors (independent variables) and the nutritional status of children. The dependent variable in this analysis was a binary variable denoting whether or not children were overweight/obese.

2.2.5. Ethical consideration

Ethical approval for the execution of this study was obtained from the Tanzania National Institute for Medical Research (NIMR) reference NIMR/HQ/R.8a/Vol.IX/4250. Written consent was obtained from the parents of all school children who participated in the study,

indicating their willingness to allow their children to participate. Written consent was also obtained from school officials, while pupils aged 6 to 13 years provided both verbal and written consent. To ensure confidentiality, each pupil was assigned an identification number.

2.3. Results

2.3.1. Characteristics of the primary school children

Majority of the participants (67.3%, n=81) were aged between 6 and 9 years. There was a relatively equal distribution of male and female children (46.0% and 54.0%, respectively). Half of the children were in private schools, while the other half were in public schools. In terms of grade/class level, 58.1%, (n=144) of the children were in grades 1 to 3, and 41.9%, (n=104) were in grades 5 to 6. Employment was the most common occupation among fathers (35.9%, n=89), while among mothers, majority were businesswomen (37.5%, n=93). In terms of family structure, most children were from households with 1 to 3 adults (71.4%, n=177) while 61.7%, (n=153) came from families with 1 to 3 children. The birth order distribution showed that, majority of children were from families with 1 to 3, (48.8%, n=121). Majority of children (91.9%, n=228) had not experienced death of either parent (Table 2.1).

Table 2.1: Socio-economic and demographic characteristics of the primary school children (N=248)

Characteristic	No. of Respondents	%
Age		
6 – 9	167	67.3
10 – 13	81	32.7
Sex		
Male	114	46.0
Female	134	54.0
School type		
Private	124	50
Public	124	50
School location		
Rural	124	50
Urban	124	50
Grade/Class Level		
1 – 3	144	58.1
5 – 6	104	41.9
Fathers occupation		
Employed	89	35.9
Farmer	41	16.5
Businessman	76	30.6
Studying	40	16.1
I don't know	2	0.8
Mothers occupation		
Employed	57	23.0
Farmer	30	12.1
Businesswoman	93	37.5
Housewife	47	19.0
I don't know	21	8.5
Birth order		
1 – 3	79	28.2
4 – 6	121	48.8
> 6	57	23.0
Death of either parent		
Yes	20	8.1
No	228	91.9
Number of adults living in the household		
1 – 3	177	71.4
4 – 6	63	25.4
> 6	8	3.2
Number of children living in the household		
1 – 3	153	61.7
4 – 6	95	38.3

2.3.2. Environmental and other health risk factors affecting the health of primary school children

Among the selected participants, 17.7%, (n=44) preferred to drink boiled water, while majority, (82.3%, n=204), consumed un-boiled water. The sanitation facilities used by children indicated that, 71%, (n=176) had access to flush toilets, whereas 29%, (n=72) utilized pit latrines. Regarding waste disposal methods, 73.4%, (n=182) used pit systems, 8.9%, (n=22) resorted to burning, 2.8%, (n=7) used in open dumping, while 14.9%, (n=37) relied on dustbin trucks. Four weeks preceding the survey, 58.9% of the participants experienced sickness, while 41.1% did not get sick. In terms of seeking treatment, majority of children (21%, n=52) sought medical assistance from government health facilities, while 9.7% of the children sought medical assistance from religious/missionary health facilities. Additionally, 14.9% of the children visited local pharmacies to purchase some drugs/pills, 2.4% consulted local or traditional healers, while the remaining (47.6%) did not seek any treatment. Sleeping under mosquito nets was practiced by a significant proportion of the children, with 89.9%, (n=223) using mosquito nets for protection against mosquitoes, while 10.1% did not use mosquito nets. Hand hygiene practices indicated that, 81.5% of the respondents washed their hands before taking meals and after visiting toilets while 73% washed their hands using water only (Table 2).

Table 2.2: Environmental and other health risk factors associated with primary school children (N=248)

Characteristics	No. of Respondents	%
Drinking water		
Boiled	44	17.7
Not boiled	204	82.3
Kind of toilet facility		
Flush toilet	176	71
Pit latrine	72	29
Place to waste disposal		
Pit	182	73.4
Burning	22	8.9
Open dumping	7	2.8
Dust bin track	37	14.9
Sick in the past 4 weeks		
Yes	146	58.9
No	102	41.1
Seeking treatment		
Government	52	21.0
Religious/missionary	24	9.7
Pharmacy/drugstore	37	14.9
Local shop	11	4.4
Local herbs/traditional healer	6	2.4
None	118	47.6
Sleep under mosquito net		
Yes	223	89.9
No	25	10.1
Hands washing before meal		
Frequently	202	81.5
Infrequently	46	18.5
Hands washing after visiting a toilet		
Frequently	181	73
Infrequently	67	27
Materials used for hand washing		
Water only	238	96
Water and soap	10	4
Wearing shoes		
Sometimes	35	14.1
Always	213	85.9

2.3.3. Factors associated with nutritional status of the primary school children

2.3.3.1. Stunting

The chi-square test conducted for comparative analysis revealed significant associations between children's stunting rate and factors such as age, school type, birth order, parental death, and the number of children within the household (Table 3). This suggested that, children aged 10-13 years, those attending public schools, those born as fourth or later siblings, those who have experienced the death of either mother or father, and those living in households with more than four siblings were more likely to be stunted. Conversely, sex, school location, source of drinking water, and seeking treatment did not exhibit a significant association with stunting ($p>0.05$). There was a relatively stronger tendency for male children, those attending schools located in rural settings, those who did not consume boiled water, and those who did not seek any treatment when sick to be stunted. Although these tendencies were not statistically significant, they indicated a higher likelihood of stunting among these groups of children.

Table 2.3: Association between children's stunting (Height for Age Z-score) and socio-economic, environmental and health characteristics (N=248)

Characteristics	Stunted (n, %)	Normal (n, %)	P-Value
Age			0.000*
6 – 9	7(4.2)	16(95.8)	
10 – 13	19(23.5)	62(76.5)	
Sex			0.219
Male	15(13.2)	99(86.8)	
Female	11(8.2)	123(91.8)	
School type			0.021*
Public	19(15.3)	105(84.7)	
Private	7(5.6)	117(94.4)	
School location			0.060
Rural	18(14.5)	106(85.5)	
Urban	8(6.5)	116(93.5)	
Birth order			0.036*
1 – 3	4(5.7)	66(94.3)	
4 – 6	11(9.1)	110(90.9)	
>6	11(19.3)	46(80.7)	
Death of either parent			0.031*
Father	1(16.7)	5(83.3)	
Mother	4(36.4)	7(63.6)	
Both	0(0.0)	3(100)	
None	21(9.2)	207(90.8)	
Number of children			0.001*
1 – 3	8(5.2)	145(94.8)	
4 – 6	18(18.9)	77(81.1)	
Source of drinking water			0.587
Boiled	3(6.8)	41(93.2)	
Not boiled	23(11.3)	181(88.7)	
Seeking treatment			0.156
Government	9(34.6)	43(19.4)	
Religious/missionary	2(7.7)	22(9.9)	
Pharmacy/drugstore	0(0.0)	37(16.7)	
Local shop	1(3.8)	10(4.5)	
Local	0(0.0)	6(2.7)	
Herbs/traditional healer			
None	14(53.8)	104(46.8)	

*P-Value: Chi square test, *p<0.05c for n greater than 5; Fisher's Exact Test, **p<0.05 for n less than five*

2.3.3.2 Underweight

The chi-square test conducted for comparative analysis revealed that, there were no significant associations between children's

underweight rate and their age, sex, school type, school location, birth order, death of either parent, number of children living in the household, type of drinking water, and the location where they seek treatment when they were sick. These factors did not show a significant association with underweight, ($p>0.05$) (Table 2.4). There was a relatively higher tendency for children who were aged 6-9 years, male children, children in public schools, those studying in urban settings, children without both parents, children born as fourth or later siblings, those living in households with more than four children, children who consumed un-boiled water, and children who did not seek any treatment or seek treatment from government health facilities to be underweight. Although these tendencies were not statistically significant, they increased the likelihood of underweight among these groups of children.

Table 2.4: Association between children's Weight for Age Z-score and socio-economic, environmental and health characteristics (N=167).

Characteristics	Underweight (n, %)	Not underweight (n, %)	P-Value
Age			. [a]
6 – 9	9(5.4)	158(94.6)	
10 – 13			
Sex			0.733
Male	5(6.7)	88(95.7)	
Female	4(4.3)	70(93.3)	
School type			0.181
Public	6(8.2)	67(91.8)	
Private	3(3.2)	91(96.8)	
School location			1.000
Rural	4(5.1)	75(94.9)	
Urban	5(5.7)	83(94.3)	
Birth order			0.250
1 – 3	1(1.9)	53(98.1)	
4 – 6	5(6.0)	79(94.0)	
>6	3(10.3)	26(89.7)	
Death of either parent			0.174
Father	0(0.0)	4(100)	
Mother	1(33.3)	2(66.7)	
Both	0(0.0)	2(100)	
None	8(5.1)	150(94.9)	
Number of children			0.119
1 – 3	4(3.3)	116(96.7)	
4 – 6	5(10.6)	42(89.4)	
Drinking water			0.625
Boiled	2(8.0)	23(92.0)	
Not boiled	7(4.9)	135(95.1)	
Seeking treatment			0.367
Government	4(12.5)	28(87.5)	
Religious/missionary	0(0.0)	18(100)	
Pharmacy/drugstore	1(2.9)	33(97.1)	
Local shop	0(0.0)	8(100)	
Local herbs/traditional healer	0(0.0)	6(100)	
None	4(5.8)	65(94.2)	

*P-Value: Chi square test, *p<0.05c for n greater than 5; Fisher's Exact Test, **p<0.05 for n less than five *[an] It is important to note that weight-for-age reference data were not provided beyond the age of 10 years. This was due to the fact that this indicator does not differentiate between height and body mass during the age period when many children undergo pubertal growth spurt. Consequently, some children could appear to have excess weight based on weight-for-age, while in reality they were simply experiencing increased height.*

2.3.3.3 Thinness and overweight/obesity

The chi-square test conducted for comparative analysis revealed significant association between children's thinness and overweight/obesity. The significant factors for thinness were more prevalent among children from public school, live in the household with children number greater than four and who drink or use un-boiled water. While significant associations' factors for being overweight or obese were more prevalent in pupils that study in private schools, live in the household composed of 1-3 children and who drink un-boiled water. However, there were no significant association for factors such as age, sex, school location, birth order and death of either parents. However, thinness was more prevalent in 10-13 years old, more in male, in rural areas, who were born greater than three and drink un-boiled water. On the other side of been overweight or obese it was more prevalent on children aged 10-13 years, who were female, attending private school, residing in urban areas and live in the household with fewer number of children in the household (Table 2.5).

Table 2.5: Association between children BMI for Age Z-score and socio-economic, environmental and health characteristics.

Characteristic	BMI-for-age			
	Thinness (n, %)	Normal (n, %)	Overweight/obese (n, %)	P Value
Age				0.429
6 – 9	9(36)	58(34.5)	14(25.5)	
10 – 13	16(64)	110(65.5)	41(74.5)	
Sex				0.660
Male	13(11.4)	74(64.9%)	27(23.7)	
Female	12(9)	94(70.1)	28(20.9)	
School Type				0.000*
Public	19(76)	96(57.1)	9(16.4)	
Private	6(24)	72(42.9)	46(83.6)	
School location				0.564
Rural	13(52)	87(51.8)	24(43.6)	
Urban	12(48)	81(48.2)	31(56.4)	
Birth Order				0.525
1 – 3	4(16)	48(28.6)	18(32.7)	
4 – 6	13(52)	84(50)	24(43.6)	
>6	8(32)	36(21.4)	13(23.6)	
Death of either parent				0.141
Father	1(4)	5(3)	0(0)	
Mother	3(12)	7(4.2)	1(1.8)	
Both	0(0.0)	1(0.6)	2(3.6)	
None	21(84)	155(92.3)	52(94.5)	
Number of children				0.004*
1 – 3	9(36)	103(61.3)	41(74.5)	
4 – 6	16(64)	65(38.7)	14(25.5)	
Source of drinking water				0.050*
Boiled	6(24)	23(13.7)	15(27.3)	
Not boiled	19(76)	145(86.3)	40(72.7)	
Treatment seeking				0.053*
Government	3(12)	39(23.2)	10(18.2)	
Religious/missionary	2(8)	12(7.1)	10(18.2)	
Pharmacy/drugstore	1(4)	32(19)	4(7.3)	
Local shop	3(12)	6(3.6)	2(3.6)	
Local herbs/traditional healer	1(4)	4(2.4)	1(1.8)	
None	15(60)	75(44.6)	28(50.9)	

*P-Value: Chi square test, *p<0.05c for n greater than 5; Fisher's Exact Test, **p<0.05 for n less than five*

2.3.3.4 Determinant of nutritional status of primary school children

After the covariate shows significant difference in p-value then logistic regression was used for determination of relative odds between the dependent and independent factors. In bivariable logistic regression model, age of the child, school type, location of school, birth order, death of either parents and children number in the household were independent predictors of stunting with $p<0.05$. Therefore, all the variables were fitted into a multivariable logistic regression model. However, only age remained significantly associated with stunting. In this study, children aged 10-13 years were 0.2 times more likely to be stunted (AOR=0.26 95% CL; 0.09, 0.73) compared to children aged 6-9 years (Table 2.6). Furthermore, in bivariable logistic regression model, school type and number of children were found significantly associated with be overweight/obese at $p< 0.05$. In multivariate logistic regression model school type remained significantly associated with being overweight/obese. This study showed that children from private school were 0.31 (AOR=0.31; 95% CL: 0.102, 0.957) more likely to be overweight/obese than children in public school (Table 2.6).

Table 2.6: Determinants of nutritional status among primary school children

BIVARIATE LOGISTIC REGRESSION					
		HAZ		BAZ	
Characteristics		cOR (95%, CL)	p-value	cOR* (95%, CL)	P- Value
Age			0.000*		0.708
	6-9	Ref		Ref	
	10-13	0.143(0.057-0.356)		0.848(0.357-2.010)	
School Type			0.017*		0.009*
	Public	Ref		Ref	
	Private	0.331(0.134-0.818)		0.281(0.108-0.730)	
School location			0.043*		0.833
	Rural	Ref		Ref	
	Urban	0.406(0.170-0.973)		0.915(0.400-2.092)	
Birth order			0.017*		0.122
	1-3	Ref		2.694(0.767-9.458)	
	4-6	0.485(0.266-0.880)		Ref	
Child number			0.001*		0.007*
	1-3	Ref		Ref	
	4-6	0.236(0.098-0.568)		0.309(0.103-0.730)	
MULTIVARIATE LOGISTIC REGRESSION					
		HAZ		BAZ	
Characteristics		aOR (95%, CL)	p-value	aOR* (95%, CL)	P-Value
Age			0.010*		0.950
	6-9	Ref		Ref	
	10-13	0.260(0.093-0.728)		0.972(0.399-2.369)	
School Type			0.550		0.042*
	Public	Ref		Ref	
	Private	0.722(0.249-2.097)		0.313(0.102-0.957)	

*P-Value: Logistic Regression; *p<0.05; aOR; Adjusted Odds Ratio; CL: Confidence Interval; bivariate analysis covariate factors; school type, number of children, source of drinking water, treatment seeking: multivariate analysis covariate factors; age, school type, school location, birth order, child number*

2.4. Discussion

2.4.1 Prevalence of undernutrition and overnutrition among primary school children

The primary objective of this study was to assess the nutrition status of primary school-aged children in both Dodoma urban and Chamwino districts, located in Dodoma. About 67.3%, (n=167) of the participants fell within the age range of 6 to 9 years, which was

termed “the young strata." This age range was consistent with the Tanzanian national guidelines for admitting students to Standard I, in which children are required to be six years of age or older and possess the ability to read and write. Stunting prevalence was observed to be higher among boys than in girls however it was not significantly associated. The reason for poor nutrition status among boys was due to poor dietary intake due to consumption of more of unhealthy food compared to their counterparts, due to economic norms constraints boys face in their family lead in variations of food distribution. This observation aligns with findings from studies conducted in Tanzania and other African countries. These studies have consistently shown that, boys have a higher likelihood of experiencing stunting compared to their girl counterparts (Mohamed *et al*., 2022).

