Title: Assessing the School Food Environment and its Role on Healthy Eating Behaviours among School Age Children in Dar es Salaam, Tanzania

Authors: Nyabasi Makori[1*], Dyness Kejo[1], Hoyce Mshida[1], Beatrice Bachwenkizi[1], Devotha Mushumbusi[1], Zahara Daudi[1], Monica Chipungahelo[1], Ai Zhao[2] and Anselm P Moshi[1]

[1]Tanzania Food and Nutrition Centre

[2] Vanke School of Public Health, Tsinghua University, Beijing, China

Abstract

School food environment plays a crucial role in shaping children's dietary habits and promoting healthy eating practices. The study investigated the school food environment in Temeke Municipality, Dar es Salaam, focusing on its role in promoting healthy eating among school-age children. A cross-sectional survey was conducted across four schools, with food vendors (N= 20) and teachers (N=8) interviewed using structured questionnaires. The study aimed to assess food offerings, school oversight, and vendors' knowledge of food quality.

The findings disclosed that 62.5% of the schools partially implemented school feeding guidelines, while 37.5% did not implement them. Among the surveyed schools, 37.5% had food storage facilities, 25.0% had functioning kitchens, and none had dining halls. The food environment included both healthy and unhealthy options, with 55.6% of food and beverages classified as healthy and 44.4% as unhealthy. Popular unhealthy items included samosas (95.5%), fried potato chips (87.0%), and fried mashed potato balls (73.9%).

The study also compared the calorie portions of foods purchased by students with the Recommended Dietary Allowances (RDA) for different age groups. The percentage of RDA covered by these portions ranged from 8.0-19.0% for ages 5-8, 6.0-19.0% for ages 9-13, and 5.0-16.0% for ages 14-18. Furthermore, food vendors demonstrated low knowledge of food safety, hygiene, and nutrition, with only 22.0% aware of the national food guidelines. The overall food environment exposed students to unhealthy food options, with significant gaps in the implementation of health guidelines. Findings highlight the need for interventions to improve food offerings and promote healthier food choices around schools. Particularly, the government must develop a comprehensive, mandatory school feeding policy, secure sustainable funding, and enhance community and parental engagement. Investing in school infrastructure, regulating unhealthy food vendors, scaling successful local models, improving intersectoral coordination, and addressing age-specific nutritional needs are also critical for ensuring the long-term adequacy and sustainability of school feeding programs, benefiting all students, especially the most vulnerable.

Highlights

- Significant portion of schools only partially implement school feeding guidelines.
- Most foods available at surveyed schools are deep-fried.
- The cost of portions purchased by students varies widely.
- The portions provided do not adequately meet the recommended caloric intake for all age groups.
- Food vendors at the schools lack sufficient knowledge of nutrition, food safety, and hygiene.
- A mandatory school feeding policy is key to sustainability and equity

Key words

School food environment, school children, healthy food, malnutrition, school feeding programme, food vender, food environment.

1. Introduction

The school food environment encompasses the various physical, economic, political, and sociocultural factors that influence children's food acquisition, purchasing behaviors, and consumption patterns within the school setting (1). It includes the conditions, opportunities, and determinants that shape dietary choices and nutritional status among school-aged children (2, 3). The school food environment plays a pivotal role in shaping children's eating behaviors and overall health, with research indicating that the food available within and around schools significantly impacts both short-term health outcomes and long-term nutrition trajectories (4). In the context of school-aged children, the food environment can either encourage healthy, balanced eating habits or perpetuate poor dietary patterns that contribute to various health issues, including obesity, stunting, and micronutrient deficiencies (5). **More recently, studies emphasize the growing influence of ultra-processed foods, which are high in sugar, fats, and salts, leading to shifts in adolescent dietary habits and an increase in diet-related diseases worldwide** (6)**.**

Often, schools are situated in areas with abundant food outlets offering energy-dense, low-cost foods, increasing the likelihood of students purchasing those foods. These environmental conditions directly influence students' food choices, with implications for dietary behaviors (7). **Recent evidence suggests that food availability, coupled with aggressive marketing tactics by vendors, amplifies unhealthy eating patterns, particularly among vulnerable groups like children** (8)**.** Schools are a critical setting for nutrition interventions, as children and adolescents spend a significant portion of their waking hours within the school environment, making it an ideal location for fostering healthy eating habits. **The overavailability of unhealthy food options in this environment may contribute to the development of poor dietary patterns, limiting acceptance of nutrient-dense foods, and potentially influencing lifelong eating habits** (9)**.** Early childhood nutrition is essential for promoting optimal growth, health,

and cognitive developme(10)nt, and for mitigating both immediate health concerns and the risk of chronic diseases later in life (11).

Globally, malnutrition in all its forms remains a major public health challenge, affecting children, adolescents, and adults alike (12). **Malnutrition is recognized not only as a health concern but also as a significant barrier to economic development, limiting productivity and hindering the achievement of global poverty reduction goals** (10). A recent cross-sectional study in Tanzania (2024) documented a triple burden of malnutrition among school-aged children, with stunting, anemia, and overweight affecting 32%, 34%, and 4.2% of the population, respectively (13). **This trend highlights the increasing vulnerability of school-aged children to malnutrition in sub-Saharan Africa, driven by rapid urbanization, dietary shifts, and the expanding prevalence of processed food consumption** (14). This situation underscores the growing need for targeted interventions in schools to mitigate the negative consequences of poor dietary behaviors.

Changes in the food environment have facilitated the widespread consumption of energy-dense foods, high in fats, sugars, and salt, as well as a marked increase in the consumption of sugar-sweetened beverages, particularly among adolescents (15). **The rise in demand for processed foods has been closely linked to demographic shifts, urbanization, and globalization, with Tanzania experiencing a notable increase in middle-income groups who are more likely to consume convenience foods** (16). Over the past two decades, Tanzania, like many other African countries, has witnessed a surge in demand for processed and convenience foods, driven by shifts in consumer lifestyles and time-use patterns (17). Factors such as food availability, affordability, accessibility, and desirability have become key determinants of food choices. **This trend is not only confined to urban and peri-urban areas but is increasingly penetrating rural communities, driven by changes in labor dynamics and time-saving considerations related to food preparation** (18).

The shifts in food environments are especially concerning for school-aged children and adolescents, as they directly impact food preferences, dietary behaviors, and ultimately, nutritional outcomes. **However, research on the school food environment and its impact on nutrition outcomes in Tanzania remains limited. Existing studies often focus on broad dietary habits rather than the specific environmental factors that shape food choices within the school context** (19)**.** To address these challenges, the Tanzanian government, through the Ministry of Education, developed the School Feeding and Nutrition Guideline in 2018. This guideline aims to provide a framework for the sustainable provision of food and nutrition services in schools, offering standardized procedures for effective implementation and ensuring consistent food availability in schools (20). Moreover, these policies are critical in enhancing the quality of school feeding programs and ensuring their long-term sustainability at the national level.

Despite these efforts, adherence to the guidelines has been inconsistent, and challenges in implementation persist. Studies indicate that insufficient infrastructure, lack of trained staff, and limited community involvement remain significant barriers to effective school feeding programs (21)**.** Failing to comply with the guidelines can result in inconsistent implementation of school feeding programs, which may negatively affect the quality and nutritional adequacy of the meals provided. Inadequate implementation may result in improper meal planning, which, in turn, can lead to imbalanced diets that fail to meet the nutritional needs of students, potentially hindering growth and development. Challenges in the implementation of school feeding programs have been documented in other contexts, such as Rwanda, where insufficient infrastructure has been identified as a major barrier (22). **In addition, evidence suggests that the quality of the food offered through school feeding programs often does not meet the nutritional standards necessary to support children's health and academic performance** (23)**.**

Adherence to the basic requirements outlined in the school feeding guidelines is essential for the successful operation of these programs. These requirements include the establishment of appropriate infrastructure, such as well-ventilated kitchens equipped with fuel-efficient stoves, proper storage facilities, a reliable water supply, cooking and serving utensils, a canteen, garbage disposal systems, and adequate hygiene and sanitation facilities(24). The objective of this study is to assess the school food environment in Temeke District, Tanzania by examining the types of foods available, the factors influencing students' food preferences, and the role of infrastructure, vendor knowledge, and food healthiness in shaping these preferences.

This study is particularly relevant in the Tanzanian context due to the limited research on school food environments, and the growing concern over the triple burden of malnutrition affecting children. By providing insights into the specific challenges and opportunities within the school food environment at Temeke District, this research will contribute to the evidence base needed for more effective nutrition interventions in Tanzanian schools. Additionally, this study will help policymakers and stakeholders identify key factors influencing food choices and improve the implementation of school feeding programs in the region.

2. Methods and Approaches

2.1. Study Area

The study was conducted at Temeke Municipal, located in the southern part of the Dar es Salaam Region, Tanzania. The municipality consists of two divisions (Mbagala and Chang'ombe), 30 wards, and 142 subwards/streets. Temeke municipality was purposefully selected because it includes low, medium, and high-income earners, as well as both rural and urban residents, making it a representative sample of the broader Dar es Salaam population. Temeke District comprises 134 primary schools, of which 51 are private institutions, and 2 cater to children with special educational needs. Additionally, the district has 63

secondary schools, 37 of which are private, and 26 are public.

2.2.Study Design and Target Population

A cross-sectional survey was conducted in December 2023 to collect baseline data on the school food environment in Temeke Municipal. The survey targeted a purposively selected sample of four (4) publich Schools (2 primary and 2 secondary) schools, including both urban and peri-urban schools, to ensure representation of diverse student populations from different food environments, socio-economic backgrounds, cultural contexts, and ethnic groups. Furthermore, the 4 public schools were purposively selected based on their similarities in food environment settings, which offered a focused and consistent comparison within the public sector. This targeted approach ensured that the data collected would provide valuable insights into the food environments specifically found in public schools, as distinct from the settings in private institutions, which often have different resources and food provision structures. Moreover, the choice of only four schools was dictated by the resource constraints of this pilot study. This focused approach allowed for a thorough, manageable analysis with the intention of scaling the study up in the future to include a larger number of schools across various regions in Tanzania. This phased approach ensures that the findings from this pilot study can be used to inform broader research and policy initiatives.

Target Population

School children and adolescents aged 6-18 years from either a secondary or primary school in Temeke municipality, Dar-es salaam, Tanzania.

Inclusion and Exculsion Criteria

The study focused exclusively on government schools, deliberately excluding private schools, based on several key distinctions. Students in private schools normally comes from higher-income families and often don`t rely much on schools foods but rather bring take aways from their homes. Thus, the research targeted students in government schools, as they are primarily from low-income families and are more susceptible to micronutrient deficiencies, which is the central problem this study aims to address. In addition, special schools and single sex schools were not included in the study Also venders and teachers who were not willing to concent were not involved in the study.

2.3. Sampling technique and Sample size calculation

To select the schools for the study, a simple lottery method was used. First, all 83 public primary schools were assigned a unique number. These numbers were written on individual pieces of paper, which were then mixed. Two pieces of paper were drawn randomly, and the corresponding schools were included in the study. The same process was followed for the 26 public secondary schools, resulting in the random selection of 2 secondary schools. Once the schools were chosen, the researchers conveniently involved the food vendors operating near these schools and the health teachers who were present on the day the survey was conducted.

2.4. Data Collection

The data collection tools were pre-tested with a small sample of food vendors to ensure the clarity, accuracy, and reliability of the instruments. This was done in nearby primary school known as Bunge Primary School in Ilala City Council of Dar es Salaam where 3 food venders were interviewed. Based on the feedback received during the pre-testing phase, the tools were refined to enhance their precision and ensure they effectively captured the required information. Data collection was conducted by experienced researchers using pre-tested semi-structured questionnaires, checklists, and observation guides. Data collection tools were designed and validated through pretesting but also using tools used during survey

done in Tanzania on School Malaria and Nutrition of 2021. These tools were designed to provide comprehensive insights into the school food environment and the factors influencing students' food choices and nutritional outcomes.

