ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 15 No. 4
September 2015
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

TRADE-OFFS IN COSTS, DIET QUALITY AND REGIONAL DIVERSITY: AN ANALYSIS OF THE NUTRITIONAL VALUE OF SCHOOL MEALS IN GHANA

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Volume 15 No. 4 September 2015
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ABSTRACT

There is a paucity of studies in the literature regarding the nutrient content and costs of school meals provided across West Africa. Where studies exist, comparative analysis is constrained by inconsistencies in measurements of portion sizes, meal composition and costs. This study reviews the available literature on the nutritional value of school meals in West Africa and reinterprets the meal contributions to the recommended daily intake for the 9-10 year old age group. The nutritional content of school meals from the Ghana School Feeding Programme is then analyzed through a linear modelling analysis of menus obtained from 34 districts in the country. Meal composition and associated nutritional content were constrained by the Government per child budget allocation of GHS 0.40 (USD $0.26) per meal. Prices were compiled from two of Ghana's major markets including Tamale in the north and Accra in the south. Descriptive statistics were used to analyze regional and seasonal variations with respect to energy, protein, fat, vitamin A and iron content. Adequacy was set at 30 % of daily requirements for the relevant age group. The combined mean nutritional values of meals, using the mean yearly price of ingredients in each market, were as follows: energy – 654 kcal, protein - 13g, fat – 24g, iron – 4mg and vitamin A – 19mcg. The corresponding mean weight of the raw ingredients used to prepare a meal was 208g. The findings suggest that the majority of meals provided adequate amounts of protein and additionally in the North, most meals also had sufficient calories. However, meals were found to contain insufficient amounts of vitamin A and iron. Seasonal variations in the nutritional value of meals were not identified. This analysis shows that the current per child per day budget allocation is likely sufficient to meet some, but not all, of the nutritional adequacy targets for the programme. In the short term, there are opportunities to optimize the nutritional content of school meals in Ghana, including the use of fortification, although in the medium term, fostering healthy eating habits and consuming diets composed of nutrient rich varieties will see more enduring results. Strengthening both the meal planning and the monitoring of the school meal service provision could enhance programme implementation.

Key words: School meals, health, nutrition, meal quality, nutrient content, costs, evaluation.

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BACKGROUND

Recent data from a global survey indicated that every country where data was available is looking to provide meals to school children at some scale [1]. These programmes can be considered as a form of conditional transfer where regular attendance is rewarded with the provision of a meal, snack or a ration that may be further distributed amongst the household members[2]. Ideally, this should encourage parents to preferentially select school over manual work or looking after siblings as the regular daily activity for their children, with the opportunity cost of sending one's children to school being offset by the provision of the meal[3]. This incentive should increase the time spent at school and can be measured through increased enrolment rates, attendance and a lower drop-out and initial age of enrolment, while improved attainment and cognition may be measured with test scores and fewer repeated grades[4].

With regard to attainment, the reduction in short term hunger at school should also complement the beneficial effects of more time spent at school[5]. The direct improvement in health and resistance to infection resulting from a decrease in malnutrition may also decrease absences due to ill-health[6]. Of particular concern in West Africa is the prevalence of childhood anaemia, which can cause both health and attainment related issues[7]. Addressing the prevalence of childhood anaemia has been shown to improve cognition levels and is an example of the benefits of implementing iron supplementation programs[8]. In the longer term, the reduction in malnutrition is thought to positively impact the nation's health and productivity [9].

Though the impact of school feeding programmes in low-income settings is generally heterogeneous and context specific, a number of evaluations have demonstrated the benefits in terms of education, health and nutrition of school children and their siblings (Alderman & Bundy [2], Bundy *et al.* [4] and Kristjansson *et al.* [10] for recent reviews of the evidence). There is little evidence, however, on the interaction between the quality of school food service and benefits to school children. In particular, few studies in the literature examine the nutritional value of the meals in low-income settings, how the nutrition content of the meals compares to daily nutritional requirements, and how the associated costs and cost-efficiency vary across different food combinations.

The Ghana School Feeding Programme (GSFP) began in 2005 as a joint initiative between the Governments of Ghana and the Netherlands. Currently, the programme reaches approximately 1.6 million children across the country [11]. Programme implementation is currently entirely funded by the Government of Ghana, with the annual budget in 2011 being GHS 67.1 million or USD $43 million[12]. The funding is allocated on a per-child daily basis provided to private sector caterers tasked with the school meal service delivery. To date, the Government has not set standards for the nutritional content of the meals. Despite the considerable investments from the government and other donors, there are currently no studies focusing on the nutritional value of the meals that are provided by the programme.

This paper examines the nutritional value of the school lunch programme in Ghana using a linear model, combining data from school menus, food composition tables and prices.

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The primary objective of the study was to assess to what extent school lunch menus are providing the expected 30% Recommended Daily Intake (RDI) for primary school children, who are typically aged between 6-12 years . The secondary objective was to identify seasonal and regional variations in the nutritional value of meals across the country throughout the school year.

This paper is structured as follows: firstly, there is a review of the recent literature on the nutritional value of school meals in West Africa. It then describes the methods used in the modelling analysis, presents and discusses the research findings, and then concludes.

Literature review

Initially, search terms including "school feeding", "school meals", "school lunch", "nutritional value", "nutritional content" and "contribution to" were used in the Ovid MEDLINE database and narrowed to studies in Western Africa; however, this returned no suitable studies. Additionally, a search was made of the grey literature, Google Scholar and through discussions with experts. The references in relevant studies were also scrutinised. Papers were only included, which provided descriptive statistics on the nutritional value of meals provided in schools in countries in the region. Eventually, 6 papers were identified of which 5 were from Nigeria, while the other was from Ghana. Central to the interpretation of these studies is the contribution of the meals towards the Recommended Daily Intake (RDI) of this age group. Ideally, school meals provide 30-45 % of daily nutrient intake[4]. Most of the studies grouped a relatively broad age range of children into a single population sample and a few provided an analysis of the RDI for smaller age intervals. Additionally, there is heterogeneity between studies in the sources for the RDI data. The study participants fell within the 3-16 years age bracket, and all the studies included the 9-10 year age group. Therefore, while macro and micronutrient values have been transcribed exactly as found in the original source, the contributions towards the RDI have been reinterpreted using values for the 9-10 year age group. Selection of this age group has the additional benefit of being close to the median age group for children in primary school and arguably provides the most relevant reference values when evaluating meals for the range of age groups present in primary school. The sources for the RDI values for calorific energy[13], protein[14], fat[15], iron[16] and Vitamin A[16] have been taken from the most reputable sources available including the Food and Agriculture Organization of the United Nations (FAO) and the WHO (Table 1).

The macro and micronutrients covered in this review are those that are most relevant to school- aged children[17] including energy, protein, fat, iron and Vitamin A. Ideally, the analysis would have included the iodine content of meals as per the guidance on school feeding programmes[4]; however, the West African Food Composition table[18] (WA FCT) used in the analysis omitted data for this key nutrient.

