I, Caitlin J. Zivkovich, hereby submit this original work as part of the requirements for the degree of Master of Science in Nutrition.

It is entitled:
An Evaluation of a Supplemental Snack Feeding Program on Growth in School-aged Children Living in Rural Tanzania, East Africa

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This work and its defense approved by:

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An Evaluation of a Supplemental Snack Feeding Program on Growth in School-aged Children
Living in Rural Tanzania, East Africa

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Committee Chair: Debra A. Krummel, Ph.D, R.D.
Abstract

An Evaluation of a Supplemental Snack Feeding Program on Growth in School-aged Children Living in Rural Tanzania, East Africa

Objective: To assess the impact of a 130 kcal supplemental snack on growth in primary school children ages 4 ½ to 11 years old.

Design: Non-randomized, experimental design.

Setting: Roche Village, Rorya District, Tanzania, East Africa.

Participants: A cohort (N=321) and subset (n=42) of pupils age 4 ½ -11 years that attend primary school in Roche Village where a supplemental snack feeding program was implemented.

Main outcome measures: Calculation of Z-scores for underweight (weight-for-height Z-score), stunting (height-for-age Z-score), and wasting (weight-for-age Z-score).

Analysis: Children were identified as underweight, stunted and wasted if their weight-for-age, height-for-age, and weight-for-height Z-scores were <-2 SD of the National Center for Health Statistics reference standards.

Results: At baseline, the prevalence of underweight, stunting, and wasting was 2.2%, 5.3%, and 0.9%, respectively. At follow-up, no student had a Z-score of <-2 SD for underweight, stunting, or wasting. There was a significant decline in the mean height-for-age Z-scores (-.37952) and mean weight-for-age Z-scores (-.19452) from baseline to follow-up among the subset.

Conclusion: At the beginning of the study, the prevalence of underweight, stunting, and wasting was low in Roche village. In a subset of the sample, height and weight significantly declined from baseline to follow up. Continued anthropometric measurements on pupils who participate in the supplemental snack feeding program will help to track its effect on their growth.
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# Table of Contents

Abstract .................................................................................................................................................. 2

Acknowledgements ................................................................................................................................. 4

Table of Contents .................................................................................................................................. 5

Introduction ........................................................................................................................................... 6

Background ............................................................................................................................................. 11

Methods ................................................................................................................................................ 25

Table 1 .................................................................................................................................................. 32

Table 2 .................................................................................................................................................. 33

Analysis ................................................................................................................................................ 34

Results .................................................................................................................................................. 35

Table 3 .................................................................................................................................................. 36

Discussion ............................................................................................................................................ 37

Conclusion ............................................................................................................................................ 45

Appendix 1 ........................................................................................................................................... 47

Appendix 2 ........................................................................................................................................... 51

References ............................................................................................................................................ 53
INTRODUCTION

The current global burden of disease is beset with several major forms of malnutrition. A variety of conditions including obesity, protein-energy malnutrition, and micronutrient deficiencies fall under the umbrella term of “malnutrition” and affect many populations, with adverse effects on health, mortality, and productivity [1]. Malnutrition is increasingly recognized as a prevalent and important health problem in developing countries [2]. In these countries, the most common nutritional problems are protein-energy malnutrition, iron deficient anemia, iodine deficiency disorders and vitamin A deficiency [2].

Although malnutrition can affect any age group, children are especially vulnerable to its effects, as poor nutrition typically manifests in altered growth patterns. Stunting, wasting, and underweight are three main measures of child undernutrition that are recognized worldwide [3]. Stunting affects about 195 million children under the age of five in the developing world, and nearly one in four children under age five (129 million) is underweight [3]. These statistics are significant because children who are undernourished at an early age risk lifelong damage, including poor physical and cognitive development, poor health (such as repeated infectious disease), and even early death [3]. Several studies have documented that severely malnourished children run a much greater risk of dying than others, and recently, an elevated risk of mortality has also been observed in children who suffer from a moderate level of malnutrition [4].

For some children, a state of malnutrition does not prove fatal, yet persists over time. In this case, malnutrition remains a serious problem as it adversely affects a child’s growth and
development and can have serious long-term consequences [2]. Undernourished children are usually expected to attain maturity later than healthy children, and worse, their mental capabilities, and hence learning skills, are very much reduced [2]. For example, in preschool children in developing countries, height has been positively correlated with scores on global tests of development and motor activity, while stunting in early childhood has been associated with long-term deficits in cognition and school achievement [5]. There is also evidence that childhood malnutrition impairs the capacity for physical work later in adulthood [6].

Child undernutrition is not spread evenly across the globe but is concentrated in a few countries and regions [3]. More than 90 percent of the world’s stunted children live in Africa and Asia, where rates of stunting are 40 percent and 36 percent respectively [3]. Among these nutritionally vulnerable populations, hunger and undernourishment form a vicious cycle, which is often ‘passed down’ from generation to generation: The children of impoverished parents are often born underweight and are less resistant to disease; they grow up under conditions that impair their intellectual capacity for their whole lives [7]. A public health problem of this magnitude can be viewed not only as a personal health hazard, but also a serious impediment to a country’s national development [6].

