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# Paucity of Nutrition Guidelines and Nutrient Quality of Meals Served to Kenyan Boarding High School Students

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**Abstract:** Adequate nutrition is vital for the optimal growth, development, and general well-being of adolescents. A lack of nutritional guidelines for school meals poses a major challenge in the provision of nutritious meals to students in Kenyan boarding high schools. The aim of the study was to investigate the nutrient quality and portion sizes of meals served to students and the adequacy of the meals in meeting students' health requirements. A cross-sectional study was carried out among 50 catering or kitchen managers of 50 high schools in Kenya. Data were obtained through researcher-assisted questionnaires. It was established that menus were simplistic in nature, lacked variety, and were repetitive. With regard to nutrients, menus offered to students were excessively high in dietary fiber, containing three or five times more than the recommended daily intake. In most cases, students were underfed on nutrients such as carbohydrates, vitamin A, folic acid, potassium, calcium, proteins, and vitamins B1–12, resulting in low energy provision. It is concluded that a majority of the Kenyan high schools studied do not provide nutritionally adequate meals. The government of Kenya should have nutrition guidelines to ensure that schools provide diets with high food and nutrient quality to students.

**Keywords:** adolescents; high schools; nutrition guidelines; meals; Kenya

## 1. Introduction

The burden of malnutrition, which includes under- and over-nutrition, is an emerging crisis in developing countries. Adequate nutrition is vital for optimal growth, development, and general well-being, particularly of children and adolescents [1]. Availability of adequate nutrition, either at home or through the education system, contributes to the reduction of malnutrition, especially among children who attend school [2]. There is evidence that educational institutions in developing countries are grappling with malnutrition that could have far-reaching effects on the health of school-goers, ultimately compromising an entire generation's health. For example, in Africa chronic and acute

under-nutrition and micronutrient deficiency of iron, iodine, zinc, and vitamin A persist among children and adolescents, according to Gegios et al. [3]. Additionally, overweight and obesity have increasingly become epidemics in most countries [4]. All forms of malnutrition negatively impact the ability of children to stay in school and learn throughout the year, and affect health by creating deficiency diseases such as protein energy malnutrition, as well as predisposing children to chronic lifestyle diseases in adulthood [5,6].

Schools provide a perfect opportunity for the prevention of malnutrition, as they provide the best access to a large number of people, including family and community members, school staff, and young people. In most developed countries with well-established school feeding programmes, such as Britain, France, the USA, and Italy, school meals and school feeding have been used as an effective mechanism to address child nutrition, education enrolment, school retention, and hygiene issues [7]. Additionally, they provide income-generation, employment, and economic integration benefits to the communities in which they are implemented [8]. This demonstrates that provision of food in the right portion sizes translates into improved nutrition, nutrition education, and adoption of health measures for the sustained provision of adequate quality, quantity, and composition of the meals and snacks provided [9]. Hence, there is a need for country-specific guidelines and menu designs that address the nutrition priorities of the target populations, and the objectives of the feeding programs [9].

In Kenya, students in boarding high schools are a vulnerable group as they depend on meals provided by the school as the main source of all their nutrient needs. Studies carried out in Kenya show that there are no legislated or advised nutrition guidelines for use in school feeding programmes [10]. Therefore, school feeding programmes in the country are guided by other factors, not necessarily nutrition guidelines. For example, one current school feeding programme geographically targets regions with the highest poverty rates, the lowest education achievement rates, or the highest numbers of children residing in highly marginalized areas, for provision of free food [10]. This is unfortunate because Kenya faces numerous nutrition deficiencies due to inadequate protein, vitamin A, and iron intake [11] among children and adolescents. Eventually these may influence children's cognitive development, lower school performance, limit adult productivity, reduce immunity, and eventually contribute to a high burden of morbidity and mortality [10].

The lack of an adequate school feeding policy and nutrition guidelines indicates the lack of adequate knowledge and precise benchmarking with regard to food rations, nutrient content, and feeding patterns when administering food to children and adolescents who attend school. Additionally it implies compromise in the provision of quality nutritious meals to school-going adolescents. Hence, there is a heavy reliance on the World Health Organization's (WHO's) recommended daily allowance (RDA) as it is an internationally accepted standard [11]. Therefore, the study investigated the nutrient quality, portion size, and suitability to meet health requirements of meals offered to students in Kenyan boarding high schools.