In a study conducted in Nigeria, all the primary schools in 3 districts of Osun State were visited and the head cook answered a structured questionnaire regarding the recipes, ingredients, quantities and cooking instructions of popular meals provided at each school [19]. Standardized menus, derived from the means of the questionnaire data, were produced and analysed. The organoleptic properties of meals were assessed to examine whether the meals would be palatable for children. The study identified common ingredients to include cowpea, palm oil, onion, salt and pepper. Typically the meals would consist of a mixture of a legume (cowpea, for example), a cereal (rice, for example) or a tuber (yam, for example), usually with fish in a stew or soup and sometimes with egg. Fruits were not included in the meal plan despite their consumption being a fairly commonplace recommendation with recognised health benefits[20]. All 5 standardised meals for the week contained beans. However, the protein content for each cooked meal ranged from 8.06g/100g in rice and beans with vegetable soup and fish to 20.45g/100g for "beans, maize and stew with egg". The addition of egg on this day resulted in a significantly higher protein content than other days ($p<0.05$). For the Thursday meal, cocoa powder was also included resulting in significantly more carbohydrate, zinc, iron and calcium than the other meals; 68.63g/100g, 4.02mg/100g, 10.66g/100g, 216.01mg/100g, respectively ($p<0.05$). The study highlighted that meals with beans tended to be higher in protein and carbohydrate. With respect to energy, the meal that provided the greatest number of calories was beans and yam (porridge) with fish stew 804.94kcal (42.01% RDI) while the one that provided the least calories was rice and beans with melon soup and fish 379.69 kcal (19.83 RDI). All of the meals provided sufficient iron and protein at least 6.05g (33.99% RDI) and 16.93g (64.99% RDI), respectively.

In a cross-sectional survey[21], 5 primary schools were purposively selected from the 22 schools in Abuja, Nigeria. Twenty five pupils and 6 teachers were randomly chosen from each school. Additionally, 5 of the pupils from each school were randomly selected to participate in a 3-day weighted food intake study. Pupils replied to a structured questionnaire regarding meals served, portion size and acceptability of meals, while the teachers focused on their perception of pupils' reaction to meals, portion size, taste and academic performance of pupils and enrolment rates. Results were presented as the amount actually consumed by pupils after accounting for the waste left on the plate. The most frequently served meals were Indomie noodles, jollof rice, beans pottage, Tuwo (a stiff plain rice pudding) and soup, yam pottage, yam and beans pottage and moi-moi (spiced beans pudding). Pupils rated Indomie noodles as their favourite dish (78.4%) followed by jollof rice (12.8%). The most common reasons for not liking or completing the meals were: not being hungry (35.4%), not tasty (22.4%) and too cold (19.2%). The questionnaire completed by the teachers revealed that 63.4% of pupils liked the meal and that no pupil rejected the meal provided. With regard to improvements to meals preffered by the pupils, 56% suggested that the taste of meals should be improved, followed by number (17.6%) and quantity (16.8%). By contrast, 76% of teachers thought the meal was attractive, 47% thought it was tasty and 66.7% thought the serving size was adequate. The results of the 3-day food intake study revealed that the pupils' mean nutrient intakes from school meal servings were: energy 268 kcal (13.99% RDI), protein 8.13g (31.21% RDI), iron 2.18mg (12.25%RDI) and Vitamin A 92.07 RE (18.41% RDI). The findings suggest that protein was the only outcome measure of interest that met the intended 30% value. The study did not provide a mean meal weight. The amount of waste left on the plate was not discussed and may have contributed to the nutritional intake being reduced. The authors commented that the lack of meat in any of the dishes may have caused the low protein intake.

In a cross-sectional study of 728 children from rural communities in the Akure North Local Government area of Ondo State, school meals were provided on a self-sponsored basis whereby children contributed to the weekly cost of meals [22]. Children were randomly selected from 5 of the 11 primary schools in the area and ranged in ages from 6 to 15, with the majority aged between 9-14 years. The study provided results for nutrient values per 100g dried weight on 4 separate days. Calorific energy values ranged between 379-413kcal, carbohydrate 56.5-69.4g, fat 4.6-12.7g, protein 14.9-22.3g, iron 1.3-1.9mg and 831-9510µg of Vitamin A. Per meal the values were energy 3.6MJ (860 kcal) (44.91% RDI), protein 42.2g (162.00% RDI), Iron 3.5mg (19.66% RDI), Vitamin A 7702 µg (1540.40% RDI). While the study mentioned popular ingredients in the region, it did not elaborate on what meals were typically composed of, or which ingredients were used and their quantities. Portion sizes were approximately 215g of dried ingredients.

In a study [23] of 160 pupils, aged 3-15 years old, in a public primary school in Ile-Ife, Osun State, Nigeria, meals were analysed for their nutritional content. The weekly meal plan consisted of rice and fish, porridge (yam, cowpea and palm oil), rice and cowpea, cowpea and egg and rice and fish. The weight of each meal served ranged from 38±3g to 62±4g, the calorific energy value ranged from 604-889kJ (114-212 kcal), protein 5.0-17g, fat 5.3-15g, carbohydrate 2.7-20g and iron 1.66-3.4mg. The mean values per meal were energy 772±129KJ (9.63% RDI), protein 9±5.0g (34.55% RDI), fat 8.6±4g (13.46% RDI), iron 2.7±0.7mg (15.17% RDI. The costs per meal were reported at 30 naira or $0.20 USD. Fruit and vegetables were not found in this sample of menus.

The small meal weights in the study above are in stark contrast to the considerably larger portion sizes presented in a study[24] on the GSFP from 4 districts in the Central region of Ghana. School meals were analysed each day for a week at participating schools where 123 pupils, aged 7-16 years old, consumed a meal. Here, the mean weight of the meal was 450.7±133.6g with 75.6% of pupils consuming the whole portion. The mean energy intake was 799.5±301.3kcal (41.70% RDI), protein 24.5±17.9g (94.05% RDI), vitamin A 788.8±805.0µg (157.76% RDI), iron 6.1±5.8 (34.27% RDI). The meals considered consisted of a staple dish of rice, beans, gari, yam, banku and plantain. Side dishes were either stews consisting of oil, onion and tomatoes or fish dishes. Animal source foods were never included in dishes.

The final study in the literature review compared school meals from an urban setting, Ibadan, with a rural setting Akingbile, a village 10km from Ibadan, in Nigeria[25]. One hundred and fifty pupils aged 10-12 years were sampled from each school and the school meals were cooked using ingredients bought for 20 Kobo, which was the recommended minimum to be spent on each child at the time of the study. In the urban school, the nutritional value of each meal was: Energy 290.4±6.3 kcal (15.14% RDI), crude protein 5.8±0.7g (22.26% RDI), fat 5.6±0.6g (8.56% RDI) and iron 4.5±0.6mg (25.28%RDI). While in the rural school the values were: Energy 334.2±9.1 kcal (17.34% RDI), crude protein 5.8±0.5g (22.26% RDI), fat 6.1±1.1g (9.55% RDI) and iron 5.1±0.3mg (28.65% RDI). The protein consumption of children from the urban school was slightly higher and the study authors attributed that to “better consumption of animal protein foods”.

