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Nutrient composition and dietary diversity of on-site lunch meals, and anthropometry of beneficiary children in private and public primary schools in Ghana

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Abstract

Background: On-site lunch provided through the Ghana School Feeding Programme is expected to be nutritionally adequate thereby contributing to reducing hunger and malnutrition. **Aim:** The aim of this study was to assess the dietary diversity and nutrient composition of on-site school lunch and estimate the extent to which it met the Food and Agriculture Organization Reference Nutrient Intakes for children aged 3–12 years. **Methods:** In this cross-sectional food consumption survey, on-site lunch menus were reviewed, dietary diversity assessed and meal preparation/serving observed during a typical school week. Three randomly selected portion sizes were weighed and the average weight (grams) entered into the RIING nutrient software to estimate the nutrient composition. Anthropometry of participants enrolled in seven public ($n = 113$) and six private ($n = 216$) primary schools in Hohoe municipality, Ghana was analysed using World Health Organization Anthroplus software. **Results:** The menu consisted largely of energy-dense staples, some vegetables and fish. Eggs, dairy and fruits were never served. Meals served in the public and private schools were statistically similar. Fat (23.8 *vs.* 27.7 g), iron (3.0 *vs.* 2.8 mg), vitamins A (417.3 *vs.* 280.8 μg retinol equivalent) and C (25.1 *vs.* 16.5 mg) requirements were fully met. Energy (420.6 *vs.* 462.2 kcal), protein (6.8 *vs.* 6.8 g), thiamin (0.18 *vs.* 0.17 mg) and zinc (1.3 *vs.* 1.2 mg) were 50–75% met. Calcium (62.6 *vs.* 61.4 mg), riboflavin (0.09 *vs.* 0.07 mg) and niacin (1.6 *vs.* 1.3 mg) were 26–37% met. Concerning nutritional status, prevalence of stunting (8.9% *vs.* 7.9%), underweight (3.6% *vs.* 5.7%), thinness (1.8% *vs.* 3.7%) and overweight/obesity (3.5% *vs.* 4.2%) were also statistically similar. **Conclusion:** Enhancing dietary diversity is crucial to achieving nutrient-dense school meals.

Keywords

School feeding programmes, school meals, diet quality, macro- and micronutrients, school age children, nutritional status

Introduction

Despite considerable decline, malnutrition among school age children remains a public health concern in Ghana. Prevalence of underweight (9.3%), stunting (8.5%), wasting (5.7%) and overweight (4.6%) (Agbozo et al., 2016) are quite similar to those of children under five years (11% underweight, 19% stunting, 5% wasting and 3% overweight) (UNICEF, 2016). The nutritional status of children is grossly different between low- and middle-income countries (UNICEF, 2016). Underweight levels in sub-Sahara Africa (19%), for instance, are lower compared with South Asia (30%) whereas stunting in both regions is similar (36% *vs*. 37%). Meanwhile, in the Middle East and North Africa, as well as in Latin America and the Caribbean, malnutrition rates are much lower. Apart from children under five years, school age children, defined as children between the ages of five and 12 years, are the most malnourished globally (UNICEF, 2012). Commonly

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reported nutritional problems among children include micronutrient deficiencies such as vitamin A, iron, iodine and zinc, and protein energy malnutrition, as well as underweight and stunting (Liu et al., 2015; UNICEF, 2012). Increased energy expenditure combined with decreased meal frequency, reduced maternal attention, and parasitic infections escalate the problem of micronutrient deficiencies in children (Aliyar et al., 2015). Consequences of childhood malnutrition are manifold and have health and socio-economic implications. These include high susceptibility to infections, increased morbidity, poor physical growth, low academic performance associated with reduced productivity in adulthood, and increased risk of non-communicable diseases in later years (Liu et al., 2015; UNICEF, 2016).

Across the life span, energy and nutrient requirements vary depending on sex, age, physiological state and physical activity levels. To maintain normal growth, children age 5–12 years have a daily energy requirement of between 1467 and 2341 calories (FAO, 2001). For instance, the daily energy requirement for 8–9 year olds is 1830 kcal and that for 10–11 year olds is 2150 kcal. Total fat intake should not exceed 30% of the caloric intake. Daily protein requirement is about 20 g. Regarding micronutrients, Reference Nutrient Intakes (RNIs) for thiamin and riboflavin are 1.0 mg, niacin 13 mg, vitamin B6 1.0 mg, vitamin C 35 mg, vitamin A 500 μgRE, calcium 700 mg, iron 20 mg and zinc 9 mg (FAO/WHO, 2001).