## 2. Materials and Methods

### 2.1. Study Area and Target Population

A cross-sectional study was conducted in May through to July 2019, to assess the portion size and composition of meals offered to Kenyan boarding high school students aged 15 to 18 years, on a daily and weekly basis. The target population was catering managers or head cooks who were in charge of kitchens in high schools. The study was conducted in eight counties, namely Nakuru, Uasin Gishu, Nandi, Kakamega, Nairobi, Kisumu, Laikipia, and Elgeyo Marakwet, where 50 selected boarding high schools categorized by the Kenyan Ministry of Education as national, extra county, county, and private, were included.

## 2.2. Sampling Design

Purposive judgmental sampling was used to select eight out of the 47 counties, and 50 out of over 3000 high schools in Kenya were selected to participate in the study. This was done based on preliminary knowledge of the various counties and the number of schools they had in each of the Ministry of Education school categories. One catering manager/head cook from each of the 50 schools was interviewed.

## 2.3. Food Frequency Questionnaire

Food frequency questionnaires were used to collect dietary information from the school catering managers or cooks about the school menus and meals that were provided to students in the high schools. This information was based on the types of foods and meals offered to the students on both a daily and a weekly basis, the frequency of food provision, and the portion size of meals offered to students, all based on the school menus. This was necessary to establish the types of meals offered in the high schools, and the meal frequency and portion sizes served to students to provide nutrients in comparison to the WHO's 2006 guidelines for RDA.

## 2.4. Ethical Approval

Approval for conducting the study was granted by the National Commission for Science, Technology and Innovation (NACOSTI) in Kenya, under permit number NACOSTI/P/1981086/28440. Permission was also granted by the education sections of all the participating counties and the head teachers of each of the 50 schools. Informed consent was also obtained from the respondents, whose participation was voluntary after assurances of anonymity and confidentiality.

## 2.5. Data Analysis

NutriSurvey Software for Windows (2007) was used to generate dietary intake data. Many of the foods in the school menus were native Kenyan local foods; therefore, additional nutrient composition was obtained from the Kenya Food Composition Tables 2018, compiled by the FAO/Government of Kenya [12], which has a collection of the foods consumed. The nutrient profile of each food was then added from the Food Composition Tables into the nutrient database of NutriSurvey Software for Windows. Additionally, Minitab 18 Statistical Software for analysis was used to separate the means ANOVA, as the data being analyzed had more than two groups from which comparison was to be made. The level of significance was  $p < 0.05$ .

## 3. Results

### 3.1. Mean Quantity of Each Food Consumed Daily among School Categories

The results in Table 1 show the quantities of each type of food provided daily to individual students in the different school categories. Githeri (a mixture of maize and beans) was provided in the highest (377 g) quantities in county schools, while private schools provided the least. The highest (166 g) provision of ugali (stiff porridge) was by national schools, while private schools served the least. Compared to all other school types the highest (278 g) amount of rice was served by the private schools. Legume service was highest (90 g) in county schools and lowest in private schools, and vegetables were provided most (121 g) in county schools and least in private schools. Bread and potatoes were served across all school types. The least provided foods were spreads, tea, coffee, and milk. Animal-source foods such as eggs, sausage, and beef mainly appeared in the menus of private schools compared to other school types.

**Table 1.** The mean amounts in grams of the foods provided daily to students aged 15–18 years in the selected high schools.