Prevalence of underweight differed between public and private schools, with rates of 8.6%, (n=6) observed in public schools and 3.2%, (n=3) in private schools for children aged below 10 years. These differences were attributed to various factors such as lifestyle variations, feeding habits, parental education and differences in socioeconomic status. There appeared to be a significant impact of rural and urban backgrounds on underweight prevalence. Children from rural areas tended to be more underweight compared to their urban counterparts due to poor access to food and lower level of education which lead to unawareness about the importance of nutrition and health which affect their dietary choices. This trend of rural-urban variations has been reported in similar studies, even among children below five years of age (TNNS, 2018; Lorraine *et al.,* 2021).

In this study, prevalence of thinness among school-aged children aged 6-13 years was approximately 2.8%, (n=7). The observed magnitude of thinness was lower when compared to findings from other studies conducted in various regions. For instance, studies conducted in Tanzania (11.2%), Ghana (19.5%), Forega, Ethiopia

(21.4%), Southern Ethiopia (13.6%), Northern Ethiopia (26.1%), Nigeria (18.9%), and West Bengal, India (28%) reported higher prevalence rates of thinness among children aged 6-13 years (Mohamed *et al.,* 2022). Prevalence of thinness differed significantly between public and private schools, with rates of 76.0% in public schools and 24.0% in private schools. This discrepancy was attributed with absence of school feeding programs in public schools, which have led to extended periods of hunger or reliance on snacks that are purchased during break times, due to distance from home to school many students opt to remain at school since when they go back to home and found no food which lead them to have fatigue and affect regular attendance and participation in school. These factors could contribute to the higher prevalence of thinness among children in public schools (Mwaikambo *et al.,* 2015).

Students attending private schools usually come from families with higher socio-economic status. Wealthier families can afford school fees and might enroll their children in schools that offer school lunch programs. These families might provide transportation to or from school to home by private cars or school buses, ensuring easier access to nutritious meals. This context could explain the lower prevalence of thinness among children attending private schools since pupils receive adequate food which is diversified have sedentary behaviours i.e., low rate for walking to school since they are carried with either school bus or parents care. That's why the thinness rate for pupils that attend private school is low and high rate of been overweight or obesity is highly observed, these observations are in line with a study conducted by Mwaikambo *et al.* (2015).

This study also revealed a lower prevalence of overweight/obesity among school aged children compared to similar studies conducted in Tanzania. For instance, a previous study conducted in Tanzania by Vincent *et al.* (2012) reported a 15% prevalence of overweight/obesity among school children aged 9-11 years. Another study involving primary school children aged 7-17 years in Arusha

Urban, Tanzania, reported an overweight and obesity prevalence of approximately 18% (Chomba *et al.,* 2019). In the selected study sample, the prevalence of overweight/obesity among primary school children was 16.4% in public schools and 83.6% in private schools.

Urban schools exhibited a higher prevalence of overweight/obese pupils compared to the rural schools. This was due to urbanization characteristics were high availability of calorie food were sold within and around school with low price due to given money for the children was low. Many schools especially private school had small area for playground that involve engaging pupils to participate in physical activities were many of them face problem of excess weight for one's height. This trend could be attributed to shifts in lifestyles and dietary behaviours across various population groups within the region. Environmental factors such as the increased availability of fast-food outlets in urban areas may have contributed to these trends. This phenomenon agreed with findings from a study conducted in Morogoro, Tanzania (Muhomba *et al.,* 2023).

2.4.2 Determinant factors of stunting and overweight/obesity among primary school children

In the bivariate logistic regression analysis, several factors including the child's age, school type, birth order, school location, and the number of children in the household were identified as independent predictors of stunting, with $p< 0.05$. Consequently, all these variables were included in a multivariable logistic regression model and upon adjustment, only age maintained significant associations ($p<0.05$) with stunting. Stunting demonstrated a noteworthy increasing trend with advancing age, with older age emerging as an independent predictor of stunting. This study highlights an inverse association, indicating that a decrease in age leads to 19% increase in the stunting rate of children aged 10-13 compared to children aged 6 to 9 years.

According to the findings of this study, age was found to have a significant impact on the nutritional status of the children. This was significantly associated with increase in age increase risk of be stunted due to inadequate nutrition during childhood can hinder proper growth and lead to a height deficit. This pattern could be explained by the understanding that, stunting is a form of chronic malnutrition that becomes more evident during later childhood stages. As the child's age surpasses the critical window of growth, the ability to reverse the stunting condition diminishes*(Bliznashka et al.,* 2021). This observation was in line with previous reports showcasing the progression of height deficit with increasing age in sub-Saharan Africa(Mushtaq *et al.,* 2011). This was inconsistent with a study conducted in Ethiopia(Berhanu *et al.,* 2023), which indicated that the risk of malnutrition tends to decrease as a child grows older.

School type and the number of children living in the household were identified as significant ($p<0.05$) predictors of overweight/obesity. It was observed that, 80% of pupils attending private schools were more likely to become overweight or obese compared to their counterparts in public schools. This phenomenon was be attributed to the fact that, a considerable number of pupils in public schools skipped meals, which could lead to lower weights and under nutrition. Increase in obesogenic environments was noted for children whose movements were restricted by their parents or guardians. This trend was noticed in children who had limited opportunities to engage in spontaneous physical activities due to be able to have supportive environment for playing at school and not allowed at home to engage in activities of playing with their peers. Increase of obesogenic environments especially in urban areas as well as lack of enough space for school located in urban areas that could allow students to engage themselves in different physical activities are in line with those reported by(Pangani *et al.,* 2016).

Children living in households with fewer than four children exhibited a positive association with being overweight or obese, unlike their

counterparts in larger households. This was due to inappropriate feeding practices such as using food for emotional comfort, parental behaviours for sedentary lifestyles adaption and poor eating habits which cause their children to follow their parents practices. This situation arisen from the availability of sufficient and excess food for children in families with fewer members. This correlation was also reported by(Pangani *et al.,* 2016). It is crucial for the public to recognize these patterns as indicators of an increasing double burden: Children with ample food resources are more susceptible to overweight and obesity, while those facing food scarcity are at high risk of becoming underweight.

2.5. Conclusions and Recommendations

This study provided significant insights into the prevalence of stunting, thinness, underweight, and overweight/obesity among pupils aged 6 to 13 years in both public and private schools in Dodoma. The prevalence of under nutrition (stunting, underweight, and thinness) was higher in boys than in girls, more common in public schools than in private schools, and more prevalent among pupils residing in rural areas. Conversely, the prevalence of over nutrition (overweight and obesity) was higher in private schools, more common among girls than boys, and prevalent among pupils residing in urban areas. The findings also revealed an association between stunted pupils and their age. Similarly, there was an association between being overweight/obese and the type of school children attended. In this context, the study established a correlation between stunting and overweight/obesity. It was recommended based on this study that, monitoring children's nutrition status in school is of greatest importance. Efforts should be directed by the government and other stakeholders towards providing school feeding programs, especially in public schools, to mitigate the consequences of under nutrition resulting from children experiencing hunger at school. Raising awareness of parents about the academic performance and health consequences of both under nutrition and over nutrition problems in pupils is essential. Lastly, enhancing

nutrition interventions aimed at improving the nutritional status of primary school pupils in Tanzania should be a priority.

2.6. Strength and Limitation

The findings of this study could be generalized to primary school children attending both rural and urban districts of Dodoma, as the feeding practices of primary school children are generally similar. A longitudinal study could have enabled the subjects to be profiled over time. Additionally, respondents' ability to accurately remember and answer certain questions was a limitation especially on demographic characteristics of their parents. Reporting of hygiene practices (i.e., hands washing practices, materials used for hand washing, ways of wastewater disposal, ways for solid waste disposal and wearing shoes practices) could have been inflated, as is often the case with self-reported hygiene behaviours. The education level of the children's parents could also introduce a source of bias.

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Data availability statement

The data that support the findings of this study are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflict of Interest

The authors have no conflict of interest to declare.

Reference

Agbozo, F., Atito, P., & Abubakari, A. (2016). Malnutrition and associated factors in children: A comparative study between public and private schools in Hohoe Municipality, Ghana. *BMC Nutrition*, *2*(1). https://doi.org/10.1186/S40795-016-0073-7

Alderman, H., development, & D. H.-W., (2017). How important is parental education for child nutrition? *Elsevier*. Retrieved September 25, 2023, from https://www.sciencedirect.com/science/article/pii/S0305750X17300451

Ali, M., Kassahun, C., Wubneh, & C.E. M, (2022). Determinants of undernutrition among private and public primary school children: A comparative cross-sectional study toward nutritional transition in. *Elsevier*. Retrieved September 25, 2023, from https://www.sciencedirect.com/science/article/pii/S0899900721004378

Amare, M., Arndt, C., K. A. T. & W. B. E., (2020). Urbanization and child nutritional outcomes. *Academic.Oup.ComM Amare, C Arndt, KA Abay, T BensonThe World Bank Economic Review, 2020•academic.Oup.Com*. Retrieved September 25, 2023, from https://academic.oup.com/wber/article-abstract/34/1/63/5126503

Appleby, L. J., Tadesse, G., Wuletawu, Y., Dejene, N. G., Grimes, J. E. T., French, M. D., Teklu, A., Moreda, B., Negussu, N., Kebede, B., Yard, E., Gardiner, I., & Drake, L. J. (2019). Integrated delivery of school health interventions through the school platform: Investing for the future. *PLoS Neglected Tropical Diseases*, *13*(1). https://doi.org/10.1371/JOURNAL.PNTD.0006449

Assemie, M. A., Alamneh, A. A., Ketema, D. B., Adem, A. M., Desita, M., Petrucka, P., & Ambaw, M. M. (2020). High burden of undernutrition among primary school-aged children and its determinant factors in Ethiopia; A systematic review and meta-analysis. *Italian Journal of Pediatrics*, *46*(1). https://doi.org/10.1186/S13052-020-00881-W

Berhanu, G., Dessalegn, B., Ali, H., Heliyon, & K. A., (2023).

Determinants of nutritional status among primary school students in Dilla Town; Application of an ordinal logistic regression model. *Cell.ComG Berhanu, B Dessalegn, H Ali, K AnimutHeliyon, 2023•cell.Com*, *9*, 2405–8440. https: //doi. org/ 10. 1016/j.heliyon.2023.e13928

Bhattacharyya, M., & Roy, S., (2021). Burden of malnutrition among school-going children in a slum area of Kolkata: A matter of concern. *Ncbi.Nlm.Nih.GovM Bhattacharyya, S Roy, A Sarkar, RN Sinha, AK Mallick, S BandyopadhyayJournal of Family Medicine and Primary Care, 2021•ncbi.Nlm.Nih.Gov*. Retrieved September 25, 2023, from https://www. ncbi. nlm. nih. gov/ pmc/ articles/ PMC8483088/

Bliznashka, L., Danaei, G., Fink, G., Flax, V. L., Thakwalakwa, C., & Jaacks, L. M. (2021). Cross-country comparison of dietary patterns and overweight and obesity among adult women in urban Sub-Saharan Africa. *Public Health Nutrition*, *24*(6), 1393–1403. https://doi.org/10.1017/S1368980019005202

Chomba, H., Martin, H., &, J. K. (2019). Prevalence and predictors of obesity among 7-to 17-year-old schoolchildren in Urban Arusha, Tanzania. *Hindawi.ComH Chomba, HD Martin, J KimyweJournal of Nutrition and Metabolism, 2019•hindawi.Com*. Retrieved September 25, 2023, from https://www. hindawi. com/ ournals/jnme/2019/3106597/abs/

De Onis, M., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*, *85*(9), 660–667. https:// doi. org/ 10.2471/BLT.07.043497

Endris, N., Asefa, H., international, & L. D.-B. (2017). Prevalence of malnutrition and associated factors among children in rural Ethiopia. *Hindawi.ComN Endris, H Asefa, L DubeBioMed Research International, 2017•hindawi.Com*. Retrieved September 25, 2023, from https://www.hindawi.com/journals/ bmri/2017/6587853/

Fact sheets - Malnutrition. Retrieved September 25, 2023, from

https://www. who. nt/news-room/fact-sheets/detail/malnutrition

Hlaing, M., Ohnamr, M., Tun, S., & Khine, T. (2021). Dual burden of malnutrition among primary school children in Myanmar. *Scirp.OrgMM Hlaing, M Ohnamr, S Tun, T Khine, WW Win, SS Hlaing, HP Linn, KHW Phyu, NN WinFood and Nutrition Sciences, 2021•scirp.Org*. Retrieved September 25, 2023, from https://www.scirp.org/html/2-2702995_107182.htm

John, S., Mchau, G., Ayubu, H., Mafung'a, S., & Ainan, S. (2019). Diet and nutrition status among school-age children and adolescents in Tanzania. *Tfnc.Go.TzS John, G Mchau, H Ayubu, S Mafung'a, S Ainan, W Kyatikila, E Lyimo, F Chacky…tfnc.Go.Tz*. https://doi.org/10.1080/08035250410024998

Khanam, S., Heliyon, & M. H., (2017). Prevalence and determinants of malnutrition among primary school going children in the haor areas of Kishoreganj district of Bangladesh. *Cell.ComSJ Khanam, MA HaqueHeliyon, 2021•cell.Com*. https://doi.org/10.1016/j.heliyon.2021.e08077

Kothari, C. (2004). *Research Methodology 2 rev*. http://dl .saintgits. org/jspui/ bitstream/ 123456789/1133/1/Research Methodology C R Kothari (Eng) 1.81 MB.pdf

Mekonnen, T., Tariku, A., & Abebe, S. M. (2018). Overweight/obesity among school aged children in Bahir Dar City: Cross sectional study. *Italian Journal of Pediatrics*, *44*(1). https://doi.org/10.1186/S13052-018-0452-6

Mohamed, A., Lazaro, S., Chack, F., Moshi, G., Kaswahili, P., and Msoga, J. (2022). Nutritional Status Among Pupils Aged (5-19) Years in Public Primary Schools in Mainland Tanzania. *Tanzania Public Health Bulletin*, 1(8), 9-26.