Face-to-face interviews were conducted with food vendors to gather data on the school food environment including the foods sold to students, the food products available on school premises, food pricing, students' food preferences, food safety and hygiene practices, and the vendors' knowledge of nutrition and its relevance to health. Interviews were conducted with head teachers and health teachers to explore the implementation of school feeding programs, the availability of food around the school, and other nutrition-related policies and practices. Using a structured checklist, researchers assessed various aspects of the food environment. The checklist focused on evaluating the variety and quality of food products sold, the accessibility of food outlets for students, and the types of offerings available.

2.3.Data Analysis

The Statistical Package for the Social Sciences (SPSS) for Windows software (IBM version 21, Armonk, NY, USA) was used to analyze the information collected from food vendors and teachers. Descriptive statistics were applied to the quantitative data, and the results were presented in Tables and figures **as percentages. Qualitative data were categorized into themes, tallied, and then presented as percentages in Tables.**

Calories contribution to the Recommended Dietary Allowance (RDA) was calculated using Excel, based on the weight of each food type purchased by students from food vendors. These values were compared to the standard calorie requirements for school meals, as outlined in the school feeding guidelines and the RDA for each age group. The findings were presented in Tables, with detailed descriptions of the assumptions made and the age groups considered.

Information on the types of food available around the schools, along with their prices, was summarized in tables, including descriptions of each food item and its selling price.

2.4.Ethical Clearance

Permission to conduct the study was obtained from the National Institute for Medical Research. The Prime Minister's Office, Regional Authority, and Local Government (PORALG) granted permission to carry out the study in primary and secondary schools. The Ministry of Education, through the regional and district health and education offices in Temeke Municipal Council, informed head teachers about the upcoming research. Prior to data collection, the researchers conducted pre-visits to each school to introduce the study objectives to the head teachers. Informed consent forms were obtained from both teachers and food vendors.

3. Results and Discussion

3.1.School Feeding Programme, policies and guidelines

The School Feeding Programme (SFP) plays a vital role in improving educational outcomes and student well-being. The survey revealed high awareness of existing policies and guidelines related to the program across all participating schools. However, adherence to these guidelines was varied, with 62.5% of schools partially adhering, while 37.5% were not implementing them at all (Fig 1). Partial implementation of school feeding guidelines is contributed by several factors, key challenges identified include insufficient infrastructure, such as the lack of functional kitchens and dining halls, which hampers the ability of schools to properly prepare and serve nutritious meals. This highlights the need for stronger enforcement and improved communication among stakeholders involved in the program's implementation.

A significant challenge identified was the lack of adequate infrastructure, which aligns with the findings of Roothaert et al.(25) who emphasize that infrastructure is crucial for the success and sustainability of

224 school feeding programs. The survey showed that only 37.5% of schools had access to food storage
225 facilities, and just 25% had functional kitchens (Fig 1). Furthermore, none of the schools had a dining hall
226 (Fig 1), which is essential for creating an environment where students can enjoy meals in a social setting.
227 The absence of these facilities not only complicates meal distribution but also undermines the nutritional
228 and social benefits of the program.
229 Ndayishimye and Dushimimana(26) argue that effective collaboration among stakeholders is key to
230 overcoming infrastructure deficits. The survey findings suggest that stronger coordination between
231 government bodies, schools, and local communities could mobilize resources for improving critical
232 facilities. The lack of proper food storage facilities is particularly concerning, as Tamiru et al. (27) noted
233 that inadequate storage can lead to food spoilage, compromising meal safety and quality. Without well-
234 equipped kitchens, the hygiene and safety of food preparation are at risk, diminishing the program's overall
235 effectiveness.
236 The absence of dining halls is another significant challenge. Assey and Mwila (21) emphasize the
237 importance of dining spaces in fostering positive eating habits and social interaction. Without such spaces,
238 students miss out on these benefits, potentially hindering their social development. This is further
239 supported by Sando et al.(20), who highlight the role of dining areas in encouraging healthy socialization
240 among students.
241 From a policy perspective, the deficiencies in infrastructure call for a review and reform of the school
242 feeding guidelines. Kamanga et al. (28) argue that policies should prioritize not only the provision of food
243 but also the necessary facilities for safe storage, preparation, and consumption. Strengthening these
244 guidelines will ensure that schools are better equipped to manage and implement effective feeding
245 programs.

Therefore, the identified deficiencies in food storage, kitchen facilities, and dining halls pose substantial barriers to the effectiveness of school feeding programs. To address these challenges, there is a need for robust stakeholder collaboration and enhanced policy support focused on improving infrastructure in schools. These findings reflect broader trends seen across African school feeding programs, as discussed by Mainje et al.(29), who emphasize that the sustainability of such programs depends not only on food availability but also on the infrastructure and institutional support necessary to deliver quality meals to students.

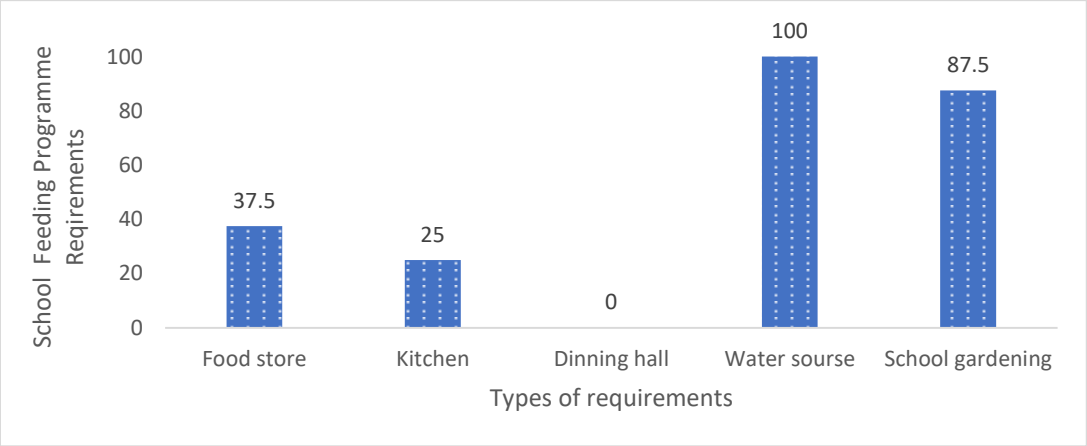

Figure 1: Existing infrastructure to support school feeding program in primary and secondary schools

3.2. Availability of food and beverages around the school environment

The availability of food and beverages around schools plays a significant role in shaping students' dietary habits and, consequently, their health outcomes. Schools are often surrounded by a variety of food outlets such as shops, canteens, restaurants, and fast-food outlets that influence students' food choices. The survey findings indicate a wide availability of food options in the surrounding environment, with a majority being sold at affordable prices ranging from TZS 100 to 1000 (USD 0.0004-0.4) (Table 4). While affordability can make these options appealing, the prevalence of unhealthy foods such as high-sugar, high-fat, and high-salt snacks raises concerns about the nutritional value of what students consume.

The low cost and easy access to unhealthy foods significantly contribute to poor dietary habits among students, as these options are often more attractive than healthier alternatives. Tandoh et al. (30) highlight how the marketing and availability of unhealthy foods in school environments can influence students' eating behaviors, particularly when these foods are heavily marketed and readily available. This easy access to fast food outlets, grocery stores, and canteens exacerbates the issue by providing convenient, low-cost food that typically lacks essential nutrients, increasing the risk of poor nutrition (1).

Moreover, the peer behavior in school settings further reinforces these unhealthy eating habits. Students are often influenced by their peers' food choices, feeling social pressure to conform to unhealthy dietary patterns. This social dynamic is particularly impactful in school environments, where adolescents are still forming long-term eating habits. Iyassu et al.(31) emphasize the strong correlation between peer influence and dietary behaviors in schools, noting that the peer pressure to consume unhealthy foods can undermine efforts to promote healthier eating.

A school environment supportive of healthy eating is crucial for countering the negative impact of easy access to unhealthy foods. Creating such an environment requires comprehensive changes, including high-level policy modifications at both state and national levels, which can significantly influence eating behaviors and food availability. Marketing and sponsorship of unhealthy foods in and around schools needs to be controlled to reduce the influence of these foods on children's food choices (32). Policies that encourage healthier food options and limit the availability of unhealthy foods around schools could substantially improve students' nutrition.

Furthermore, studies have shown that the physical environment surrounding schools directly impacts food choices. Research has reported that adolescents are more likely to consume sugary drinks and processed snacks when such foods are readily available in their vicinity (33, 34). Thus, addressing the marketing and availability of these foods is essential for improving the overall dietary habits of students.

The need for healthier food availability in school environments is evident. It has been demonstrate that school canteens in New Zealand face similar challenges in providing healthy food (35). These barriers include financial constraints, limited access to nutritious food suppliers, and a lack of supportive policies. However, promoting healthier food options and ensuring that they are easily accessible can foster better dietary habits among students. To foster better nutrition and health outcomes for students, the availability of healthier food **options** in and around schools must be prioritized. This can be achieved through stronger regulation and policy reforms, as well as a shift in the food marketing strategies that currently promote unhealthy options. Introducing healthy food guidance in schools and surrounding areas can help shape better purchasing and consumption habits among students, leading to improved health outcomes in the long term (36).

Consequently, the availability of cheap, unhealthy food options around schools is a significant challenge to promoting better nutrition and health among students. Addressing this requires a combination of policy changes, improved food environments, and greater regulation of food marketing. The efforts should focus not only on reducing the availability of unhealthy foods but also on promoting and ensuring access to healthier food alternatives in the school environment.

Table 1: Common Food available around the school environment and their price

Types of Food	Price (TZS) (USD)	Description
Samosa	100 (0.00037)	A fried or baked pastry with a spicy potato filling. The filling is wrapped in dough and folded into a triangular or cone-shaped
Fried cassava	100 (0.00037)	Big cassava chips deep fried in cooking oil
kachori	100 (0.00037)	Fried mashed potato balls covered in wheat flour
Mandazi	100 (0.00037)	A form of fried bread (deep fried)
Potato Chips	500-1000 (0.183-0.37)	Fresh Potato chips fried in vegetable oil normally go with chicken or fish but in the visited schools it is just fried potato chips
Bajia	100 (0.00037)	Deep fried ball of wheat flour and beans or pigeon peas and spices (garlic, parsley, curry powder, cumin, red pepper, hot pepper, onions, baking powder
Fried sweet potato	100 (0.00037)	Same as cassava fried chips

Half cake	100 (0.00037)	Deep fried rolled ball of wheat fluor, sugar, baking powder, unsalted butter, egg, milk etc. It is a deep-fried product with crunchy crust made from chemically leavened wheat flour dough
Vishet	100(0.00037)	coconut pulp, sugar plus food colours
Rice with beans	100-1000 ((0.00037)-0.37)	One measure (i.e. one spoon is TZS 100, thus one student can one or more spoons up to a maximum of 10 spoons equals to TZS 1000
Bread	100 (0.00037)	Baked and leavened food made of a mixture of flour (wheat), water and yeast
Mango	100 (0.00037)	Fresh mango fruit or slices
Fruit juice	200 (0.00074)	Fresh cocktail Juice, single fruit, sold in a glass of approximately 250 ml
Fried Irish potatoes	100 (0.00037)	Large pieces of Irish potato deep fried
Ice cream	100 (0.00037)	Frozen dessert made from milk or cream flavoured with sugar
Pilau	1000 (0.0037)	A rice dish cooked in broth with meat and spices. Sold on small plates approximately 150g
Candy	100-200 (0.00037-0.00074)	Sweet confectionary
Biscuits	100-600 (0.00037-0.220)	Small baked unleavened cake, typically flat crisp and sweet
Carbonated drinks	200-600 (0.00074-0.220)	Contain small bubbles of CO_2 such colas and others
Salted snacks	300-500 (0.110-0.183)	Snacks made from sliced whole potatoes or nuts containing a lot of salt

NB: Number . in bracket = USD cents

3.3.Estimation of Caloric Intake from School Food Vendors and Its Implications for Nutritional Status in Schoolchildren

This study investigates the caloric intake of students from various age groups (5-8, 9-13, and 14-18 years) through food purchases from vendors around surveyed schools. The findings provide valuable insights into the adequacy of school meals in meeting daily nutritional requirements. As shown in Table 2, the amount of calories students consume from portions of different foods and beverages purchased from food vendors at their schools was assessed. The table also reflects the percentage preference for different types of foods available at these schools.