The United Republic of Tanzania is a developing country in East Africa where issues of poverty, food shortage, and disease seem to significantly affect the health status of the population. According to the 2004/05 Tanzania Demographic and Health Survey, 38 percent of children under the age of five living in the country are chronically malnourished, and the World Food Programme of the United Nations estimates that more than 40 percent of the population
is living in chronic food deficit regions [8]. A recent study by Knueppel et al. [9] found that 48.1% of households in Tanzania are severely food insecure, meaning that their ability to obtain access to sufficient, safe, nutritious food is compromised [9]. Malnutrition, as measured by anthropometry, has been identified as the most widespread nutrition disorder in Tanzania [10].

Each year since 1990 the United Nations Development Program (UNDP) has published the Human Development Index (HDI), which is a summary of human development that measures the average achievements in a country in three basic dimensions of human development: a long and healthy life (measured by life expectancy), access to knowledge (measured by mean of years of schooling for adults aged 25 years and expected years of schooling for children of school-going age) and a decent standard of living (measured by gross national income per capita in USD) [11]. Tanzania’s HDI value for 2010 was 0.398—in the low human development category—positioning the country at 148 out of 169 countries with comparable data [11]. A mean of 5.1 years of schooling for adults and a GNI per capita of $1,344 illustrate that factors of poverty and lack of education may contribute to the prevalence of malnutrition throughout the country.

The Global Hunger Index (GHI), a figure that measures the presence of hunger in various regions, is calculated for eighty-four developing and transitional countries. The figure is arrived at by combining the following three indicators into one score: level of child malnutrition, rates of child mortality, and the proportion of people who are calorie deficient. A score of 0 indicates the least hunger, and a score of 100 indicates the worst hunger [3]. The GHI is considered extremely alarming if the country has a score of 30 or higher [3]. The 2010 GHI assigned
Tanzania a score of 20.7- a value indicative of an “alarming” level of hunger affecting the country [3]. In addition to providing insight into the level of hunger a country is experiencing, data gathered to establish the GHI can also be used to track different trends. For example, although Tanzania’s score improved from 2009 to 2010, the 2010 report indicated that 35% of the Tanzanian population remained undernourished and 16.7% of children were underweight [3].

The scope of the problem facing children in Tanzania, and many developing countries, seems to involve not only suboptimal nutrition status, but rather an interaction of poverty, poor nutritional status, and lack of education. This interaction presents youth in developing countries with an environment that challenges their ability to grow and thrive, and threatens their capacity to develop into healthy adults. A widely used approach to target the problems of hunger and malnutrition among youth is the implementation of school feeding programs.

Utilizing data collected at various intervals throughout the program period and using a nonrandomized experimental design, this study investigates the impact of a supplemental snack feeding program carried out in rural Tanzania. The following research questions are posed:

1) What was the prevalence of stunting (as determined by height-for-age), wasting (as determined by weight-for-height), and underweight (as determined by weight-for-age) among students at Roche Primary School in July 2008, prior to implementation of a snack provided by a school feeding program?
2) Did Z-scores for stunting (height-for-age), wasting (weight-for-height), and underweight (weight-for-age) change in students who participated in the feeding program?

The following hypotheses are tested in this study:

1) The prevalence of stunting (as determined by height-for-age), wasting (as determined by weight-for-height), and underweight (as determined by weight-for-age) will decrease among students participating in the feeding program.

2) Z-scores for stunting (height-for-age), wasting (weight-for-height), and underweight (weight-for-age) will improve among students participating in the feeding program.
BACKGROUND

School feeding programs have been established in most parts of the world with the goals of reducing hunger and malnutrition [12]. In the United States, for example, the USDA enacted the National School Lunch Program to “safeguard the health and well-being of the nation’s children and to encourage the domestic consumption of nutritious commodities and other foods” [12]. In rural Pakistan, malnutrition and low levels of education were the impetuses to begin school feeding [6]. In Kenya, school-based snacks were distributed to test their effect on school performance, growth, and nutritional status [13]. Regardless of their country of origin or specific incentive, it is important to review the impact of such programs to document successes and failures in regard to a particular program’s identifiable goals. The practices of school feeding are insufficiently evaluated for effectiveness, and this lack only discourages investment in nutrition programs and precludes well-informed decision making [14].

There is, however, Murphy et al. [13], who tested whether providing school-based snacks affected health outcomes such as school performance, growth, and nutritional status. They enrolled ~900 children aged 7-9 years from 12 schools in a nutrition program conducted in the Embu District, Kenya. A sample of N= 533 children were randomized to receive one of three snacks designed to address previously defined micronutrient deficiencies as identified by the Nutrition Collaborative Research Support Program, conducted from 1983-1986 in the same district of Kenya. Snacks were provided to the sample as follows: energy snack n = 140, milk snack n = 141, meat snack n = 126, or control group n = 126. All snacks were initially designed to provide ~260 kcal, (~15% of a pupil’s energy requirement), but the amount was increased to
~315 kcal (~20% of the energy requirement) after the first three months to account for the active level of a child’s physical activity. The daily energy intake from the snacks averaged ~130 kcal/day over the two year period of the study, taking into account days the snack was not consumed such as on weekends, school holidays, and days missed because of illness.

Although equicaloric, the snacks differed in micronutrient values. The milk snack was higher in calcium than the other snacks, providing 38% of the recommended intake; Vitamin B-12 was high in both the milk and meat snacks, providing 83 and 106% of the recommended intake, respectively [13]. The basis of the composition of all three of the snacks was a local staple known as *githeri*, a stew of maize, beans, and vegetables (kale, onion). The energy snack consisted solely of 230g of *githeri*; the meat snack consisted on 225g of *githeri* that contained ~38% cooked minced beef, by weight, and the milk snack consisted of 100g of *githeri* accompanied by a 250g glass of milk. All snacks were tested by staff and children outside the intervention areas to ensure palatability and ease of preparation.