Mohammadi, S., Bolourian, M., Badpeyma, M., Nasiri, M., Ghamsari, A. A., & Movahedinia, S. (2022). Prevalence and Risk Factors of Malnutrition among Primary School Children in Iran. *Health-Providers.IrS Mohammadi, M Bolourian, M Badpeyma, M Nasiri, A Alizadeh Ghamsari, S MovahediniaHealth Providers, 2022•health-Providers.Ir*, *1*(3), 149–161.

https://doi.org/10.22034/hp.2022.362440.1025

MoHCDGEC, MoH, NBS, OCGS, and ICF. (2022). Tanzania Demorgraphic and Health urvey Indicator Survey (TDHS-MIS) 2022. *Dar Es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, NBS, OCGS, and ICF*, *1*(1), 1–630.

MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. (2018). Tanzania National Nutrition Survey using SMART Methodology (TNNS) 2018. *Dar Es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF*, *1*(1), 1–103.

MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. (2021). National Multisectoral Nutrition Action Plan (NMNAP) 2021. *Dar Es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF*, *1*(1), 1–136.

Mosha, T., (2010). Prevalence of overweight and obesity among children aged 6-12 years in Dodoma and Kinondoni municipalities, Tanzania. *Ajol.InfoTC Mosha, S FungoTanzania Journal of Health Research, 2010•ajol.Info*. Retrieved September 25, 2023, from https://www. ajol. info/i ndex. php/thrb/article/view/56202

Muhomba, E., Msollo, S., &Health, A. (2023). Prevalence and determinants of overweight and obesity among school children in Morogoro region, Tanzania. *Ajol.InfoES Muhomba, SS Msollo, AW MwanriTanzania Journal of Health Research, 2023•ajol.Info*. https://doi.org/10.4314/thrb.v24i1.3

Mushtaq, M. U., Gull, S., Khurshid, U., Shad, M. A., & Siddiqui, A. M. (2011). Prevalence and socio-demographic correlates of stunting and thinness among Pakistani primary school children. *BMC Public Health*, *11*. https://doi.org/10.1186/1471-2458-11-790

Mwaikambo, S. A., Leyna, G. H., Killewo, J., Simba, A., & Puoane, T. (2015). Why are primary school children overweight and obese? A cross sectional study undertaken in Kinondoni district, Dar-es-salaam. *BMC Public Health*, *15*(1). https://doi.

org/10. 1186/S1 2889-015-2598-0

National Bureau of Statistics - (2022) Population and Housing Census - Preliminary Report in Swahili Language. Retrieved September 25, 2023, from https://www. nbs. go. tz/index.php/en/census-surveys/population-and-housing-census/802-matokeo-ya-mwanzo-ya-sensa-ya-watu-na-makazi-ya-mwaka-2022

Obesity and overweight. Retrieved September 25, 2023, from https://www. who. int/news-room/fact-sheets/detail/obesity-and-overweight

Pangani, I., Kiplamai, F., & J. K.-A. (2016). Prevalence of overweight and obesity among primary school children aged 8–13 Years in Dar es Salaam city, Tanzania. *Hindawi.ComIN Pangani, FK Kiplamai, JW Kamau, VO Onywera Advances in Preventive Medicine, 2016•hindawi.Com*. Retrieved September 25, 2023, from https://www.hindawi.com/journals/apm/2016/1345017/abs/

Yeasmin, & S., Sci, (2016). Prevalence and determinants of undernutrition among school age slum children in Dhaka City. *CiteseerS Yeasmin, K IslamBangladesh. J Nutr Health Sci, 2016•Citeseer*. Retrieved September 25, 2023, from https://citeseerx. ist. psu. edu/ document? repid= rep1 &type= pdf&doi =25 bf55065eaf153a62923388e9f90158cf3256e0

I

CHAPTER THREE

MANUSCRIPT TWO

3.0 Influence of School Food Environment on Eating Behaviours of Primary School Children in Dodoma: A Cross-Sectional Study

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Abstract

Background: Rapid changes in food environments, where less nutritious foods have become cheaper and more accessible, have led to the double burden of malnutrition. The role that food environments have played in shaping the double burden of malnutrition has gained global interest. There is a lack of research on food environments in low to middle-income countries. The aim of this study was to investigate the influence of school food environments on the eating behaviours of primary school children (6-13 years) in public and private schools in Dodoma, Tanzania.

Methods: A cross-sectional study was conducted from January 2023 to April 2023, involving 248 pupils across eight primary schools in Dodoma. Four schools were selected from Chamwino Rural district, comprising of two public schools and two private schools. The other four schools were located in Dodoma Urban district, consisting of two public schools and two private schools. Eight school administrators (i.e., school head teachers and food/health

teachers) provided information on the physical, nutritional, and socio-cultural school food environment, while from 62 items food frequency questionnaire students reported their intake of carbohydrate-rich foods, protein-rich foods, vitamins and mineral-rich foods, and lipids and sugar-rich foods. Multilevel modeling was employed to assess the individual-level variance in eating behaviours and to investigate the association of the school food environment with these dietary behaviours.

Results: After adjusting for student characteristics, the school level accounted for a small proportion of the variance in eating behaviours, specifically 11.3% to 11.6% of the variance in carbohydrate-rich foods, 12.6% to 11.4% of the variance in protein-rich foods, 20.3% to 19.4% of the variance in vitamin and mineral-rich foods, and 11.0% to 10.1% of the variance in lipids and sugar-rich foods that were investigated. In model 2, controlling for other factors, carbohydrate-rich foods were not found to be significant (i.e., $p > 0.05$). However, protein-rich food intake, lipid and sugar-rich food intake was found to be significant in relation to the death of either parent, while vitamins and mineral-rich food intake was found to be significant in relation to the number of adults living in the household (i.e., $p<0.05$). None of the investigated school food environmental factors were found to be related to the children's reported intake of carbohydrate-rich foods, protein-rich foods, vitamins and mineral-rich foods, or lipids and sugar-rich foods.

Conclusion: Most of the variances in the investigated eating behaviours were at the personal level. The investigated school-level factors did not appear to exert a strong influence on the dietary behaviours of children. The study didn't limit its evaluation of dietary habits to school meals alone. However, it recognized that what students ate at school could impact what they ate at home, and vice versa. Longitudinal studies using adequate measures of the school food environment are needed.

Keywords: School food environment, Eating behaviours, Primary school children

3.1. Introduction

Food environment encompasses the various food sources and products that surround individuals in their daily lives. According to FAO (2022), the food environment refers to the interface that influences how people obtain and consume food within the broader food system. It includes factors such as the availability, accessibility, affordability, desirability, convenience, marketing, and characteristics of food sources and products. The food environment is undergoing rapid transformation across countries due to changes in dietary patterns and food behaviours (Sagbo *et al.*, 2018). It recognizes that individuals are influenced by multiple aspects when acquiring and consuming food. This includes their ability to access desirable and convenient food options, the impact of food marketing, and the unique properties of food, such as taste and appearance. In many settings, there is now widespread availability of processed, convenient, and relatively affordable foods (Turner *et al.,* 2020).

The term "school food environment" encompasses all the areas, facilities, and conditions within and surrounding the school premises where food is available, obtained, purchased, and/or consumed. These include tuck shops, kiosks, canteens, food vendors, and vending machines(*FAO, 2022*). Research indicates, that the school food environment significantly influences children's food choices (Mekdes *et al.,* 2012; Fabiana *et al.,* 2022; FAO 2023; Constance *et al.,* 2021; Mika *et al.,* 2020). In addition to peer pressure, children often feel compelled to purchase and consume unhealthy food options (Pacific *et al.,* 2020). The school food environments vary globally, with some countries implementing nationally provided school lunch programs (e.g., the United States, United Kingdom, Japan, France, and Sweden), while others do not (e.g., Australia and Canada). The quantity and quality of foods offered, as well as their cost, availability of subsidies, and the presence of other "competitive" foods in vending machines, canteens, or other outlets, also differ between countries. It has been suggested that, modifying the school food environment could be one of the most crucial

strategies for improving children's eating behaviours (Driessen *et al.,* 2014).

Dietary pattern analysis is a method commonly used to assess the nutritional status of a population(*Assessment, 2018).* The term "dietary pattern" refers to the overall composition of different foods, beverages, and nutrients in a diet, including their quantities, proportions, variety, and habitual consumption frequency. This approach to dietary pattern analysis has gained popularity over traditional methods that focus on analyzing single foods or nutrients. This shift is due to the recognition that, nutrients are not consumed in isolation but rather as part of a broader dietary context (Naska *et al.,* 2017). Examining the entire diet provides a more comprehensive understanding of the correlations between different dietary components and the complex interactions between diet and health (Mukanu *et al.,* 2022).

The role of diet in preventing overweight and obesity is significant and can be modified (Arouca *et al.,* 2019). A healthy diet plays a crucial role in preventing excessive weight gain, excessive body fat, and the associated risks of premature death and disability caused by nutrition-related non-communicable diseases, such as cardiovascular diseases and diabetes (WHO, 2021). It is important to note that, obese children are more likely to become obese adults, increasing the risk of developing various co-morbidities. In many Low- and Middle-Income Countries, there is a nutrition transition occurring due to globalization and urbanization. The availability of cheaper imported foods, particularly in urban areas, has led families to alter their dietary patterns, shifting away from traditional boiled staple or local foods (e.g., cassava, plantain, and potatoes) towards energy-dense, deep-fried, refined foods, sugary snacks and beverages, and a lower consumption of fruits and vegetables (Cockx *et al.,* 2017).

Children are exposed to a complex food environment that promotes the consumption of unhealthy, nutrient-poor foods. Factors such as

parental food preferences and other environmental influences can contribute to either unhealthy or healthy eating habits in children. In Tanzania, school children often have access to deep-fried snacks and processed foods from street vendors, including fried cassava and potatoes, Tanzanian buns ("mandazi"), and flavored ice pops(Kagaruki *et al.,* 2021; Mosha *et al.,* 2022). However, there is limited information available on the influence of the school food environment on eating behaviours of children in Low- and Middle-Income Countries. In Tanzania specifically, few studies have reported on the prevalence of such behaviours (Minja *et al.,* 2021; Kessy and Killenga *et al.,* 2022; Mosha *et al.,* 2022), while information on eating patterns and behaviours remains insufficient. The aim of this study was to examine the school food environment among primary school children in Dodoma and to assess how the food environment influences the eating behaviours of children aged 6 to 13 years in Dodoma.

3.2. Materials and Methods

3.2.1 Description of study area

The study was conducted in Dodoma region, Tanzania. The Region had a total land area of 41,311 sq. kms. with an average population of 3,085,625. Dodoma Region is divided into eight administrative districts, namely Dodoma City Council, Bahi, Chamwino, Chemba, Kondoa Town Council, Kondoa District Council, Kongwa, and Mpwapwa. Dodoma is one of the regions with high prevalence of undernutrition among children less than five years (TDHS, 2022). It is a fast-growing city with rapidly changing lifestyles, modernization, and socio-economic transition. This study focuses on two districts which are Dodoma urban (Urban setting) and Chamwino districts (Rural setting) were selected purposely to allow comparison in the eating behaviours of primary school children in the two districts. Dodoma urban district is served with 56 outreach and mobile clinics, 4 special clinics, 51 dispensaries, 6 health centers, 4 hospitals and 6 parastatal institutions. There are 106 primary schools under Dodoma urban district. Chamwino district is served with five health centers,

and had 120 primary schools. The districts are entirely dependent on agriculture and animal husbandry. Food crops grown in the two districts are sorghum, maize, paddy, beans, bulrush millet, groundnuts, and finger millet. Cash crops grown are sunflower and simsim. The districts had large numbers of livestock, including cattle, goats, sheep, poultry, and pigs(NBS, 2022).

3.2.2. Study design

A cross-sectional study design was employed for this study.

3.2.3. Study frame (population) and eligibility

The study included all children aged 6 to 13 years studying in primary schools in the selected districts. Exclusion criteria were children with physical or mental impairments, chronic illnesses, and those enrolled in boarding schools or participating in special school programs.

3.2.4. Sampling techniques

Selection of private and public schools was carried out by purposive sampling technique. Pupils were randomly selected into the sample to ensure fairness, boys and girls were given an equal opportunity to be included in the sample. A total of eight schools, with four schools from private and four schools from public schools were randomly selected into the sample. Within each class, a representative sample of children was chosen using a random selection process.

3.2.5. Sample size

The school children aged 6-13 years in each school selected were stratified according to gender then simple random sampling was applied using the formula by(Kothari, 2004).

$$n = \frac{z^2 p(1-p)}{d^2}$$

Where ***n*** is the desired sample size. The estimation was built on the following assumptions: ***z*** was the standard score corresponding to a given confidence level, ***p*** was the expected prevalence of overweight and obesity among school-aged children in Dodoma-

Tanzania was 18.6% (Mosha *et al.*, 2010) and ***d*** was the margin of error set at 5%.

3.2.6 Data Collection

3.2.6.1 Construction of a questionnaire

A questionnaire was constructed to gather information from the participants. It was divided into three sections. Section A was designed to establish rapport with the participants. Section B focused on collecting socio-economic data, including the child's age and sex, parents' educational background, instances of parental death, and the number of adults and children residing in the household. Section C solicited to gather information related to eating behaviours. In this section, a 62-item Food Frequency Questionnaire (FFQ) was employed to assess the frequency of consumption of various foods. Semi structured interview were conducted with school staff, with two participants from each school. These interviews included one school principal and one school health/food teacher. Interviews were also carried out with all food vendors and sellers operating in food outlets near or around the schools. To minimize the potential observer effect, structured observations of the schools and their immediate surroundings were conducted over a period of two to three days. This approach was taken to ensure that, the presence of observers did not influence the behaviours of those who were observed.

3.2.6.2 Pre-testing the questionnaire

The questionnaire was pre-tested outside the study area. Necessary adjustments were made to the questions based on the feedback and insights gathered from the respondents.

3.2.6.3 Administration of the questionnaire

Before administration of the questionnaire enumerators were trained to acquaint themselves with the proper procedure to administer the questions and record the responses. The pre-tested questionnaire,

was then administered to the study subjects through face-to-face interviews during the mid-morning and lunch hours.

3.2.7. Statistical analysis

Data for this study were coded, entered, and analyzed using IBM SPSS Statistics for Windows software, version 26 (IBM Corp., Armonk, N.Y., USA). Demographic characteristics of primary school children were summarized and expressed as frequencies and percentages. Descriptive statistics, including frequencies and percentages, were used to identify the most common eating behaviours and food choices of the children. Analysis of variances (ANOVA) was conducted to analyses the consumption of food within a week, allowing us to obtain weekly intake and their corresponding 95% confidence intervals. Descriptive analyses of the school food environment were conducted, categorized into nutritional aspects (presence of nutritional guidelines, existence of nutritional committees), sociocultural elements (responsibility of staff for student diets, prioritizing nutritious food for students), and physical factors (presence of canteens, availability of water sources, presence of outlets for fruits and vegetables). These analyses were expressed in terms of frequencies. The influence of factors of school food environment on the dietary behaviours of the children, a multi-level linear mixed model was utilized. Initially, an unadjusted multilevel model was used to test selected dietary behaviours as response variables with no predictor variables, thereby examining the between-school variance. Subsequently, a model with individual-level covariates (such as age, gender, residence, etc.) was conducted to assess whether the between-school variance was simply due to an interaction, collaboration or cooperation between two or more individual (compositional effect).