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Volume 15 No. 4 September 2015
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

In summary, the literature review highlights that there are relatively few studies on the nutritional values of school meals in West Africa. Within existing studies, little mention is made of portion sizes. Portion size is crucial for comparisons between different studies. Studies were relatively small, geographically isolated and varied in how the schemes were funded. As such, individually, they may not be representative of programmes as a whole. Additionally, none of the studies published recipes or ingredient lists for the meals that were analysed, which makes further processing of the data limited. There was considerable heterogeneity in terms of the target age-groups and the nutritional values of meals. No standards were reported for adequacy of nutrient intake.

METHODOLOGY

Data on menus were requested from the GSFP. Of the 216 districts in Ghana, 38 districts provided unique menus of which four districts were excluded: One due to the menu not being interpretable and three due to the inability to model the meals appropriately with the limited data for prices and recipe composition. The remaining 34 menus, comprising 170 meals, were used in the model (Figure 1). The Central region of Ghana has a disproportionately large representation with menus from 17 districts, while there were no menus from districts in the Upper West, Upper East and Greater Accra regions.

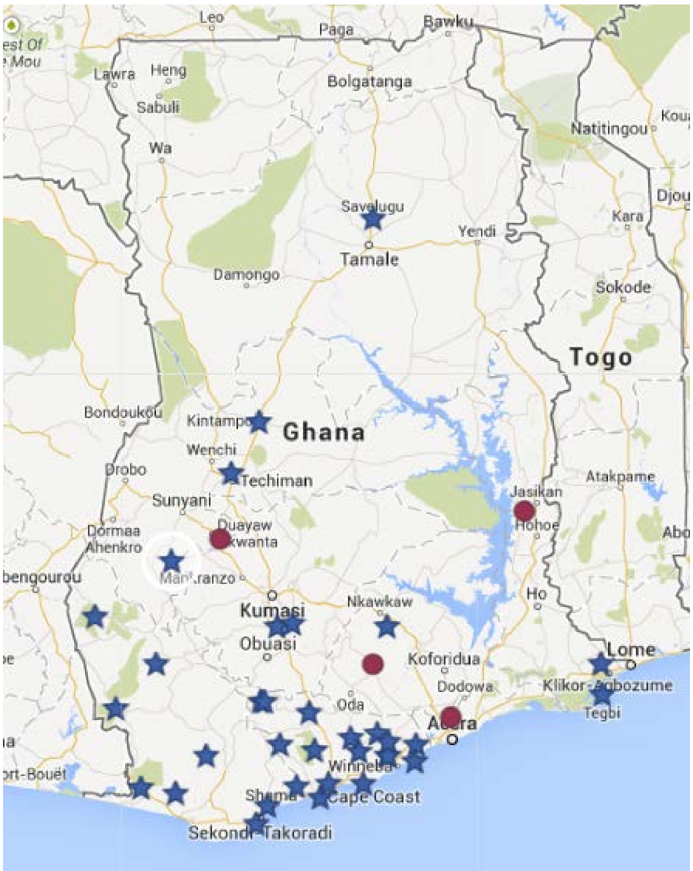

Figure 1: Map of Ghana showing location of menus obtained. (Blue stars denote included menus, red circles denote excluded menus)

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The menu data included a timetable of daily meals provided to the students, Monday through to Friday, for a period of one or two weeks. For consistency, only the first week of each timetable was considered here although there were no differences between the first and second week. Some menus came with supplementary information, for example a desire to provide fruit at least once a week and so on. These were not included in the model as they were reported inconsistently. In addition, data on menus were made available from a recent pilot study conducted in five schools in the Northern and Greater Accra regions where the objective was to measure the quantity of raw ingredients used in the preparation of school meals for the GSFP [26].

Modelling assumptions from School menu forms

Meals in Ghana are typically made of a staple such as rice, and a side dish like groundnut stew[27]. The description of meals from the menus that were received was fairly basic and as such a framework for modelling meals was devised (Figure 3) to represent the large set of meals as accurately as possible. It is representative of the vast majority of meals although at times discretion has been used to remove certain items such as fried plantain or Agushi (melon) seeds, if a singular item could not be modelled due to unavailability of accurate price or nutritional value information of the ingredient. Some leeway was allowed to maximise the number of menus retained within the sample. These items were replaced with a similar food that was appropriate for Ghana. Other examples of approximations include generalising meal entries like fried fish to fish stew, again for similar reasons namely the paucity of data on the portion size of fried fish portion size and its nutritional content once fried. Staples that were made from the same base ingredient were also labelled and considered the same; for example, Tuo Zaafi and Kenkey were considered one and the same for modelling purposes as they are both made from maize. This framework allowed the 45 unique meal combinations of staples and side dishes from the menu data to be coded. Due to a lack of peer reviewed published data on meal composition, recipes themselves were compiled from a variety of sources including Ghanaian recipe websites that had collated recipes from other recipe books[28, 29], recipes from a recipe book issued by the Peace Corps[30] and some input from a nutritionist in Ghana.

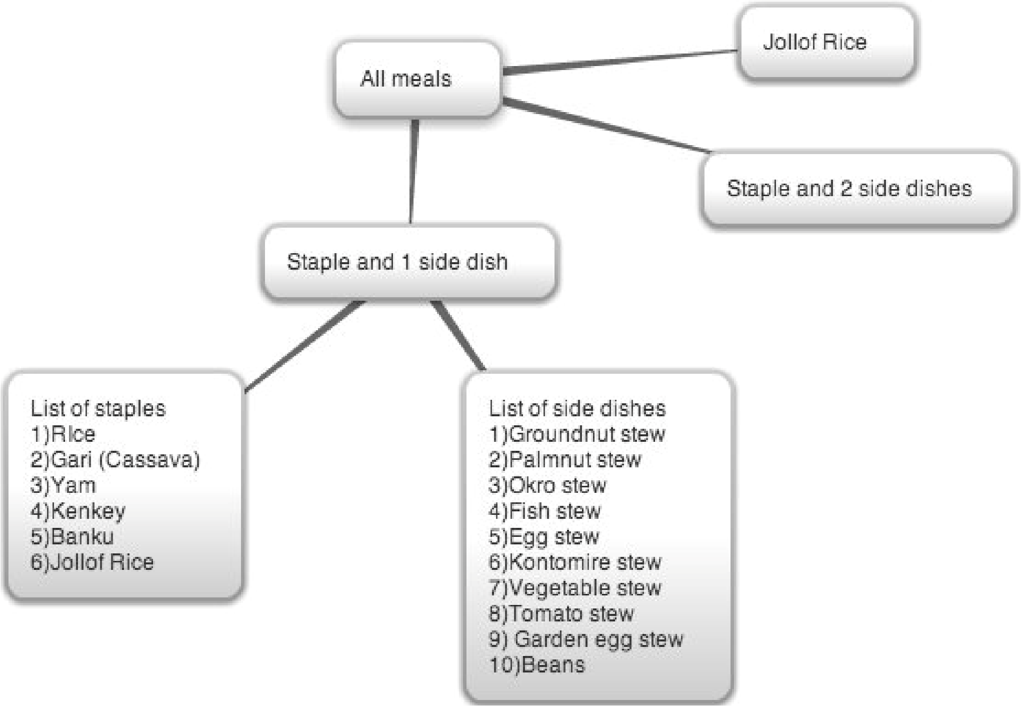

Figure 2: Framework for school meal composition in Ghana

Data from the pilot study was used to estimate the ratio of staple to side dishes (Table 2) and also to standardise the amount of oil and black pepper (0.3%) used in side dishes. Ghanaian side dishes tend to have a palm oil base and from the field study the mean amount of oil, as a percentage of the weight of raw ingredients, was 26.5% for stews and 12.1% for bean side dishes. None of the meals from the 5 schools in the field study served yam, banku or kenkey and so the portion ratio for these three dishes is the mean for rice and gari meals, for which there was data.