Promotion of healthy habits requires reduced intake of saturated and trans-fat, sugar, salt and refined foods and adequate intake of micronutrients. Diets of school children should rely primarily on fruits and vegetables, whole grains, low-fat milk, beans, fish, and lean meat (Osowski et al., 2015). However, the energy and nutrient content of on-site school meals often does not meet the dietary requirements. In Mexico, for instance, the average energy content of school meals was 1501 kcal per day, meeting 88% of the dietary needs (Flores et al., 2009). In England, school meals fell short of recommended daily intakes for non-starch polysaccharides, zinc, calcium, iron and vitamin A (Nelson et al., 2007).

In developing countries, the situation is no different. A lunch serving in the Ghana School Feeding Programme (GSFP) should provide at least 664 kcal energy, 16.3 g protein, 11.1 g fat, 22 mg calcium, 3.7 mg iron, 375 μgRE vitamin A, 0.19 mg thiamin, 0.10 mg riboflavin, 10.4 mg niacin and 4 mg vitamin C (Fisher, 2007). Nutrient evaluation of meals provided in three beneficiary GSFP schools in 2012 showed that energy, protein, vitamin A, zinc, iron and magnesium values met almost 100% of the RNI; vitamin C met 59% of the daily RNI; riboflavin met 25% and calcium met 22% of the required RNI (Danquah et al., 2012). Portion sizes served in the private schools are typically larger and provided higher energy and fat. But the micronutrient values are similar to those provided in the GSFP (Owusu et al., 2017).

Provision of on-site school meals through the GSFP is a national social protection system that could reduce short-term hunger, improve nutritional status, child development and boost local agricultural production. Globally, school meals are recognized as a way to tackle childhood malnutrition and poor eating habits in school children and this has driven the harmonization of National School Food Policies across Europe (Bonsmann et al., 2014). Particularly in developing countries, intake of nutritionally adequate school meals has a ripple effect for poor families. Yet, impact evaluation of the GSFP has focused mainly on school enrolment and attendance. Little attention has been paid to quality and quantity of the meals served. Although private schools, considered as schools for wealthy families, also provide mandatory on-site meals paid for by parents, the meals are seldom monitored.

This study estimated the energy and nutrient composition of meals served in selected public schools that are beneficiaries of the GSFP and private schools that provide their own school meals. We assessed the dietary diversity of the on-site lunch meals as well as the energy, macro- and micronutrient content and compared values with the FAO RNI for school age children. The extent to which the meals met the RNI requirements was evaluated. Finally, anthropometry of beneficiary children was measured, and the resulting indices were used to determine their nutritional status.

Materials and methods

Study design and sampling

The design was a cross-sectional food consumption survey. Nutrient composition of the meals served in selected public and private schools, dietary diversity of the meals and nutritional status of the beneficiary school children were assessed. The study was conducted in the Hohoe municipality in Ghana. For administrative purposes, the municipality is sub-divided into seven zones called sub-districts. The municipality has 69 public and 22 private primary schools with a total number of 17,265 enrolled pupils. Out of the 69 public primary schools, 15 schools comprising 4000 pupils are beneficiaries of the GSFP. A multistage sampling approach was used to select a representative sample of seven public schools, one from each sub-district. All the six private schools that provided mandatorily daily on-site lunch were also selected for comparison. Age range of the target population was 3–12 years and the pupils were in kindergarten one and two and primary one to six – totalling eight classes. Based on the total student population as well as the age–sex distribution, a proportionate number of 113 participants was selected from the public schools and 216 from the private primary schools. The study protocol was reviewed and approved by the Ghana Health Service Ethics Review Committee (ethical approval ID GHS-ERC: 15-04-15).

Data collection procedures

In the public schools, caterers designed the menu and the meals were prepared by local cooks. Typically, the caterers had senior secondary education or vocational skills training whereas the cooks had little or no formal education. The private schools employed cooks without any professional training in catering. The government of Ghana contributes 0.4 Cedis per child per day for meals served in the GSFP whereas in the private schools, parents pay between 1.0 and 2.0 Cedis per child per day.

The caterers/cooks provided the weekly menus, comprising the daily dishes, list of ingredients for the meal preparation as well as the quantity of the ingredients (often described in household measures). The weekly menu for each school was reviewed and the list of food items used for meal preparation in a typical school week was recorded in a food frequency questionnaire (FFQ). The FFQ was semi-structured to obtain both quantitative and qualitative dietary data. It contained a list of foods categorized into 10 groups according to the FAO minimum dietary diversity indicator (FAO, 2016). The 10 food groups were grains, tubers and plantain (staple foods); beans, peas and lentils (pulses); nuts and seeds; dairy; meat, poultry and fish; eggs; dark green leafy vegetables; other vitamin A-rich foods; other vegetable; and other fruits. Each food item had six frequency of consumption categories ranging from none per week to five times per week. The weight of ingredients used for each meal preparation was also recorded.