3.2.8 Ethical consideration

Ethical clearance was obtained from the National Institute for Medical Research (NIMR) ethical committee with reference number NIMR/HQ/R.8a/Vol.IX/4250 and from Sokoine university of

Agriculture with reference number SUA/ADM/R.1/8/960. Additional permits to conduct the study in schools were sought from the Regional, District and Ward/Village/Hamlet authorities. The recruitment process was done after introducing the study to the school's administrations, followed by selection of students and then permission was asked from the teachers/parents/caregivers. Research objectives and procedures were explained to school teachers and those who agreed to participate were asked to sign informed consent.

3.3. Results

3.3.1 Socio-demographic characteristics of the primary school pupils

Around two-thirds of the participants (67.3%, n=167) fell within the age range of 6 to 9 years, and there was a relatively even distribution between male and female children, with 46.0%, (n=114) and 54.0%, (n=134) being male and females respectively. Regarding parental education, a significant proportion of fathers (57.7%, n=143) and mothers (57.3%, n=142) had primary school level. Among those with known education levels, various levels of education observed. Regarding family structure, majority of children came from households with 1 to 3 people (71.4%, n=177) and 1 to 3 children (61.7%, n=153). Majority of children (91.9%, n=228) had not experienced the death of either parent (Table 3.1).

Table 3.1: Socio-demographic characteristics of primary school children (N=248)

Characteristic	No. of Respondents	%
Age		
6 – 9	167	67.3
10 – 13	81	32.7
Sex		
Male	114	46.0
Female	134	54.0
Fathers Education		
Incomplete primary	24	9.7
Complete primary	28	11.3
Secondary	24	9.7
University	29	11.7
I don't know	143	57.7
Mothers Education		
Incomplete primary	24	9.7
Complete primary	30	12.1
Secondary	17	6.9
University	35	14.1
I don't know	142	57.3
Death of either parent		
Father	6	2.4
Mother	11	4.4
Both	3	1.2
None	228	91.9
Number of adults		
1 – 3	177	71.4
4 – 6	63	25.4
> 6	8	3.2
Number of children		
1 – 3	153	61.7
4 – 6	95	38.3

3.3.2. School food environment characteristics

Table 2 shows the characteristics of the school food environment in the surveyed primary school of Dodoma (n=8)

Political Environment: Nutritional and policy guidelines were available in all the surveyed schools. Four of the surveyed schools have a school feeding committee, while the remaining schools did not. Private schools, in particular, had school feeding programs in place and enforce rules that restricted students from purchasing

foods around the school or bringing foods from home. In contrast, public schools did not impose such restrictions. Socio-cultural Environment: In most private schools, there was a high level of responsibility for students' diets, ensuring that children had diverse food options and the food was prepared safely and in a sanitary environment. In public schools, where there were no formal feeding programs, access to and availability of healthy and unhealthy foods depended on the economic status of the students, as they were the ones who purchased foods sold around the school. Physical Environment: Private schools typically had a dining hall or canteen where children obtained their meals. Public schools, on the other hand, relied on school shops and food sources like kiosks for students to purchase foods during school hours. Both types of schools had access to clean water, but neither public nor private schools had a dedicated outlet for fruits and vegetables on their premises (Table 3.2).

Table 3.2: Characteristics of the school food environment in surveyed primary school of Dodoma Urban and Chamwino Districts (n=8)

Characteristics	No. of Public school		No. of Private school		Total number of schools
	Yes	No	Yes	No	
Nutritional school food environment					
-Nutritional guidelines at school	4	0	4	0	8
-School feeding committee	0	4	4	0	8
-Eating modalities for food	1	3	4	0	8
-School feeding program	1	3	4	0	8
-School policy for child nutrition	4	0	4	0	8
-Rules for selling foods around school	2	2	0	4	8
-Allow to bring food from home	4	0	0	4	8
Sociocultural school food environment					
-High perceived responsibility for students' diet	0	4	4	0	8
-Prioritization of food and nutrition for students	0	4	4	0	8
-Perception regarding the availability and accessibility of healthy foods	4	0	4	0	8
-Perception regarding the availability and accessibility of unhealthy foods	4	0	4	0	8
Physical school food environment					
-Presence of canteens/Dinning hall	2	2	4	0	8
-Presence of fruit and vegetable store	0	4	0	4	8
-Access to clean water	4	0	4	0	8
-Availability of school shop	2	2	0	4	8
-Availability of food source i.e., kiosk	4	0	0	4	8

3.3.3. Eating behaviours

3.3.3.1. Frequency of food consumption

Carbohydrates: Cereals and cereal products were commonly consumed 1-2 days per week. Roots and tubers were consumed by 75.8%, (n=188) of the respondents. Proteins: Most respondents consumed protein-rich foods from pulses and nuts. Animal protein-rich foods were also consumed 1-2 times per week. Vitamins and Minerals: Approximately 60.5%, n=150 of the respondents consumed vegetables 1-2 times per week to obtain vitamins and minerals. Fruits were consumed by 58.5%, (n=145) of the respondents in the same frequency. Fats and Oils: A significant 86.7%, (n=215) of the respondents consumed oil and fat-rich foods within the week. Sugar: Beverages were consumed by most respondents, with 74.2%, (n=184) consuming them 1-2 times per week. These findings provide insights into the dietary habits of the respondents, showing the frequency of consumption of different food groups. It is important to consider these patterns when assessing dietary preferences and nutritional intake (Table 3.3).

Table 3.3: Frequency of consumption of various food groups among primary school children aged 6-13 years

Food groups	Intake			
	Never (n, %)	Low (1-2 times/week) (n, %)	Moderate (3-4 times/week) (n, %)	High (5-7 times/week) (n, %)
Carbohydrate-rich foods				
Cereal-based products	3(1.2)	228(91.9)	17(6.9)	0(0)
Roots, tubers, banana	56(22.6)	188(75.8)	4(1.6)	0(0)
Protein-rich foods				
Pulse, seeds, nuts	59(23.8)	183(73.8)	6(2.4)	0(0)
Meat, poultry, fish	44(17.7)	199(80.2)	5(2)	0(0)
Vitamins and Minerals rich foods				
Vegetable	57(23)	150(60.5)	40(16.1)	1(0.4)
Fruits	101(40.7)	145(58.5)	2(0.8)	0(0)
Lipids and sugar rich foods				
Oil and fats	33(13.3)	215(86.7)	0(0)	0(0)
Snacks/confectionary	52(21)	184(74.2)	12(4.8)	0(0)
Beverages	8(3.2)	207(83.5)	33(13.3)	0(0)

3.3.4 Comparison

On average, children consumed carbohydrate rich foods i.e., cereal-based products mean intake of 1.4 (95%; 1.37-1.52) times per week and roots, tubers, bananas with mean intake of 0.9 (95%; 0.87-1.02) times per week. Consumption of carbohydrate-rich foods was similar between boys and girls. The average consumption of protein-rich foods from pulses, seeds, and nuts was 1.1 (95%; 1.05-1.24) times per week, and for meat, poultry, and fish, was 1.0 (95%; 0.89-1.02) times per week. Boys consumed protein-rich foods more frequently than girls in a given week. Vegetables were consumed 1.2 (95%; 1.01-1.28) times per week, while fruits were consumed 0.7 (95%; 0.67-0.079) times per week. Girls had a higher consumption of vegetables than boys within a week, whereas boys consumed more fruits than girls during the week. On average, oils and fats were consumed 0.9 (95%; 0.84-0.93) times, snacks or confectionary 1.0 (95%; 0.96-1.13) times, and beverages 1.6 (95%; 1.47-1.67) times per week. Oils and fats were consumed more by girls than boys, snacks or confectionary products were preferred by girls over boys, and beverages were predominantly consumed by boys compared to girls during the week (Table 3.4).

Table 3.4: Intake of various food groups among primary school children aged 6-13 years.

Intake/Times per week	Boys		Girls		Total	
	Mean	**CL**	**Mean**	**CL**	**Mean**	**CL**
Carbohydrate-rich foods						
Cereal based products	1.40	1.29-1.52	1.47	1.37-1.57	1.44	1.37-1.52
Roots, tubers, and bananas	0.99	0.88-1.11	0.90	0.81-0.99	0.94	0.87-1.02
Protein-rich foods						
Pulses, seeds, nuts	1.07	0.92-1.22	1.21	1.08-1.33	1.14	1.05-1.24
Meat, poultry, fish	0.95	0.85—1.05	0.96	0.89-1.02	0.96	0.89-1.02
Vitamin and mineral rich foods						
Vegetables	1.16	0.97-1.36	1.13	0.95-1.32	1.15	1.01-1.28
Fruits	0.72	0.62-0.82	0.74	0.65-0.82	0.73	0.67-0.79
Lipids and sugar rich foods						
Oils and fats	0.90	0.83-0.97	0.87	0.82-0.93	0.89	0.84-0.93
Snacks/confectionary	1.10	0.96-1.24	0.99	0.89-1.10	1.04	0.96-1.13
Beverages	1.54	1.40-1.68	1.60	1.45-1.74	1.57	1.47-1.67

CL-Confidential Interval of 95%

3.3.5. Association between the school environment and dietary behaviours

3.3.5.1 Carbohydrate rich foods

The unadjusted models indicated that, the between-school variances in dietary behaviours were low, with an intra-class correlation (ICC) of 11.3%. After adjusting for individual-level covariates, this percentage increased slightly to 11.6% for carbohydrate-rich foods. Finally, in model three, upon including both individual-level and school-level covariates, none of the school-level food environment factors were found to be associated with dietary behaviours (Table 3.5).

Table 3.5: School differences in intake of carbohydrate-rich foods and the effect of individual and school level factors

Factors	Carbohydrate rich foods		
	Model 1	**Model 2**	**SE**
Random effects			
ID-Respondent variance	0.113	0.116	
SE (Standard error)	0.020	0.022	
ICC (Intra-covariance of residual) (%)	11.3	11.6	
Individual covariates			
Gender (Male)		0.024	0.065
Age (10-13)		0.023	0.094
Class level (1-3)		0.095	0.087
Child no (1-3)		0.041	0.075
Father education			
Incomplete primary		0.024	0.151
Complete primary		-0.031	0.142
Secondary		0.018	0.138
University		0.052	0.154
I don't know		1	
Mother education			
Incomplete primary		0.015	0.156
Complete primary		-0.027	0.137
Secondary		0.103	0.145
University		-0.142	0.145
I don't know		1	
Death of either parent			
Father		0.215	0.207
Mother		-0.112	0.165
Both		0.483	0.294
None		1	
Adults no.			
1-3		-0.212	0.185
4-6		-0.249	0.189
>6		1	

Results obtained from multilevel linear regression analyses with student ID as random effect: Model 1= unadjusted model with no predictors, model 2= model with individual covariates, model 3= model with individual and school level covariates: Values are expressed as estimates and standard errors (SE).

3.3.5.2 Protein rich foods

The unadjusted models revealed that, between-school variances in dietary behaviours were low, with an intra-class correlation (ICC) of 12.6%. When adjusting for individual-level covariates, this percentage decreased to 11.4% for protein-rich foods. In model

three when combining both individual-level and school-level covariates, none of the school-level food environmental factors were found to be associated with dietary behaviours (Table 3.6).

Table 3.6: School differences in intake of protein rich foods and the effect of individual and school-level factors.

Factors	Protein rich foods		
	Model 1	**Model 2**	**SE**
Random effects			
ID-Respondent variance	0.126	0.114	
SE (Standard error)	0.023	0.021	
ICC (Intra-covariance of residual) (%)	12.6	11.4	
Individual covariates			
Gender (Male)		-0.055	0.064
Age (10-13)		-0.018	0.093
Class level (1-3)		-0.005	0.086
Child no (1-3)		0.125	0.074
Father education			
Incomplete primary		0.109	0.150
Complete primary		-0.006	0.141
Secondary		0.168	0.137
University		-0.037	0.153
I don't know		1	
Mother education			
Incomplete primary		-0.130	0.155
Complete primary		-0.205	0.136
Secondary		0.162	0.144
University		0.251	0.144
I don't know		1	
Death of either parents			
Father		0.449[a]	0.205[a]
Mother		0.186	0.163
Both		0.661[a]	0.292[a]
None		1	
Adults no.			
1-3		-0.041	0.184
4-6		-0.199	0.187
>6		1	

Results obtained from multilevel linear regression analyses with student ID as random effect: Model 1= unadjusted model with no predictors, model 2= model with individual covariates, model 3= model with individual and school level covariates: Values are expressed as estimates and standard errors (SE): p-Value: [a]$P<0.05$.

3.3.5.3 Vitamin and minerals rich foods

The unadjusted models indicated that, between-school variances in dietary behaviours were low, with an intra-class correlation (ICC) of 20.3%. After adjusting for individual-level covariates, this percentage decreased to 19.4% for vitamins and mineral-rich foods. In model three, when combining both individual-level and school-level covariates, none of the school-level food environmental factors were found to be associated with dietary behaviours (Table 3.7).

Table 3.7: School differences in intake of vitamins and minerals rich foods and the effect of individual and school-level factors.

Factors	Vitamin and minerals rich foods		
	Model 1	Model 2	SE
Random effects			
ID-Respondent variance	0.203	0.194	
SE (Standard error)	0.037	0.036	
ICC (Intra-covariance of residual) (%)	20.3	19.4	
Individual covariates			
Gender (Male)		0.021	0.084
Age (10-13)		0.045	0.123
Class level (1-3)		-0.075	0.112
Child no (1-3)		-0.089	0.096
Father education			
Incomplete primary		0.067	0.195
Complete primary		0.072	0.184
Secondary		0.057	0.179
University		-0.039	0.199
I don't know		1	
Mother education			
Incomplete primary		0.067	0.203
Complete primary		0.208	0.177
Secondary		-0.041	0.188
University		-0.127	0.188
I don't know		1	
Death of either Parent			
Father		0.403	0.268
Mother		-0.191	0.213
Both		0.227	0.381
None		1	
Adults no.			
1-3		-0.649[a]	0.240[a]
4-6		-0.568[a]	0.244[a]
>6		1	

Results obtained from multilevel linear regression analyses with student ID as random effect: Model 1= unadjusted model with no predictors, model 2= model with individual covariates, model 3= model with individual and school level covariates: Values are expressed as estimates and standard errors (SE): p-Value: [a]P<0.05.

3.3.5.3 Lipids and sugar rich foods

The unadjusted models revealed that in between-school variances in dietary behaviours were low. The intra-class correlation (ICC) indicated a value of 11.0%. After adjusting for individual-level covariates, this value decreased to 10.1% for lipids and sugar-rich foods. In model three, when combining both individual-level and school-level covariates, none of the school-level food environment factors were found to be associated with dietary behaviours (Table 3.8).

Table 3.8: School differences in intake of lipids and sugar rich foods and the effect of individual and school-level factors.

Factors	Lipids and sugar rich foods		
	Model 1	Model 2	SE
Random effects			
ID-Respondent variance	0.110	0.102	
SE (Standard error)	0.020	0.019	
ICC (Intra-covariance of residual) (%)	11.0	10.1	
Individual covariates			
Gender (Male)		0.034	0.061
Age (10-13)		-0.015	0.089
Class level (1-3)		-0.114	0.089
Child no (1-3)		-0.092	0.070
Father education			
Incomplete primary		0.035	0.141
Complete primary		0.074	0.133
Secondary		0.137	0.129
University		-0.040	0.144
I don't know		1	
Mother education			
Incomplete primary		-0.032	0.147
Complete primary		0.066	0.128
Secondary		0.198	0.136
University		-0.117	0.136
I don't know		1	
Death of either parent			
Father		0.407[a]	0.193[a]
Mother		-0.196	0.154
Both		-0.118	0.276
None		1	
Adults no.			
1-3		-0.265	0.174
4-6		-0.134	0.177
>6		1	

Results obtained from multilevel linear regression analyses with student ID as random effect: Model 1= unadjusted model with no predictors, model 2= model with individual covariates, model 3= model with individual and school level covariates: Values are expressed as estimates and standard errors (SE): p-Value: [a]$P<0.05$.