Analysis of the data was performed among all groups, comparing baseline mean intake to mean intake that occurred throughout the two year feeding period. Usual intakes were estimated by 24-h recalls at baseline and up to 21 times during the feeding period. Over the course of the 2 years, energy intakes increased by 18, 36, 90, and 128 kcal/day in control, energy, milk and meat groups, respectively. Changes in home intake, however, did occur for children in the energy and milk group, and this is an important element to consider when evaluating the effect of a school feeding program on health outcomes. For children in the energy group, intake decreased by an average of 95 kcal/day and by 39 kcal/day for children in
the milk group. Conversely, intake by children who received the meat snack did not decrease. Researchers cited the possible reason for this occurrence to be that children in the meat group were more active and/or growing faster, so in turn were hungrier. Researchers also considered the scenario that some of the children may have been experiencing varying levels of anorexia due to iron and zinc deficiencies that were noted at baseline. Since the meat snack provided iron and zinc in addition to calories, it is possible that their appetites may have improved as a result of increased iron and zinc intake. In any case, it is important to note if changes in home intake occur among children who receive a snack at school. This situation then alters the nature of the school snack, making it a source of energy replacement rather than a supplemental source of energy. Circumstances in which this occurs may account for failed improvement of nutritional status in children who participate in feeding programs in which such status is assessed.

Additionally, Hall et al. [14] evaluated the effect of a large-scale school nutrition program in southern Vietnam. The evaluation focused specifically on the impact of the school nutrition program on gains in height and weight among its participants. A cohort of N= 1080 children in grade one at a primary school participated in the overall study. A sample of n= 360 children were in the “program” group and attended schools where they received a school snack; 720 children served as a “comparison” group and attended different schools that were proximal in distance, but where no school snack was served. Nearby schools were selected for comparison in an effort to minimize environmental factors that can affect food supply and disease transmission.
Baseline examinations were conducted at the start of the school year during which each child was weighed using a digital scale to the nearest 0.1 kg and measured for height to the nearest 0.1 cm using a stadiometer. There were no statistically significant differences between the study groups regarding mean age, height, weight, and anthropometric indices at baseline.

Beginning in November of 2003, children in the program group were provided with a snack on each school day. The snack consisted of 200 ml of ultra heat-treated cow’s milk that was fortified with vitamins A and D and provided 150 kcal, along with a 30-gram packet of baked biscuits made from wheat flour and fortified with 18 vitamins and minerals that also provided 150 kcal. The snack of milk and biscuits also contained 1400 IU retinol, 60 μg iodine, 5 mg iron and 6 mg zinc. The students consumed the snack, which totaled 300 kcal, on school days (five days/week) during a formal break. Consumption was supervised by teachers to ensure intake.

It should be noted that feeding was interrupted twice throughout the course of the program; once due to bacterial contamination of the milk and another time due to cuts in funding. Frequency and composition of the school snack had to be altered to accommodate these new fiscal restrictions, resulting in a lower number of calories provided to the students each day and the insertion of a new milk formula. Taking these changes into account, researchers concluded that the program provided children with the equivalent of 90 kcal/day over 17 months.
A final assessment was performed in April of 2005 during which children who were studied at baseline were measured again for height and weight using the same methods that were used at baseline. Researchers also administered a questionnaire to children in grade three at both the program and comparison schools. The goal of this questionnaire was to determine whether or not changes in home intake had occurred during the duration of the nutrition program. Children in grade three, as opposed to grade one, were interviewed because they were deemed old enough to answer questions about their own intake. These children were simply asked if they had eaten breakfast before they came to school that day and if they had eaten when they got home from school the day before. Based on reports from the grade three children, researchers concluded that there was no evidence that the nutrition program led to changes in home intake among the grade one children who were being evaluated.

Results of the final review showed that the children in the program group gained significantly more weight and height than children in the comparison group. Although significant, differences between the means were rather small: 0.24 kg in weight (3.19 vs. 2.95 kg, P <0.001) and 0.27 cm in height (8.15 vs. 7.88 cm, P= 0.008). Further, the greater weight gain of children in the program group occurred concurrently with a common improvement in anthropometric indices calculated as Z-scores in both groups. Both weight-for-age and height-for-age Z-scores improved in the program group as well as in the comparison group. Researchers identified three factors that may have played a role in this occurrence: the fact that all children were dewormed at least once (deworming→ drop in prevalence of underweight and stunting), that an improved environment due to economic and social
development (resulting in increased availability of food), or that the effects of the season on food intake (surveys were done at different times of the year) [14]. Although the common improvement in anthropometric indices may tarnish the perceived value of the nutrition program for improving nutritional status, it provides constructive data that can be used to improve school feeding programs. The weight-for-age Z-scores, an index used to determine the degree of underweight, indicated that older children gained slightly more weight than younger children (P < 0.001), and that children who had a better initial weight-for-age gained more weight (P < 0.001), indicating they were less undernourished at the start of the program. The height-for-age Z-score, which measures the degree of stunting, showed that children who were less stunted initially gained slightly more height than children who were more severely stunted (P = 0.011). Both the weight-for-age and height-for age Z-scores demonstrate that children who are the most undernourished (most underweight, most stunted) seem to benefit the least from feeding programs. This suggests that for feeding programs to be truly biologically beneficial for children who most need it, the energy density of the snack may need to be increased to provide a greater proportion of the child’s daily energy requirement.