Categories	Main Foods (g)	Extra County Schools	National Schools	Private Schools	County Schools
Starchy Staples	Rice	158.57 ± 51.9	173.25 ± 39.3	277.61 ± 121.9	225 ± 45.5
	Potatoes	7.95 ± 18.4	44.91 ± 41.8	35.31 ± 29.6	19 ± 26.2
	Chapatti	0.00	22.50 ± 45.0	15.61 ± 29.6	0
	<sup>1</sup> Githeri	335.79 ± 172.2	375.43 ± 197.6	123.75 ± 51.0	377 ± 48.5
	<sup>2</sup> Ugali	146.56 ± 46.0	166.61 ± 66.4	78.36 ± 14.1	141 ± 2.02
	Bread	61.07 ± 38.6	100.00 ± 0.0	100.00 ± 0.0	100 ± 0.0
	Scones	27.57 ± 50.6	0.00	17.86 ± 35.7	0
Beverages	White tea	109.00 ± 48.5	150.00 ± 0.0	132.86 ± 64.2	201 ± 30.3
	Black tea	58.57 ± 77.58	0.00	0.00 ± 0.0	0
	Cocoa	2.43 ± 4.9	5.71 ± 6.6	3.04 ± 6.1	0
	<sup>3</sup> Uji	111.43 ± 105.0	0.00	87.50 ± 71.5	36 ± 50.5
	Coffee	0.00	3.04 ± 6.0	4.29 ± 4.9	0
Dairy	Milk	0.00	26.79 ± 53.57	0.00 ± 0.0	0
Fruits and Vegetables	Fruit	0.70 ± 0.78	0.50 ± 0.6	1.75 ± 0.9	0
	Cabbage	40.50 ± 29.8	42.29 ± 48.9	35.96 ± 15.3	121 ± 71.7
	Kales	47.15 ± 25.6	52.00 ± 66.17	8.34 ± 16.69	0
Legumes	Green grams	0.00	0.00	15.00 ± 17.4	16 ± 22.7
	Beans	71.74 ± 54.8	78.21 ± 13.1	29.57 ± 34.7	64 ± 90.9
Meat	Beef	12.17 ± 10.6	13.79 ± 13.1	16.07 ± 14.48	8.0 ± 1.0
	Sausage	0.00	0.00	2.86 ± 3.3	0
Eggs	Egg	0.50 ± 1.5	6.25 ± 4.8	30.00 ± 40.0	0
Spreads	Spreads	0.00	0.00	15.00 ± 0.0	0
	Total	1191	1261	1030	1308

Figures are means ± standard deviation; <sup>1</sup> githeri is a meal prepared from a stewed mixture of dry maize and beans; <sup>2</sup> ugali is stiff porridge prepared from maize meal; <sup>3</sup> uji is a drinking porridge prepared from maize or millet meal.

### 3.2. Food Groups Provided by the Different Categories of High Schools

Foods appearing in the school menu were classified into eight food groups (Table 2). Results showed that the most provided group was the starchy staples which contributed 64 to 68% of the total diet. The highest servers of the staples were county schools (898 g) and the lowest were private schools. Dairy products (milk) were only served in national schools. Private schools were the leading providers of fruits, while county schools' menus did not feature fruits. Legumes were the main source of proteins across all the school types, with a high of 6% of the diet, except for the private schools, which included more animal proteins in their menus than all the other school types.

**Table 2.** The mean amount in grams of the food groups served daily to students aged 15–18 years old in different school types and their percentage contributions to the total dietary intake (g/student/day).

Food Group	Extra County Schools	National Schools	Private Schools	County Schools
Starchy Staples	849 ± 47 (68.69)	883 ± 61 (67.66)	736 ± 35 (64.50)	898 ± 26 (68.65)
Beverages	170 ± 25 (13.75)	159 ± 1 (12.18)	52 ± 21 (4.56)	201 ± 30 (15.37)
Dairy	0 (0)	27 ± 54 (2.07)	0 (0)	0 (0)
Fruits	80 ± 92 (6.47)	60 ± 69 (4.60)	200 ± 105 (17.53)	0(0)
Vegetables	88 ± 16 (7.12)	78 ± 9 (5.98)	44 ± 12 (3.86)	121 ± 21 (9.25)
Legumes	36 ± 29 (2.91)	78 ± 13 (5.98)	45 ± 36 (3.94)	80 ± 68 (6.12)
Meat	12 ± 11 (0.97)	14 ± 13(1.07)	19 ± 17 (1.67)	8 ± 1 (0.61)
Eggs	1 ± 2 (0.08)	6 ± 5 (0.46)	30 ± 40 (2.63)	0 (0)
Spreads	0 (0)	0 (0)	15 ± 10 (1.31)	0 (0)
Total	1236 (100)	1305 (100)	1141 (100)	1308 (100)

Values are means ± standard deviations. Values in parenthesis are percentage contributions to total dietary intake.