3.4. Discussion

Although it is advised to consume all food groups at least three to four times a week (at moderate intake), our results showed that many children consume all food groups only 1-2 times per week (as

low intake). This is followed by children who do not consume any food groups, and a smaller but still substantial number consumed food groups three to four times per week (as moderate intake). Assessment of the dietary patterns of children in the study revealed that, in a week, most children (more than 50%) consumed cereals, tubers, and fats and oils groups. Only a few of them had a high intake of vegetables, fruits, meat, poultry, fish, and pulses groups per week. This suggests an overall unhealthy food habit among most of the girls in the study. This observation aligns with previous studies, where eating habits are mainly characterized by low intake of fruits and vegetables and higher consumption of foods rich in starch and sugar (M'bobda *et al.,* 2020).

As shown earlier in the present study, dietary habits are mostly characterized by cereals and tubers like rice, maize, cassava, and corn, indicating that, carbohydrate-rich foods served as the major source of energy for the majority of children in the study. Similar findings were reported in a study in Tanzania among primary school children(Mosha *et al.*, 2022). The main reason for lack of balanced diet in the food habits of children could be attributed to lack of nutritional knowledge regarding healthy dietary patterns and habits among the parents of the respondents. A healthy diet must be balanced, not only in terms of macronutrients intake (proteins, carbohydrates, and fats) but also in terms of micronutrients intake (vitamins and minerals). The need for maintaining optimal food habits throughout a child's lifetime is essential for optimizing their health and well-being (Bliznashka *et al.,* 2021; Khamis *et al.,* 2022).

Consumption of fruits, vegetables, whole grains, fish, nuts, and legumes, classified as healthy foods with low levels of sugar and fat, was reported as low intake. Children consumed these types of food 2-3 times per week. Children with such dietary habits were at a lower risk of becoming overweight or obese, as they consumed more non-obesogenic foods. This observation aligns with findings by (Liberali *et al.,* 2020). Dietary patterns may also vary depending on

the cultural and economic context, as well as other factors such as lifestyles, accessibility, and the availability of foods. Currently, living standards are on the rise, leading to complex changes in diet, lifestyles, and health (Alshammari *et al.,* 2017; Mosha *et al.,* 2022).

This study comprehensively examined the influence of school food environment on the eating behaviours of primary school children in Dodoma. We found, that there was no significant association between the intake of carbohydrate-rich foods and individual characteristics (i.e., socio-demographic characteristics) of the pupils. Maize and legumes were the major sources of energy, carbohydrates, and protein in Tanzania and are grown in various agro-ecological zones (Nicholaus *et al.*, 2020; Shane & Mtaki, 2018). Intake of carbohydrates was high. This could be due to the availability of carbohydrate-rich foods in school canteens, which were more appealing to children. Starchy root foods are more affordable and easily accessible from vendors outside the school (Ogum *et al.*, 2018).

There was a significant association between the consumption of protein-rich food and individual characteristics i.e., death of either parent of the pupils. Children whose fathers had died had a lower intake of protein rich foods compared to those who had both parents alive. This could be due to lack of awareness among many mothers about the importance of consuming protein rich foods. On the other hand, Children whose mothers had died had higher consumption of protein rich foods compared to those with both parents alive. This could be attributed to the preferences of animal protein foods for children who are living with their fathers. The data reveal that, the mean intake of protein-rich foods for both males and females' pupils whose parents were alive and those who have died were equal. Expensive animal foods and a lack of knowledge regarding the nutritional value of foods were the reasons behind poor consumption of iron-rich foods (Khan and Saleem, 2018).

There was a significant association between the consumption of vitamin and mineral-rich foods and individual characteristics, i.e., the number of adults living in the household. There was low intake of fruits and vegetables with low family size due to socio economic status since family with limited financial resources may prioritize cheaper, less nutritious food option over fresh produce; due to low family size few family members may not fully understand the importance of a balanced diet that includes ample fruits and vegetables. This could be due to lack of awareness on the importance of consuming fruits and vegetables, as well as the socio-economic status of the family (Khan *et al.,* 2022).

There was a significant association between the consumption of lipid and sugar-rich foods and individual characteristics, i.e., the death of either parent. The positive estimate of 0.407 suggests that, on average, children who had lost their mothers tended to consume more lipids and sugar-rich foods compared to children who had both parents. The negative estimate of -0.196 suggests that, on average, children who had lost their fathers tended to consume fewer lipids and sugar-rich foods compared to their peers who had both parents. The estimate of -0.118 suggested that, on average, children who had lost both parents also tended to consume fewer lipids and sugar-rich foods compared to children who had not lost any parent. Children who lost their mother tended to consume more lipids and sugar rich foods this may be due to less parental care from their father due to time constraints brought by busy lifestyles and long work hours which lead to reliance on convenient processed foods rather than fresh foods. While, Children who lost their father tended to consume lower lipids and sugar rich foods this may be due to awareness for mothers on the importance of a buy healthier food, and fully understand of the importance of a balanced diet that includes ample fruits and vegetable. This may be due to the socio-economic status that supports them to buy healthier foods, lack of parental care, as well as accessibility and affordability of readily available foods (Ogum *et al.,* 2018).

Lack of association between the presence of food outlets in the school neighborhoods and the dietary habits of the children could be explained by the fact that, the children were not allowed to leave the school compounds during school hours (as reported by head teachers). Therefore, the pupils could only access these stores before or after school hours. The association between food outlets and adolescents' food intake has been documented to relate with free school-leaving policies. The children also could have a limited amount of pocket money at school(Abizari and Ali, 2019). Some of the effects at the school level might also be influenced by factors at the family environmental level. Effects of school food environmental factors can thus vary depending on, availability/accessibility of foods at home and parental modeling.

3.5. Conclusion and Recommendation

Most of the variance in the eating behaviours investigated was at personal level. Thus, in this sample, the investigated school-level factors do not appear to exert a strong influence on the eating behaviours of children. The socioeconomic status of the school might also influence intake. Including such factors in future studies might help provide better insights. Longitudinal studies using validated measures of the school food environment are needed

3.6. Strength and Limitation

The study reveals several personal characteristics of children at surveyed school could potentially influence the dietary habits of the children. However, consumption of carbohydrates was not significant associated with any individual characteristics of the children however other food groups such as protein food groups, vitamin rich foods and fats oil foods shows significance influence on dietary behaviours in various factors such as living with both parents, number of people living in the household respectively. It also added to the scarce literature on the potential impact of schools on the eating behaviours of young children in Dodoma, Tanzania. Multilevel

modelling was used and several eating behaviours were included. There was a high participation rate of students and school administrators of the schools included. The use of measures of the school food environment that have not been validated constituted a weakness. Also, the use of small number of selected schools due to limited funds to support the study could have led to lead to limited information. The study didn't limit its evaluation of dietary habits to school meals alone. However, it recognized that what students ate at school could impact what they ate at home, and vice versa. Longitudinal studies using validated measures of the school food environment are needed.

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Data availability statement

The data that supported these findings are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflict of Interest

The authors declare no conflict of interest.

Reference

Abizari, A. R., & Ali, Z. (2019). Dietary patterns and associated factors of schooling Ghanaian adolescents. *Journal of Health, Population, and Nutrition*, *38*(1), 5. https://doi.org/10.1186/S41043-019-0162-8

Alshammari, E., Suneetha, E., Adnan, M., Khan, S., & Alazzeh, A. (2017). Growth Profile and Its Association with Nutrient Intake and Dietary Patterns among Children and Adolescents in Hail Region of Saudi Arabia. *BioMed Research International*, *2017*. https://doi.org/10.1155/2017/5740851

Arouca, A., Moreno, L. A., Gonzalez-Gil, E. M., Marcos, A., Widhalm, K., Molnár, D., Manios, Y., Gottrand, F., Kafatos, A., Kersting, M., Sjöström, M., Amaro-Gahete, F. J., Ferrari, M., Huybrechts, I., Gonzalez-Gross, M., De Henauw, S., & Michels, N. (2019). Diet as moderator in the association of adiposity with inflammatory biomarkers among adolescents in the HELENA study. *European Journal of Nutrition*, *58*(5), 1947–1960. https://doi.org/10.1007/S00394-018-1749-3

Assessment, F. D. (2018). A resource guide to method... - Google Scholar. (n.d.). Retrieved September 25, 2023, from https://scholar. google. com/ scholar ?hl= en&as _sdt=0%2C5&q=Assessment%2C+F.+D.+%282018%29.+A+resource+guide+to+method+selection+and+application+in+low+resource+settings.+FAO%3A+Rome%2C+Italy%2C+152.&btnG=

Bliznashka, L., Danaei, G., Fink, G., Flax, V. L., Thakwalakwa, C., & Jaacks, L. M. (2021). Cross-country comparison of dietary patterns and overweight and obesity among adult women in urban Sub-Saharan Africa. *Public Health Nutrition*, *24*(6), 1393–1403. https://doi.org/10.1017/S1368980019005202

Cockx, L. ;, Colen, L. ;, & De Weerdt, J. (2017). *From corn to popcorn? Urbanization and food consumption in sub-saharan Africa: evidence from rural-urban migrants in Tanzania*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2961692

Driessen, C. E., Cameron, A. J., Thornton, L. E., Lai, S. K., &

Barnett, L. M. (2014). Effect of changes to the school food environment on eating behaviours and/or body weight in children: a systematic review. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *15*(12), 968–982. https:// doi. org/10. 1111/OBR.12224

Food and Agriculture Organization of the United Nations. School Food and Nutrition. Healthy food Environment and School Food. Available online: http:// www. fao. org/ schoolfood/areas-work/food environment/en/ (accessed on 16/6/2023) - Google Search. Retrieved September 25, 2023, from

Kagaruki, G. B., Mahande, M. J., Kimaro, G. D., Ngadaya, E. S., Mary Mayige, T., Selemani, M., Jaacks, L. M., Jaffar, S., Mfinanaga, S. G., & Bonfoh, B. (2021). Prevalence and Correlates of Cardio-Metabolic Risk Factors Among Regular Street Food Consumers in Dar es Salaam, Tanzania. *Diabetes, Metabolic Syndrome and Obesity : Targets and Therapy*, *14*, 1011–1024. https://doi.org/10.2147/DMSO.S287999

Khamis, A. G., Akwilina, W., Mwanri, M., Senkoro, K., Kreppel, B., Bonfoh, S., Godfrey, M., Kwesigabo, G., Wendelin Mwanri, A., Senkoro, M., Kreppel, K., Bonfoh, B., & Mfinanga, S. G. (2022). Dietary patterns, nutrient intakes and metabolic conditions among agro-pastoralists in Monduli District, Tanzania. *Taylor & FrancisAG Khamis, AW Mwanri, M Senkoro, K Kreppel, B Bonfoh, SG Mfinanga, G KwesigaboNutrition and Dietary Supplements, 2022•Taylor & Francis*, *Volume 14*, 11–20. https://doi. org/10. 2147/NDS.S355730

Khan, D. S. A., Das, J. K., Zareen, S., Lassi, Z. S., Salman, A., Raashid, M., Dero, A. A., Khanzada, A., & Bhutta, Z. A. (2022). Nutritional Status and Dietary Intake of School-Age Children and Early Adolescents: Systematic Review in a Developing Country and Lessons for the Global Perspective. *Frontiers in Nutrition*, *8*. https://doi. org/10. 3389/FNUT.2021.739447

Khan, R., Physiology, & S. S. (2018). Association of anaemia with dietary practices in adolescent girls. *Pjp.Pps.Org.PkR Khan, S SaleemPakistan Journal of Physiology, 2018•pjp.Pps.Org.Pk*.

Retrieved September 25, 2023, from http://www.pjp.pps.org.pk/index.php/PJP/article/download/166/500

Kothari, C. (2004). *Research Methodology 2 rev*. http://dl. saintgits.org/jspui/ bitstream/123456789/1133/1/Research Methodology C R Kothari (Eng) 1.81 MB.pdf

Liberali, R., Kupek, E., Obesity, M. A.-C., & 2020, undefined. (2020). Dietary patterns and childhood obesity risk: a systematic review. *Liebertpub.ComR Liberali, E Kupek, MAA AssisChildhood Obesity, 2020•liebertpub.Com*, *16*(2), 70–85. https: //doi. org/10. 1089/chi.2019.0059

M'bobda, C. M., Ngondi, J. L., Ntentie, F. R., Tchuente, B. R. T., Nguedjo, M. W., Azantsa, B. G. K., & Oben, J. E. (2020). Assessment of Dietary Habits and Nutritional Status of Women of Childbearing Age in Cameroon: A Cross Sectional Study. *Open Journal of Epidemiology*, *10*(04), 369–392. https://doi.org/10.4236/ojepi.2020.104030

Mosha, M. V., Paulo, H. A., Msuya, S. E., Grosskurth, H., & Filteau, S. (2022). Lack of an association between dietary patterns and adiposity among primary school children in Kilimanjaro Tanzania. *BMC Nutrition*, *8*(1). https://doi.org/10.1186/S40795-022-00529-4

Mosha, T., (2010). Prevalence of overweight and obesity among children aged 6-12 years in Dodoma and Kinondoni municipalities, Tanzania. *Ajol.InfoTC Mosha, S FungoTanzania Journal of Health Research, 2010•ajol.Info*, *12*(1). https://www.ajol.info/index.php/thrb/article/view/56202

Mukanu, M. M., Delobelle, P., Thow, A. M., & Mchiza, Z. J. R. (2022). Determinants of dietary patterns in school going adolescents in Urban Zambia. *Frontiers in Nutrition*, *9*. https://doi.org/10.3389/FNUT.2022.956109/FULL

Naska, A., & Lagiou, A., (2017). Dietary assessment methods in epidemiological research: current state of the art and future prospects. *Ncbi.Nlm.Nih.Gov*. Retrieved September 25, 2023, from https:// www. ncbi.nlm.nih.gov/pmc/articles/PMC5482335/

NBS 2022 - Google Search. Retrieved September 25, 2023, from

https:// www. google.com/search?client=firefox-b-d&q=NBS+2022

Nicholaus, C., & Martin, H., (2020). Dietary practices, nutrient adequacy, and nutrition status among adolescents in boarding high schools in the kilimanjaro region, Tanzania. *Hindawi.ComC Nicholaus, HD Martin, N Kassim, AO Matemu, J KimiyweJournal of Nutrition and Metabolism, 2020•hindawi.Com*. Retrieved September 25, 2023, from https://www.hindawi.com/journals/jnme/2020/3592813/

Ogum Alangea, D., Aryeetey, R. N., Gray, H. L., Laar, A. K., & Adanu, R. M. K. (2018). Dietary patterns and associated risk factors among school age children in urban Ghana. *BMC Nutrition*, *4*(1). https://doi.org/10.1186/S40795-018-0230-2