National School Feeding and Nutritional Services Guidelines (37) suggest that food served at school should ideally provide 60-75% of the daily recommended nutritional requirements. **However, the results of this study highlight a notable gap between the guidelines and actual caloric intake from foods**

purchased at school. Specifically, the percentage of the Recommended Daily Allowance (RDA) of calories obtained from foods purchased at school varies by age group and food type:

- **Age group 5-8 years**: 8-24% of the daily recommended caloric intake.
- **Age group 9-13 years**: 6-19% of the daily recommended caloric intake.
- **Age group 14-18 years**: 5-16% of the daily recommended caloric intake.

Across all age groups, the majority of calories were derived from deep-fried potato chips (16-24% of the RDA) and cooked rice (13-19% of the RDA), which were the most frequently purchased items. **This consumption pattern is consistent with findings from Faber et al.** (37) **which emphasized the high caloric but low-nutrient profile of foods sold by informal vendors in South African schools, with fried foods being a dominant choice. Similarly, studies in other regions, such as Mexico and South Asia, reveal that schoolchildren often purchase foods that are energy-dense but nutrient-poor, contributing to poor dietary quality** (38, 39)

The study underscores a significant shortfall in the adequacy of school meals. According to the national guidelines, school meals should contribute 60-75% of students' total daily caloric intake, but the data from this study show much lower contributions. **This discrepancy suggests that school meals may not be providing enough energy to support optimal growth, development, and academic performance in children and adolescents.**

Inadequate caloric intake, especially in developing countries, has well-documented effects on both physical health and academic performance. **Malnutrition, particularly caloric insufficiency, is a leading factor contributing to stunting (low height-for-age), a condition that has been observed in a significant proportion of schoolchildren in Tanzania.** A recent cross-sectional survey conducted in Tanzania Mainland reported a 32% prevalence of stunting among school adolescents, with even higher rates (45.8%) among older adolescents (40). **These figures are consistent with findings from Timsina**

(41), **who noted the persistent nutritional deficiencies among adolescents in Nepal, further emphasizing the global nature of this issue.** Stunting often goes hand in hand with micronutrient deficiencies, such as iron deficiency, which was observed in 34% of surveyed adolescents in Tanzania. These deficiencies are known to impair cognitive function, reduce physical performance, and increase susceptibility to infections, all of which negatively impact students' academic achievement and behavioral health.

The impact of inadequate nutrition on cognitive performance and academic success is profound. Malnutrition impairs brain function, leading to difficulties in concentration, memory, and problem-solving, which are essential for effective learning. Moreover, insufficient nutrients can affect emotional well-being, contributing to mood swings, irritability, and an increased risk of mental health disorders. **In fact, several studies, including those by Otinwa et al.** (42) **and Briefel et al.**(43)**, have demonstrated that poor dietary habits, particularly in school environments, can severely affect both the mental and physical health of children, leading to long-term consequences.**

Given the findings of this study and the prevalent nutritional deficiencies observed among schoolchildren and adolescents, there is a pressing need for policy reforms, strategies, and interventions aimed at improving the nutritional quality of school meals. Policies should ensure that school food vendors provide foods that meet the nutritional standards outlined in the National School Feeding and Nutritional Services Guidelines. **As highlighted by Phetla et al. (44) and Gautam (45),** these policies should include promoting nutrient-dense foods such as fruits, vegetables, legumes, and lean proteins, while reducing the availability of high-calorie, low-nutrient foods like deep-fried snacks and refined carbohydrates. Additionally, the role of school feeding programs in addressing these issues is vital. **According to Pongutta**(45)**, complex school nutrition programs have shown positive results in improving the**

nutritional status of school-aged children, underscoring the importance of integrating nutrition into the school environment.

The implications of malnutrition among schoolchildren and adolescents extend beyond immediate health outcomes. Children and adolescents represent a significant portion of the population, with recent census data showing that those aged 5-18 make up 37.6% of the total population, or approximately 23,198,206 individuals. As future parents and labor force participants, ensuring that these students receive adequate nutrition is critical not only for their individual health and development but also for broader national health and economic goals (46). **If these children and adolescents grow up with nutritional deficiencies, the consequences could extend to future generations, affecting the nation's long-term economic and social stability.**

This study emphasizes the urgent need to address nutritional deficits in schoolchildren and adolescents, particularly the insufficient caloric intake from meals provided by school food vendors. **The high prevalence of stunting and micronutrient deficiencies in Tanzania—and similar trends in other developing regions—calls for immediate action to improve the quality of school meals.** By aligning school feeding programs with national guidelines and improving food offerings in schools, it is possible to reduce the risks associated with malnutrition and promote better health outcomes for future generations.

Table 2: Amount of calories student get from foods served at School compared to RDA

Type of food most preferred by school children	**Potato samosas**	**Fried cassava**	**Kachori**	**Chips**	**Cooked rice and beans**	**Fruit juice**
Percentage (foods preferred by students)	95.70%	87%	73.90%	21.70%	43.50%	17.40%
Unit of measurement (g)	Piece	Piece	Piece	Small plate	Small plate	Glass (ml)
Estimated weight g	50	30	25	150	150	250
Energy Kcal/100 g as stipulated in Tanzania food composition Table	194	346.5	237.6	249	199.1	45

Energy Kcal/weight consumed by each school child	97	103.9	59.2	373.5	298.6	11.2
Assuming that a child buys 2 pieces of snack or one plate of rice plus a glass of juice	205.2	219	129.6	384.7	309.8	
RDA for school children Aged 5-8 years (Kcal)	1600	1600	1600	1600	1600	1600
RDA for school children Aged 9-13 years (Kcal)	2000	2000	2000	2000	2000	2000
RDA for school children Aged 14-18 (Kcal)	2400	2400	2400	2400	2400	2400
Day school food served should meet 60-75% of 1600 RDA (Kcal) for age 5-8 years	960 - 1200	960-1200	960-1200	960-1200	960-1200	960-1200
Day school food served should meet 60-75% of 2000 RDA (Kcal) for age 9-13 years	1200 - 1500	1200-1500	1200- 1500	1200-1500	1200 -1500	1200 -1500
Day school food served should meet 60-75% of 2400 RDA (Kcal) for age 14-18 years	1440-1800	1440-1800	1440-1800	1440-1800	1440-1800	1400 -1800
Percentage of average RDA each child get from meals served at School assuming that a child buy at least 2 pieces of snack and a glass of juice						
RDA for school children Aged 5-8 years (Kcal)	13	14	8	24	19	
RDA for school children Aged 9-13 years (Kcal)	10	11	6	19	15	
RDA for school children Aged 14-18 (Kcal)	9	9	5	16	13	

3.4. Healthiness of foods and beverages within and around the school

A healthy school food environment encourages students to make better food choices. According to the NOVA Food Classification system (47,48), foods are categorized based on the processes they undergo after being separated from nature and before consumption. The classifications include: unprocessed or minimally processed, processed culinary ingredients, processed, and ultra-processed. An assessment of the foods and beverages sold around schools at Temeke Municipal, Tanzania, indicated that 11.11 % fall

385 under the category of unprocessed or minimally processed and 11.11% processed culinary ingredients),
386 33.33 % processed foods while 44.44% were ultra-processed (Table 3). **The majority of foods found in**
387 **the school environments were items high in calories, added sugars, saturated or trans fats, and**
388 **sodium, but low in essential nutrients** (49). These unhealthy dietary patterns raise significant public
389 health concerns, contributing to obesity and chronic diseases among school-aged children (50).
390 Research shows that many children consume high amounts of fried foods, sweets, and sugary drinks. For
391 example, a survey in Tanzania demonstrated high intakes of junk food among school-aged children(51).
392 Similarly, a study in Kenya found that most primary school children consumed sweetened beverages and
393 junk foods, including chips, sweets, sausages, doughnuts, and chocolate, in the week prior to assessment
394 (52). There is growing evidence that children in developing countries are increasingly making unhealthy
395 food choices, largely due to a lack of knowledge and misconceptions about nutrition (53). This trend
396 reflects a shift in the perception of food, evolving from a source of nourishment to a lifestyle marker and
397 source of pleasure, often influenced by media that promotes high consumption of processed foods rich in
398 calories, fat, and sugar, while offering little to no essential nutrients (54).

399 Efforts to counteract these trends are essential. Research highlights the importance of nutritional
400 education, both within schools and the broader community, in helping children make better food choices
401 (55). Promoting positive attitudes toward healthy eating can be achieved through comprehensive school
402 food policies that encourage healthier food options (56). This can be further supported by creating a school
403 food environment that limits access to unhealthy foods and beverages while enhancing the availability of
404 nutritious alternatives (57). Importantly, interventions should not only focus on the immediate school
405 environment but also take into account the broader community and media landscape that influences
406 children's food preferences (58)

Overall, addressing unhealthy eating patterns in school environments requires a multifaceted approach, which includes nutritional education, better food policies, limiting unhealthy food marketing, and improving the affordability and accessibility of healthy foods (59, 60). By fostering a healthier food environment in and around schools, we can reduce the risks associated with poor nutrition and contribute to the overall well-being of children and adolescents.

Table 3: Classification of Food available at Schools assessed at Temeke District

Type of food	Ingredients /description	Unprocessed/ minimally processed	Processed Culinary Ingredients	Proceed foods	Ultra-processed foods
Samosa	A small triangular pastry (wheat flour) filled with spiced meat or vegetables and deep fried in oil.				☑
Kachori	A spicy, deep-fried snack that is often filled with a mixture of lentils or potatoes, and spices and deep **fried**				☑
Fried Cassava	Cassava is boiled then cut into large chips and deep fried in oil eaten with sprinkled salt and chill and **deep fried**				☑
Irish Potato Chips	A thin slice of potato fried in oil and salted or flavored and **deep fried**				☑
Mandazi	Wheat dough deep fried in oil, ingredients include water, wheat flour, yeast, sugar, **deep fried**				☑
Half cake	Wheat flour dough with sugar, baking soda and baked			☑	
Bagia	Bean cake, sugar added, baked				☑
visheti	coconut pulp, sugar plus food colors and **deep fried**				☑
Sweet potato	Sweet potato slice **deep fried**				☑

Bread	A mixture of flour, water, salt, yeast and other ingredients, kneaded until the flour is converted into a stiff paste or dough, followed by baking the dough into a loaf, salt added			☑	
Tambi (spaghetti)	Long, thin, solid cylindrical paste produced by mixing milled wheat, water, eggs (sometimes optional ingredients). Ingredients are thoroughly mixed and extruded. Can be boiled and eaten with stew			☑	
Cooked rice	Also referred to as boiled rice is usually cooked on high heat until a rolling boil, then simmered with the lid on, and steamed over the residual heat after turning off the heat. It is usually served with stew of beans or meat or fish or vegetables			☑	
Mangoes	Fresh fruits are eaten raw	☑			
Fruit Juice	Fresh Juice			☑	
Pilau	A dish of rice, meat etc. seasoned with spices and cooked in a broth or baked			☑	
Cowpea	Fruits	☑			
Meat Soup	Meat **boiled, salt added,** spices added		☑		
Cooked beans	**boiled,** species and **salt added**		☑		
	Percentage (%)	11.11	11.11	33.33	44.44

3.5.The Presence of Food Products in the School Environment: Implications for the Nutrition and Health of School Children and Adolescents

The presence and consumption of specific food products sold by food vendors around schools have a profound impact on the nutritional status and overall health of schoolchildren and adolescents (61). These foods, which include a combination of highly processed snacks, sugary beverages, and some more

nutritious options, can significantly influence students' dietary habits, growth, and academic performance (61). The categories of foods sold by vendors at the surveyed schools are briefly discussed, respecting their nutritional implications.