The process of cooking, dishing and serving meals was observed. In both the private and public schools, meals were prepared under sheds and mid-shift tents. In a few schools, the meals were prepared by caterers in their homes and transported to the school. Meals were dished using a standard kitchen ladle with a fairly equal quantity scooped for each child irrespective of age, sex or class. During each school day (Monday to Friday), portion sizes served to three pupils were randomly selected and weighed on an electronic kitchen scale (MC-1001). The average weight of the three or two closest servings was recorded. In all, the weight of 65 portion sizes was recorded: 35 for the public schools and 30 for the public schools.

Statistical analysis

The weight of each serving (in grams) was entered into a nutrient database software called RIING (Research to Improve Infant Nutrition and Growth) designed by the Department of Nutrition and Food Science, University of Ghana. The database contains locally available and commonly consumed foods in Ghana. The software generates nutrient values for energy, protein, carbohydrate, sugar, fat, cholesterol, fibre, total vitamin A, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate, pantothenic acid, vitamins C, D, E, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, zinc and water. Food ingredients used in preparing each meal were matched to the closest food code in the database. The average weight of each portion size was entered into the RIING software and a code that best described the meal was chosen in the database. Energy and nutrient values of each portion size were automatically generated onto an Excel sheet. Out-of-range nutrient values were flagged and cross-checked to identify possible coding errors. The Excel output was exported into STATA (version 13.1) for analysis. Energy and nutrient values were compared with one-third of the FAO RNI requirements for school age children as the on-site lunch is one of the three main meals in a day and, per guidelines of the GSFP, is required to meet at least one-third of the daily RNI requirements (Fisher, 2007). The extent to which the meals met the dietary requirements for each nutrient were then estimated. Differences in the energy and nutrient values between the public and private schools were assessed by *t*-test and reported as means with the corresponding standard deviations (SDs) at 5% statistical significance.

A dichotomous response of 'consumed' and 'not consumed' corresponding to a score of 1 and 0, were assigned to each food item listed in the FFQ. When any food item from one of the 10 food groups was consumed on every school day, a maximum score of 5 was assigned to that group. Hence, for the 10 food groups, the total maximum score that a school could obtain from Monday to Friday was 50. A school's diet was rated as diversified if, during the week, at least half (25) of the total dietary diversity score was obtained. This is based on the FAO Minimum Dietary Diversity indicator whereby consumption of at least five out of the 10 food groups indicates dietary diversity and reflects adequate micronutrient dietary quality (FAO, 2016).

Anthropometric indices of the school children were measured following the WHO standard anthropometry guidelines. To be eligible, the pupil should have been enrolled in the school for at least one complete academic year. Anthropometric measurements included mid-upper arm circumference (MUAC), height and weight. Body mass index (BMI) was calculated as weight in kg divided by height in cm^2. Aided by the WHO Anthroplus software (version 10.4), weight, height and MUAC measurements were converted to weight-for-age *Z* scores (WAZ), height-for-age *Z* scores (HAZ), BMI-for-age *Z* scores (BAZ) and MUAC-for-age *Z* scores (MAZ). The resulting indices were used to estimate proportions of underweight (WAZ< –2 SD), stunting (HAZ<–2 SD), thinness (BAZ< –2 SD), obesity (BAZ <1 SD) and acute malnutrition (MAZ<–2 SD).

Results

Demographic characteristics of participants

Overall, 329 pupils in public ($n = 113$) and private ($n = 216$) schools were randomly selected. Although male to female proportions (49.2% *vs*. 50.8%) were equal, the mean age of pupils in the public school tended to be higher than in the private schools (8.7 ± 2.6 *vs*. 8.1 ± 2.5 years; $p =$

Table 1. Mean energy and nutrient value of the on-site lunch served and a comparison with one-third of the Food and Agriculture Organization Reference Nutrient Intake guidelines.