Pacific, R., Martin, H. D., Kulwa, K., & Petrucka, P. (2020). Contribution of Home and School Environment in Children's Food Choice and Overweight/Obesity Prevalence in African Context: Evidence for Creating Enabling Healthful Food Environment . *Pediatric Health, Medicine and Therapeutics*, *Volume 11*, 283–295. https://doi. org/10. 2147/PHMT.S257549

Sagbo, H., & Ekouevi, (2018). Prevalence and factors associated with overweight and obesity among children from primary schools in urban areas of Lomé, Togo. *Cambridge.OrgH Sagbo, DK Ekouevi, DT Ranjandriarison, S Niangoran, TA Bakai, A Afanvi, S DieudonnéPublic Health Nutrition, 2018•cambridge. Org*. Retrieved September 25, 2023, from https://www. cambridge. org/ core/ journals/public-health-nutrition/article/prevalence-and-factors-associated-with-overweight -and-obesity-among-children-from-primary-schools-in-urban-areas-of-lome-togo/7B5DF5AECA4947B431E1E41D4B62187E

Shane, T., & Mtaki, B. (2018). *Tanzania - United Republic of Grain and Feed Annual 2018 Tanzania Corn, Wheat and Rice Report*. https://www. google. com/ search? q=Mtaki%2C+B.+%282019%29.+Tanzania—United+ Republic+ of+Grain +and+ Feed+

Annual+2019+Tanzania+Corn%2C+Wheat+and+Rice+Report. &client=firefox-b-d&sca_ esv= 568110489 &sxsrf= AM9H kKlPB x2PiO 3NWO 4cqbj 9z3fv LcRdu g%3A1 69562 8464277&ei=sDwRZYO

Turner, C., & Kalamatianou, (2020). Food environment research in low-and middle-income countries: a systematic scoping review. *Academic. Oup.ComC Turner, S Kalamatianou, A Drewnowski, B Kulkarni, S Kinra, S KadiyalaAdvances in Nutrition, 2020•academic.Oup.Com*. Retrieved September 25, 2023, from https://academic.oup.com/advances/article-abstract/11/2/387/5488467

CHAPTER FOUR

4.0 GENERAL DISCUSSION

The primary objectives of this research were twofold: first, to investigate the factors associated with the anthropometric measurements of primary school children aged between 6 and 13 years, and second, to explore how the school's food environment influenced the eating behaviours of primary school children in Dodoma region. The study found that prevalence of stunting, was 15.3% (n=19) among pupils in public schools and 5.6% (n=7) among those in private schools. Stunting is more common among boys than girls, and its occurrence increased with age. This trend could be attributed to the fact, Boys are at high risk of being stunted compared to girls due to less parental attention, less parental preferences as well as gender bias compared to their counterparts; that stunting was a type of long-term malnutrition that becomes more apparent as children grow older. As a child surpasses the critical growth period, the ability to reverse stunting diminishes. This observation is consistent with research conducted in Tanzania and other African countries, which consistently demonstrated that boys, have a higher likelihood of experiencing stunting compared to girls. Additionally, the likelihood of a child becoming stunted increases with age (Bliznashka *et al.,* 2021; Mohammadi *et al.,* 2022).

The occurrence of underweight varied between public and private schools, with figures of 8.6% (n=6) observed in public schools and 3.2% (n=3) in private schools for children aged below 10 years. This disparity could be explained by a range of factors, including differences in lifestyles, eating habits, parental education levels, and socio-economic status. Rural and urban backgrounds seemed to have a noteworthy influence on the prevalence of underweight. Children from rural areas tended to experience higher rates of underweight compared to their urban counterparts. This pattern of rural-urban disparities has been documented in related studies even among children below the age of five years (TNNS, 2018). As for the

prevalence of thinness, there was a significant contrast between public and private schools, with rates of 76.0% in public schools and 24.0% in private schools within the study area. This variation could be attributed to the absence of school meal programs in public schools, which might result in extended periods of hunger or a reliance on snacks purchased during breaks. These factors could contribute to the higher prevalence of thinness among children in public schools(Mwaikambo *et al.,* 2015).

Both the age of the children and the number of children living in the household emerged as important factors for predicting stunting. Stunting exhibited a notable upward trend as children grew older, with older age being identified as an independent predictor of stunting after controlling covariate of age, school type, school location, birth order and child number. This research underscored an inverse relationship, indicating that as a child's age decreased, there was a 19% increase in the likelihood of stunting for children aged 10-13 years in comparison with those aged 6 to 9 years. This observation aligns with prior studies that documented a progression of height deficits with increasing age in sub-Saharan Africa (Mushtaq *et al.,* 2011). Additionally, having more than four children in the household also proved to be a significant predictor of stunting among children. This finding could be attributed to reduced levels of childcare and diminished dietary intake due to the larger number of children in the household. Similar results have been reported in other regions of the world (Yeasmin and Islam, 2016).

In this study, it was also observed that, occurrence of overweight and obesity in school-aged children was lower compared to similar findings from research conducted in Tanzania. For example, a prior investigation in Tanzania by Mosha *et al.* (2021) reported a 15% prevalence of overweight and obesity among school children aged 9-11 years. Another study involving primary school children aged 7-17 years in Arusha Urban, Tanzania, reported a combined prevalence of overweight and obesity of approximately 18%

(Chomba *et al.,* 2019). In our specific study sample, the prevalence of overweight and obesity among primary school children was 16.4% in public schools and 83.6% in private schools. Notably, urban schools exhibited a higher prevalence of overweight and obesity among pupils compared to their rural counterparts. This trend could be attributed to changes in lifestyles and dietary habits. Environmental factors, such as the increased availability of fast-food establishments in urban areas, are contributing factors to these trends. This observation aligns with the findings of a study conducted in Morogoro, Tanzania (Muhomba *et al.,* 2023).

The type of school and the number of children residing in the household emerged as significant factors predicting overweight and obesity. It was observed that, a substantial 49, 80% of pupils attending private schools had a higher likelihood of developing overweight or obesity compared to their peers in public schools. This phenomenon could be linked to the fact that a significant number of pupils in public schools tended to face the following challenge such as skip meals, commuting to and from school potentially leading to lower weights and under nutrition. An increase in environment that promotes obesity was noted among children whose physical activities were restricted by their parents or guardians, particularly in cases where children had limited opportunities for spontaneous physical activities. These findings were consistent with those reported by Pangani *et al.* (2016). Furthermore, children living in households with fewer than four children exhibited a positive association with being overweight or obese, which contrasted with their counterparts in larger households. This situation arose from the presence of sufficient and excess food for children in families with fewer members, a correlation also highlighted by Pangani *et al.* (2016). It is essential for the public to recognize these patterns as indicators of a growing double burden of malnutrition: children with ample access to food resources are more vulnerable to overweight and obesity, while those facing food shortage and scarcity are at a higher risk of becoming underweight.

Furthermore, in this study, unadjusted models revealed that in between-school variances in dietary behaviours were low. The intra-class correlation (ICC) indicated a value of 11.0%. After adjusting for individual-level covariates, this value decreased to 10.1% for lipids and sugar-rich foods. When combining both individual-level and school-level covariates, none of the school-level food environment factors were found to be associated with dietary behaviours (Table 3.8). Predominantly consisted of cereals and starchy foods such as rice, maize, cassava, and corn. This suggested that, carbohydrate-rich foods serve as the primary source of energy for the majority of children in the study. Similar discoveries were made in a study conducted among primary school children in Tanzania (Mosha *et al.,* 2022). The primary reason behind the absence of a well-balanced diet among the children in the study population could be attributed to lack of nutritional knowledge among the parents regarding healthy habits. A healthy diet should not only be well-balanced in terms of macronutrients (such as proteins, carbohydrates, and fats) but also in terms of micronutrients (including vitamins and minerals). It is crucial to emphasize the importance of maintaining healthy dietary habits throughout a child's life to promote their optimal health and well-being, as highlighted in previous studies (Bliznashka *et al.*, 2021; Khamis *et al.,* 2022).

In this study, we conducted a comprehensive examination of how the school food environment influenced the eating habits of primary school children in Dodoma. Our findings indicated that, there was no significant link between the consumption of carbohydrate-rich foods and the individual characteristics, such as socio-demographic factors, of the students. Maize and legumes serve as the primary sources of energy, carbohydrates, and protein in Dodoma, and they are cultivated in various agro-ecological zones of the country, as noted in previous studies (*Mtaki, 2019*; Nicholaus *et al.,* 2020). Consumption of carbohydrates was high. This could be attributed to the availability of carbohydrate-rich foods in school cafeterias, which tended to be quite appealing to children. Additionally, starchy root

foods were both cost-effective and readily accessible from vendors located outside the school (Ogum *et al.,* 2018).

A significant positive correlation existed between the consumption of foods rich in protein and the individual characteristics of the pupils, specifically the survival status of their parents. Nearly half of children who had lost their fathers tended to have a lower average intake of protein-rich foods compared to their peers whose both parents were alive. This could be attributed to the limited awareness among many mothers regarding the importance of incorporating protein-rich foods into their children's diets. Conversely, children who had lost their fathers tended to have a higher average intake of protein-rich foods compared to those with both parents alive. This difference could be attributed to the recognition among males of the importance of providing diverse and nutritious foods for their children. However, the data revealed that, the average consumption of protein-rich foods remained the same for both children living with parents and those who had no parents. The primary reasons behind this inadequate intake of protein-rich foods are the high cost of animal-based protein sources and a lack of knowledge about the nutritional value of foods, as discussed by Khan and Saleem. (2018).

A notable adverse relationship existed between the consumption of foods rich in vitamins and minerals and individual characteristics, specifically the number of adults residing in the household. There was low intake of fruits and vegetables with low family size due to socio economic status since family with limited financial resources may prioritize cheaper, less nutritious food option over fresh produce; due to low family size few family members may not fully understand the importance of a balanced diet that includes ample fruits and vegetables. This phenomenon could stem from a lack of awareness regarding the significance of including fruits and vegetables in the diet, as well as the socioeconomic status of the family (Khamis *et al.,* 2022)

There was a significant positive link between the consumption of foods rich in lipids and sugars and individual characteristics, specifically the loss of a parent. The positive estimate of 0.407 indicated that, on average, majority of children who had lost their mothers tended to consume foods containing high amount of lipids and sugars compared to children who had not experienced loss of either parent. Conversely, the negative estimate of -0.196 suggested that, on average, children who had lost their fathers tended to consume foods with less lipids and sugar compared to their peers who had both parents alive. Additionally, the estimate of -0.118 implied that, on average, children who had lost both parents also tended to consume fewer lipids and sugar-rich foods compared to children who had not lost either parent. Children who lost their mother tended to consume more lipids and sugar rich foods this may be due to less parental care from their father due to time constraints brought by busy lifestyles and long work hours which lead to reliance on convenient processed foods rather than fresh foods. While, Children who lost their father tended to consume lower lipids and sugar rich foods this may be due to awareness for mothers on the importance of a buy healthier food, and fully understand of the importance of a balanced diet that includes ample fruits and vegetable. This trend could be influenced by factors such as their socio-economic status, which enabled them to purchase healthier foods, the absence of parental care, as well as the accessibility and affordability of readily available foods (Ogum *et al.,* 2018)

Absence of a connection between the availability of food establishments in the vicinity of a school and the dietary preferences of the children could be clarified by the fact that, the pupils were restricted from leaving the school premises during school hours, as reported by school head teachers. Consequently, the students could only visit these food establishments before or after school hours. The relationship between food outlets and the dietary choices of pupils has previously been linked to policies that permit students to leave the school compound freely. Additionally, due to nearly half of

the children were given small amount of money to spend at school, it's likely that, children of this age had limited pocket money available for their personal use (Abizari and Ali, 2019).

CHAPTER FIVE

5.0 GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1 General conclusions

This study yielded valuable insights into the prevalence of stunting, thinness, underweight, and overweight/obesity among pupils aged 6 to 13 years attending both public and private schools in Dodoma region. The findings revealed that, undernutrition (including stunting, underweight, and thinness) was more common among boys than girls, more prevalent in public schools than in private schools, and was higher among pupils residing in rural areas compared to their counterparts in urban settings. Conversely, overnutrition (including overweight and obesity) was more prevalent in private schools, more common among girls than boys, and prevalent among pupils living in urban areas. Stunting was influenced by factors such as student's age and the number of children living in the household, while being overweight/obese was associated with the type of school attended and a lower number of children in the household. The study also showed that, most of the variations in eating behaviours observed were at the individual level. Results indicated that, a significant number of children consumed all food groups only one to two times a week to do not meet dietary diversity score, indicating a low intake of these foods. Specifically, the assessment of children's seven days food frequency questionnaire revealed that, over the course of a week, more than 50% of the children consumed cereals, tubers, fats and oils food groups. However, only a few of them had an adequate intake of vegetables, fruits, meat, poultry, fish, and pulses during the week. This suggested that, overall children did not eat balanced diet in the study. Consequently, the study found that the investigated school-level factors did not have a substantial impact on the dietary behaviours of children involved in the study.

5.2 Recommendations

Based on the finding of this study, it is crucial to closely monitor the nutritional status of schoolchildren by ministry of health, nutritionist

and other related stakeholder. Priority should be given by ministry of Education to implementing school feeding programs, particularly in public schools, to address issues related to undernutrition problems. Unhealthy snacking, as well as poor dietary choices that increase the risk of lifestyle-related diseases associated with overweight and obesity particularly in private schools. Moreover, it is essential to raise awareness among parents about the academic and health implications of both undernutrition and overnutrition of their children by Nutritionist. There is an urgent need to enhance nutritional interventions aimed at improving the nutritional well-being of primary school pupils in Tanzania. Furthermore, conducting longitudinal or cohort studies to allow one to study the school, home and neighborhood food environment and make follow up of children.