Modelling the costs per meal

In this model, the main constraint on the maximum potential nutritional value that it is possible to deliver via the GSFP is the cost of the meal. In a recent costing exercise [12], the estimated financing provided via contracts to caterers was GHS 0.40 (0.26 USD) per child. There is a tax of 5% applied to the price paid to caterers, which leaves at most GHS 0.38 to spend on meals. Other expenditures for caterers would leave 93% of this value, GHS 0.3534, available to spend on ingredients.

In the first instance, prices were taken from the Ministry of Food and Agriculture (MOFA) of Ghana [31]. While prices were quoted for a small selection of locations in Ghana, this paper uses retail prices from Accra, the capital city of Ghana, and Tamale, the capital city of the Northern Region sampled once a week during 2011. These prices were screened for obvious typographical errors, namely those by a factor of ten, by excluding prices that were less than 10% of the mean yearly price. This excluded 4 price points in Tamale, and is an insignificant proportion of the overall price data collected. The only prices for the ingredients used that were not available from this source in both markets were for garden eggs and okra, which were more difficult to obtain. The price

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of okra is a singular annual value from Abuja, Nigeria 2006[32] and has been adjusted to 2011 Ghanaian Cedis[a]. The prices for garden eggs were from a study on garden egg production in Ghana [33]. Using the mean yearly prices of ingredients from Accra, okra and garden eggs account for 0.7% and 3.0%, respectively, of the total weight of the ingredients used for the 170 meals within the sample. The use of these two ingredients is relatively small and unlikely to have a large impact on the main findings. The MOFA price for eggs was recorded per single egg and so a weight of 60g per egg has been used for the conversion of prices per kg. The price data for Tamale had considerably fewer data points and where an average of 2 or more prices were not available for ingredients from MOFA the yearly mean was used in the term by term analysis. The prices used in the analysis are summarised in Tables 3, 4 and 5.

When modelling the meals all the ingredients used were considered to be unfortified; for example, palm oil was refined and contained 0mcg of Vitamin A. Price data and recipes were then imputed into a linear programming application with further processing in Microsoft Excel. Staple and side dishes of 100g were created and then combined into meals using the proportions from the field study. The meal price constraint of GHS 0.3534 was used to scale the portion sizes. The linear programming application referenced the WAFCT[18] to obtain the nutritional value for each of the ingredients.

Dietary Diversity Score

The meals were analysed for the variety of ingredients used by grouping them into eight food groups as specified by the Individual Dietary Diversity Score (IDDS) protocol[34]. The eight food groups included: (a) Grain, roots or tuber (b) Vitamin A-rich plant foods (c) Other fruits or vegetables (d) Meat, poultry, fish and seafood (e) Eggs (f) Pulses, legumes and nuts (g) Milk and dairy products (h) Fats and oils. Plant foods were considered high in Vitamin A if they contained more than 130mcg/ 100g of food.

The analysis presented here is descriptive and was conducted in R version 3.0.1 for Mac OS X. Having reviewed an earlier study, it was hypothesized that this modelling exercise would show that not all of the nutritional requirements would be met by the sample of menus using GHC 0.35 as the price constraint [35].

RESULTS

The majority of students attending school in Ghana[12] reside in Ashanti, Greater Accra and Brong-Ahafo, while the vast majority of the menus samples are from the Central and Western regions (Table 6).

One hundred and seventy meals were analysed from the 34 districts with the most frequently served meals being gari and beans (17.6%), rice and beans (7.6%), rice and fish stew (7.6%) and finally rice and groundnut stew (7.1%) (Figure 3). The mean IDDS of the sample of meals was 4.22(0.54) with a range of three to six.

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[a] 80 Nigerian Niara 2006 = 0.68 USD 2011; (1USD 2011 = 1.528 GHS), 0.68 USD = 1.039GHS

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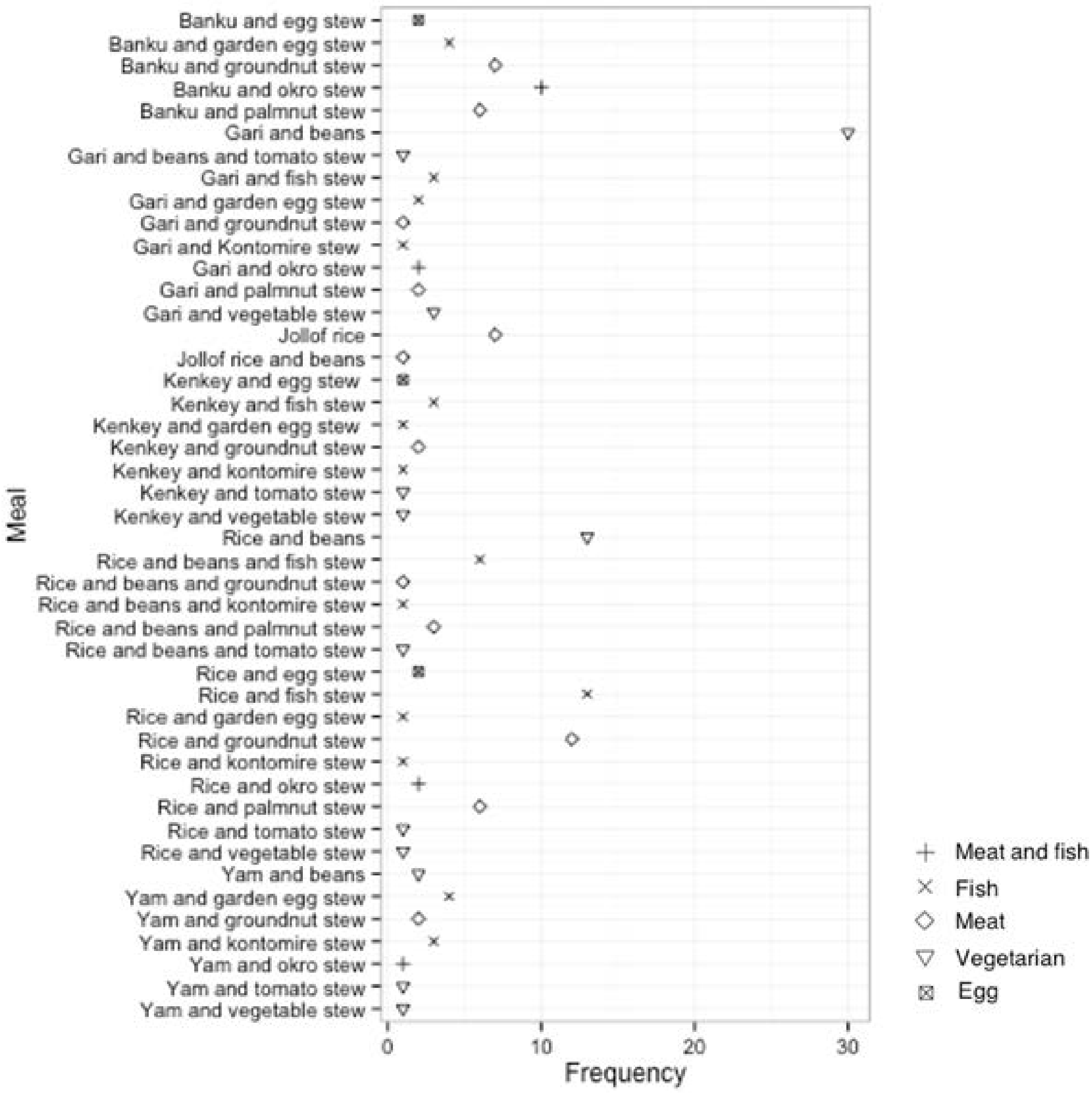