(i) Candies, Sweet Snacks, and Deep-Fried Snacks (100% Availability)

Candies and Sweet Snacks: These items are typically high in sugars, fats, and calories while being low in essential nutrients like vitamins, minerals, and fiber. Excessive consumption of sugary foods can contribute to the development of obesity, dental caries, and insulin resistance, particularly in schoolchildren and adolescents. A study conducted in Nairobi, Kenya established that there is a significant relationship between energy-dense foods found around schools and the nutritional status of the adolescents (61). Over time, regular intake of these foods can increase the risk of metabolic disorders (62). **Moreover, snacking behavior, which includes frequent consumption of these items, has been linked to poor nutritional outcomes, such as insufficient intake of essential micronutrients, and has been associated with a higher risk of developing obesity and type 2 diabetes among children and adolescents** (63)**.**

Deep-fried cassava chips, deep-fried sweet potatoes, and deep-fried irish potatoes: Fried snacks are energy-dense and high in trans fats or saturated fats, which can increase the risk of cardiovascular diseases, obesity, and dyslipidemia (imbalanced levels of fats in the blood) (64). Although they provide calories, they offer little nutritional benefit in terms of vitamins and minerals. The high glycemic index of these foods can cause blood sugar spikes, leading to energy crashes (65) that may impair concentration and focus in the classroom. **Studies have shown that energy-dense snacks contribute significantly to the dietary habits of schoolchildren and adolescents, thus influencing their overall health and cognitive performance** (66)**.**

(ii) Samosas (95.7% Availability)

Samosas are typically made with refined flour, saturated fats, and sometimes meat fillings. While they provide some protein from the meat, they are primarily a source of empty calories. The high fat content and the use of refined flour make them less nutrient-dense. Consuming samosas frequently can contribute to poor weight management and increase the risk of obesity and related metabolic disorders. **Regular consumption of such obesogenic foods has been associated with poor nutritional outcomes, including the development of insulin resistance, which can further escalate the risk of metabolic syndrome and cardiovascular diseases**(66, 67)**.**

(iii) Salted Crisps, Ice Cream, and Fresh Fruit Juice with Added Sugar (87.5% Availability)

Salted Crisps: are typically high in sodium and unhealthy fats, which can contribute to high blood pressure (hypertension) and cardiovascular diseases. Excessive salt intake is associated with an increased risk of stroke, kidney disease, and obesity. Additionally, their low fiber and micronutrient content make them poor choices for growing children who require nutrient-dense foods for development. **A study by Fox et al.** (69) **highlighted how the availability of high-sodium and high-fat snack foods in the school environment contributes to poor dietary habits and the increasing rates of childhood obesity and hypertension.**

Ice Cream: is high in sugars, saturated fats, and calories. **Frequent consumption of such high-sugar foods can also increase the likelihood of developing long-term health issues like obesity and type 2 diabetes** (70)**.** Ice cream also offers little in terms of essential nutrients like vitamins and minerals, and the sugar content can have a detrimental effect on oral health, contributing to tooth decay (69, 70).

Fresh Fruit Juice with Sugar Added: While fresh fruit juice contains some vitamins and minerals, the addition of sugar increases the glycemic load and calorie content (73), making it similar to soda in terms of its effects on blood sugar levels. Regular consumption can lead to weight gain, obesity, and an increased

risk of type 2 diabetes (74). Moreover, the lack of fiber in fruit juice (due to the removal of pulp) means that it does not offer the same digestive benefits as whole fruits. **This concern is also echoed in studies that highlight the impact of sugar-sweetened beverages on childhood obesity and type 2 diabetes rates** (75)**.**

(iv) Fruits and mineral water (87.5% Availability)

Fresh fruits are an excellent source of vitamins, minerals, fiber, and antioxidants (76). They provide essential nutrients like vitamin C, potassium, and folate, which are crucial for growth, immune function, and overall health (77). Fruits help in maintaining a healthy digestive system, skin health, and cognitive function (77, 76) . Including fruits in the school diet is vital for students' physical and mental development, as they help prevent nutrient deficiencies and chronic diseases. **A shift towards including more whole fruits in school meals has been shown to contribute to better overall health outcomes, including improved immune function and cognitive abilities** (5)**.**

Mineral Water: Adequate hydration is critical for maintaining cognitive function, physical performance, and overall health (79). While mineral water is a healthy beverage choice, it's important that students choose water over sugary beverages to avoid the adverse effects of high-calorie, high-sugar drinks. Mineral water also provides essential electrolytes, which are vital for maintaining fluid balance and muscle function (80, 81).

(v) Carbonated drinks (65.2% Availability)

Carbonated drinks (Soda, Soft Drinks): These drinks are high in sugars (often in the form of high-fructose corn syrup) and provide empty calories with no nutritional benefit. They are one of the leading contributors to obesity, tooth decay, and the development of insulin resistance (82, 83). The excessive sugar content can lead to spikes in blood glucose levels, followed by crashes that affect concentration and learning. In the long term, frequent consumption of sugary carbonated drinks is linked to an increased risk of metabolic

syndrome, type 2 diabetes, and cardiovascular diseases (84, 85, 86). **Increased access to sugary soft drinks in the school environment has been associated with negative health outcomes, such as obesity, poor academic performance, and an increased risk of chronic diseases** (87)**.**

(vi) Cooked Rice and Vegetables (50% Availability)

Cooked rice: Rice, especially white rice, is a refined carbohydrate and has a high glycemic index, meaning it can lead to rapid spikes in blood sugar levels (88, 89). Although it provides energy in the form of carbohydrates, rice lacks essential vitamins, minerals, and fiber (90). Pairing rice with vegetables or proteins can make it more nutritionally balanced. However, frequent consumption of rice without adequate vegetables or protein can contribute to nutritional imbalances.

Vegetables: When included in school meals, vegetables are an important source of fiber, vitamins, and minerals, such as vitamin A, vitamin C, and potassium. These nutrients are essential for immune function, cellular repair, and bone health. Increasing the availability of vegetables in school meals is crucial for improving the overall nutritional quality of students' diets. **Vegetables are a key component in mitigating nutrient deficiencies and promoting healthy weight management, particularly when integrated into school meal programs** (91).

(vii) Milk and Fruit Juice with No Sugar Added (25% Availability)

Milk is a rich source of calcium, protein, and vitamin D, all of which are essential for bone health, muscle development, and immune function. Including milk in school meals can help meet the nutritional needs of growing children and adolescents. However, the milk provided should be low-fat or skimmed to avoid excessive saturated fat intake.

Fruit Juice with No Sugar Added: This is a better alternative to sugary fruit juices. Unsweetened fruit juice retains some of the vitamins, minerals, and antioxidants from the fruit, particularly vitamin C and potassium, without the added sugar. However, consuming whole fruits is preferable due to the additional

fiber they provide, which is lost during juicing. **Research supports the importance of whole fruits over fruit juices in promoting better digestive health and weight management** (92)**.**

(viii) Bread and Doughnuts (12.5% Availability)

Bread: Depending on the type (e.g., whole-grain vs. refined), bread can provide carbohydrates and fiber. Whole-grain bread is a better choice because it provides more fiber, B vitamins, and minerals compared to refined bread. However, excessive consumption of refined carbohydrates (like white bread) can contribute to insulin resistance and weight gain.

Doughnuts are high in sugar and saturated fats, which can contribute to weight gain, insulin resistance, and the development of obesity and cardiovascular diseases. They are low in nutritional value, providing few essential vitamins, minerals, or fiber.

The variety of food products sold by vendors around schools, especially those high in sugars, refined fats, and empty calories, poses significant challenges for maintaining optimal nutritional health in schoolchildren and adolescents. The prevalence of deep-fried snacks, sugary beverages, and processed foods in the school environment increases the risk of obesity, insulin resistance, poor academic performance, and the development of chronic diseases like type 2 diabetes and cardiovascular diseases. **To improve the nutritional status of students, it is essential to restrict the availability of unhealthy, nutrient-poor foods and promote the inclusion of nutrient-dense options such as fruits, vegetables, whole grains, and lean proteins in school food offerings.**

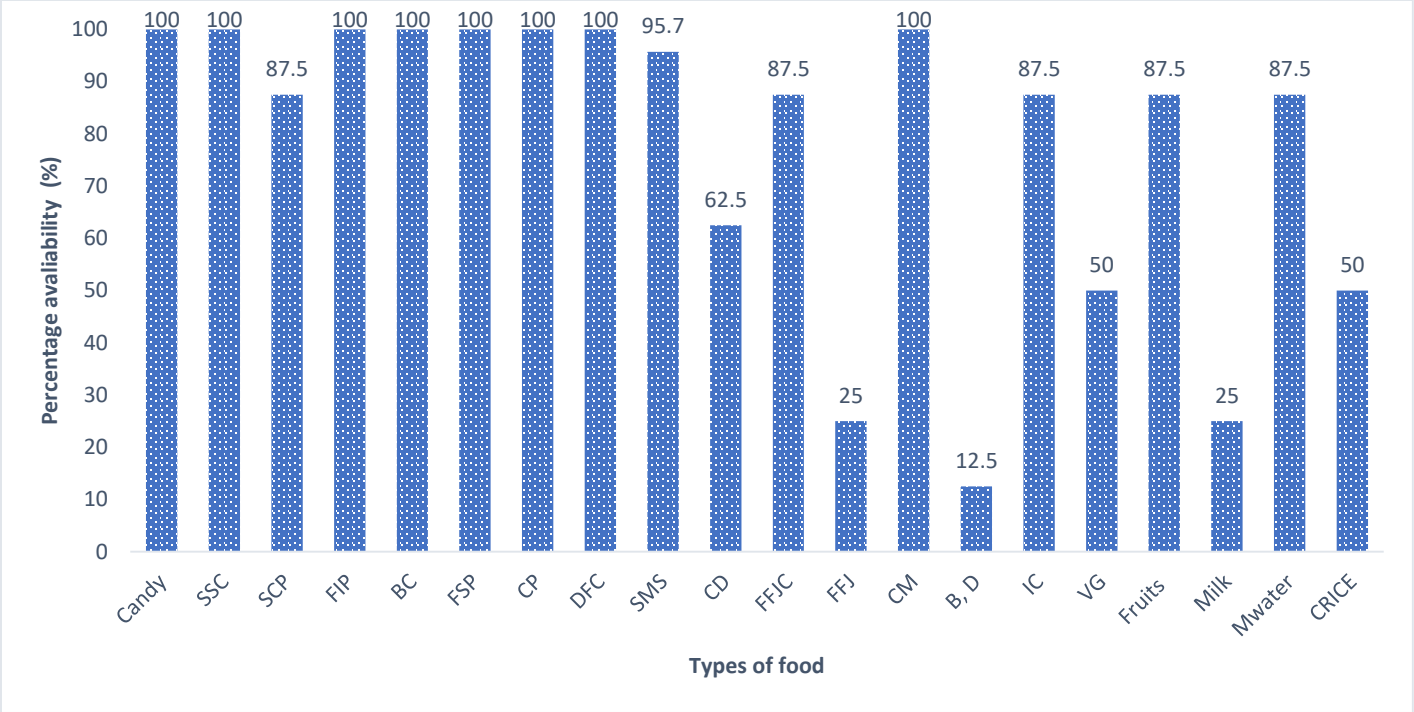

Figure 2: Food available in surveyed schools

NB: SSC = Sweet Snacks, SCPS = Salted Crips, CD=Carbonated drinks, FFJC Fresh Fruit Juice with sugar added, FFJ =Fresh Fruit Juice no sugar added, CM=cooked meal, B, D Bread, Donuts, IC=Ice cream, VG=Vegetables, Fruits =Mixed Fruits, CRICE=Cooked rice, M. water = Mineral water.