Reference

Abizari, A. R., & Ali, Z. (2019). Dietary patterns and associated factors of schooling Ghanaian adolescents. *Journal of Health, Population, and Nutrition*, *38*(1), 5. https://doi.org/10.1186/S41043-019-0162-8

Bliznashka, L., Danaei, G., Fink, G., Flax, V. L., Thakwalakwa, C., & Jaacks, L. M. (2021). Cross-country comparison of dietary patterns and overweight and obesity among adult women in urban Sub-Saharan Africa. *Public Health Nutrition*, *24*(6), 1393–1403. https://doi.org/10.1017/S1368980019005202

Bryant, M., Burton, W., O'Kane, N., Woodside, J. V., Ahern, S., Garnett, P., Spence, S., Sharif, A., Rutter, H., Baker, T., & Evans, C. E. L. (2023). Understanding school food systems to support the development and implementation of food based policies and interventions. *International Journal of Behavioural Nutrition and Physical Activity*, *20*(1). https://doi.org/10.1186/S12966-023-01432-2

Carducci, B., Oh, C., Keats, E.,D. R.& C. D., (2020). Effect of food environment interventions on anthropometric outcomes in school-aged children and adolescents in low-and middle-income countries: a systematic. *Academic.Oup.ComB Carducci, C Oh, EC Keats, DE Roth, ZA BhuttaCurrent Developments in Nutrition, 2020•academic.Oup.Com*. Retrieved September 26, 2023, from https:// academic. oup. com/cdn/article-abstract/4/7/nzaa098/5846037

Chomba, H., Martin, H., &, J. K. (2019). Prevalence and predictors of obesity among 7-to 17-year-old schoolchildren in Urban Arusha, Tanzania. *Hindawi.ComH Chomba, HD Martin, J KimyweJournal of Nutrition and Metabolism, 2019•hindawi.Com*. Retrieved September 25, 2023, from https://www. hindawi. com/journals/jnme/2019/3106597/abs/

Dolipska, A., Majerczyk, & M., A. (2018). Eating behaviours of primary school pupils from Slaskie, Malopolskie and Opolskie Voivodeships in Poland. *Bibliotekanauki.PlA Dolipska, M Majerczyk, A Góra, K Janion, E SzczepanskaRoczniki*

Państwowego Zakładu Higieny, 2018•bibliotekanauki.Pl. Retrieved September 26, 2023, from https://bibliotekanauki.pl/articles/873431.pdf

Downs, S., Ahmed, S., & Fanzo, (2020). Food environment typology: advancing an expanded definition, framework, and methodological approach for improved characterization of wild, cultivated, and built. *Mdpi.Com*. Retrieved September 26, 2023, from https://www.mdpi.com/2304-8158/9/4/532

El-Kassas, G., metabolism, & F. Z. (2017). The dual burden of malnutrition and associated dietary and lifestyle habits among lebanese school age children living in orphanages in North Lebanon. *Hindawi.ComG El-Kassas, F ZiadeJournal of Nutrition and Metabolism, 2017•hindawi.Com*. Retrieved September 26, 2023, from https://www. hindawi. com/ journals/ jnme/ 2017/ 486343 1/abs/

Food and Agriculture Organization of the United Nations. School Food and Nutrition. Healthy food Environment and School Food. Available online: http:// www. fao. org/schoolfood/areas-work/foodenvironment/en/ (accessed on 28 August 2022). - Google Search. (n.d.). Retrieved September 26, 2023,

Hawkes, C., Smith, T. G., Jewell, J., Wardle, J., Hammond, R. A., Friel, S., Thow, A. M., & Kain, J. (2015). Smart food policies for obesity prevention. *Thelancet.ComC Hawkes, TG Smith, J Jewell, J Wardle, RA Hammond, S Friel, AM Thow, J KainThe Lancet, 2015•thelancet.Com*, *385*, 2410–2421. https://doi.org/10.1016/S0140-6736 (14) 61745-1

Jang, M., Brown, R., & Vang, P. Y. (2021). The Relationships Between Parental Stress, Home Food Environment, and Child Diet Patterns in Families of Preschool Children. *American Journal of Health Promotion*, *35*(1), 131–139. https://doi. org/10. 1177/0890117120929541

John, S., Mchau, G., Ayubu, H., Mafung'a, S., & Ainan, S. (2019). Diet and nutrition status among school-age children and adolescents in Tanzania. *Tfnc.Go.TzS John, G Mchau, H*

Ayubu, S Mafung'a, S Ainan, W Kyatikila, E Lyimo, F Chacky…tfnc.Go.Tz. https://doi.org/10.1080/08035250410024998

Khamis, A. G., Akwilina, W., Mwanri, M., Senkoro, K., Kreppel, B., Bonfoh, S., Godfrey, M., Kwesigabo, G., Wendelin Mwanri, A., Senkoro, M., Kreppel, K., Bonfoh, B., & Mfinanga, S. G. (2022). Dietary patterns, nutrient intakes and metabolic conditions among agro-pastoralists in Monduli District, Tanzania. *Taylor & FrancisAG Khamis, AW Mwanri, M Senkoro, K Kreppel, B Bonfoh, SG Mfinanga, G KwesigaboNutrition and Dietary Supplements, 2022•Taylor & Francis*, *Volume 14*, 11–20. https://doi. org/10. 2147/NDS.S355730

Khan, R., Physiology, & S. S. (2018). Association of anaemia with dietary practices in adolescent girls. *Pjp.Pps.Org.PkR Khan, S SaleemPakistan Journal of Physiology, 2018•pjp.Pps.Org.Pk*. Retrieved September 25, 2023, from http://www.pjp.pps.org.pk/index.php/PJP/article/download/166/500

Kothari, C. (2004). *Research Methodology 2 rev*. http://dl. saintgits. org/jspui/ bitstream/123456789/1133/1/Research Methodology C R Kothari (Eng) 1.81 MB.pdf

Lytle, L., place, & R. S. (2017). Measures of the food environment: A systematic review of the field, 2007–2015. *Elsevier*. Retrieved September 26, 2023, from https://www.sciencedirect.com/science/article/pii/S1353829216300843

Mekonnen, T., Tariku, A., & Abebe, S. M. (2018). Overweight/obesity among school aged children in Bahir Dar City: Cross sectional study. *Italian Journal of Pediatrics*, *44*(1). https://doi.org/10.1186/S13052-018-0452-6

Micha, R., Karageorgou, D., Bakogianni, I., Trichia, E., Whitsel, L. P., Story, M., Peñalvo, J. L., & Mozaffarian, D. (2018). Effectiveness of school food environment policies on children's dietary behaviours: A systematic review and meta-

analysis. *PLoS ONE*, *13*(3). https://doi.org/10.1371/JOURNAL.PONE.0194555

Mohammadi, S., Bolourian, M., Badpeyma, M., Nasiri, M., Ghamsari, A. A., & Movahedinia, S. (2022). Prevalence and Risk Factors of Malnutrition among Primary School Children in Iran. *Health-Providers.IrS Mohammadi, M Bolourian, M Badpeyma, M Nasiri, A Alizadeh Ghamsari, S MovahediniaHealth Providers, 2022•health-Providers.Ir*, *1*(3), 149–161. https://doi.org/10.22034/hp.2022.362440.1025

Monteiro, C. A., Moubarac, J.-C., Cannon, G., Ng, S. W., Popkin, B., & Monteiro, C. (2013). Ultra-processed products are becoming dominant in the global food system. *Wiley Online LibraryCA Monteiro, JC Moubarac, G Cannon, SW Ng, B PopkinObesity Reviews, 2013•Wiley Online Library*, *14*(S2), 21–28. https://doi. org/10. 1111/obr. 12107

Mosha, M. V., Msuya, S. E., Kasagama, E., Ayieko, P., Todd, J., & Filteau, S. (2021). Prevalence and correlates of overweight and obesity among primary school children in Kilimanjaro, Tanzania. *PLoS ONE*, *16*(4 April). https://doi. org/10. 1371/ JOURNAL.PONE.0249595

Mosha, M. V., Paulo, H. A., Msuya, S. E., Grosskurth, H., & Filteau, S. (2022). Lack of an association between dietary patterns and adiposity among primary school children in Kilimanjaro Tanzania. *BMC Nutrition*, *8*(1). https://doi.org/10.1186/S40795-022-00529-4

Mosha, T., (2010). Prevalence of overweight and obesity among children aged 6-12 years in Dodoma and Kinondoni municipalities, Tanzania. *Ajol.InfoTC Mosha, S FungoTanzania Journal of Health Research, 2010•ajol.Info*, *12*(1). https://www. ajol. nfo/index. php/thrb/ article /view/ 56202

Mtaki, B. (2019). Tanzania—United Republic of Grain and Feed Annual 2019 Tanzania Corn, Wheat and Rice Report. - Google Search. (n.d.). Retrieved September 26, 2023,

Muhomba, E., Msollo, S., & A. M (2023). Prevalence and determinants of overweight and obesity among school children in Morogoro region, Tanzania. *Ajol.InfoES Muhomba, SS Msollo, AW MwanriTanzania Journal of Health Research, 2023•ajol.Info*. https://doi.org/10.4314/thrb.v24i1.3

Mukanu, M. M., Delobelle, P., Thow, A. M., & Mchiza, Z. J. R. (2022). Determinants of dietary patterns in school going adolescents in Urban Zambia. *Frontiers in Nutrition*, *9*. https://doi.org/10.3389/FNUT.2022.956109/FULL

Mushtaq, M. U., Gull, S., Khurshid, U., Shad, M. A., & Siddiqui, A. M. (2011). Prevalence and socio-demographic correlates of stunting and thinness among Pakistani primary school children. *BMC Public Health*, *11*. https://doi.org/10.1186/1471-2458-11-790

Mohamed, A., Lazaro, S., Chack, F., Moshi, G., Kaswahili, P., and Msoga, J. (2022). Nutritional Status Among Pupils Aged (5-19) Years in Public Primary Schools in Mainland Tanzania. *Tanzania Public Health Bulletin*, 1(8), 9-26.

MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. (2018). Tanzania National Nutrition Survey using SMART Methodology (TNNS) 2018. *Dar Es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF*, *1*(1), 1–103.

MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF. (2021). National Multisectoral Nutrition Action Plan (NMNAP) 2021. *Dar Es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF*, *1*(1), 1–136.

Mwaikambo, S. A., Leyna, G. H., Killewo, J., Simba, A., & Puoane, T. (2015). Why are primary school children overweight and obese? A cross sectional study undertaken in Kinondoni district, Dar-es-salaam. *BMC Public Health*, *15*(1). https://doi. org/10. 1186/S12889-015-2598-0

National Bureau of Statistics - 2022 Population and Housing Census - Preliminary Report in Swahili Language. (n.d.). Retrieved

September 25, 2023, from https://www. nbs.go. tz/index.php/en/census-surveys/population-and-housing-census/802-matokeo-ya-mwanzo-ya-sensa-ya-watu-na-makazi-ya-mwaka-2022

Negash, S., Agyemang, C., Matsha, T. E., Peer, N., Erasmus, R. T., & Kengne, A. P. (2017). Differential prevalence and associations of overweight and obesity by gender and population group among school learners in South Africa: A cross-sectional study. *BMC Obesity*, *4*(1). https://doi.org/10.1186/S40608-017-0165-1

Nicholaus, C., Martin, H., & N. K (2020). Dietary practices, nutrient adequacy, and nutrition status among adolescents in boarding high schools in the kilimanjaro region, Tanzania. *Hindawi.ComC Nicholaus, HD Martin, N Kassim, AO Matemu, J KimiyweJournal of Nutrition and Metabolism, 2020•hindawi.Com*. Retrieved September 25, 2023, from https://www. hindawi. com/j ournals/ jnme/ 2020/3592813/

Ochola, S., M., P. & M. (2014). Dietary intake of schoolchildren and adolescents in developing countries. *Karger.ComS Ochola, PK MasiboAnnals of Nutrition and Metabolism, 2014•karger.Com*. Retrieved September 26, 2023, from https://karger.com/anm/article/64/Suppl. 2/24/40622

Ogum Alangea, D., Aryeetey, R. N., Gray, H. L., Laar, A. K., & Adanu, R. M. K. (2018). Dietary patterns and associated risk factors among school age children in urban Ghana. *BMC Nutrition*, *4*(1). https://doi.org/10.1186/S40795-018-0230-2

Pangani, I., Kiplamai, F., & J. K. (2016). Prevalence of overweight and obesity among primary school children aged 8–13 Years in Dar es Salaam city, Tanzania. *Hindawi.ComIN Pangani, FK Kiplamai, JW Kamau, VO OnyweraAdvances in Preventive Medicine, 2016•hindawi.Com*. Retrieved September 25, 2023, from https://www.hindawi.com/journals/apm/2016/1345017/abs/

Pienaar, A. E. (2015). Prevalence of overweight and obesity among primary school children in a developing country: NW-CHILD

longitudinal data of 6-9-yr-old children in South Africa. *BMC Obesity*, *2*(1). https://doi.org/10.1186/S40608-014-0030-4

Rovner, A., Nansel, T., & Wang, J., (2011). Food sold in school vending machines is associated with overall student dietary intake. *Elsevier*. Retrieved September 26, 2023, from https://www. sciencedirect. com/ science/article/pii/S1054139X10004271

Sanyaolu, A., Okorie, C., Qi, X., Locke, J., & Rehman, S. (2019). Childhood and Adolescent Obesity in the United States: A Public Health Concern. *Global Pediatric Health*, *6*. https://doi.org/10.1177/2333794X19891305

Smith, D., Cummins, S., Clark, C., & Stansfeld, S. (2013). Does the local food environment around schools affect diet? Longitudinal associations in adolescents attending secondary schools in East London. *BMC Public Health*, *13*, 70. https://doi. org/10. 1186/1471-2458-13-70

Society, A. & L.., P. (2018). Neighbourhood food environments: food choice, foodscapes and planning for health. *Cambridge.OrgAA LakeProceedings of the Nutrition Society, 2018•cambridge.Org*. Retrieved September 26, 2023, from https://www.cambridge.org/core/journals/proceedings-of-the-nutrition-society/article/neighbourhood-food-environments-food-choice-foodscapes-and-planning-for-health/63D1FAB5F3952F8D2DFA5182A1C81A6B

TAMISEMI. (2016). Profile of Dodoma Region. Retrieved from http://www. dodoma. go.tz/profile - Google Search. (n.d.). Retrieved September 26, 2023,

Turner, C., Kalamatianou, & S. D.(2020). Food environment research in low-and middle-income countries: a systematic scoping review. *Academic.Oup.ComC Turner, S Kalamatianou, A Drewnowski, B Kulkarni, S Kinra, S KadiyalaAdvances in Nutrition, 2020•academic.Oup.Com*. Retrieved September 25, 2023, from https://academic.oup.com/advances/article-abstract/11/2/387/5488467

United Nations Children's Fund. United Nations Children's Fund. United Nations Special Rapporteur on the Right to Food. In Protecting Children's Right to a Healthy Food Environment; UNICEF and United Nations Human Rights Council: Geneva, Switzerland, (2019). Available online: https://www.unicef.nl/files/Advocacy-briefhealthy-food-enviro-final.pdf (accessed on 4 Aug 2023) - Google Search. (n.d.). Retrieved September 26, 2023,

Williams, J., Scarborough, P., Townsend, N., Matthews, A., Burgoine, T., Mumtaz, L., & Rayner, M. (2015). Associations between food outlets around schools and BMI among primary students in England: A cross-classified multi-level analysis. *PLoS ONE*, *10*(7). https://doi.org/10.1371/JOURNAL.PONE.0132930

Yeasmin, S., Sci, K. & I.-B. (2016). Prevalence and determinants of undernutrition among school age slum children in Dhaka City. *CiteseerS Yeasmin, K IslamBangladesh. J Nutr Health Sci, 2016•Citeseer*. Retrieved September 25, 2023, from https:// citeseerx. ist.psu. edu/ document? repid=r ep1& type= pdf&doi= 25bf550 65eaf15 3a62923388e9f90158cf3256e0

APPENDICES

Appendix 1: Questionnaire for School Children

Questionnaire number: .....Date of interview: .....
Name of school: .....
Type of school: 1= Public…… 2= Government…….
Location of the school: 1= Rural…….2= Urban…….