Furthermore, Walingo et al. [12] performed a comprehensive evaluation of a school lunch program (SLP) in western Kenya. Throughout this African country, various government and World Food Program-sponsored school feeding programs exist in areas where the agricultural potential is low and the economic state is depressed. However, no such programs exist in the Emuhaya District of Kenya, so parent-teacher associations have organized to support their own feeding programs. The main objective of Walingo et al. was to compare the nutrient intake and nutritional status indicators of participating and nonparticipating pupils in
these school lunch programs throughout the Emuhuya District of Kenya, where programs are supported through the contributions of money or food by parents or guardians of the school’s pupils.

From the twenty primary schools within the district that have school lunch programs, 8 were randomly selected for inclusion in the study. A sample of n= 160 pupils who participated in the program were randomly selected to make up the participant group and n= 160 pupils that did not participate in the program were randomly selected to make up the nonparticipant group. To be designated as participants, pupils had to have been participating in the school lunch program for at least 2 continuous years. Participation in the program was based on the usual practices of the SLP: consumption of the school lunch five days per week. Nonparticipants that made up the comparison group were from the same class and in the same age range as the participants. Because participation in the SLP is based on the ability of families to financially contribute to the feeding program through the donation of food or money, economic status is another variable that is examined in this particular study to determine its relation to nutritional status.

The data collection process that was performed on both groups involved both the pupil and their caregiver. Several instruments were used to determine the pupil’s usual intake: a 24-hour diet recall, sociodemographic survey, weekly food frequency questionnaire; the family’s socioeconomic status was ascertained through scheduled interviews; and the pupil’s nutritional status was determined by height and weight. The school lunch consisted of boiled maize and beans fried in vegetable oil; on average, the energy and protein quantity of the school lunch
was 841 kcal and 40g protein per student per day [12]. Prior to being served, the volumes of food portions were weighed, then served and consumed by each pupil in the participant group. In order to provide the most accurate consumption data, any left over portions were weighed again to determine the volume of school lunch actually consumed by the student.

The nutritional status assessment of the children involved measuring weight to the nearest 0.1 kg on an electronic scale, and measuring height to the nearest 0.1 cm using a height meter. This data was used to calculate Z-scores for underweight, stunting and wasting. Results of the study revealed that these nutritional status indicators were less favorable among the nonparticipant group. Severe underweight, severe stunting, and severe wasting were all significantly higher among the nonparticipants than among the participants (P < .05). The school lunch consumed by the participant pupils contributed 35% to the total DRI for energy and 117.6% for protein intake. In comparison, nonparticipant pupils who relied on a home lunch received 30% of the DRI for energy and 70.6% of the DRI for protein via the lunch time meal. Attendance among the participants was better than the nonparticipants, who often traveled home for lunch providing a window of opportunity to not return for afternoon classes. Among the nonparticipants, hunger was a significant reason for missing school (x^2 = 69.13, df=4). Economic status of participant versus nonparticipant families appeared to have an effect on nutritional status: parent income was identified as having a significant relationship to the nutritional status of pupils (P < .05); parents’ level of education and nature of occupation were positively associated with weight-for-age and height-for-age of participant pupils; and pupils from households where parents were employed (42.6%) tended to be of a significantly better nutritional status than those whose parents were not employed. Further, 46% of the caregivers
interviewed indicated that the conditions of the school lunch program (contributions of food or money) were not favorable for their economic situation. This data displays how income level, level of education, and nature of occupation can influence nutritional status; therefore, if school feeding programs can be externally funded to eliminate economic disparity, they can provide the unique opportunity to improve both the nutritional status and attendance records of students who are in the greatest need.

Further, Pappas et al. [6] conducted a review of a comprehensive nutrition project carried out in rural Pakistan. After a national survey revealed that in rural areas of Sindh-Pakistan, 18.3% of girls and 14.6% of boys were stunted, the government took action to fund the Tawana Pakistan Project (TPP), a feeding program implemented to promote nutrition and social development among primary school girls living in the poorest districts of Pakistan. In addition to the high rates of stunting seen among females, only 22% of girls over 10 years old had completed primary level or higher schooling, and the literacy rate among females aged 15 years or older was just 36% [6]. Thus, the project was engineered to focus on females, targeting problems of poor nutritional status and low levels of education. The main goals identified at the outset were to combat malnutrition and increase school enrollment in an area where not only are stunting and wasting common problems, but the rates of educational achievement and literacy also remain low.

This large-scale program focused on providing freshly prepared noon meals from locally available foods to over 400,000 girls (N= 417,665) over the course of the two year study. Rural women who volunteered to help out with the program at the different schools were trained on
ways to execute day-to-day operations of the program, including tasks such as menu planning, purchasing, cooking, serving, and cleaning. The school lunch was to provide one-third of energy requirements for its participants based on the average caloric needs of primary-school age girls, and the volunteers were trained to serve equal portions of food to each girl.