Energy/nutrient	FAO 30% RNI[a]	Public school Mean ± SD[b]	Private school Mean ± SD[b]	p-value[c]
Energy, kcal	618	420.6 ± 89.5	462.2 ± 112.3	0.359
Protein, g	13	6.8 ± 1.7	6.8 ± 1.3	0.990
Carbohydrate, g	52	49.1 ± 13.2	48.1 ± 6.6	0.870
Fat, g	11	23.8 ± 9.6	27.7 ± 10.7	0.500
Vitamin A, μg RE	167	417.3 ± 326.7	280.8 ± 262.5	0.404
Thiamin, mg	0.3	0.18 ± 0.18	0.17 ± 0.16	0.960
Riboflavin, mg	0.3	0.09 ± 0.04	0.07 ± 0.05	0.381
Niacin, mg	4.3	1.6 ± 0.8	1.3 ± 0.9	0.240
Pantatonic acid, mg	1.33	0.14 ± 0.09	0.19 ± 0.13	0.324
Vitamin B6, mg	0.33	0.02 ± 0.01	0.02 ± 0.01	0.551
Vitamin B12, μg	0.6	0.02 ±0.02	0.01 ±0.02	0.291
Folate, μg	33	18.1 ± 13.8	26.7 ± 15.2	0.306
Vitamin C, mg	12	25.1 ± 20.2	16.5 ± 8.0	0.176
Iron, mg	3	2.95 ± 0.4	2.8 ± 0.40	0.803
Calcium, mg	233	62.6 ± 14.5	61.4 ± 21.7	0.901
Zinc, mg	2.4	1.3 ± 0.4	1.2 ± 0.2	0.487
Magnesium, mg	33	7.8 ± 4.3	5.6 ± 3.3	0.696
Phosphorus, mg	162	116.5 ± 49.0	117.2 ± 58.0	0.968
Sodium, mg	<450	281.2 ± 156.2	367.3 ± 239.2	0.390
Potassium, mg	600	29.5 ± 14.0	33.0 ± 17.6	0.695
Copper, mg	0.4	0.20 ± 0.13	0.16 ± 0.13	0.285

[a]Represents one-third of the FAO RNI for school age 7–10 years (FAO, 2001).
[b]Reported as mean values per serving with the corresponding standard deviation.
[c]Differences determined from independent *t*-test.
FAO: Food and Agriculture Organization; RNI: Reference Nutrient Intake; RE: retinol equivalent.

0.049). Regarding school grade, 25.8% were in kindergarten, 38.3% in lower primary (classes 1–3) and the remaining 35.9% in upper primary (classes 4–6). More than half (62.0%) resided with both parents, 21.9% with a single parent and 16.1% with other relations. About one-third of the caregivers were not involved in any income generating activity. Concerning meal frequencies, 37.1% reportedly ate four or more times in a day while the reminder ate three times. Close to half (41.9%) were given money to buy food/snack in school or sent food from home. Detailed background characteristics of the study participants have been described elsewhere (Agbozo et al., 2016, 2017).

Nutrient value of the on-site lunch

Mean energy and nutrient value of meals served in public schools where the GSFP was implemented was not significantly different from those served in the private schools (Table 1). Values were compared with one-third (30%) of the Food and Agriculture Organization (FAO) reference nutrient intake for children 7–10 years. Vitamin A tended to be much higher in the public school meals whereas energy, fat and folate tended to be slightly higher in the private school meals. Protein, the B vitamins and minerals such as iron, calcium and zinc were particularly similar across the two groups of schools. Breakdown of the nutrient composition of the on-site lunch in the typical school week for selected nutrients of public health significance is presented in Table 2.

Comparison of nutrient value of the on-site lunch to FAO RNI guidelines

Figure 1 shows a comparison of the extent (in percentage) to which nutrient values of the on-site meals met the FAO RNI guidelines for 7–10 year old children. Generally, requirements for fat and vitamins A and C were met above the thresholds. In both the public and private school meals, fat (218% *vs*. 254%) needs met more than twice the FAO RNI guidelines with the private school meals providing over 30% extra fat compared with the public schools. Similarly, requirements for vitamins A (250% *vs*. 168%) and C (208% *vs*. 142%) were met in excess but the meals served in the public schools had higher excess values. Meanwhile, meals served in both schools fully met the requirements for iron (100% *vs*. 93%). Conversely, RNI for energy was 68% met in the public schools and 75% met in the private schools. Requirements for thiamin (60% *vs*. 57%), zinc (54% *vs*. 50%) and protein (52%) were about half met whereas the meals contributed just one-quarter to one-third of the requirements for niacin (37% *vs*. 30%), riboflavin (30% *vs*. 23%) and calcium (27% *vs*. 26%). Except for fat and energy, composition of the public school meals met the macro- and micronutrient needs to a greater

Table 2. Energy and nutrient value of the on-site lunch served in the public and private schools in a typical school week.

	Monday		Tuesday		Wednesday		Thursday		Friday	
Energy/nutrients	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private
Energy, kcal	379	551	474	393	427	382	421	544	398	441
Protein, g	4.7	6.0	7.3	7.7	9.2	6.4	4.5	6.6	8.3	7.3
Fat, g	26.8	42.1	29.3	17.6	15.7	14.2	30.1	41.3	12.8	23.4
Vitamin A, μg RE	159	333	777	126	393	283	282	330	497	332
Thiamin, mg	0.06	0.16	0.25	0.19	0.27	0.17	0.06	0.18	0.27	0.16
Riboflavin, mg	0.05	0.07	0.07	0.08	0.09	0.04	0.06	0.08	0.10	0.08
Niacin, mg	1.3	1.2	1.3	1.5	1.8	1.0	1.6	1.0	1.8	1.8
Vitamin C, mg	12	18	30	10	38	17	7	19	43	17
Calcium, mg	55	65	54	63	77	39	63	63	63	77
Iron, mg	2.8	1.8	2.1	3.3	3.9	2.6	2.0	2.0	4.3	4.4
Zinc, mg	0.9	1.1	1.2	1.3	1.6	1.2	1.3	1.2	1.4	1.5

Only mean values for nutrients of public health importance are shown.
RE: retinol equivalent.