Figure 3: Frequency of meals within the sample menus

Using the mean yearly prices in Accra, the mean protein content of school meals was comfortably within the 30-45%[4] of RDI range that is expected (

Table 7). The value for fat intake (31.22%) is also within that range while the value for energy intake is slightly below the target range. The iron (18.97%) and vitamin A (3.08%) content of the meals are considerably less than the expected values.

When using mean yearly prices in Tamale, the RDI values achieved by meals are considerably greater than those using Accra prices (Table 8). This is probably due to the lower cost of certain ingredients, especially those of cereals, which may itself cause an increase in the calorific value of meals while also increasing the weight of the side dish serving, which would in turn increase the protein and fat content of the whole meal serving. The lower cost of ingredients in Tamale is also reflected in the reduced annual cost, relative to Accra prices, to provide an arbitrary amount of each nutrient daily for

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each child (Table 9). The values for Accra and Tamale have been compared to the existing benchmarks for on-site meals and fortified biscuits [4].

More than 75% of the meals that were valued using Accra prices have an adequate amount of protein and the majority of meals provided sufficient amounts of fat (Figure 4). The vast majority of meals provided insufficient amounts of iron, with half of the meals providing less than 2.41g (15.55% of the RDI). Additionally, none of the meals provided sufficient amounts of Vitamin A. Using Tamale prices yielded a similar pattern with regard to the indicators relative to each other; however, the values tended to be shifted higher than those for Accra (Figure 5). The lower prices of certain ingredients in Tamale resulted in at least 75% of meals meeting the intended amount of calorific energy, protein and fat. Despite this, the meals remained deficient in Vitamin A and iron.

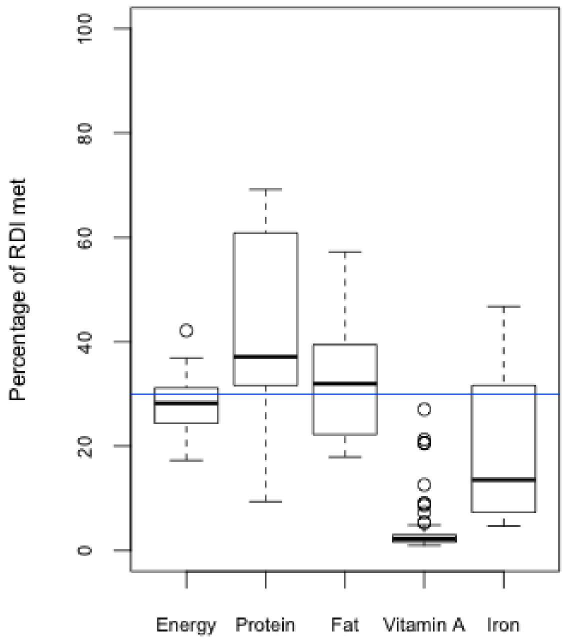

Figure 4: Box plots with nutritional value of school meals in Accra using yearly prices

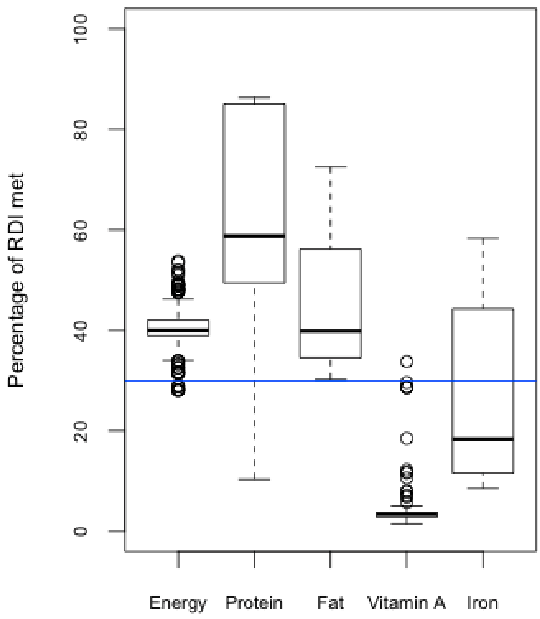

Figure 5: Box plots with nutritional value of school meals in Tamale using yearly prices

No substantive differences in the nutritional value of meals were found between the three school terms, see (Figure 6) and (Figure 7), respectively. When using the maximum prices of ingredients from Accra in each time period, the protein content of meals was higher than the minimum expectation, while meals remained deficient in Vitamin A and iron when the minimum prices were used. Using prices from Tamale resulted in a weak trend, suggesting that nutritional values are highest in Term 1 across all 5 of the indicators with values being the lowest in Term 2.