### 3.3. Mean Amount of Nutrients Provided by the Diet

Table 3 shows an estimate of the mean amount of nutrients provided by the diet for each student in the four school categories. Results indicate that protein intake is highest in national schools (62 g) and lowest in private schools. Retinol and Vitamin A intake were significantly higher in private schools compared with other school types. Retinol intake was lowest (26 µg) in extra county schools while vitamin A provision in extra county and county schools ranged from 114 to 40 µg. The highest (8.15 µg) intake of vitamin B<sub>1</sub> was in county schools, which also exceeded the required daily intake, compared to the lowest intake in extra county schools, which had an almost eight-times lower intake. Vitamin B<sub>12</sub> provision is highest in private schools (1.55 µg) and lowest in county schools (0.7 µg). Its provision in extra county schools and private schools was significantly different.

**Table 3.** The mean amount of nutrients provided daily by the total diet of the high-school students in the sampled schools.

Nutrients	Units	School Type			
		Extra County Schools	National Schools	Private Schools	County Schools
Energy	K Cal	1453.1 <sup>a</sup> ± 267.3	1729.0 <sup>a</sup> ± 309.0	1494.0 <sup>a</sup> ± 294	1576.0 <sup>a</sup> ± 201
Minerals	g	12.46 <sup>ab</sup> ± 2.8	13.95 <sup>a</sup> ± 3.5	9.73 <sup>b</sup> ± 0.9	13.40 <sup>ab</sup> ± 2.12
Proteins	g	52.98 <sup>a</sup> ± 9.4	61.80 <sup>a</sup> ± 12.9	44.80 <sup>a</sup> ± 7.2	56.35 <sup>a</sup> ± 11.9
Fat	g	27.38 <sup>a</sup> ± 5.9	37.27 <sup>a</sup> ± 12.8	38.80 <sup>a</sup> ± 16.7	28.75 <sup>a</sup> ± 2.9
Carbohydrates	g	227.8 <sup>a</sup> ± 40.9	264.8 <sup>a</sup> ± 35.3	228.8 <sup>a</sup> ± 33.7	249.0 <sup>a</sup> ± 26.3
Dietary fiber	g	45.83 <sup>a</sup> ± 11.9	48.63 <sup>a</sup> ± 13.1	26.13 <sup>ab</sup> ± 3.6	45.80 <sup>ab</sup> ± 10.0
Retinol	µg	26.08 <sup>b</sup> ± 10.6	66.10 <sup>b</sup> ± 31.9	191.6 <sup>a</sup> ± 129.0	35.40 <sup>b</sup> ± 4.5
Vitamin A	µg	114.6 <sup>b</sup> ± 43.8	169.8 <sup>ab</sup> ± 148.5	253.2 <sup>a</sup> ± 160.4	39.5 <sup>b</sup> ± 4.74
β-Carotene	mg	882 <sup>a</sup> ± 488	975 <sup>a</sup> ± 1205	167 <sup>a</sup> ± 310	33.75 <sup>a</sup> ± 4.88
Vitamin B <sub>1</sub>	mg	0.80 <sup>c</sup> ± 0.2	0.97 <sup>bc</sup> ± 0.3	7.55 <sup>a</sup> ± 8.0	8.15 <sup>ab</sup> ± 10.2
Vitamin B <sub>2</sub>	mg	0.56 <sup>a</sup> ± 0.0	0.75 <sup>a</sup> ± 0.2	0.6 <sup>a</sup> ± 0.2	0.6 <sup>a</sup> ± 0.1
Vitamin B <sub>12</sub>	µg	0.74 <sup>b</sup> ± 0.5	1.12 <sup>ab</sup> ± 0.8	1.55 <sup>a</sup> ± 0.9	0.7 <sup>ab</sup> ± 0.1
Vitamin B <sub>6</sub>	mg	0.21 <sup>c</sup> ± 0.1	0.43 <sup>ab</sup> ± 0.2	0.48 <sup>a</sup> ± 0.2	0.15 <sup>bc</sup> ± 0.0
Folic acid	µg	32.89 <sup>b</sup> ± 14.2s	38.13 <sup>b</sup> ± 15.6	68.50 <sup>a</sup> ± 34.9	19.95 <sup>b</sup> ± 3.9
Vitamin C	mg	67.74 <sup>a</sup> ± 26.8	44.5 <sup>a</sup> ± 37.6	63.0 <sup>a</sup> ± 17.9	31.60 <sup>a</sup> ± 6.6
Sodium	mg	1631.0 <sup>a</sup> ± 471	1851.0 <sup>a</sup> ± 430	1592.9 <sup>a</sup> ± 179.3	1978.0 <sup>a</sup> ± 195
Potassium	mg	1542.0 <sup>a</sup> ± 610	1863.0 <sup>a</sup> ± 537	1279 <sup>a</sup> ± 345	1657 <sup>a</sup> ± 345
Calcium	mg	455.4 <sup>a</sup> ± 91.8	474.0 <sup>a</sup> ± 233	254.9 <sup>b</sup> ± 29.6	292.8 <sup>ab</sup> ± 56.4
Magnesium	mg	295.3 <sup>a</sup> ± 67.5	330.2 <sup>a</sup> ± 80.4	210.9 <sup>b</sup> ± 25.2	290.1 <sup>ab</sup> ± 43.5
Phosphorus	mg	1336.0 <sup>a</sup> ± 351	1551.0 <sup>a</sup> ± 399	900.6 <sup>b</sup> ± 116.7	1456.0 <sup>ab</sup> ± 254
Iron	mg	19.52 <sup>a</sup> ± 8.0	19.55 <sup>a</sup> ± 7.4	12.00 <sup>a</sup> ± 4.0	14.25 <sup>a</sup> ± 1.9
Zinc	mg	8.32 <sup>ab</sup> ± 1.4	9.55 <sup>a</sup> ± 1.9	6.78 <sup>b</sup> ± 1.0	8.80 <sup>ab</sup> ± 1.7