3.6.Food preferences of school children

The survey findings revealed that most preferred foods by school children at Temeke Municipality were largely the deep-fried snacks, including samosa (95.5%) fried potato chips (87%) and fried marched potato bolls (73.9%) (Fig 3). Deep-frying is a cooking method that involves immersing food in oil at temperatures ranging from approximately 150 to 200°C, the process causes the cell walls in the food to rupture and form pores that facilitate oil absorption (93). The absorption of oil in fried food increases with higher polyunsaturated fatty acids (PUFA) content in oils, lower frying temperatures, longer exposure times (93). Frequent consumption of fried foods (four or more times a week) is associated with an increased risk of developing type 2 diabetes, heart failure, obesity, and hypertension and raises mortality rates (94). Deep fried foods are preferred due to their superior sensory qualities especially colour, odour, flavour, and texture. The appeal of deep-fried foods rises from their reasonable pricing, delicious taste, and the

convenience of their quick and easy preparation process (51). However, these foods are unhealthy because the frying process changes the chemical structure of fats from Cis to trans fats, and makes it difficult for the body to break it down, leading to negative health effects. Trans fats are associated with an increased risk of various diseases including heart related diseases, cancer, diabetes and obesity (95, 96, 97). The level of trans fats in the final deep-fried product depends on the type of oil used, temperature reached and frequency of reuse of the oil (98, 99). In this case the common oil used is sunflower which has a short frying life and shelf life of the food product due to their susceptibility to oxidation and contains 20% TFA (100). Thus, the food industry needs to develop safe products and at the same time accommodate the consumer's tests and preferences. This study was conducted in a view to provide insight onto the target consumers food preference in developing a nutrient dense snack bar for school children and adolescents in a view to tackle the challenge of micronutrient deficiency among this group.

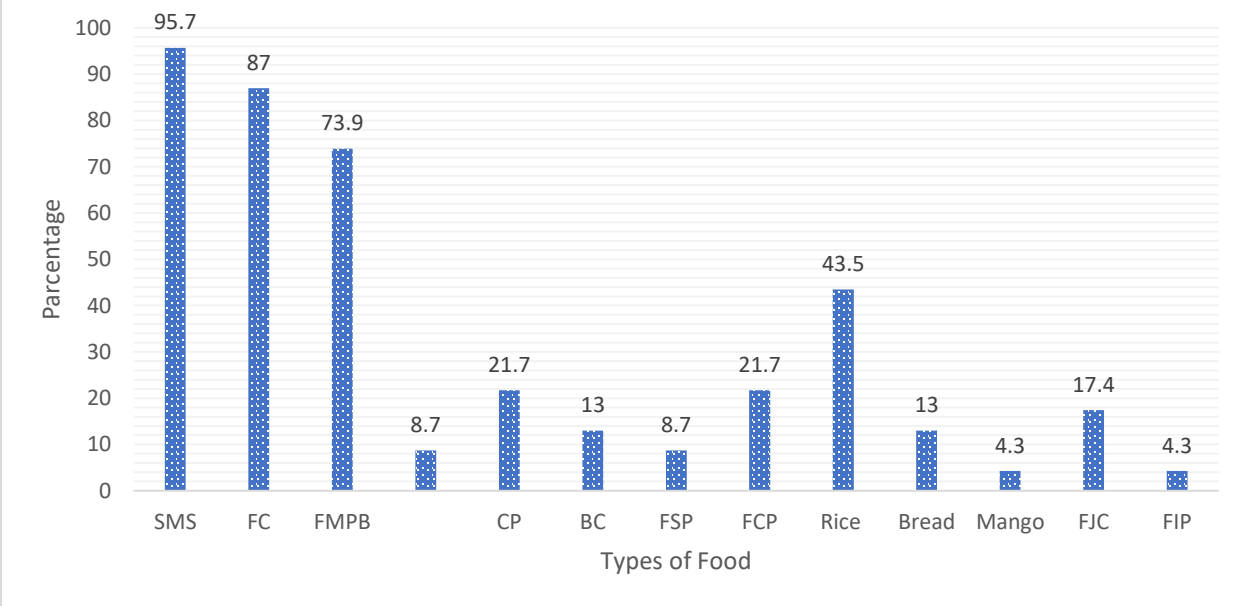

Figure 3: Types of food found around the environment

NB: SMS = samosa, FC Fried potato Chips, FMPB = Fried Marched potato bolls, BC = Bean cake, FSP = Fried Sweet Potato, FCP= Fried coconut pulp (with sugar and food colors), FJC =Mixed Fresh Juice, Fried Irish Potato

3.7.Food vendor premises: Cleanness, hygiene and food safety

According to the Food regulation 2009 food vendors around or within schools fall under persons who prepare, pack or serve food and some parts of the regulation apply to them. Under section 36 parts that apply to school food venders were identified which guide them. Assessment of compliance of seven minimum requirements of food hygiene regulation by the food vendors is given in Table 3. From this assessment compliance to the minimum requirements of food hygiene regulation 2009 by food vendors are only 29 %, whereas non-compliance is 71%. **This level of non-compliance reflects a considerable risk to food safety and student health, highlighting the need for urgent intervention.**

The low level of compliance raises serious concerns regarding food safety and student health. Non-compliance can lead to increased risks of foodborne illnesses, which can have severe consequences, particularly for children whose immune systems are still developing. **Studies have shown that poor food handling practices are directly linked to the spread of foodborne pathogens, which can cause outbreaks of gastrointestinal illnesses in schools, posing a significant public health threat** (101)**.** The presence of unsafe food handling practices in schools can contribute to outbreaks, potentially leading to significant health crises. **Inadequate food safety measures have been shown to exacerbate foodborne illnesses in children, particularly when vendors fail to implement basic hygiene practices such as handwashing, temperature control, and proper food storage** (102)**.** Given that a large percentage of vendors are not adhering to hygiene standards, there is a need for comprehensive training programs. The programs should focus on educating vendors about the importance of food hygiene, safe food handling practices, and the specific requirements outlined in the Food Hygiene Regulation 2009. **Moreover, integrating practical, hands-on training sessions would allow vendors to learn how to implement food safety measures effectively, reducing the risks of contamination and ensuring safer food consumption in schools (103). In addition to educational programs, regular inspections and**

584 **enforcement of food safety regulations are essential to ensuring that vendors comply with hygiene**
585 **standards. A study by Masiku et al.** (104) **emphasizes the critical role of continuous monitoring and**
586 **feedback mechanisms to reinforce food safety standards in informal markets, which could also be**
587 **applied to food vendors in school environments. Such measures could serve to address the gap in**
588 **compliance observed and encourage sustainable food safety practices among school food vendors.**
589 **The implementation of food safety standards is particularly vital for vulnerable populations, such**
590 **as schoolchildren, who are more susceptible to foodborne diseases (105).**
591 Training programs could be supplemented with practical workshops to ensure that vendors are equipped
592 to comply with the regulations. **These workshops should focus on core food safety practices, including**
593 **temperature control, cross-contamination prevention, and the maintenance of clean food**
594 **preparation areas. Such initiatives have been shown to improve food safety knowledge and practices**
595 **among vendors, particularly in low-resource settings (101, 103). By strengthening compliance with**
596 **food hygiene standards, we can mitigate the risk of foodborne illness outbreaks and ensure that**
597 **school environments are conducive to the health and well-being of students.**

598 **Table 3: Compliance with Hygiene Regulation**

S/N	Minimum Food Hygiene Regulation Requirement	Complied	Not complied
1	Not use his bare hands to handle any unwrapped food		1
2	Take all reasonable steps to prevent customers from using their bare hands to handle any unwrapped food		1
3	Not use his breath to open any bag or wrapper intended for use in such preparation, packing and serving;		1
4	Wipe his hands with clean towel or any other clean and suitable material	1	
5	Avoid the placing, carrying or storing any unwrapped food in such a manner that a plate, dish or container comes into contact with the food in other plate, dish or container		1

6	Not use any raw material or ingredient that may be contaminated with parasites, pathogenic microorganisms, toxic, or decomposed or foreign substances which may cause the finished food product unfit for human consumption	1	
7	Not keep any raw material, ingredient, intermediate food product or finished food product at temperatures that is likely to support the reproduction of pathogenic microorganisms or the formation of toxins		1
	Total	2	5
	Percentage (%) compliance	29	71

599

600 **3.8. Food vendors' knowledge on food safety and nutrition**

601 Food hygiene and safety involves practices that prevent contamination and minimize the risk of foodborne
602 illnesses. The survey assessed the level of knowledge among food vendors about food safety and nutrition,
603 findings from the survey revealed that among food vendors formally registered at school, 22% have fully
604 knowledge on food safety and nutrition, 39% have partial knowledge and 39% had no knowledge indicated
605 in Fig 4. Food vendors normally either prepare the food at the school or bring to school foods prepared to
606 home and save to students. Knowledge of food safety and nutrition, particularly food safety hygiene, is
607 critical to protect the health of consumers, especially schoolchildren.

608 It is very important to consider knowledge of food safety and nutrition for the selection and recruitment
609 of food vendors to ensure they recognize their obligation to promote the health and safety of students. **A**
610 **study by Elsahoryi et al.** (106)**, highlights the importance of assessing vendors' food safety**
611 **knowledge and practices before allowing them to serve food, as poor practices can significantly**
612 **increase the risk of foodborne illnesses in school environments.** Food vendors must be equipped to
613 prepare and serve healthy, balanced diets, which requires an assessment of their knowledge regarding food
614 preparation, balanced meals and food groups. In this study, an evaluation of vendors' understanding
615 revealed that only 30% (n=20) could identify four out of five food groups that constitute a balanced diet.
616 Meanwhile, 56.5% (n=20) could identify two to three groups, and 30% (n=20) could not identify any food
617 groups at all. **This finding is consistent with research on vendors food safety knowledge, atttitude**

618 **and practice conducted in Myanmar by Maung** (107)**, who observed that food vendors in urban**
619 **areas often lacked essential nutrition knowledge, limiting their ability to provide balanced meals to**
620 **consumers.** Based on the findings, schools and relevant authorities should consider conducting training
621 sessions focusing on food safety practices and nutrition education for enhancing food vendor's knowledge.
622 A study on food safety knowledge and awareness of food handlers in school feeding programmes in
623 Mpumalanga, South Africa by **Sibanyoni et al.** (108) **found that targeted training and regular**
624 **assessments of food handlers' knowledge were crucial to improving food safety practices in school**
625 **feeding programs.** Regular assessments and certifications could also help maintain high standards and
626 ensure that all vendors are equipped to provide healthy and safe meals. Moreover, **the knowledge gaps**
627 **observed in this study reflect the broader challenges identified in studies by Islam et al.**(109) **and**
628 **Klutse and Sampson** (110) **who emphasized that food vendors in many countries lack adequate**
629 **training, which hinders their ability to follow food safety protocols effectively.** In particular, vendors'
630 understanding of food safety often remains limited, which could lead to unsafe food practices, especially
631 in school environments where children are at higher risk of foodborne illnesses. **A study conducted by**
632 **Ma et al. (111) in Handan, China found that food safety education for vendors significantly**
633 **improved hygiene practices, which in turn led to safer food for children.** Thus, it is essential to invest
634 in comprehensive and continuous food safety education programs tailored to food vendors in schools. This
635 can ensure not only compliance with hygiene standards but also a deeper understanding of the nutritional
636 needs of schoolchildren, promoting healthier eating habits and improved overall health outcomes.