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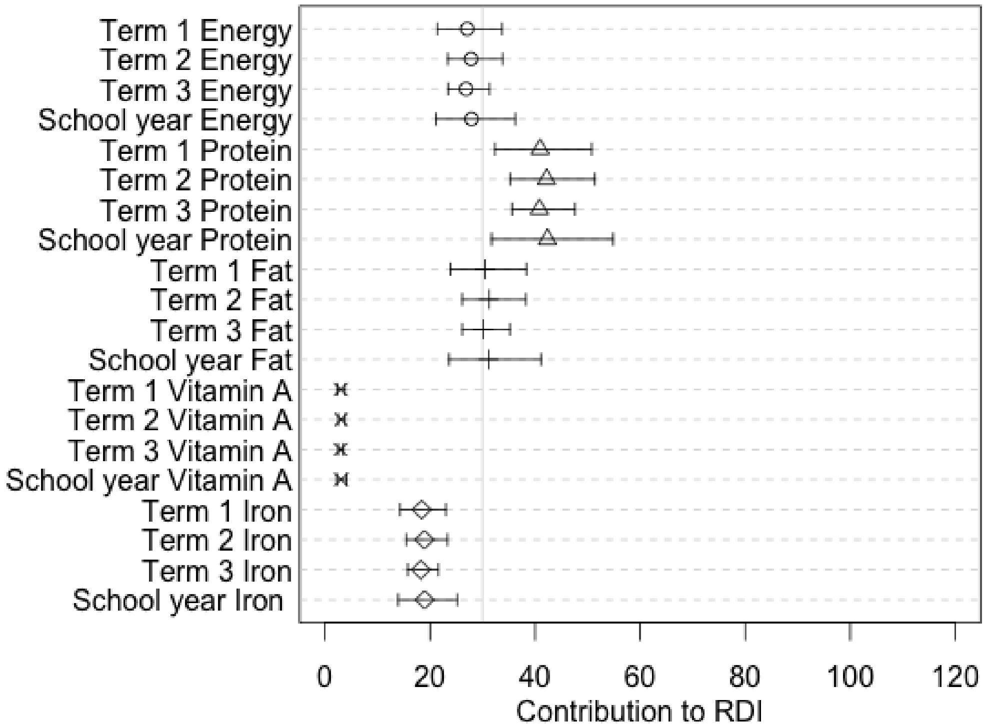

Figure 6: Nutritional value of meals in Accra using termly price data

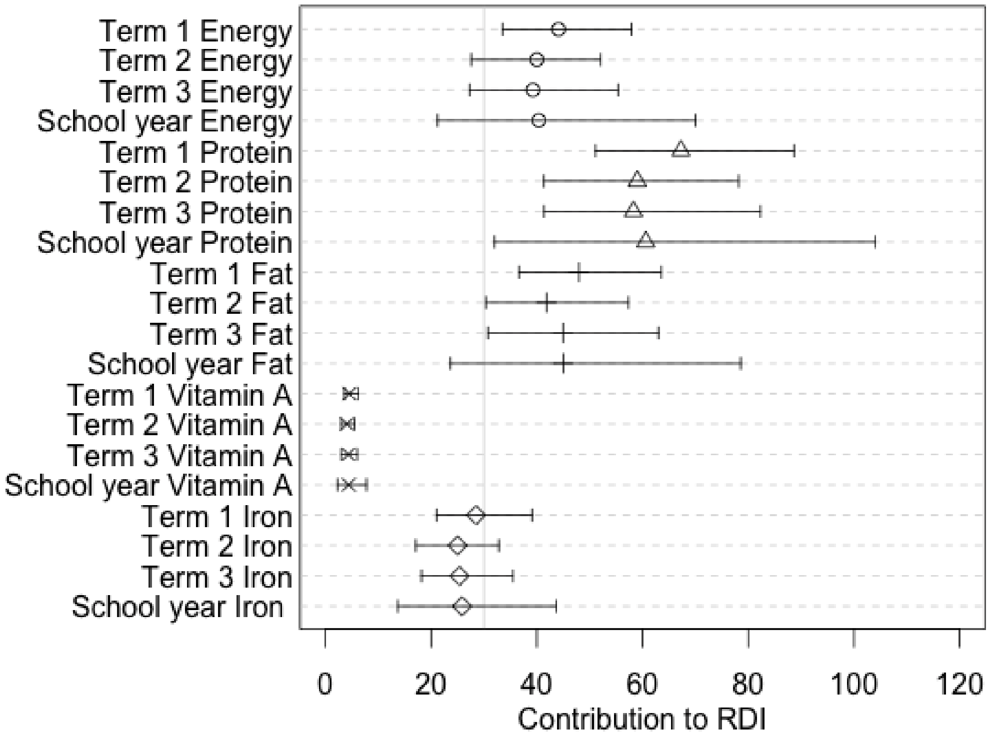

Figure 7: Nutritional value of meals in Tamale using termly price data

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DISCUSSION

Modelling the available selection of menus using the 0.40 GHS per child budget allocation from the GSFP suggested that the school meals can have adequate amounts of protein and fat to meet recommendations. The analysis identified important regional differences in the nutritional value of meals. The value for each of the five nutrient indicators was higher when using prices in Tamale compared to Accra. Additionally, the majority of meals modelled using prices in Tamale also met the calorific energy value. However, in all cases the iron content of meals could be increased while the Vitamin A content needs to be substantially increased to meet adequacy requirements.

Seasonal variations were not identified in this analysis, probably due to a combination of factors. While dividing the school year into three time periods provided inconclusive results, using shorter time intervals, assuming that there are significant seasonal differences in the price of ingredients, should provide a more accurate estimate of what meals can provide. It may also facilitate planning of different meals for each of the terms depending on seasonality and price of ingredients.

The relatively high amount of protein in school lunches may be partly due to the inclusion of several meals that have beans, fish, meat or egg in their side dishes. Foods that are naturally high in protein are an ideal way of increasing school children's protein intake, especially if the meals that are consumed at home are high in starch and low in protein[36]. As has been previously mentioned, eggs are an excellent source of protein, but the cost of a single egg using retail prices in Accra is roughly GHS 0.30, which by itself is nearly the total of the daily per capita budget for the meal. Analysis of the IDDS suggests that meals were relatively diverse compared to traditional World Food Programme (WFP) assisted programmes. However, the results for this linear modelling exercise suggest that the GSFP meals are less cost-efficient than traditional WFP programmes (Table 9).

The use of retail prices within this analysis was to provide a conservative estimate of what can be provided by caterers. More favourable procurement costs may also facilitate increasing the use of eggs and meat in more of the meals provided, thus further increasing the protein content of meals.

Substituting ingredients from the original recipe list for those with higher micronutrient content may prevent the shortfall in the Vitamin A and iron from meals. For example, improvements to the Vitamin A content of meals could be made by substituting yam (0mcg/100g) with orange flesh sweet potato (727mcg/100g) (OFSP)[18]. Making substitutions to meals also requires assessing how palatable and acceptable it would be to local populations and especially to children. Maintaining the palatability, variety and taste of meals is essential so that all the food provided is consumed and enjoyed by the children. Variety also affords some leeway in that, if a child refuses to eat a particular meal or does not complete it due to taste, other more favoured meals in the weekly plan may balance the deficit. Planning the nutritional content of meals on a weekly basis rather than daily is an alternative method to making sure that intake targets are met. Redistributing the meal budget across the week may also allow for the provision of a

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piece of fruit once a week, which as previously mentioned was suggested as desirable on some of the sample menus that were received.

An alternative strategy would be to use fortification methods to improve the nutritional value of meals. For example, fortified palm oil contains considerably more Vitamin A than the unfortified version and has been shown to reduce Vitamin A deficiency[37]. Only 11.44g of the fortified version would be needed to meet the entire daily requirement of 500mcg, which is less than the amount used in this sample of meals. The iron content of meals could be supplemented through the use of micronutrient sprinkles.