Values are means ± standard deviation; values with the same letter (a to c) superscript on the same row are not significantly different at  $p < 0.05$  as assessed by Fisher's least significant difference.

Intake of vitamin B<sub>6</sub> and folic acid were significantly higher in private schools compared to all other school categories, while national schools had the highest calcium and magnesium intakes. Only the private schools' phosphorous intake was very low—900.6 mg—when compared to other schools. There was a significant difference in zinc provision between national and private schools at 9.55 and 6.8 mg, respectively (Table 3).

### 3.4. Percentage Fulfillment of Different Nutrients

The percentage fulfillment of the recommended daily allowance of nutrients for students in the four categories of schools is shown in Table 4. Results show that school meals did not meet 100% of the energy needs of the students. Carbohydrates, proteins, and fats provided 57.6, 11.8, and 30.5% of energy requirements, respectively. The meals met more than 75% of the nutritional requirements for proteins, fats, and carbohydrates. The diets fell short in vitamins A, C, and B<sub>12</sub>. In terms of minerals, calcium was the nutrient for which the requirements were least fulfilled (3–37%). The mineral requirements that were adequately fulfilled were phosphorous, iron, and zinc.

**Table 4.** Percentage fulfilment of the different nutrients according to school type.

Nutrients	Units	Recommended Value/Day <sup>1</sup>	Percentage (%) Fulfilment			
			Extra County Schools	National Schools	Private Schools	County Schools
Energy	kCal	2036.3	71.35	84.91	73.37	77.40
Proteins	g	60.1	88.15	102.83	74.54	93.76
Fat	g	69.1	39.62	53.94	56.15	41.61
Carbohydrates	g	290.7	78.36	91.09	78.71	85.66
Dietary fiber	g	30	152.77	162.10	87.10	152.67
Vitamin A	µg	1000	11.46	16.98	25.32	3.95
Vitamin B <sub>1</sub>	mg	1.15	69.57	84.35	656.52	708.70
Vitamin B <sub>2</sub>	mg	1.35	41.48	55.56	44.44	44.44
Vitamin B <sub>12</sub>	µg	3	24.67	37.33	51.67	23.33
Vitamin B <sub>6</sub>	mg	1.4	15.00	30.71	34.29	10.71
Folic acid	µg	400	8.22	9.53	9.53	4.99
Vitamin C	mg	100	67.74	44.50	63.00	31.60
Sodium	mg	2000	81.55	92.55	79.65	98.90
Potassium	mg	3500	44.06	53.23	36.54	47.34
Calcium	mg	1200	37.95	3.95	21.24	24.40
Magnesium	mg	375	78.75	88.05	56.24	77.36
Phosphorus	mg	1250	106.88	124.08	72.00	116.48
Iron	mg	13.5	144.59	144.81	88.89	105.56
Zinc	mg	8.5	97.88	112.35	79.76	103.53

<sup>1</sup> WHO, [11].