SECTION A: Socio-economic and demographic characteristics of the school children

1. Sex: 1=Male 2=Female
2. Age (years) …….
3. Date of birth of respondent……
4. Class/Grade level: Standard ……..
5. Birth order….
6. Is your biological mother alive? 1= Yes 2= No
7. Is your biological father alive? 1= Yes 2= No
8. What is the number of adults (≥18 years) in your household? 1= ≤4 2= 5-7 3= >7
9. What is the number of children (<18 years) in your household? 1= ≤2 2= 3-5 3= >5
10. What is your father's education level (if he is present)? 1= Incomplete primary 2= Primary 3= Secondary 4= University 5=I don't know
11. What is your mother's education level (if she is present)? 1= Incomplete primary 2= Primary 3= Secondary 4= University 5= I don't know
12. What is your father's occupation (if he is present)? 1= Employed 2= Farmer 3= Business 4= I don't know
13. What is your mother's occupation (if she is present)? 1= Employed 2= Farmer 3= Business 4= Housewife 5= I don't know
14. What is the main source of drinking water for members of your household? 1= Pipe water 2= Protected spring 3= Unprotected spring 4= Protected well 5= Unprotected well

15. What kind of toilet facility do members of your household usually use? 1= Flush or pour flush toilet 2= Pit latrine 3= Open defecation
16. Where do you dispose of your solid waste (e.g. Bottle, unused buckets, food packages etc.)? 1= Pit 2= Burning 3= Open dumping

SECTION B: Children's meals consumption and other characteristics at school

17. Does your parent restrict you on foods to buy on the way to or from school or at school? 1=Yes 2= No
18. Does, your parents give you money to spent at school? 1= Yes 2= No
19. If yes how much……
20. If no, do you carry food from home to ate at school 1= Yes 2= No
21. Do you prefer purchase foods at school? 1= Yes 2= No
22. Reason for food/drink purchase……
    ….
23. Where do you frequently purchase your food and drinks items? 1= School canteen 2= School stores 3= Private store 4= Table top vendors 5= Food retailers outside the school 6= other (specify)……
24. How many food features do you visit when you are at school? 1= None 2= 1-2 3= More than three
25. What time it takes for you to walk to the nearest food feature? 1= One to five minutes 2= Six to ten minutes 3= More than ten minutes
26. What is your perception regarding walking time to neighbour food features? 1= Safety concern 2= Easy mobility
27. Which foods are mostly consumed by people your age? Mention three foods
    1. ……
       ……,

2. ……
……
3. ……
……

28. Which types of foods are available in and around your school?
Mention three
1. ……
……..……,
2. ……
……..,
3. ……
……..

29. Which type of food source are available in and around your school?
Mention three
1. ……
……..,
2. ……
……..,
3. ……
……..

30. Which type of foods would young people want to be available in and around your school?
Mention three
1. ……
……..,
2. ……
……..,
3. ……
……..…

31. Which type of food sources would young people want to be available in and around school?
Mention three
1 ……,
2. ……,

3……
……...

32. Are there any company that come by to school and encourage on the type of food and drinks that you should consume? 1= Yes 2=No
33. If yes, Mention three
    1. ……
    ……..
    2. ……
    ……..
    3. ……
    ……..

SECTION C: Children eating behaviours

1. Do you take breakfast before going to school? 1=Yes 2=No
2. Do you purchase foods or drinks on the way to or from school? 1= Yes 2= No
3. Do you purchase foods or drinks at school (during free periods or lunchtime)? 1= Yes 2= No
4. How is the price of different food types that are mainly consumed by young people like you? 1= Good 2= Bad
   If Good explain how
   ……
   …….
   If Bad explain how
   ……
   ……
   ……
   ……
5. What are the factors that influence the food choice you have? 1= Taste 2= Texture 3= Appearance 4= Familiarly 5= Smell 6= other (specify)……...
6. What do young people like you consider when deciding on place to source food from?

1= Hunger/Thirst 2= Copying friends 3= Not having anything to eat/drink from/at school 4= wanting foo/drink to eat later

7. Is there an opportunity for you to purchase food outside school? 1= Yes () 2= No ()
8. If yes, what are the factors influencing you to purchase food outside school?
   Mention three
   1. ……..
   2. ……..
   3. .....
9. If No, what limit you from not purchasing food outside school? Mention reason behind…….....
10. Do you consume food or drinks at home after school hours? 1= Yes 2= No
11. If yes, name them…….……
12. Did you have dinner yesterday? 1= Yes 2= No
13. If yes, what did you eat……
14. What kind of food do young people your age consider to be health?
    Mention three
    1. ……..
    2. ……..
    3. ……..,……..,……..,……..

15. What kind of food do young people your age consider to be unhealthy?
    Mention three
    1. ……
    2. ……
    3. ……..,……..,……

SECTION D: Children food, snack and beverages consumption pattern

16. In the past week, about how often did you eat/drink each of the following food items?

Food items	**Frequency**								
Cereal based products	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**≥2 times a week**
Ugali, nguna, aji (made of refined sembe, cassava, refined sorgum, other)									
White rice, vitumbua									
Refined pastry (e.g. Chapati, white bread, doughnut,pie, pasta, other baked good)									
stiff porridge									
Rice									
Biriani									
Chapati									
Rice and meat pilau									
Roots tubers and bananas									
Irish potatoes									
Sweet potatoes									
Cassava									
Banana									
Cassava with coconut									
Banana with meat									
Potato chips									
Pulses, seeds, nuts									
Legumes (beans, peas, lentils)									
Nuts (Bambara nuts, Ground									

nuts, walnut, cashew nut, almond,and others)									
Seeds (pumpkin seeds, sesame seeds, other)									
Meat, poultry, fish									
Read meat (e.g. Beef, Lamb, Pork)									
Processed meaats (e.g. Sausage, Salami, Ham, Bacon, Cured meat, frankfurter)									
Organ meat (e.g. Kidney, liver, heart)									
Poultry (Chicken, Turkey, Duck, Pigeon, Eggs and other poultry)									
Oilyand white fish (e.g. uspipa, nile perch, trout, , mackerel, tune, Tilapila))									
sardine									
Broths (meat or fish based)									
Vegetables									
Dark green leafy vegetables (e.g. Spinach, Amaranth, Kale, sweet potato leaves, cassava leaves, pumpkin leaves)									
Cruciferous vegetables (e.g. Cabbage, Broccoli, Brussel sprouts, Cauliflower, Kohirabi)									
Dark orange vegetables (e.g Carrot, Pumpkin, Sweet potato)									
Other vegetables (e.g. Eggplant, Tomato, Cucumber, Onion,)									
Vegetable relish with oil									
Vegetable relish coconut oil									
Fruits									
Citrus Fruits (e.g. Orange, Lemon, Grapefruit, Tangerine, Lime,)									
Other fruits (Apple, pear, peach, plum, plum, prune, grapes, berries, avocado, melon)									
Fruit jams									
Mixed Juices									

Fruit salad with citrus fruit such as oranges or pulp fruits such as papaya									
Oils and fats (Foods which are concentrated in fats and oils)									
Coconut oil									
Vegetable oil									
Sunflower oil									
Corn oil									
Soyabean oil									
Other oil (e.g. Sesame, cottonseed)									
Snacks/confectionary									
Potato/Banana crisps or other salty snacks foods									
Cakes									
Candies (Sweet of all types)									
Sweetened sismis seeds (Kashata za ufuta)									
Chocolate									
Kachori (spicy potato balls)									
Popcorn									
Chama									
Sweetened ice lollies/ Ice cream									
Sweetened peanuts (Kashata za karanga)									
Sweet biscuits (e.g. Cream biscuits, Choc chip cookies)									
Beverages									
Plain water (tap or boiled)									
Tea/Coffee									
Fresh Fruit juice									
Processed juice									
Bottle water									
Water packed in polythelene (Maji ya Kondoro)									
Energy drink (e.g. azam, Moo,)									
Milk (e.g. milk flavoured ice cream, fresh milk, flavoured milk, yoghurt, fermented milk)									
Soda/Soft drinks									

SECTION E: Anthropometric measurements and health status

1. Have you ever been sick in the past 4 weeks? 1=Yes 2=No
2. If yes, what disease(s) did you suffer from? ……
3. Did you seek treatment for the disease/condition? 1=Yes 2=No
4. Where did you seek treatment? 1=Government health facility 2=Religious/missionary health facility 3=Pharmacy or Drug store 4=Local shop 5=Local herbs/traditional healer 6. Others: specify ……
5. Did you sleep under the mosquito net last night? 1=Yes 2=No
6. How often do you wash your hands before having a meal? 1= Frequent 2= Infrequent
7. How often do you wash your hand after using the toilet? 1= Frequent 2= Infrequent
8. What is the material that you use for hand washing? 1= Water only 2= Water and soap
9. How often do you wear shoes? 1= Never 2= Sometimes 3= Always
10. Height (cm): ……. ……
11. Weight (kg): ……..

Appendix 2a: Key Informant Checklist with School head teachers

1. Are there school policies and practices influencing child nutrition?
2. If yes, mention them

……
……
……
……
…….

3. Is there food canteen around your school?
4. If yes how many……
……
5. Is there any program concerning food/meals offered to children during school hours?1= Yes 2=No
6. If yes how is it offered……
……
7. If No is there a plan for offering food/meals to children during school hours?
.....
.....
8. Are there any presence of food source/products around school i.e., any food from vendors or food outlets or any alternative food option available to students? 1= Yes 2= No
9. Are there any rules related to sale of foods outside schools with consideration of quality or hygiene or safety?1=Yes 2=No
10. If yes how active are they?
.....
.....

Appendix 2b: Key Informant Checklist with School Teacher

1. Are there modalities that students should follow concerning seeking food/beverage/snacks outside the school premises during break time and/or lunchtime?1=Yes 2=No
   If yes mention the modalities
   ……
   .....
   .....
   .....
   .....
2. Are students allowed to bring food from home? 1=Yes 2=No
3. What is your perception regarding influence of availability of healthy and unhealthy foods on children food choices and dietary quality?
   ……
   ……
   ……
   ……
   ……
   ……
4. What is your perception regarding influence of accessibility of healthy and unhealthy foods on children food choices and dietary quality?
   ……
   ……
   ……
   ……
   …

Appendix 3: Key Informant Checklist with Food vendors within school premises

1. What are the types of foods that you selling?
   ……
   ……
   ……
   ……
2. Which cooking method do you usually use to prepare these foods?
   ……
   ……
   …
3. How do you serve foods per children?
   ……
   ……
   ……
4. What can you say about children's purchasing practices?
   ……
   ……
   ……
5. How often children spent purchasing?
   ……
   ……
6. How much children spent purchasing?
   ……
   ……
7. What are the other products that you observed children eating?
   ……
   ……
   ……
8. What is your opinion about children's nutrition?
   ……
   ……
   ……

Appendix 4: Key Informant Checklist with Food outlets sellers

1. What services do you provide to the children or what is available for selling?
   ……
   ……
   ……
2. What is the time is it to open and to close?
   ……
   ……
3. How safety is the food that you selling?
   ……
   ……
   ……
4. Do you sell foods of within shelf life? 1= Yes 2= No
5. Do you carry any food outlets food promotions? 1=Yes 2= No
   If yes, mention
   ……
   ……
   ……
   ……
   ……...
6. What are the rules and regulation kept by the school and ministry of education?
   ……
   ……
   ……
7. What is your perception regarding children preference and what you are selling?
   ……
   ……
   ……
8. What is your perception of young people's food and drink purchasing practices and their concern about nutrition?
   ……
   ……

Appendix 5 (a): Structured observation within the School environment

Researcher's observation hint:

1. What type of food and beverages children brought from home and/or the street?
2. What children purchase at school canteen, vendors or food outlets
3. How much do children spent at school canteen, vendors or food outlets
4. Take photos from all food vendors and food outlets to document product available
5. Take photos to school's kitchen to observe and take pictures of daily school meal as well as it is preparation and served
6. How many toilets are there in a given school?
7. Is there presence of water and soup that children wash their hands after using the toilet?

Appendix 5(b): Data for mapping food outlets/food vendors

ID	District Name	Ward Name	School Name	Southern (Longitudes)	Northern (Latitudes)	Food Outlet Name	Description

Appendix 6: Ethical Clearance Certificate

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
3 Barack Obama Drive
P.O. Box 9653
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NIMR/HQ/R.8a/Vol.IX/4250

Permanent Secretary
Ministry of Health
Government City Mtumba
Health Road
P.O. Box 743
40478 Dodoma

31 March 2023

Ms Vivian Richard Kilandeka
Sokoine University of Agriculture
P O Box 1279
Dar es Salaam

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled **"Influence of School Food Environment on eating behaviors and nutritional status of Primary School children (7-13 years) in Dodoma" (Richard, K. *et al.*)** has been granted ethical clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from the National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III Section 10 (2).
5. Sites: Dodoma region.

Approval is valid for one year: 31 March 2023 to 30 March 2024.

Name: Prof. Said S. Aboud

Signature
CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Prof. Tumaini J. Nagu

Signature
CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH

c.c: Director, Health Services-TAMISEMI, Dodoma.
RMO of Dodoma region.
DMOs/DEDs of Dodoma City Council and Chamwino districts.

Appendix 7: Letter of clearance from SUA

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY.

SOKOINE UNIVERSITY OF AGRICULTURE
OFFICE OF THE VICE-CHANCELLOR

P.O Box 3000, CHUO KIKUU, MOROGORO, TANZANIA.
Phone: +255 (023) 2640006/7/8/9, Direct Line: +255 (023) 2640015,
E-mail: vc@sua.ac.tz, Website: https://www.sua.ac.tz

Please refer to:
Our Ref: SUA/ADM/R.1/8/960 **Date:** 22nd December, 2022

Permanent Secretary,
President's Office,
Regional Administration and Local Government,
P.O. Box 1923, Mji wa Serikali,
41185 DODOMA.
Email: ps@tamisemi.go.tz

RE: UNIVERSITY STAFF, STUDENTS AND RESEARCHERS CLEARANCE

The Sokoine University of Agriculture was established by University Act No. 7 of 2005 and SUA Charter, 2007 which became operational on 1st January 2007 repealing Act No. 6 of 1984. One of the mission objectives of the University is to generate and apply knowledge through research. For this reason the staff and researchers undertake research activities from time to time.

2. To facilitate the research function, the Vice Chancellor of the Sokoine University of Agriculture (SUA) is empowered to issue research clearance to staff, students, research associate and researchers of SUA on behalf of the Tanzania Commission for Science and Technology.

3. The purpose of this letter is to introduce to you **Ms. Vivian Richard Kilandeka** a bonafide **MSc. (Human Nutrition)** student with Registration number **MHN/D/2021/0032** of SUA. By this letter **Ms. Vivian Richard Kilandeka** has been granted clearance to conduct research in the country. The title of the research in question is ***"Influence of School Food Environment on Eating Behaviors and Nutritional Status of Primary School Childred (7 – 13 years) in Dodoma."***

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA

4. The period for which this permission has been granted is from **January, 2023** to **April, 2023**. The research will be conducted in **Dodoma Urban and Chamwino District, Dodoma Region.**

5. Should some of these areas/institutions/offices be restricted, you are requested to kindly advice the researcher(s) on alternative areas/institutions/ offices which could be visited. In case you may require further information on the researcher please contact me.

6. We thank you in advance for your cooperation and facilitation of this research activity.

Yours sincerely,

VICE CHANCELLOR
SOKOINE UNIVERSITY OF AGRICULTURE
P. O. Box 3000

Prof. Maulid W. Mwatawala
FOR: VICE-CHANCELLOR

c.c. Director, DPRTC, SUA. - To note in file.

c.c. Student – **Ms. Vivian Richard Kilandeka**

Appendix 8: Turn tin Original Report

Turnitin Originality Report

Influence of School Food Environment on Eating Behaviors and Nutritional Status of Primary School Children (6-13 years) in Dodoma By Vivian Kilendeka

Similarity Index 17%