Limitations

A number of important considerations limit the validity of these findings. In many of the studies mentioned in the literature review, a variety of RDI values were used depending on both the age of the children and the choice of the source. In this analysis, the age range of 9-10 years is used as it should be close to the median age of primary school children in Ghana. If an older age group were to be considered, the percentage of RDI met that is most susceptible to change is for protein intake. The value for boys and girls aged 7-10 years old is 25.6g/day and 26.2g/day, respectively. However, that value increases considerably when the children enter adolescence with the values at ages 11-14 years old being 40.5g/day and 41.0g/day and at ages 15-18 years old being 57.9g/day and 47.4g/day for boys and girls, respectively[14]. Robust data on the price of ingredients is essential for modelling exercises of school feeding programmes and yet there were discrepancies between the sources of price data that inevitably compromise the strength of conclusions from this study. In addition, the price data used in the analysis comes from the main regional markets and will likely not reflect the prices in the many of the rural communities targeted by the programme. Ideally, the modelling framework for the portion size of main and side dishes would have come from a larger field study that evaluated a greater range of dishes. While there are undoubtedly regional differences in how the same meal is prepared, a standardised meal was required for the modelling exercise. However, published materials do not seem to make available the details of the recipes and ingredients. Meals that are actually served in schools may use a greater variety of ingredients for a more authentic Ghanaian taste but limited availability for both price data and recipes necessitated the use of simple recipes and ingredient list. Where possible, a nutritionist who was more familiar with Ghanaian food was consulted.

Opportunities for further work

Obtaining improved data by standardised monitoring of the ingredients, menus and prices is critical to the modelling process, allowing both an accurate costing of meals at current prices as well as budgeting the cost of meals in the future. This would also allow the development of menus that take advantage of produce that is in season and cheaper than alternatives. Developing nutritional standards for meals, as well as standard measures for caterers to easily provide adequate portion sizes, is an important area for further work. While this paper focuses on evaluating the collective nutritional value of meals from the sample of menus received, there is considerable scope for optimising the individual recipes that are being prepared.

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CONCLUSION

This analysis shows that paying caterers GHS 0.40 (USD $0.26) per child per day is sufficient to meet some, but not all, of the nutrient adequacy targets for the programme. Supplementing meals with fortified ingredients or substituting some ingredients for those that are more nutritionally dense may allow a well-rounded meal to be provided for that same amount. In the short term, there are opportunities to optimise the nutritional content of school meals in Ghana, including the use of fortification, although in the medium term, fostering healthy eating habits and consuming a diet composed of nutrient rich varieties will see more enduring results[38]. The lack of accurate data on the quantity and quality of the meals highlights a critical gap in the evaluation process of the GSFP. More accurate price data collection could potentially facilitate the promotion of particular recipes at certain times of the year or in certain locals to maximise both the nutritional value and portion size of meals. Conclusive evidence of seasonal or regional price differences may also allow for a varied meal budget throughout the year for different areas of the country. While the Government of Ghana directs a considerable amount of funding towards school feeding programmes, monitoring programme output and the actual benefit children receive, remains an important challenge. Ensuring that school meals are providing the intended nutritional value is critical for programme to be effective and promotes accountability to funders and the general public. Greater monitoring will also highlight areas within menu plans that are deficient and could be improved upon.

ACKNOWLEDGEMENT

We are grateful for the support from the Government of Ghana in providing the data on the menus from the national school feeding programme. We would also like to acknowledge the inputs and feedback from a number of colleagues at Imperial College, London's Partnership for Child Development including Rosanna Agble, Getrude Ananse-Baden, Lutuf Abdul-Rahman, Salha Hamdani, Kristie Watkins and Daniel Mumuni.

Aulo Gelli designed the study and supported the analysis. Alvin Parish undertook the review, developed the models for the meals and undertook the bulk of the analysis. Both authors contributed to the writing of the paper. Aulo Gelli was supported by the Partnership for Child Development and the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), led by the International Food Policy Research Institute (IFPRI). Alvin Parish was supported by the Partnership for Child Development.

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Table 1: Summary of Recommended Daily Intake values (RDI) for children aged 9-10 years old Modelling parameters obtained from the field study

	Units	Group		
Energy		**Girls 9-10**	**Boys 9-10**	**Combined**
	kcal/day	1854	1978	1916
	MJ/day	7.755	8.276	8.0155
	kJ/kg/day	254	279	266.5
	kcal/kg/day	60.8	66.6	63.7
Protein		Girls 7-10	Boys 7-10	Combined
	g/day	26.2	25.9	26.05
	g/kg/day	0.92	0.92	0.92
Fat[b]		Girls 9-10	Boys 9-10	Combined
	g/day	61.8	65.9	63.9
Iron[c]		Bioavailability %	Children 7-10	
	mg/day	15	5.9	
	mg/day	12	7.4	
	mg/day	10	8.9	
	mg/day	5	17.8	
		Girls 7-10	Boys 7-10	Combined
Vitamin A	µg/day	500	500	500

[b] RDI for fat intake for children 2-18 years is 25-35% of Energy requirement as fats. Values in table are for 30% of Energy requirement as fat expressed in g/day using conversion factor 9kcal/g[39]
[c] The RDI that will be used in this paper will be 17.8mg/d. It is thought that a mixed diet has an iron bioavailability of 14-18% while a vegetarian diet has 5-12%.[40] The lower iron bioavailability has been used to reflect the prevalence of a lack of meat in typical diets

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Table 2: Portion sizes of main and side dished by percentage of raw ingredients (* Denotes mean taken from field study data, ^ denotes extrapolation from data)

Meal	Staple	Side dish
Rice and stew	Rice (68%)*	Stew (32.%)*
Rice and beans	Rice (41%)*	Beans (59%)*
Gari and stew	Gari (34%)^	Stew (66%)^
Gari and beans	Gari (21%)*	Beans (79%)*
Yam or Kenkey or Banku and Stew	Yam or Kenkey or Banku (60%)^	Stew (40%)^
Yam or Kenkey or Banku and beans	Yam or Kenkey or Banku (26%)^	Beans (74%)^

Table 3: Price of ingredients in Accra and Tamale, sampled once a week for the time period (Jan-Jun 2011 and Sep-Dec 2011 inclusively). This time frame should span the whole of the school year in Ghana when the school-feeding programme is operational. All prices are in GHS/kg; numbers in parenthesis denote standard deviation