## 4. Discussion

### 4.1. Diversity of Foods Provided

The low diversity of food items in the schools categories other than private schools may be a result of limited government funding in public schools, while the more diverse foods in private school menus might be influenced by the purchasing power of the parents, who pay higher school fees. A study by Zuilkowski et al. [13] on primary schools in Nairobi showed that low-cost private schools (LCPS) spent an average of Ksh 1962 per annum on school meals, while public schools spent almost half of this. This can be extrapolated to secondary schools, which are guided by the same document, i.e., the National School Meals and Nutrition Strategy 2017–2022 [14]. Furthermore, studies show that parents with students in private schools are more likely to pay more money to ensure that their children are well-fed [13]. This may be the reason for the increased diversity of school meals in private schools. Additionally, private schools have been shown to have better autonomy to make decisions regarding the foods that should appear in school menus compared to public schools [9]. Private schools also served the lowest amount of starchy staples such as ugali and githeri. Their main source of carbohydrates is rice. This could be explained by the high amount of energy required to cook maize and beans, making it expensive, hence their preference to cook rice.

### 4.2. Food Groups Provided

The starchy staples, which contributed more than 60% of the entire diet, have been found to be the major foods fed to school children in developing countries [15] because they are easily available and are a cheap source of energy compared to other food groups. Thompson and Amoroso [16] indicate a shift from a varied diet rich in micronutrients to one derived from predominantly high-carbohydrate starchy staples. Animal-source foods are the least provided foods in school menus because they are expensive, in the context of school feeding in developing countries. A study by Cornelsen et al. [17] in Kenya found that price was the most frequently reported barrier to the provision of animal-source Foods (ASF), therefore affordability is the main hindrance to their service. Additionally, the study revealed that milk was provided only by the national schools because they reared dairy animals in their school farms and therefore had a constant supply of milk. Azzarri et al. [18] suggest that livestock

ownership confers on households more opportunities to increase the consumption of animal-source food as it translates into cheaper or more reliable access to animal-source food supplies. A study by Kabunga et al. [19] showed that the adoption of improved dairy cow breeds at farm level led to increased consumption of milk in Ugandan households and translated to improved dietary quality among young children. Meat and eggs, the least-provided foods, contributed an estimated 2% to the total dietary intake among the high-school students. The major source of proteins were legumes, which are known to have lower protein quality compared to animal sources [16]. From the foregoing, school feeding policies should advocate for boarding schools to rear animals for milk, eggs, and meat for the cheaper supply of high-quality protein.

The provision of fruits in private schools and not at all in county schools may be explained by the purchasing ability of the parents of children attending private schools, compared to those attending county schools. Fruits are known to be an expensive source of energy and therefore this could be the reason for the high intake in private schools. Review studies on the determinants of fruit and vegetables consumption among adolescents consistently show that high income levels largely influence fruit intake, often because of affordability [20–22].

The high provision of vegetables in county schools could be attributed to the parents who sometimes supply vegetables from their farms as a form of school fees payment, since most of these types of schools are commonly found in rural areas. A review on the determinants of vegetable consumption among adolescents by Rasmussen et al. [20] showed that availability of vegetables is one of the determinants that greatly influence vegetable intake, which may be true in this study. Furthermore, low vegetable provision in private schools could be attributed to the children's lack of engagement in school gardening activities owing to limited land sizes in private schools. Despite epidemiological evidence by He et al. [23] for the health benefits of a diet rich in fruits and vegetables, such as reduced risk of chronic diseases later in life, large numbers of adolescents do not meet the WHO requirement of a daily intake of at least 400 g (roughly equivalent to five servings per day) of fruits and vegetables [24]. A study by Peltzer and Pengpid [25] in seven African countries, including Kenya, found that most adolescents (77.5%) did not consume the recommended daily servings of vegetables. Similar results to this have been reported by Doku et al. [26], who found that 56% and 48% of adolescents in Ghana rarely consumed fruits and vegetables. According to South African dietary guidelines, it is recommended that adolescents consume at least one fruit and/or vegetable in a meal [24]. This recommendation was not met in this study. This could be due to the limited variety of fruits (banana and orange) and vegetables (kale and cabbage) that appear on most of the school menus. This study is in agreement with other studies that fruit and vegetable consumption is consistently low in many low middle income countries [27]. This implies that nutrition guidelines for school feeding in Kenya should recommend the minimum fruit and vegetable portions that should be provided to students.