Nutrition status was assessed at baseline by “community organizers” who were trained and supervised by NGO staff. Scales and measuring tapes were provided to each school to measure weight and height at the initiation of the project; measurements were conducted quarterly from then on. Ages of the girls were determined using local area calendars that referenced important local and national events. Rates of malnutrition were determined at baseline and defined using three standard indicators: stunting, underweight, and wasting. Changes in these indicators were then used to detect changes in the levels of malnutrition among an analytical sample of 203,116 girls, made up of those who received at least two sets of measurements at least 6 months apart, and received the school lunch. Differences in anthropometry were tested using McNemar’s test. At baseline, 23.2% of girls were stunted and 14.3% were wasted. Over the study period, improvements in all three measures of nutritional status were observed. Wasting, a measure of acute malnutrition, decreased by 45% (p < .001), and stunting, a measure of chronic malnutrition, decreased by 6% (p < .001). In addition to positive results regarding malnutrition, school enrollment for girls increased by 40% across the program districts. Once more, this study demonstrates the ability of a school feeding program to positively impact, not only nutrition status, but school enrollment and attendance. In addition to these positive outcomes, the TPP venture is particularly impressive due to its ability to empower and mobilize communities, especially women, to work together to promote
community development and social progress. Like the TPP, the VLFP relies on the ability and enthusiasm of the women who live in Roche village to make the program a success and promote the growth of the community.

Finally, in 2003, Ash et al. [15] published the results of a study aimed at addressing micronutrient deficiencies in primary school-aged children in rural Tanzania through the use of a fortified beverage. Although the major goal of this intervention was to correct deficiencies of iron and Vitamin A, researchers employed methods to track not only changes in micronutrient status but also changes in anthropometrics. Tracking changes in weight and height that occurred in children who consumed the fortified beverage versus those who consumed an unfortified beverage is beneficial because the results can be evaluated to consider the effect that micronutrient deficiencies may have on nutritional status indicators such as stunting, wasting, and underweight.

This study was carried out in six rural primary schools in the Mpwapwa District of Tanzania, where seasonal variations significantly affect the availability of fruits and vegetables, and where the consumption of animal products is minimal. This combination of poverty and unfavorable ecology, which can be observed in a variety of rural villages, can often lead to a diet that is poor in micronutrient-rich food sources, such as iron and Vitamin A [15]. Researchers chose to study issues of iron and Vitamin A deficiency in this population because of the serious repercussions deficits in these particular micronutrients present to a large number of children worldwide; Vitamin A deficiency increases mortality risk for 250 million children, whereas iron deficiency leads to poor cognitive performance and other health problems [15].
At the beginning of the trial, N= 830 children were randomly allocated to the “fortified” (n= 392) or “unfortified” (n= 382) group. Baseline examinations were conducted to determine anemia and iron status, and to measure weights and heights of each child. Baseline characteristics in both groups were similar; the prevalence of anemia was comparable, equal proportions of children in the two groups had low serum retinol concentrations, and there were no significant differences in weight, height, and BMI. As the study commenced, each child received either a fortified beverage or an unfortified beverage at school (Monday through Friday) over a six month intervention period, per their respective group. The beverages were identical in terms of taste and appearance, and each provided 90 calories per serving. The fortified beverage, however, and not the placebo, provided 30-120% of the daily value (US food industry standard) of various micronutrients including iron, Vitamin A, iodine, zinc, ascorbic acid, riboflavin, folic acid, Vitamin B-12, Vitamin B-6, and Vitamin E.

Six month post-intervention follow up examinations were completed by the same examiners who carried them out at baseline on remaining participants, N= 774. The final N differs from the beginning N= 830 due to a drop-out rate of 7% that was mainly the result of relocation and low attendance. After the intervention, the mean hemoglobin concentration had dropped in both groups (112.9 and 116.0 g/L in the nonfortified and fortified groups, respectively; P < 0.001); however, the decrease was smaller (P < 0.001) in the fortified group (-3.2 ± 13 g/L) than in the nonfortified group (-6.7 ± 13 g/L). Among children with anemia at baseline, the incremental change in hemoglobin after the 6 month intervention was small and insignificant in the nonfortified group (n= 72), whereas the change in the fortified group (n= 70) was greater and highly significant (0.2 and 9.2 g/L, respectively; P < 0.001). The prevalence of
anemia had increased in both groups but had risen more in the unfortified group than the fortified group (35.6% versus 26.3%; P < 0.001). Regarding Vitamin A status, there was no significant change in status in the unfortified group, whereas the fortified group experienced a significant drop in low serum retinol concentration (defined as < 200 μg/L): 21.4% at outset versus 11.3% at follow up. Compared to characteristics at baseline, mean heights, weights, and BMIs increased in both groups, but significant differences (P= 0.001) between the two groups did exist. Children in the fortified group gained 0.55 kg more weight, 0.57 cm more height, and 0.32 more BMI units compared to the unfortified group. The observed improved growth in the fortified group in this study is a bit surprising given the small amount of extra energy that the beverage supplied the children. Ash et al. postulate that the observed improvement in growth in the fortified group was related to the increased intakes of micronutrients which may have improved appetite, thereby, leading to increased food intake [15]. Ash et al. shed light on yet another aspect of school feeding that may impact how effective a program might be at improving nutritional status: whether micronutrient deficiencies, if present, are addressed. This makes the general case for school feeding more complex due to the fact that micronutrient imbalances differ across populations. Ash et al. provide an issue to ponder regarding the idea that extra energy might be less useful in the presence of micronutrient deficiencies. Although assessing micronutrient status of a given population prior to the implementation of a feeding program so that the proper supplement can be designed would be more labor intensive at the outset, Ash et al. demonstrate that it may positively affect outcomes. It may be that it is wise and worthwhile to address issues of caloric deficiency and micronutrient insufficiency
simultaneously to provide the greatest opportunity to improve nutritional status among rural, nutritionally at-risk populations.
METHODS

Study Setting

Roche Village is a rural community located in the Rorya District of Northern Tanzania. The Luo people inhabit this semi-arid land which lies on the eastern shore of Lake Victoria. Tanzania’s equatorial climate is hot and humid, averaging 90°F (32°C) on the coast; this is tempered by inland elevations where temperatures are milder. Rainfall is characterized by two annual maxima- March through May (the long rains) and October through December (the short rains) [16]. Cassava and millet are the main crops grown in Roche Village.