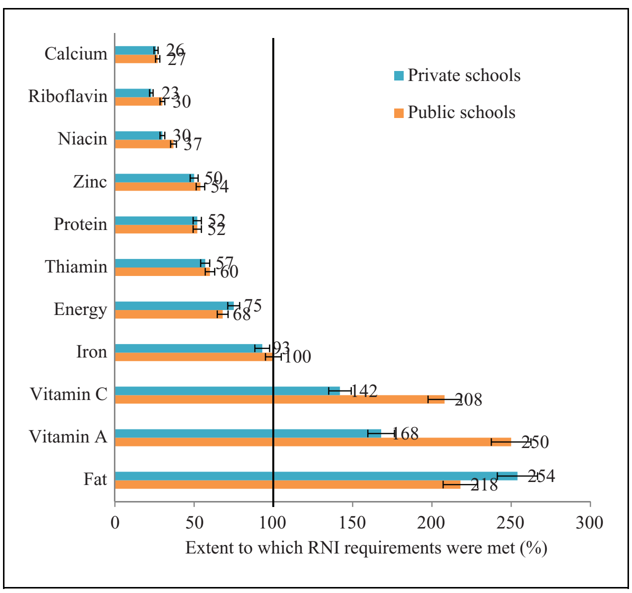

Figure 1. Extent to which nutrient value of the on-site lunch served in the public and private schools met the Food and Agriculture Organization Reference Nutrient Intake (RNI) guidelines for children aged 7–10 years.

extent than the private school meals. However, there were no statistically significant differences between the two categories of schools.

Dietary diversity of the on-site lunch

The meals served in both the public and private schools were less diversified. Presented in the radar chart in Figure 2(a) are the dietary diversity scores for meals served in a typical week-day in the 13 study schools while Figure 2(b) shows a comparison of the average dietary diversity score in the two categories of schools. No school served meat, eggs, fruits or dairy during the study period. Therefore, these food groups were not included in the radar charts. Aside from fish, dark green leafy vegetables and other vitamin A rich food, which were slightly more consumed in the public schools, the dietary patterns were similar in the two types of schools (Figure 2(b)). Dishes made from staple foods rice, corn and cassava were consumed on every school day alongside fats/oils. Rice with tomato stew dominated the menu followed by beans with gari (grated and roasted cassava) and palm oil and banku (mixed fermented corn and cassava dough) served with palm nut, okra or groundnut soup.

Protein source was predominantly plant-based, mainly from black-eye and red beans. Dried anchovies and occasionally tuna were the fish used, with an average consumption of two and three times in the private and public schools respectively. Dark green leafy vegetables and other vitamin A rich foods were consumed once per week, but consumption was slightly higher in the public schools. Varieties of green leaves used included kontomire (cocoyam leaves), ayoyo (corchorus leaves) and spinach while the other vitamin A rich foods were mainly tomatoes, palm oil and dried sorghum leaves. Nuts and seeds (palm fruit, groundnuts and melon seeds) were the least consumed food group with, on average, less than once per week consumption. The menu for the 13 schools is provided in the Supplemental Material Table 1 online.

Generally, the on-site lunch was not micronutrient adequate because none of the 13 schools met the minimum dietary diversity score of 25. Moreover, no school served fruits, eggs, meat, poultry or milk. The overall dietary diversity score was 15.6 (16.1 for the public schools and 15.0 for the private schools).

Anthropometry of participants

Generally, children enrolled in the private schools were slightly heavier, were taller, had higher MUAC and BMI as well as WAZ, HAZ, BAZ and MAZ scores. However, no statistically significant differences were observed in these