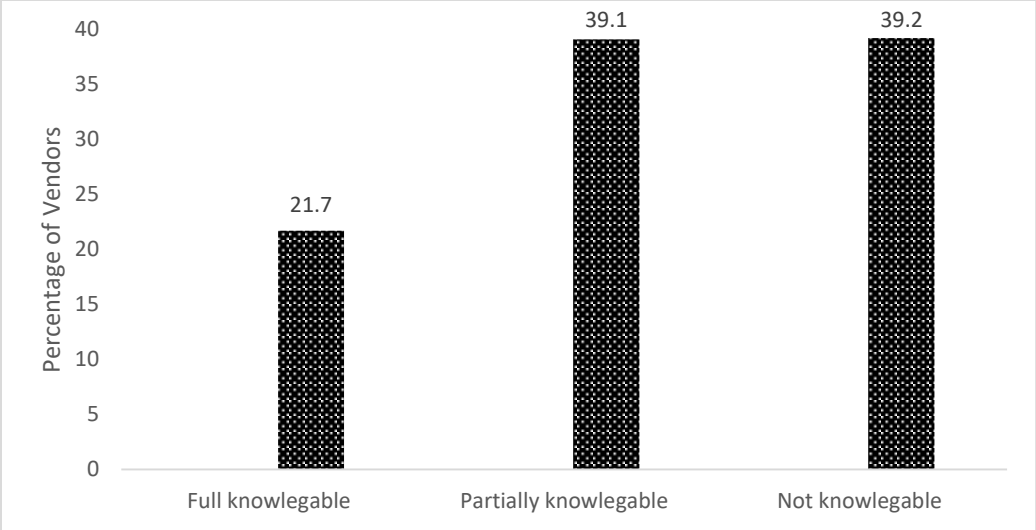

Figure 4: Vendor knowledge on food safety and nutrition

4. A critical review of the literature on the school feeding policy framework

The review unravelled strengths, gaps and challenges and came up with concrete recommendations to address the challenges and close the policy gaps. Table 4 summarizes the outcomes of this review

Table 4: Strengths, Policy Gaps, Challenges, and Recommendations for School Feeding Programs in Tanzania

Strength	Policy Gaps and Challenges	Recommendations
Policy alignment and focus: The Tanzanian government has recognized the importance of school feeding for improving student attendance, academic performance, and reducing malnutrition. The National Development Vision 2025 and the 2014 Education and Training Policy emphasize the provision of nutritious meals, safe water, and electricity in schools (112)	Tanzania lacks a unified and clear policy on school feeding, and there are no standardized guidelines for school meal quality. Participation in school feeding programs is not mandatory, leaving many students hungry (113).	**Develop clear school feeding policies**: Formulate a clear and comprehensive national policy on school feeding that ensures uniformity in meal quality and compulsory participation in feeding programs (114).
Evidence of positive impact: Successful school feeding programs, particularly in areas like Arumeru and Babati, have shown that local approaches can improve	**Inconsistent funding**: School feeding programs often face financial constraints, with limited funds allocated by the government. Dependence on	**Secure sustainable funding**: The government should allocate consistent and sufficient funding for school feeding programs and explore partnerships with local

attendance, reduce absenteeism, and enhance academic performance (115).	donors for funding also affects the sustainability of these programs (13, 29).	communities and private stakeholders to ensure sustainability (25).
Involvement of key stakeholders: The involvement of MoEST, local governments, communities, parents, and development partners is recognized as key to the success of school feeding initiatives (116).	**Limited community engagement**: While communities and parents are acknowledged, their actual involvement is minimal. Many parents view the fee-free education policy with misconceptions, affecting their participation in the program (25).	**Increase community and parental involvement**: Strengthen community and parental engagement through awareness campaigns, training, and incentivizing participation in school feeding programs (25).
Impact on student health and attendance: School meals are linked to improved student health, reduced absenteeism, and better concentration (117).	**Inadequate infrastructure**: Many schools lack proper facilities such as functioning kitchens, dining halls, and food storage. This reduces the quality and safety of meals (55).	**Invest in school infrastructure**: Prioritize investments in building and upgrading school infrastructure, including kitchens, dining halls, and storage facilities, to support the effective implementation of school feeding programs (118).
Promotion of healthy eating: The provision of school meals can help students form healthier dietary habits and improve nutrition (119).	**Unhealthy food environment**: In some schools, the food sold by vendors is unhealthy (e.g., deep-fried snacks), exposing students to poor nutrition despite school meal initiatives (36).	**Regulate and monitor food vendors**: Establish strict guidelines for food vendors within and around schools. Ensure that the food sold is nutritious and aligns with national food guidelines. Regular monitoring and health checks for vendors are also necessary (55).
Policy documentation and guidance: There are documents outlining the basic elements of school health and nutrition services, which define roles and responsibilities for various stakeholders (119).	**Absence of a comprehensive implementation framework**: While policies and strategies exist, there is a lack of a comprehensive framework for tracking and implementing the activities outlined, especially concerning vulnerable groups (37).	**Create a robust implementation framework**: Develop a detailed, actionable framework for the implementation, monitoring, and evaluation of school feeding programs, with a focus on vulnerable groups (e.g., orphans, children with disabilities) (38).
Local examples of success: Programs by the World Food Programme and Project Concern	**Limited scaling of successful models**: Successful local school feeding programs are not	**Scale up home-grown models**: Learn from successful home-grown school feeding models and scale

International show successful models of home-grown school feeding programs (39).	scaled out to other regions, limiting their impact and reach (25).	them up across the country, particularly by integrating local food production and community involvement (55).
Emphasis on multisectoral approach: There is a recognition of the need for a multisectoral approach, involving sectors like agriculture, health, and education (40).	**Weak intersectoral coordination**: Despite the policy's emphasis on multisectoral involvement, poor coordination among relevant sectors hampers the effective execution of school feeding programs (121).	**Strengthen intersectoral coordination**: Improve collaboration and coordination among sectors such as education, health, agriculture, and local governments to ensure the smooth execution of school feeding initiatives (39).
Policy alignment with national development goals: School feeding policies align with the national goals of reducing poverty and malnutrition, contributing to the country's development vision (41).	**Absence of age-appropriate strategies**: Policies do not fully recognize or address the varied nutritional needs of children at different stages (e.g., early childhood and adolescence) (122).	**Implement age-specific strategies**: Develop policies that address the unique nutritional needs of children at different educational levels, from early childhood to secondary school (55).

5. Conclusion and recommendations

The deficiencies in food storage, kitchen facilities, and dining halls significantly hinder the effectiveness of school feeding programs, emphasizing the urgent need for infrastructure improvements. To ensure the sustainability and success of these programs, it is recommended that there be enhanced collaboration among stakeholders and stronger policy support to address these infrastructure gaps.

The survey findings highlight that the current school food environment exposes students to unhealthy food options, especially deep-fried foods high in sugars and salts, while also presenting food safety risks. This points to significant gaps in the availability of healthy food options. Given that the food environment predominantly offers energy-dense, nutrient-poor foods, there is a clear need for interventions that promote healthier choices for school-aged children. Further research involving a larger and more diverse sample across multiple districts is needed to validate and expand on our findings. One potential solution

is the development of a snack bar that meets at least 75% of the daily nutritional requirements for students. This snack bar would offer a structured and accessible way for students to consume nutrient-dense foods, helping to complement their overall dietary needs.

Incorporating a snack bar into the broader school feeding program would not only provide a healthier alternative to the current food offerings but also address barriers such as affordability and convenience. These snack bars should be supplied by carefully recruited and trained vendors, ensuring they meet nutritional and safety standards. Regular training programs on food safety, hygiene, and nutrition should be implemented for food vendors, while teachers overseeing health at schools should also be well-trained in these areas. Trained teachers can assist in supervising food vendors and ensuring that they adhere to proper food safety practices.

From a policy perspective, the current deficiencies in school infrastructure call for a review and reform of school feeding guidelines. Policies should prioritize not only the provision of food but also the necessary facilities for safe food storage, preparation, and consumption. It is recommended that the implementation of school feeding guidelines become a key part of the national school inspection program to ensure the consistent delivery of safe and nutritious meals in schools.

Furthermore, additional studies are recommended to explore strategies that ensure schoolchildren have access to healthy and safe foods. Research should focus on evaluating the effectiveness of interventions like the snack bar model and identifying other methods to improve the quality of school feeding programs, ensuring they meet both nutritional and safety standards. Additionally, further research is needed to examine food choices and preferences among schoolchildren and adolescents, as well as strategies to promote healthy eating habits and align school food offerings with these preferences.

Limitation of the study

1. The study was conducted in a single district (Temeke District) in Dar es Salaam, which may limit the generalizability of the findings to other regions in Tanzania or to countries with different food environments. The sample may not fully represent the diverse socioeconomic backgrounds or regional variations in food access, potentially affecting the broader applicability of the results. A comprehensive study covering several regions will be done during scale up.
2. The study did not collect qualitative data, which could have provided deeper insights into the attitudes, perceptions, and experiences of students, school staff, and food vendors. The qualitative data could capture information on the complexities of students' food preferences or the social and cultural factors that influence dietary choices.

Reference:

1. Mohabati S, Mirahmadizadeh A, Hassanzadeh-Rostami Z, Bellissimo N, Faghih S. The relationship between weight status and food environments, peer influence and dietary intake among high-school students: a case-control study. Nutr Food Sci. 2024;54(2):391–402.

2. Mukanu MM, Thow AM, Delobelle P, McHiza ZJR. School Food Environment in Urban Zambia: A Qualitative Analysis of Drivers of Adolescent Food Choices and Their Policy Implications. Int J Environ Res Public Health. 2022;19(12).

3. Braune T, Kudlek L, Xiao C, Tang H, Demers-Potvin É, Harris HA, et al. Interpersonal determinants of diet quality and eating behaviors in people aged 13–30 years: A systematic scoping review. Obes Rev. 2025;26(1):e13835.

4. Pineda E, Bascunan J, Sassi F. Improving the school food environment for the prevention of childhood obesity: what works and what doesn’t. Obes Rev. 2021;22(2):e13176.

5. Muinga EN, Waudo J, Osur JO. Relationship between intake of energy-dense diets and nutritional

status of adolescents in primary schools in Nairobi City County, Kenya. North African J Food Nutr Res. 2024;8(17):52–65.

6. Louzada ML da C, Costa C dos S, Souza TN, Cruz GL da, Levy RB, Monteiro CA. Impact of the consumption of ultra-processed foods on children, adolescents and adults' health: Scope review. Cad Saude Publica. 2022;37:e00323020.

7. Braune T, Kudlek L, Xiao C, Tang H, Demers-Potvin E, Harris H, et al. Interpersonal determinants of diet quality and eating behaviours in people aged 13-30 years: a systematic scoping review. 2023;(August):1–14.

8. Organization WH. The State of Food Security and Nutrition in the World 2023: Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum. Vol. 2023. Food & Agriculture Org.; 2023.

9. Durao S, Wilkinson M, Davids EL, Gerritsen A, Kredo T. Effects of policies or interventions that influence the school food environment on children's health and nonhealth outcomes: a systematic review. Nutr Rev. 2024;82(3):332–60.

10. Nugent R, Levin C, Hale J, Hutchinson B. Economic effects of the double burden of malnutrition. Lancet. 2020;395(10218):156–64.

11. Bai Q, Li M, Zhou J, Imran A, de Souza TSP, Barrow C, et al. Influence of processing methods on phytochemical composition of different varieties of beans (Phaseolus vulgaris). Food Rev Int. 2024;40(7):1941–79.