The Food and Agricultural Organization (FAO) of the United Nations describes the Tanzanian diet as “based on cereals (maize and sorghum), starchy roots (cassava) and pulses (mainly beans)” [10]. Food consumption patterns reflect a monotonous diet, as these starchy foods are estimated to provide almost three quarters of the total energy supply [10]. The share of energy from protein is at the lower limit of recommendations (10-15%) and the share of energy from lipids is 12-14%, lower than the 15-30% that is recommended by the World Health Organization [10]. The poor diversity of the diet results in low consumption of micronutrient-dense foods such as animal products, fruits, and vegetables; subsequently, micronutrient deficiencies are widespread [10]. Further, the dietary energy supply does not fulfill average energy requirements of the population [10].

Trends in the diet that are seen on a national level and identified by the FAO hold true within Roche village. The dietary staple in most households in Roche Village is a porridge-like
substance known in Swahili as *ugali*, which is made from the root of the cassava plant and millet grain. It is not uncommon for many village families to have only one meal a day, resulting in a diet that is calorically deficient, lacking in sufficient protein and poor in essential vitamins and minerals [10]. Repercussions of such a diet include disturbances in growth, poor psychological and intellectual development, and increased morbidity and mortality [4].

**Selection of Study Subjects**

Despite having an abundance of information on children less than 5 years of age and adult women, the FAO reports that there is currently no data on the anthropometry of school-age children [10]. This study attempts to establish some information on school-age children and presents a data analysis on a small convenience sample from a larger ecological intervention conducted on roughly 1200 children in Roche Village. Subject data is collected at each of the three primary schools in the village where the feeding program is carried out: Roche Primary, Migeko, and Ratia. Anthropometric assessments are performed on every student who comes through the field clinic on the day volunteers can travel to the site; these students make up the convenience sample. Due to time and travel limitations, the current study focuses on children who participate in the feeding program at one particular location, Roche Primary School. After taking measurements at the Roche site on 9/19/2009, 90 students were identified as having received at least two sets of measurements: one in July 2008, and one in October 2009. Of these 90 subjects, 48 were excluded due to conflicting or incomplete data.
Description of Intervention

In July of 2008, the Village Life Feeding Program began providing a corn-based porridge known as *uji*, to Tanzanian students. Each school day, students receive a cup filled with roughly 250 ml of the uji snack. Distribution begins with the youngest children (kindergarten) and proceeds through the successive grade levels.

*Uji* is prepared each school day on school grounds by several different teams of women from the village who take turns preparing and serving it to the students. The snack is made by boiling a mixture of approximately thirty-six and a half (36.5) liters of water with roughly 2 kilograms of ground corn flour and 8 cups of sugar in a large pot over an open flame. The end product is a porridge-like substance that is similar to the Cream-of-Wheat product that we know in the United States in regards to appearance, texture, and taste. One batch makes about 100 servings; this process is performed four times per day to make a total of 400 servings of uji. Each serving of uji provides around 130 kcal of energy and trace amounts of vitamins and minerals [17]. On average, the contribution of the school snack to the participants’ daily energy needs is 7.3% [18].

Students form a long, orderly line to receive their uji. One village woman is in charge of portioning out the uji and handing it to the children, while another woman assists in keeping the children moving through the line. Distributed portions are relatively uniform as the women fill a standard-sized cup for each child that holds about 250 ml of uji. Three servings of uji were randomly measured to test the accuracy with which the volume of 250 ml was being served. Cup #1 received 270 ml, cup #2 received 270 ml, and cup #3 received 300 ml. So as not to
disrupt the distribution of the uji and the school day in general, just these three servings were measured for accuracy. The mean serving size of these three samples is 280 ml.

After receiving their uji, children sit nearby and consume it. Teachers monitor consumption to ensure that the children consume their entire cup of uji and do not share. Based on field observations, neither sharing nor incomplete consumption of uji was a problem. After finishing their snack, children return their cups to the women, who in turn clean them so they may be used for the next group. Children consume the snack every day they attend school but not on weekends, days missed because of illness, school holidays, or summer break, which runs from June-July.

Measurements

Data are collected on the children two times per year by means of a standard nutritional assessment. Pupils enter a mobile field clinic and, with the aid of a translator, verbally report their name and year of birth or age to a volunteer. In a rural village setting like Roche, a child’s year of birth or age may be recounted by the number of rainy seasons that have passed since their birth, or the occurrence of a major event that may be associated with a calendar year. Each child then proceeds through the clinic where anthropometric measurements of height, weight, and arm circumference are measured by Village Life volunteers. Baseline data was collected in July 2008 and follow-up data was collected in October 2009.