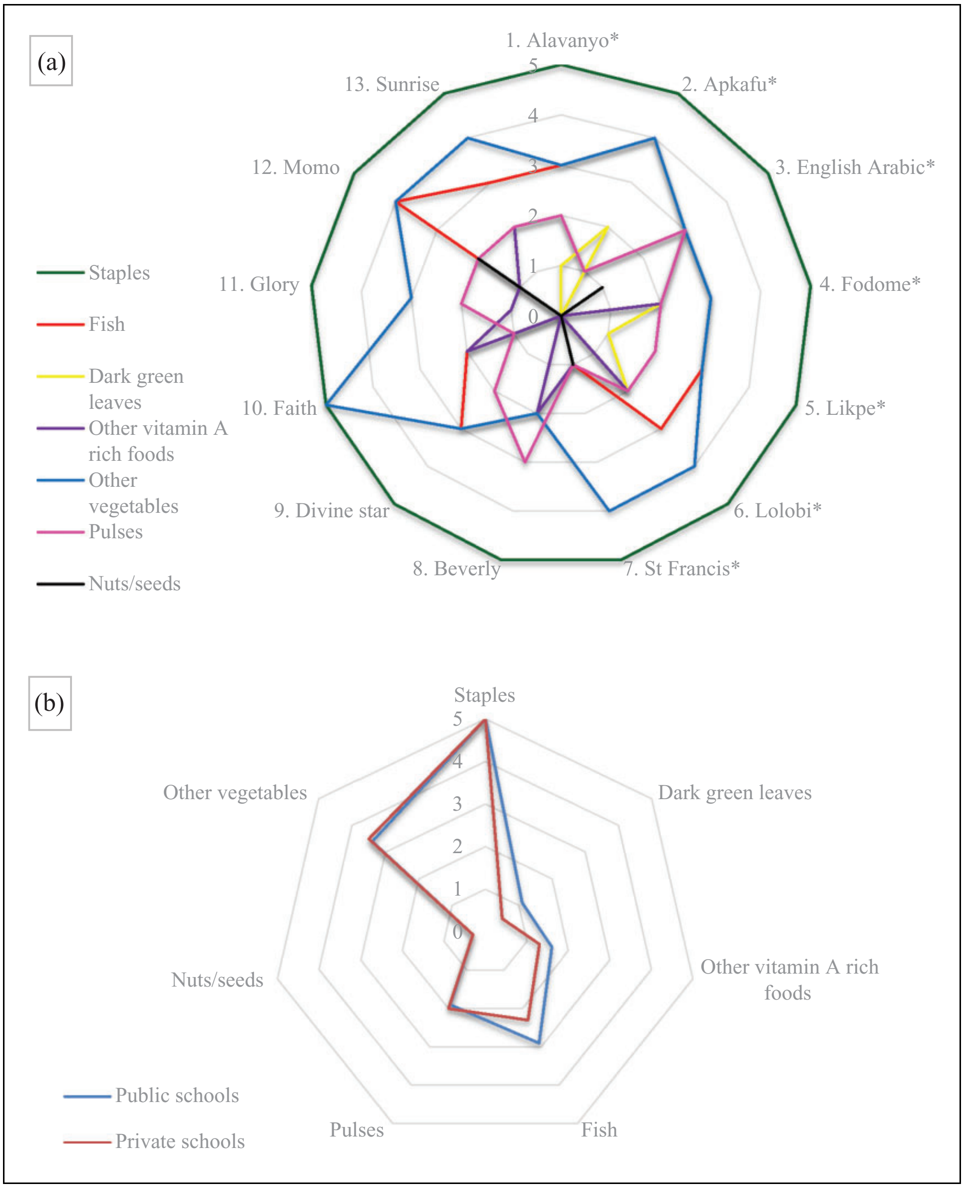

Figure 2. Weekly dietary diversity derived from the seven food groups served in the 13 study schools (a) and a comparison of the dietary diversity in the type of schools (b) Public schools *represent public schools

indicators when compared with their counterparts in the public schools. Hence, no significant differences were found in their overall nutritional status (Table 3). Overall, prevalence of malnutrition was low in the study population. In the exception of stunting and acute malnutrition, derived from the MAZ score, all the other nutritional status indicators (underweight, thinness and overweight/obesity) were slightly higher among the private school children. But the rates were only about one to two percentage points different.

Discussion

In this study, nutrient values of on-site school lunch were compared with one-third of the FAO RNI requirements. In many parts of the world, school meals and school feeding programmes are effective ways to enhance school enrolment and retention, alleviate short-term hunger and improve nutritional status. It is also a channel to enhance physical, cognitive and psychosocial health, and address hygiene issues, especially among disadvantaged elementary school children (Jomaa et al., 2011). To achieve the nutrition and health-related objectives, meals provided in the GSFP are expected to be nutritionally adequate and contribute at least one-third of the recommended daily intake for school age children (Fisher, 2007). Some private schools in Ghana also provide on-site lunch exclusive of the GSFP, but the cost is usually higher than the amount contributed by the government per child in the GSFP. Ideally, meals provided in the private schools are expected to be more diversified and nutritious than in the state-financed programme.

Table 3. Anthropometric indices and nutritional status of participants.