#### *4.3. The Mean Amount of Nutrients Provided Daily from the Total Diet*

The higher consumption of proteins by the national compared to private schools may be explained by the fact that the major sources of proteins in the diets are cereals and legumes. The low values reported in private schools could be due to their low service of these grains. Private schools provided more rice and potatoes, which are poor sources of protein. However, they provided more beef, eggs, and sausages than the other schools—implying that though their protein intake is low, it is of higher quality, since it comes from animal sources.

The national schools' diet had high mineral content, probably because most of the meals served were wholemeal, and therefore the presence of bran in the foods leads to a high mineral content in the diet. In contrast, most of the foods served in private schools such as rice, chapatti, and potatoes have low mineral content, and are processed with husks removed. For example, the processing of maize by dry milling and fractionation results in the removal of bran, which is the major constituent of the pericarp, and which contains B-vitamins and minerals [28]. Corn bran contains more iron, zinc,

and phosphorous than corn starch [29]. This shows that the micronutrient content of cereals is greatly reduced after processing, and therefore service of processed foods provides a small proportion of the daily requirements for most vitamins and minerals. Nutrition guidelines should emphasize the use of whole grain for food and food products in adequate portions in school meals to contribute to mineral provision.

The service of higher amounts of fruits, and also spreads on bread that are fortified with vitamin A, to students in private schools may have resulted in their intake of higher amounts of retinol and vitamin A than the other types of school. Margarine has been found to be one of the most suitable vehicles for vitamin A [30]. A study involving Filipino pre-school children who consumed 27 g of vitamin A-fortified margarine per day for a period of six months showed that there was a reduced prevalence of low serum retinol from 26% to 10%, hence consumption of the margarine significantly improved the vitamin A status of the children [31]. Foods high in vitamin A should be deliberately included among those in school menus based on Kenyan nutrition guidelines.

Furthermore, the significantly higher vitamins B<sub>12</sub>, B<sub>6</sub>, and folic acid in private school menus compared to the other school types may be attributed to the higher service of animal-source foods such as eggs and beef. In contrast, the low calcium, phosphorous, and magnesium provision in private schools compared to other school types may be explained by the low service of cereals and legumes, which are rich sources of magnesium and phosphorous [32]. The low intake of milk and milk products could further explain the low calcium levels in the students' diets. In national schools the provision of zinc was higher compared to private schools. This could be explained by the fact that they were served with more beans compared to other schools. They were also provided with milk, which is a rich source of zinc.

#### 4.4. Fulfillment of the Different Nutrients

The study's findings showed that school meals did not meet 100% of the energy needs of the students. This finding contradicts those of Buluku [7] who found that energy was adequately met in the diets of girls in selected boarding schools in Nairobi, Kenya. However, this finding concurs with that of Nhlapo et al. [33] who found that the meals served under a South African school feeding scheme did not meet the energy needs of school children aged 11–18 years. Carbohydrates, proteins, and fats provided 57.6%, 11.8%, and 30.5% of energy, respectively. According to the School Food Trust [34], a minimum of 50% of the energy provided should be sourced from carbohydrates, less than 35% should be met from fats and the rest from proteins. The results of this study indicate that the meals provided met the recommendations regarding the contributions of the three macronutrients to the energy needs of the high school students. This finding is similar to that of Charrondiere et al. [35] on numerous food items from different countries in which the total carbohydrate content supplied 50–80% of energy, and 7–11% of energy was from protein. Nutrition guidelines should recommend portion sizes for energy-providing foods that enable students in boarding high schools to meet all their energy requirements.

The ability of national schools to meet the required protein intake while the other school types fell short may be attributed to the provision of more food groups rich in proteins, and that this was the only school type that served milk. Protein is important in adolescent nutrition as it provides structure for the body and major components of the bones, blood, muscle, cell membranes, enzymes, and immune factors [32].