Weight was measured to the nearest 0.1 kg using a digital scale that was calibrated each morning prior to use. Height was read in centimeters and recorded to the nearest millimeter using the height side of a weight-for-height chart produced by WHO. This chart was anchored
to a level floor and adhered to the wall. Students removed their shoes for both height and weight measurements. Mid-upper arm circumference was measured to the nearest millimeter using a non-stretchable measuring tape (Teaching Aids at Low Cost). Students were instructed on the proper way to carry out all three of these measurements the night before using the NHANES measurement guidelines provided in an instructional video (http://www.cdc.gov/nchs/products/elec_prods/subject/video.htm). These methods are consistent with WHO recommendations for assessment of undernutrition. Although it is known that previous student volunteers who collected baseline data and performed additional assessments prior to October 2009 used the same instruments and methods for performing measurements, the training method that was used is unknown. Thus the validity and reliability of the data may be compromised.

Following collection, data was used to develop Z-scores for each individual. The Z-score is a calculation of how much a child’s weight or height deviates from the standard for healthy child growth set by the World Health Organization [3]. Its calculation involves the use of a standard reference population; in this study, EpiInfo version 3.5.1 utilized the CDC/WHO 1978 growth reference curves [19]. Below is an example which shows how a reference population and anthropometric measurements are used to determine an individual’s weight-for-height Z-score:

\[
\text{wt of a subject- median reference value of wt-for-ht}
\]

\[
1 \text{ SD below median reference value of wt-for-ht [20].}
\]
Such formulas were used to calculate Z-scores for three main nutritional status indicators as child undernutrition can manifest itself in different ways depending on the cause, severity, and duration [3]. A child may be described as “stunted”, “wasted”, or “underweight” based on low Z-scores (Z-scores < −2 standard deviations (SD) of WHO Child Growth Standards median) for height-for-age, weight-for-height, and weight-for-age, respectively [3].

In order to be useful, the Z-scores must have a universal interpretation. WHO recognizes the following implications for these three widely-used nutritional status indicators:

**Underweight:** As weight is easy to measure, it is the indicator for which most data have been collected in the past; evidence has shown that the mortality risk of children who are even mildly underweight is increased, and severely underweight children are at even greater risk.

**Stunting:** Children who suffer from growth retardation as a result of poor diets or recurrent infections tend to be at greater risk for illness and death; stunting is the result of long-term nutritional deprivation and often results in delayed mental development, poor school performance, and reduced intellectual capacity. This, in turn, affects economic productivity at the national level. Women of short stature are at greater risk for obstetric complications because of their smaller pelvis. Small women are at greater risk of delivering infants with low birth weight, contributing to the intergenerational cycle of malnutrition, as infants of low birth weight, or retarded intrauterine growth, tend be smaller as adults.

**Wasting:** Wasting in children is a symptom of acute undernutrition, usually as a consequence of insufficient food intake or a high incidence of infectious diseases, especially diarrhea. Wasting in turn impairs the functioning of the immune system; it can lead to
increased severity, duration, and susceptibility to infectious diseases as well as an increased risk for death [7].

The World Health Organization recommends the use of Z-scores for evaluating anthropometric data from developing countries, thus z-scores were applied in this study [20]. An advantage of using Z-scores in these countries, where malnutrition tends to be more widespread, is that individuals with indices below the extreme percentiles of the reference data can be classified accurately [20]. Another important advantage of using Z-scores for population-based application is that it is valid to calculate the mean and standard deviations for a group of Z-scores, which allows for the nutritional status of the entire population to be described [20]. Further, Z-scores provide a versatile tool for comparing rates of malnutrition between different groups and over time [12].

Data Analysis

Data was analyzed on a sample of 321 students and again on a subset of 42 students, ages 4 ½ -11 years old, using the Statistical Package for the Social Sciences version 18 (SPSS) [21]. Statistical analysis was performed to determine rates of malnutrition among the sample, and to evaluate the change of anthropometric indicators from baseline to follow-up among the subset.
Table 1. Visual reference for geographic location of study site.

[Diagram showing the geographic location in Tanzania, with branches for Roche Village, Migeko primary school, Ratia primary school, Burere Village, and Nyambogo Village.]

Rorya District, Tanzania, East Africa
Table 2. Nutrient totals report for one serving of uji.

<table>
<thead>
<tr>
<th>Primary Energy Sources</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kilocalories)</td>
<td>131 kcal</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>30.672 g</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0.772 g</td>
</tr>
<tr>
<td>Total Protein</td>
<td>1.405 g</td>
</tr>
<tr>
<td>% Calories from Carbohydrate</td>
<td>92.151 %</td>
</tr>
<tr>
<td>% Calories from Fat</td>
<td>4.915 %</td>
</tr>
<tr>
<td>% Calories from Protein</td>
<td>2.935 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamins</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin (vitamin B₁)</td>
<td>0.049 mg</td>
</tr>
<tr>
<td>Riboflavin (vitamin B₂)</td>
<td>0.016 mg</td>
</tr>
<tr>
<td>Niacin (vitamin B₃)</td>
<td>0.397 mg</td>
</tr>
<tr>
<td>Pantothenic Acid</td>
<td>0.152 mg</td>
</tr>
<tr>
<td>Vitamin B₆</td>
<td>0.080 mg</td>
</tr>
<tr>
<td>Total Folate</td>
<td>4 mcg</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>0.000 mcg</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>0.000 mg</td>
</tr>
<tr>
<td>Vitamin A (RE)</td>
<td>4 mcg</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>0.000 mcg</td>
</tr>
<tr>
<td>Vitamin E (alpha-tocopherol)</td>
<td>0.084 mg</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>0.060 mcg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minerals</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>25 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>55 mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>24 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>0.587 mg</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.387 mg</td>
</tr>
<tr>
<td>Copper</td>
<td>0.090 mg</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.102 mg</td>
</tr>
<tr>
<td>Selenium</td>
<td>3.267 mcg</td>
</tr>
<tr>
<td>Sodium</td>
<td>20 mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>84 mg</td>
</tr>
</tbody>
</table>