Anthropometry/ nutritional status[a]	Public school Mean ± SD or % (*n*/*N*)	Private school Mean ± SD or % (*n*/*N*)	*p*-value[b,c]
Weight, kg[b]	24.96 ± 8.26	25.85 ± 7.93	0.346
Height, cm	125.40 ± 15.26	127.43 ± 14.16	0.232
BMI, kg/m^2	15.44 ± 1.95	15.52 ± 1.90	0.723
MUAC, cm	17.30 ± 2.50	17.56 ± 2.33	0.354
Weight-for-age *Z* score	–0.59 ± 0.83	–0.43 ± 0.90	0.162
Height-for-age *Z* score	–0.64 ± 1.01	–0.44 ± 1.16	0.112
BMI-for-age *Z* score	–0.53 ± 0.79	–0.47 ± 0.84	0.545
MUAC-for-age *Z* score	–0.81 ± 0.73	–0.70 ± 0.76	0.552
Stunting[c]	8.9 (10/113)	7.9 (17/216)	0.095
Underweight	3.6 (3/83)	5.7 (9/157)	0.304
Thinness	1.8 (2/113)	3.7 (8/216)	0.332
Acute malnutrition	6.1 (2/33)	6.7 (2/30)	1.000
Overweight/obesity	3.5 (4/113)	4.2 (9/216)	0.782

[a] Based on World Health Organization guidelines, height-for-age *Z* score (HAZ) and BMI-for-age *Z* score (BAZ) were computed for all study participants; weight-for-age *Z* score (WAZ) for participants aged 3–10 years; and MUAC-for-age *Z* score (MAZ) for participants <5 years. The indices were used to determine stunting (HAZ <–2 SD), underweight (WAZ <–2 SD), thinness (BAZ <–2 SD), acute malnutrition (MAZ <–2 SD) and overweight/obesity (BAZ <1 SD).
[b] Differences in continuous variables were obtained by *t*-test.
[c] Differences in categorical variables were obtained by Chi-square test.
BMI: body mass index; MUAC: mid-upper arm circumference.

However, overall, not much variation was observed in the nutrient composition of the meals provided in the private and public schools. On a daily basis, the meals were heavily reliant on staple foods and fats/oils. Fish, pulses, nuts/seeds, some dark green leafy vegetables and other vitamin A rich foods were consumed about twice or fewer times in a typical week. As found in similar studies in Ghana, foods grown in our study area, particularly green leafy vegetables and fruits, were less frequently consumed (Danquah et al., 2012; Owusu et al., 2017). Fat/oils were used for almost every meal. This energy-dense dietary pattern was reflected in the nutrient value of the meals as fat requirement was over two-fold met. Meals served in private schools in Ghana have been found to have high energy and fat contents (Owusu et al., 2017).

Parish and Gelli (2015) found that meals served in the GSFP contained 654 kcal energy, 13 g protein, 24 g fat, 4 mg iron and 19 µgRE vitamin A. Comparing their findings with our study, we noticed that fat and iron values were nearly equivalent, energy and protein values in our study were 200 kcal and 6 g less respectively, while vitamins A and C values were much higher. Palm oil, made from the tropical palm fruit, is a rich source of vitamin A (Rao, 2000). Its frequent use in combination with dark green leafy vegetables, known to be rich in carotenoids (Yang et al., 1996), might contribute to the high vitamin A content of the school meals. Tomato, which has high vitamin C and lycopene, was a major constituent of most of the meals. Nutritional inadequacy of school meals is a challenge not only in resource-limited settings but also in middle- and high-income settings. For instance, Flores et al. (2009) estimated the energy and nutrient intake of Mexican school aged children and observed that daily requirements for calcium (763 mg, 75%), folic acid (167.6 µg, 82%) and energy (1501 kcal, 88%) were the least met while iron (9.1 mg, 186%), protein (42.5 g, 202%) and vitamin C (62.1 mg, 214%) requirements exceeded the thresholds. Also, Nelson et al. (2007) found in England that school meals served to young people aged 4–18 years were inadequate in zinc, calcium, iron and vitamin A.

Dairy products, eggs and meat were totally missing from the menus while very little fish was used. The meals were often eaten with tomato stew. Soup and stew accompaniments prepared with okra and dark green leafy vegetables, which are rich sources of calcium, were less frequently consumed. Hence, as in this present study where only 25% of calcium and B vitamin requirements were met, similar studies in Ghana have found that school meals hardly met micronutrient requirements, particularly for calcium and riboflavin (Danquah et al., 2012; Owusu et al., 2017). The sub-optimal dietary quality of the meals explains the micronutrient inadequacy. Conversely, Abizari et al. (2014) found that meal provided through the GSFP was micronutrient adequate. This was attributed to the addition of multiple-micronutrient-fortified corn–soya blend. But their study was conducted in northern Ghana where legumes and pulses are cultivated on a large scale. None of our study schools added fortified foods to the meals.