	Term 1 September-December				Term 2 January-March				Term 3 April-June			
Ingredient	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Maize (white flour refined)	0.83	0.12	0.7	1	0.62	0.04	0.6	0.7	0.74	0.11	0.6	0.9
Rice local (white polished)	1.99	0.06	1.9	2.1	1.93	0.08	1.8	2	1.99	0.03	1.9	2
Cassava (flour)	0.55	0.11	0.4	0.8	0.41	0.03	0.4	0.5	0.48	0.04	0.4	0.5
Yam (tuber)	0.86	0.10	0.7	1	0.78	0.06	0.7	0.9	1.05	0.11	0.9	1.2
Cocoyam (leaves)	1.27	0.11	1.1	1.5	1.13	0.07	1	1.2	1.22	0.10	1.1	1.5
Palm oil	2.88	0.13	2.7	3.2	2.82	0.13	2.5	3	2.80	0.11	2.7	3.1
Tomatoes	2.83	1.22	1.1	5.5	3.08	0.77	1.7	4.4	3.45	1.03	2	5
Black pepper	13.94	0.87	13	16	13.44	1.05	12	15	15.15	0.77	14	16
Onion	2.81	0.64	2	4.1	3.01	0.96	2	5.2	2.15	0.38	1.6	2.9
Cowpea (white dried)	1.65	0.05	1.6	1.7	1.49	0.09	1.4	1.6	1.65	0.05	1.6	1.7
Groundnut	3.09	0.29	2.7	3.6	2.08	0.11	1.9	2.2	2.48	0.21	2.2	2.8
Fish	7.29	0.80	5.7	9.3	7.37	0.67	5.9	8.4	7.53	0.43	6.8	8.3
Egg[d]	6.37	0.63	5	6.66	5.00	0.00	5	5	5.00	0.00	5	5
Beef (15-20 % fat boneless raw)	7.91	0.35	7.2	8.5	6.49	0.18	6.2	6.8	6.85	0.13	6.6	7
Garden egg/eggplant	0.77	0.35	0.37	1.23	2.15	0.55	1.45	2.8	2.38	0.44	1.83	2.89
Okra/Okro[e]	1.04	0.00	1.04	1.04	1.04	0.00	1.04	1.04	1.04	0.00	1.04	1.04

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PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 4: Price of ingredients in Accra, sampled once a week during 3 separate time periods corresponding to the three school terms in Ghana; Jan-Mar 2011, Apr-Jun 2011 and Sep-Dec 2011 inclusively, all prices in GHS/kg

	Term 1 September-December				Term 2 January-March				Term 3 April-June			
Ingredient	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Maize (white flour refined)	0.51	0.06	0.4	0.6	0.38	0.04	0.3	0.4	0.48	0.09	0.4	0.7
Rice local (white polished)	1.69	0.53	1.05	2.4	0.73	0.06	0.7	0.85	0.82	0.19	0.65	1.4
Cassava (flour)	0.67	0.34	0.55	2.0	0.61	0.10	0.4	0.7	0.71	0.17	0.4	1.2
Yam (tuber)	0.42	0.15	0.3	1.0	0.50	0.08	0.4	0.6	0.85	0.40	0.4	1.5
Cocoyam (leaves)	2.00	0.00	2.0	2.0	*1.88*	*0.00*	*1.88*	*1.88*	*1.88*	*0.00*	*1.88*	*1.88*
Palm oil	2.82	0.97	2.0	4.9	2.74	0.94	2.2	4.4	2.97	0.56	2.35	3.9
Tomatoes	1.49	0.42	0.95	2.3	1.22	0.39	0.5	2.3	2.35	0.84	1.7	3.85
Black pepper	3.81	0.63	2.2	4.25	4.11	0.62	2.8	5.0	4.12	2.08	1.8	11
Onion	1.92	0.72	1.1	3.45	2.21	0.79	1.2	4.0	1.45	0.17	1.3	1.9
Cowpea (white dried)	1.37	0.18	1.1	1.65	1.17	0.07	0.95	1.2	1.47	0.27	1.1	2
Groundnut	2.28	0.51	1.1	2.95	1.54	0.2	1.4	2.2	1.86	0.22	1.4	2.17
Fish	2.78	1.20	2.0	5.0	*2.6*	*0.00*	*2.6*	*2.6*	*2.6*	*0.00*	*2.6*	*2.6*
Egg[d]	4.79	0.66	4.17	5.83	5.00	0.00	5	5	4.87	0.64	4.17	6.66
Beef (15-20 % fat boneless raw)	2.50	0.00	2.5	2.5	4.36	0.11	4	4	4.53	0.92	2.5	5
Garden egg/eggplant	0.77	0.35	0.37	1.23	2.15	0.55	1.45	2.8	2.38	0.44	1.82	2.89
Okra/Okro[e]	1.04	0.00	1.04	1.04	1.04	0.00	1.04	1.04	1.04	0.00	1.04	1.04

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PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 5: Price of ingredients in Tamale, sampled once a week during 3 separate time periods corresponding to the three school terms in Ghana; Jan-Mar 2011, Apr-Jun 2011 and Sep-Dec 2011 inclusively, all prices in GHS/kg. Numbers in italics are imputed from the year mean due to insufficient data

Region	Number of students	National Percentage (%)	Number of menus	Percentage of all menus (%)
Ashanti	186132	26.7	2	5.9
Brong-Ahafo	105845	15.2	3	8.8
Central	42409	6.1	17	50.0
Eastern	50316	7.2	1	2.9
Greater Accra	140501	20.2	0	0.0
Northern	41065	5.9	1	2.9
Upper West	19781	2.8	0	0.0
Upper East	32301	4.6	0	0.0
Volta	29213	4.2	2	5.9
Western	49853	7.2	8	23.5
Total	697416	100	34	100

Table 6: Distribution of students benefiting from the GSFP as of December 2010 and sample menus by region

Region	Number of students	National Percentage (%)	Number of menus	Percentage of all menus (%)
Ashanti	186132	26.7	2	5.9
Brong-Ahafo	105845	15.2	3	8.8
Central	42409	6.1	17	50.0
Eastern	50316	7.2	1	2.9
Greater Accra	140501	20.2	0	0.0
Northern	41065	5.9	1	2.9
Upper West	19781	2.8	0	0.0
Upper East	32301	4.6	0	0.0
Volta	29213	4.2	2	5.9
Western	49853	7.2	8	23.5
Total	*697416*	*100*	*34*	*100*

Table 7: Summary of nutritional value of meals using mean yearly prices in Accra

	Ingredient Weight (g)	Energy (kcal)	Protein (g)	Fat (g)	Iron (mg)	Vitamin A (mcg)
Mean	170.20 (29.31)	534.48 (94.39)	11.03 (4.38)	19.95 (6.02)	3.38 (2.67)	15.42 (18.19)
Percentage of RDI met (%)	N/A	27.9	42.4	31.2	19.0	3.1
RDI value	N/A	1916	26.05	63.9	17.8	500

Table 8: Summary of nutritional value of meals using mean yearly prices in Tamale

	Ingredient Weight (g)	Energy (kcal)	Protein (g)	Fat (g)	Iron (mg)	Vitamin A (mcg)
Mean	245.43 (26.58)	773.33 (108.17)	15.79 (5.19)	28.75 (7.61)	4.60 (3.22)	21.91 (24.35)
Percentage of RDI met (%)	N/A	40.4	60.6	45.0	25.8	4.4
RDI value	N/A	1916	26.05	63.9	17.8	500

Table 9: Comparison of annual cost per nutrient delivery for Accra and Tamale, in 2011 USD and a 200 day school year, with on-site feeding and fortified biscuits

	Cost per 100 kcal delivered	Cost per g of protein delivered	Cost per 100 mcg of Vitamin A delivered	Cost per mg of iron delivered
Accra	22.9	11.1	793.1	36.2
Tamale	15.8	7.7	558.3	26.6
On-site benchmark	11	NA	19	9
Biscuit benchmark	5	NA	4	2

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