The high intake of dietary fiber in the public schools may be explained by the provision of starchy unrefined grains and pulses in meals such as githeri (a stewed mixture of maize and beans), wholemeal ugali, and vegetables such as kale, which are rich in fiber. This is an advantage, as high-fiber diets have a low glycemic index, therefore keeping students full for a longer time, which reduces the rate of hunger. For instance, a study by Ye et al. [36] showed that consumption of dietary fiber decreased hunger and increased satiety hormones in humans when ingested with a meal. This implies that the students can concentrate in class for longer without feeling hungry. However, high-fiber diets

tend to be rich in phytates, and therefore could bind key mineral elements such as calcium and also reduce absorption of minerals such as iron and zinc [37]. Private schools reported a low intake of fiber compared to the other schools because of the low provision of githeri, ugali, and kale, and the provision of potatoes, which are low in fiber as stated earlier.

The percentage fulfillment of Vitamin A was high in private schools and low in county schools due to the high intake of fruits, and Vitamin A-fortified spreads on bread. The low value reported in county schools is a result of the non-provision of fruits and spreads. This finding is similar to that of Buluku [7] on Kenyan boarding school meals that did not meet the nutrient requirements for adolescent girls. Vitamin A is a key micronutrient in adolescent nutrition. Vitamins play important roles in the body such as aiding vision, immunity (vitamin A), calcium absorption (vitamin D), and anti-oxidative protection in cell membranes (vitamin E) [32].

Calcium intake was highest in the national schools probably because of milk provision to students in national schools, compared to private schools, which did not provide milk. The ability of most school types to fully meet their phosphorous, zinc, and iron requirements in most school types could be attributed to the consumption of cereals and pulses, which are rich sources of these minerals [32]. The intake of iron and zinc appears to be overestimated because the diet was mainly composed of cereals and pulses. These minerals were mostly found in githeri, ugali, millet porridge, maize porridge, beans, and green grams, which were frequently provided.

However, cereals and legumes contain phytates which chelate with minerals and metals such as calcium, magnesium, zinc, and iron, forming insoluble salts that are not easily absorbed by humans [38]. Phytates particularly form complexes which can severely impair the availability of zinc and iron [39]. Furthermore, most schools took beverages in the form of tea, coffee, or cocoa, which may also contain tannins that could further bind the minerals [40]. Deficiencies of iron and zinc are a public health problem in developing countries, particularly among adolescents and women of reproductive age. A systematic review to evaluate iron and zinc intakes in adolescents from Ethiopia, Kenya, Nigeria and South Africa concluded that diet-related anaemia and zinc deficiencies are problems of public health significance [41]. Zinc is important in adolescence because of its critical function in growth and sexual maturation [42]. However, adolescents are at high risk of deficiency, often related to the consumption of plant-based diets, which have low zinc and iron bioavailability reported by Gibson et al. [43], which are similar to the diets provided in this study. From the foregoing it is noted that the study only focused on what schools provided to their students and did not consider how much the adolescents consumed.

## 5. Conclusions

Kenyan high schools fail to provide students with adequate nutritious foods. In comparison to the FAO [9], which acts as the worldwide benchmark for the development of school dietary guidelines, the study notes that none of the high schools in Kenya adequately meet the nutritional requirements of meals served to school-goers. Meal menus lack variation in food options, and are very repetitive and simplistic in nature. It observed that the foods most provided in schools are high fiber foods, githeri (a mixture of maize and beans), and starchy foods such as ugali (stiff porridge) and rice, while the least-consumed food are fruits, proteins—especially during breakfasts—and vegetables. National schools consume the highest quantities of dietary fiber and starch in comparison to other high schools whilst county schools consume the highest quantities of vegetables. Private schools consume the highest quantities of breakfast proteins, while county schools consume the highest quantities of legumes. The majority of Kenyan high schools fail to attain nutrient requirements in meals offered to students, while in some cases schools surpass the recommended amount, such as for dietary fiber, where schools offer three times more than the recommended amounts. The Kenyan government should work with various stakeholders to ensure the development of an adequate school feeding policy to develop and implement nutrition guidelines in the county. Additionally, an area of further research would be how much food the adolescents in Kenyan high schools consumed.

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