The menu in our study is similar to that reported by Parish and Gelli (2015), who found that the most frequently served meals were beans and gari (17.6%), rice and beans (7.6%) and rice with tomato fish stew (7.6%). Interestingly, none of the schools served meat, poultry eggs, milk or fruits whereas fat contributed over 30% of caloric intake (FAO, 2001). Amid the epidemiological transition associated with increasing rates of childhood obesity, the high fat content of the meals, especially those served in the private schools, gives cause for concern.

Previous studies that have evaluated impact of GSFP in reducing short-term hunger and improving nutritional status have shown inconclusive, positive and no effect. Plausible explanations for these inconclusive findings include variations in study design, whether the school meals were served for breakfast and/or lunch, number of meals served per school day, nutritional and health status of beneficiaries prior to programme implementation, and effect of additional interventions such as fortification, supplementation and deworming (Jomaa et al., 2011). However, effect of the child's socio-demographic status, and access to water, sanitation and hygiene facilities cannot be ruled out. Meanwhile, malnourishment among school age children is largely driven by low socioeconomic status (Agbozo et al., 2016).

A previous study which examined malnutrition among public and private schools found that significantly more children enrolled in private schools in the Hohoe Municipality were obese (9.3%) compared with public school children (2.9%) whereas underweight, stunting and thinness were significantly higher in the public schools (Agbozo et al., 2016). However, in this present study, malnutrition was generally low with no significant statistical differences in the rates of stunting, underweight, thinness, acute malnutrition and obesity between the public and private school children. This finding is expected as the dietary diversity and nutrient composition of meals served in both categories of school were largely similar. Unlike in private schools, where almost all children receive school meals, only few public school children benefit from the GSFP. Hence, it is possible that similarities in nutritional status observed in this present study indicate subtle positive effect of the school meals provided.

Even between school fed and non-school fed children, no significant differences have been found in the prevalence of malnutrition (Abizari et al., 2014; Agbozo et al., 2017). Our findings are in line with those of Danquah et al. (2012), who observed 15% stunting, 12% underweight, 4% thinness and 4% obesity among school children who benefitted from the GSFP in the Ashanti region of Ghana. Generally, our findings reflect the nutritional status of children under five years old in the study setting as the 2014 Ghana Demographic and Health Survey also reported low proportions of stunting (19%), underweight (11%) and wasting (5%) in the Volta region compared with other regions of Ghana (Ghana Statistical Service, 2015). This is contrary to the 35% thinness and 48% stunting found in a study where the GSFP was assessed in the Greater Accra Region, Ghana (Owusu et al., 2017). Selection of participants from a semi-urban setting, their lower ages and the inclusion of anaemia as a nutritional status indicator could account for their high malnutrition prevalence.

Our study is not without limitations. Ideally, to assess the nutrient adequacy of the school meals, national nutrient intake guidelines for Ghana should have been used. Unfortunately, none is available. Even though the age range of this present study's participants was 3–12 years, FAO RNI for children aged 7–10 years was used in line with the mean age (eight years) of our participants. The portion sizes served to all the school children were similar despite the age and sex differences. However, this was not within the control of the investigators. This study does not account for food gone into waste. It was presumed that each plate of food served was completely consumed. Despite these limitations, few studies have assessed the nutrient content of meals served in private schools that implement their own feeding programmes. A key strength of this study is the distinct qualitative and quantitative food consumption data.

Conclusion

Although no significant difference was observed in the nutrient content of the on-site lunch, those provided in the public schools were generally more nutritious. The meals were heavily reliant on traditional energy-dense staple foods and fat/oils and poorly diversified in fish, dark green leafy vegetables and nuts/seeds. Eggs, meat, poultry, dairy and fruits were completely lacking. The lunch did not meet the requirements for protein and most micronutrients, especially the B vitamins, calcium and zinc. Although the nutritional status of beneficiary children was quite similar, malnutrition was generally low.

To achieve a substantial nutrition-related impact of the GSFP, meals served should be diversified, nutrient dense and, if possible, fruits should be incorporated. Tailored and periodic review of menu plans in both public and private schools is crucial. This will ensure that nutritional values of the on-site lunch meet the recommended nutrient intakes, thereby contributing to health promotion.

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Supplemental Material

Supplemental material for this article is available online.

Ethical approval

The study protocol was reviewed and approved by the Ghana Health Service Ethics Review Committee (ethical approval ID GHS-ERC: 15-04-15). Participant information sheet was sent to the parents/guardians through the participants and the parents/guardians provided written consent by signing/thumb-printing the informed consent. Where no feedback was received, it was followed with a telephone call and if willing, verbal consent was obtained. The children provided assent to participate.

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