12. Fanzo J, Hawkes C, Udomkesmalee E, Afshin A, Allemandi L, Assery O, et al. 2018 global nutrition report. 2019;

13. Mchau G, Killel E, Azizi K, Henry S, Ainan S, Jumbe T, et al. Co-occurrence of Overweight, Stunting, and Anemia among Adolescents (10–19 Years) in Tanzania Mainland: A School-Based Cross-Sectional Study. Curr Dev Nutr. 2024;8(1).

14. Nel JH, Steyn NP. The nutrition transition and the double burden of malnutrition in sub-saharan african countries: How do these countries compare with the recommended LANCET COMMISSION Global Diet? Int J Environ Res Public Health. 2022;19(24):16791.

15. Lara-Castor L, Micha R, Cudhea F, Miller V, Shi P, Zhang J, et al. Intake of sugar sweetened beverages among children and adolescents in 185 countries between 1990 and 2018: population based study. bmj. 2024;386.

16. Sauer CM, Reardon T, Tschirley D, Liverpool-Tasie S, Awokuse T, Alphonce R, et al. Consumption of processed food & food away from home in big cities, small towns, and rural areas of Tanzania. Agric Econ (United Kingdom). 2021;52(5):749–70.

17. Mwanri AW, Mishili F, Assenga T, Suleiman R, Mwaseba D, Nchimbi-Msolla S. Consumption of protect and risk food groups for non-communicable diseases among women of reproductive age in rural areas of Morogoro, Tanzania. PLoS One. 2025;20(2):e0318744.

18. Reardon T, Tschirley D, Liverpool-Tasie LSO, Awokuse T, Fanzo J, Minten B, et al. The processed food revolution in African food systems and the double burden of malnutrition. Glob Food Sec. 2021;28:100466.

19. Sehgal M, Clarke RN, Marshall Q, Kumar N. Food environment research in Tanzania: A desk review. 2024;

20. Sando D, Sachin S, Moshi G, Sando M, Yussuf M, Mwakitalima A, et al. School health and

743 nutrition services for children and adolescents in Tanzania: A review of policies and programmes.
744 Matern Child Nutr. 2023;e13544.

745 21. Assey CB, Mwila PM. Enhancing School Attendance Through School Feeding Programs:
746 Evidence from Primary Schools in Ubungo Municipality, Tanzania.

747 22. de Dieu HJ, Theogene H, Emmanuel N, Faustin M, Abdou M, Emmanuel N, et al. School
748 Feeding Programme Implementation and its Challenges in Basic Education Schools in Rwanda.
749 African Educ Res J. 2023;11(3):338–50.

750 23. Jomaa LH, McDonnell E, Probart C. School feeding programs in developing countries: impacts
751 on children's health and educational outcomes. Nutr Rev. 2011;69(2):83–98.

752 24. Athumani A, Kanoa E, Loisulie P. Reflection on the Implementation Hurdles of Local School
753 Feeding Programmes in Tanzanian Public Primary Schools: A Phenomenological Inquiry. J
754 Issues Pract Educ. 2024;16(2):193–216.

755 25. Roothaert R, Mpogole H, Hunter D, Ochieng J, Kejo D. Policies, Multi-Stakeholder Approaches
756 and Home-Grown School Feeding Programs for Improving Quality, Equity and Sustainability of
757 School Meals in Northern Tanzania. Front Sustain Food Syst. 2021;5(February).

758 26. Ndayishimye I, Dushimimana JDD. Role of Stakeholders' Collaboration in the Implementation of
759 School Feeding Programme: A Case of Twelve Years Basic Education Schools in Nyabihu
760 District, Rwanda (2020-2022). African J Empir Res. 2024;5(2):426–37.

761 27. Tamiru Y, Mulugeta A, Ayelign A, Jara D, Melaku E, Gebremedhin S. Perceived benefits and
762 challenges of school feeding program in Addis Ababa, Ethiopia: a qualitative study. J Nutr Sci.
763 2024;13:e32.

764 28. Kamanga S, Phiri A, Thelma CC. The Sustenance of School Feeding Program in Chipata District:
765 A Case of Selected Beneficiary Schools in Chipata District of Eastern Province, Zambia. 2025;

766 29. Mainje M, Matumba L, Harvey JJW, Phiri H, Gama AP, Phiri A, et al. Long-term sustainability
767 of African school feeding programs, a review. Front Sustain Food Syst. 2024;8:1424354.

768 30. Tandoh A, Laar A, Pradeilles R, Le Port A, Osei-Kwasi H, Amevinya GS, et al. Addressing the
769 marketing and availability of unhealthy food and beverages in and around selected schools in
770 Ghana: a community readiness appraisal. BMJ Open. 2023;13(9):e075166.

771 31. Iyassu A, Laillou A, Tilahun K, Workneh F, Mogues S, Chitekwe S, et al. The influence of
772 adolescents' nutrition knowledge and school food environment on adolescents' dietary behaviors
773 in urban Ethiopia: A qualitative study. Matern Child Nutr. 2024;20:e13527.

774 32. Farmer KO. The impact of food and non-alcoholic beverage sponsorship and marketing in the
775 school environment on the food choices of school-going children and adolescents: A scoping
776 review 2011–2023. 2024;

777 33. Rocha LL, Pessoa MC, Gratão LHA, Carmo AS do, Cordeiro NG, Cunha C de F, et al.
778 Characteristics of the school food environment affect the consumption of sugar-sweetened
779 beverages among adolescents. Front Nutr. 2021;8:742744.

780 34. Kamwela M, Mbwana H, Jumbe T. Secondary School Food Environment and Purchase Choices
781 of Adolescents in Mbeya City. Tanzan J Health Res. 2024;25(4):1346–62.

782 35. Coady OR, Styles SE, Smith C. Barriers and enablers to providing healthy food and beverages in
783 New Zealand secondary school canteens. Health Promot Int. 2025;40(1):daaf011.

784 36. Pillay D, Ali A, Wham CA. The effect of healthy food guidance for schools on food availability,

purchasing, and consumption among school children in New Zealand and Australia: An integrative review. Nutr Res Rev. :1–40.

37. Faber M, De Villiers A, Hill J, Van Jaarsveld PJ, Okeyo AP, Seekoe E. Nutrient profile and energy cost of food sold by informal food vendors to learners in primary and secondary schools in the Eastern Cape, South Africa. Public Health Nutr. 2019;22(3):521–30.

38. Choedon T, Brennan E, Joe W, Lelijveld N, Huse O, Zorbas C, et al. Nutritional status of school-age children (5–19 years) in South Asia: A scoping review. Matern Child Nutr. 2024;20(2):e13607.

39. Martínez-Andrade G, González-Unzaga M, Romero-Quechol G, Mendoza E, Vilchis-Gil J, Duque X. Nutritional characteristics, sites of origin, and cost of foods consumed during school hours and their relationship to nutritional status of schoolchildren in Mexico city. Life. 2021;11(5):439.

40. John S, Mchau G, Ayubu H, Mafung'a S, Ainan S, Kyatikila W, et al. Diet and nutrition status among school-age children and adolescents in Tanzania. F Exch. 2021;66:72.

41. Timsina R. COMPARATIVE STUDY ON NUTRITIONAL STATUS OF PRIVATE AND PUBLIC SCHOOL ADOLESCENTS OF DHARAN SUB METROPOLITAN CITY. Department of Nutrition & Dietetics Central Campus of Technology Institute …; 2024.

42. Otinwa G, Jaiyesimi B, Bamitale T, Owolabi H, Owolewa M. Eating habits and nutrition status of Nigerian school children in rural and urban areas (NigeriaLINX pilot project). Heliyon. 2023;9(7).

43. Briefel RR, Crepinsek MK, Cabili C, Wilson A, Gleason PM. School food environments and

practices affect dietary behaviors of US public school children. J Am Diet Assoc. 2009;109(2):S91–107.

44. Phetla MC, Skaal L, Chelule KP. Dietary habits among primary school learners in the Tshwane West District of Gauteng, South Africa. Heal SA Gesondheid. 2024;29:2746.

45. Gautam M. ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY INTAKE OF ADOLESCENTS IN SCHOOLS OF LETANG MUNICIPALITY, MORANG. 2024.

46. Ochola S, Masibo PK. Dietary intake of schoolchildren and adolescents in developing countries. Ann Nutr Metab. 2014;64(Suppl. 2):24–40.

47. NN. The NOVA Food Classification System. Educhange. 2018;7(2016):1–4.

48. Martinez-Steele E, Khandpur N, Batis C, Bes-Rastrollo M, Bonaccio M, Cediel G, et al. Best practices for applying the Nova food classification system. Nat Food. 2023;4(6):445–8.

49. Musuc AM, Mititelu M, Oancea C nicoleta, Neacs SM, Belu I, Nicoleta M, et al. Evaluation of Junk Food Consumption and the Risk Related to Consumer Health among the Romanian Population. 2023;

50. Huang J, Chan SC, Pang WS, Chow SH, Fung YC, Keung VMW, et al. Factors associated with consuming unhealthy food in school children: A population-based study from Hong Kong. Heal Sci Reports. 2024;7(3).

51. Dangal A, Tahergorabi R, Raj D, Prekshya A, Kishor T, Dahal S. Review on deep - fat fried foods : physical and chemical attributes , and consequences of high consumption. Eur Food Res Technol. 2024;1537–50.

52. Njuguna HN, Yusuf N, Raza AA, Ahmed B, ... Progress towards maternal and neonatal tetanus

elimination–worldwide, 2000-2018/{Progres} accomplis en vue de l'elimination du tetanus maternel et neonatal dans …. Wkly …. 2020;

53. Area A ramtha H, An HK, Saadeh R, Zruqait A, Alenezi M. Knowledge , attitude , and practice of healthy eating among public school teachers in Kuwait. 2022;11:72–7.

54. Mkumbo DR. The influence of social media advertisements on fast-food consumption. 2022;2(1):22–32.

55. Sando D, Sachin S, Moshi G, Sando MM, Yussuf M, Mwakitalima A, et al. School health and nutrition services for children and adolescents in Tanzania: A review of policies and programmes. Matern Child Nutr. 2024;(June).

56. O'Toole TP, Anderson S, Miller C, Guthrie J. Nutrition services and foods and beverages available at school: results from the School Health Policies and Programs Study 2006. J Sch Health. 2007;77(8):500–21.

57. Minja EG, Mrimi EC, Mponzi WP, Mollel GJ, Lang C, Beckmann J, et al. Prevalence and Determinants of Undernutrition in Schoolchildren in the Kilombero District, South-Eastern Tanzania. Trop Med Infect Dis. 2024;9(5):1–15.

58. Farmer KO, Beukes RA, Sowden M, du Plessis LM. The impact of food and nonalcoholic beverage sponsorship and marketing in the school environment on the food choices of school-going children and adolescents: A scoping review, 2011–2023. Obes Rev. 2024;e13923.

59. Vermeulen H, Meyer F, Schönfeldt HC. A basic healthy food basket approach to evaluate the affordability of healthy eating in South Africa and Kenya. Front Sustain Food Syst. 2023;7:1181683.

60. Masila N, Smith KJ, Waddingham S, Jose K. Comparative analysis of school food policies in Australian jurisdictions: Insights for more effective policy action. Heal Promot J Aust. 2025;36(1):e916.

61. Kigaru DMD, Loechl C, Moleah T, Ndungu ZW. Nutrition knowledge , attitude and practices among urban primary school children in Nairobi City , Kenya : a KAP study. BMC Nutr. 2016;(2015):1–8.

62. Keeley B, Little C, Zuehlke E. The State of the World's Children 2019: Children, Food and Nutrition--Growing Well in a Changing World. Unicef. 2019.

63. Thrimavithana AM. Snacking Behavior, Its Determinants and Association with Nutritional Status Among Early Adolescents in Schools of Galle Municipality Area. Postgraduate Institute of Medicine; 2020.

64. Gadiraju T V, Patel Y, Gaziano JM, Djoussé L. Fried food consumption and cardiovascular health: a review of current evidence. Nutrients. 2015;7(10):8424–30.

65. Temesgen M, Ratta N. Adverse Effect of Fat Intake on Insulin Sensitivity and Associated Risk of Non-Communicable Diseases (NCD): A Review.

66. Gevers DWM. Parental influences on child snacking: advancing research. 2016;

67. Longo-Silva G, Menezes RCE de, Souza CAN de, Marinho P de M, Toloni MH de A, Oliveira MAA de. Factors associated with regular consumption of obesogenic foods: national school-based student health Hurvey, 2012. Rev Nutr. 2016;29(5):609–33.

68. Arora M, Singhal S, Rasane P, Singh J, Kaur S, Kumar V, et al. Snacks and Snacking: Impact on Health of the Consumers and Opportunities for its Improvement. Curr Nutr Food Sci.

2020;16(7):1028–43.

69. Fox MK, Dodd AH, Wilson A, Gleason PM. Association between school food environment and practices and body mass index of US public school children. J Am Diet Assoc. 2009;109(2):S108–17.

70. Varela P, De Rosso S, Moura AF, Galler M, Philippe K, Pickard A, et al. Bringing down barriers to children's healthy eating: A critical review of opportunities, within a complex food system. Nutr Res Rev. 2024;37(2):331–51.

71. Jokirinta J, Päkkilä J, Mourelatos E, Sipola S, Laitala ML, Karki S. Trend in basic oral treatment needs in relation to taxation of sweets, ice cream, and sugar-sweetened beverages in Finland: a registry-based study. Acta Odontol Scand. 2024;83:40335.

72. Large JF, Madigan C, Pradeilles R, Markey O, Boxer B, Rousham EK. Impact of unhealthy food and beverage consumption on children's risk of dental caries: a systematic review. Nutr Rev. 2024;82(11):1539–55.

73. Monteiro-Alfredo T, Caramelo B, Arbeláez D, Amaro A, Barra C, Silva D, et al. Distinct impact of natural sugars from fruit juices and added sugars on caloric intake, body weight, glycaemia, oxidative stress and glycation in diabetic rats. Nutrients. 2021;13(9):2956.

74. Kumar CS, Ali A, Manickavasagan A. Health benefits of substituting added sugars with fruits in developing value-added food products: a review. Int J Nutr Pharmacol Neurol Dis. 2020;10(3):75–90.

75. Blum LS, Mellisa A, Kurnia Sari E, Novitasari Yusadiredja I, van Liere M, Shulman S, et al. In-depth assessment of snacking behaviour in unmarried adolescent girls 16–19 years of age living

in urban centres of Java, Indonesia. Matern Child Nutr. 2019;15(4):e12833.

76. OWUSHI JN, ASANGA DE. Assessment Of Human Health Improved Fruits and Vegetables: The Benefits for Growing Children. Peerian J. 2024;27:117–29.

77. Nivedha S, Marichamy MS. Chapter-2 Nutritive Values of Fruits and Vegetables. Compr Guid to Hortic Pract Manag. 2024;15.

78. Minocha N, Singh A. Nutrition Essentials: Building a Foundation for Optimal Health Through Diet. In: Impact of Yoga and Proper Diet on Cardiopulmonary Function. IGI Global Scientific Publishing; 2025. p. 119–60.

79. Balogun O, Fawole A, Olaniran OP, Fatokun I. The Influence of Hydration Status on Cognitive Function and Athletic Performance. African J Sport Phys Sci. 2025;3(1):61–75.

80. Madhavan Unny N, Zarina A, Beena V. Fluid and electrolyte balance. In: Textbook of Veterinary Physiology. Springer; 2023. p. 193–211.

81. Singha R, Singha S. Mindful Water Consumption: Unveiling Its Essential Role in Disease Prevention and Longevity. Available SSRN 4979929. 2024;

82. Shoaib S, Iqbal RK. An overview of effects of carbonated drinks. Natl J Heal Sci. 2019;4(2):80–4.

83. Ladeira LLC, Nascimento GG, Leite FRM, Alves-Costa S, Barbosa JMA, Alves CMC, et al. Obesity, insulin resistance, caries, and periodontitis: syndemic framework. Nutrients. 2023;15(16):3512.

84. Malik VS, Popkin BM, Bray GA, Després JP, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. Circulation. 2010;121(11):1356–64.

911 85. Malik VS, Popkin BM, Bray GA, Després JP, Willett WC, Hu FB. Sugar-sweetened beverages
912 and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. Diabetes Care.
913 2010;33(11):2477–83.

914 86. Hu FB, Malik VS. Sugar-sweetened beverages and risk of obesity and type 2 diabetes:
915 epidemiologic evidence. Physiol Behav. 2010;100(1):47–54.

916 87. Driessen CE, Cameron AJ, Thornton LE, Lai SK, Barnett LM. Effect of changes to the school
917 food environment on eating behaviours and/or body weight in children: A systematic review.
918 Obes Rev. 2014;15(12):968–82.

919 88. Kumar A, Lal MK, Bagchi TB, Sah RP, Sharma S, Baig MJ, et al. Glycemic index of Rice: Role
920 in Diabetics. NRRI Res Bull. 2024;(44).

921 89. Ngo T Van, Kunyanee K, Luangsakul N. Insights into recent updates on factors and technologies
922 that modulate the glycemic index of rice and its products. Foods. 2023;12(19):3659.

923 90. Abid J, Ahmed S, Xia T, Wang M. Rice as a Nutritional Grain: Examining Its Role in Healthy
924 Products and Disease Prevention. Food Rev Int. 2024;40(9):3055–78.

925 91. Winson A. School food environments and the obesity issue: content, structural determinants, and
926 agency in Canadian high schools. Agric Human Values. 2008;25:499–511.

927 92. Enriquez JP, Gollub E. Snacking consumption among adults in the United States: a scoping
928 review. Nutrients. 2023;15(7):1596.

929 93. Ekblom M. Challenges Facing Food Processing MSEs in Tanzania. 2016;52.

930 94. Augustin MA, Riley M, Stockmann R, Bennett L, Kahl A, Lockett T, et al. Role of food
931 processing in food and nutrition security. Trends Food Sci Technol. 2016;56:115–25.

95. Murthy DSSN, Murali DU, Bhargava DS. Exploring The Obesity Risks of Ultra-Processed Diets.(2025). Int J Pharm Sci. 16(1):b8-15.

96. Pipoyan D, Stepanyan S, Stepanyan S, Beglaryan M, Costantini L, Molinari R, et al. The effect of trans fatty acids on human health: regulation and consumption patterns. Foods. 2021;10(10):2452.

97. Lakra P, Gahlawat IN, Wadhwa M. Trans Fatty Acids: Sources, associated medical ailments and their alternatives-A recent advances review. J Integr Sci Technol. 2021;9(2):60–9.

98. Manzoor S, Masoodi FA, Rashid R. Influence of food type, oil type and frying frequency on the formation of trans-fatty acids during repetitive deep-frying. Food Control. 2023;147:109557.

99. Anitha L, Mandlik P, Sunitha Raju K, Purnanand D, Mukherjee M, Harsha S, et al. Estimation of free fatty acids, peroxide value and trans fatty acids in reheated and reused oils of deep fat fried street foods. Res J Sci IT Manag. 2016;5(11):1–9.

100. OMS. Global Nutrition Report. Global Nutrition Report. 2018. 118 p.

101. Godrich IM, Juma MS, Mfinanga FA. Compliance of food vendors to food vending regulations in Tanzania-A case of Dodoma Municipality. Int J Res Soc Sci. 2018;8(5):109–23.

102. Faße A, Oelze N, Grote U. The Role of Food Safety Standards in Tanzania and their Implications for Food Security. Work Packag. 2015;3.

103. Kinyua C, Thebe V. Drivers of scale and sustainability of food safety interventions in informal markets: Lessons from the Tanzanian dairy sector. Sustainability. 2023;15(17):13067.

104. Masiku G theresia T, Mwijage KF, Ryoba NL, Ngulinzila NJ, Mgimba NT, Njambilo MM, et al. Knowledge, attitude, and food safety practices among university students in Kilimanjaro region, northern Tanzania. Discov Public Heal. 2024;21(1):136.

105. Organization WH. Joint external evaluation of the International Health Regulations (2005) core capacities of the United Republic of Tanzania: mission report, 14-18 August 2023. World Health Organization; 2024.

106. Elsahoryi NA, Olaimat A, Abu Shaikha H, Tabib B, Holley R. Food safety knowledge, attitudes and practices (KAP) of street vendors: a cross-sectional study in Jordan. Br Food J. 2024;126(11):3870–87.

107. Maung PP. A Study on Food Safety Knowledge, Attitudes and Prictices of Food Vendors in Yangon City (Phyo Pyae Maung, 2024). MERAL Portal;

108. Sibanyoni JJ, Tshabalala PA, Tabit FT. Food safety knowledge and awareness of food handlers in school feeding programmes in Mpumalanga, South Africa. Food Control. 2017;73:1397–406.

109. Islam S, Tanjia N, Mitra AK, Hossain A, Jasika MT, Suhi SS, et al. Inadequate food safety knowledge and hygiene practices among street food vendors in Dhaka, Bangladesh. Sci Rep. 2024;14(1):17349.

110. Klutse CM, Sampson GO. Assessment of Hygiene Practices and Knowledge of Food Safety among Street Food Vendors in the Volta Region, Ghana. Eur J Nutr Food Saf. 2025;17(1):1–10.

111. Ma L, Chen H, Yan H, Wu L, Zhang W. Food safety knowledge, attitudes, and behavior of street food vendors and consumers in Handan, a third tier city in China. BMC Public Health. 2019;19:1–13.

112. Brief FA. Agricultural production statistics 2000–2021. Agric Prod Stat 2000–2021. 2022;

113. FAO, Global Alliance for Improved Nutrition (GAIN). Leveraging Small and Medium Enterprises to improve nutrition. 2018. 64 p.

114. Amini Mshida H. TECHNICAL PROPOSAL FOR CONDUCTING GAP ANALYSIS TO EXPLORE OPPORTUNITIES AND CHALLENGES ASSOCIATED WITH INTEGRATING A NUTRITION COMPONENT INTO ANZA PROGRAMS IN ARUSHA, MANYARA, MTWARA AND DAR ES SALAAM REGIONS, TANZANIA.

115. Gillespie S, van den Bold M. Agriculture, Food Systems, and Nutrition: Meeting the Challenge. Glob Challenges. 2017 Apr;1(3).

116. Of THES. The State of Food Security and Nutrition in the World 2023. The State of Food Security and Nutrition in the World 2023. 2023.

117. UNICEF. The 2020 Joint Child Malnutrition Estimates. 2020.

118. Maijo SN. Impact of School Feeding Programme on Learners' Academic Performance in Mlunduzi Ward, Tanzania. Int J Educ Stud. 2018;5(3):125–30.

119. TDHS-MIS. 2023 Tanzania Demographic and Health Survey and Malaria Indicator Survey 2022 Key Indicators Report. Minist Heal [Tanzania Mainland], Minist Heal [Zanzibar], Natl Bur Stat (NBS), Off Chief Gov Stat (OCGS), ICF. 2022;Dodoma, Ta.

120. Food and Agriculture Organization. Nutrition-sensitive agriculture and food systems in practice. Options for intervention. Nutrition-sensitive agriculture and food systems in practice: Options for intervention. 2017. 1–86 p.

121. Management PS, Governance G. the United Republic of Tanzania President ' S Office Public Service Management and Good Governance Announcement for Singapore Cooperation Training. 2017;1–13.

122. The Tanzania Healthy Food Environment Policy Index Evidence Pack.

995