*Note:* One serving of uji (approximately 250 ml) provides approximately 131 kcal of energy and 7.3% of energy requirements based on average needs as determined by the IOM estimated energy equations formulas for males and females, ages 9-18 years old.
ANALYSIS

Statistical analysis was used to calculate the percentage of the sample that was malnourished prior to the implementation of the feeding program and for fifteen months thereafter. Additionally, paired t-tests were run on a smaller subset of the sample to monitor within subject change over the same 15 month time period. The sample consisted of N= 321 children; 186 (57.9%) were male and 135 (42.1%) were female. The subset was made up of n= 42 children who had two complete and accurate sets of measurements, one at baseline and one at follow-up. The subset had 23 males (54.8%) and 19 females (45.2%).
RESULTS

Characteristics of the children at the baseline survey are described for N= 321 participants. The mean age was 89.15 ± 20.02 months (7.4 years), the mean height was 123.54 cm ± 10.26 (48.6 inches), and the mean weight was 23.47 ± 4.64 (51.6 pounds). Mean Z-scores for height-for-age, weight-for-age, and weight-for-height were 0.0786, -0.2193 and -0.3778, respectively. A total of 5.3% percent of the sample was malnourished according to the height-for-age indicator, 2.2% were malnourished according to the weight-for-age indicator, and 0.9% were malnourished according to the weight-for-height indicator.

At follow up (n=42), the mean age was 95.88 ± 20.05 months (7.9 years), mean height was 128.50 cm ± 8.88 (50.6 inches), and mean weight was 26.31 ± 4.95 (57.9 pounds). Mean Z-scores were 0.4198 (height-for-age), 0.1431 (weight-for-age) and -0.1745 (weight-for-height). No student had a Z-score < -2 SD, thus none were malnourished according to the height-for-age, weight-for-age, or weight-for-height indicator.

The paired samples t-tests were conducted to evaluate the impact of the intervention on individual Z-scores. There was a statistically significant decrease in height-for-age from baseline (M = .7993, SD = 1.21717) to follow up (M = .4198, SD = 1.13183), t (41) = -10.280, p <.05 (two-tailed). The mean decrease in height-for-age Z-scores was -.37952, CI .95 = -.45408, -.30497. Weight-for-age also significantly decreased from baseline (M = .3376, SD = .80353) to follow-up (M = .1431, SD = .72628), t (41) = -5.478, p <.05 (two-tailed). The mean decrease in weight-for-age Z-scores was -.19452, CI .95 = 26624, -.12281. Changes in weight-for-height Z-scores were not significant.
Table 3. Mean and standard deviation of age and anthropometric measurements and indices of program participants at baseline and follow up.

<table>
<thead>
<tr>
<th>Age, Anthropometric measurement or index</th>
<th>Baseline</th>
<th>Follow Up</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 321</td>
<td>n = 42</td>
<td>n = 42</td>
<td></td>
</tr>
<tr>
<td>Age (months)</td>
<td>89.15 ± 20.02</td>
<td>80.61 ± 20.04</td>
<td>95.88 ± 20.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>123.54 ± 10.26</td>
<td>122.84 ± 9.49</td>
<td>128.50 ± 8.88</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>23.47 ± 4.64</td>
<td>23.49 ± 4.56</td>
<td>26.31 ± 4.95</td>
</tr>
<tr>
<td>Height-for-age Z-score</td>
<td>0.0786 ± 1.25</td>
<td>0.7993 ± 1.22</td>
<td>0.4198 ± 1.13</td>
</tr>
<tr>
<td>Weight-for-age Z-score</td>
<td>-0.2193 ± 0.92</td>
<td>0.3376 ± 0.80</td>
<td>0.1431 ± 0.73</td>
</tr>
<tr>
<td>Weight-for-height Z-score</td>
<td>-0.3778 ± 0.76</td>
<td>-0.2017 ± 0.66</td>
<td>-0.1745 ± 0.56</td>
</tr>
</tbody>
</table>
Results of the statistical analysis, which indicate a low prevalence of malnutrition among the supplemental snack program participants at both baseline and follow-up, as well as a general decline in Z-scores among the participant subset, are not consistent with the positive results reported in other school feeding program studies. The amount of calories provided by the uji snack (130 kcals) was most comparable to the snack provided in the Ash et al. study [15], which supplied 90 kcals. Although the snacks were similar in caloric content, and the uji snack was provided for a longer period of time than the Ash snack (15 months versus 6 months), Ash et al. [15] reported significantly higher gains in height, weight, and BMI units in their participant group versus their nonparticipant group. These positive results may be due to the fact that the Ash snack, although lesser in calories than uji and provided for a shorter duration, was fortified with micronutrients such as iron, vitamin A, iodine, zinc, vitamin C, vitamin E, and various B vitamins. It is possible that the observed improvement in growth in the Ash et al. [15] study was related to the increased intakes of micronutrients, which may have improved appetite, thereby leading to increased food intake in program participants [15].

The caloric content of uji was exactly half that of the snack provided in the Murphy et al. [13] study (130 kcals versus 260 kcals). Outcomes measured by Murphy et al. [13] were simply that of energy intakes among various groups that received one of three equicaloric snacks; no anthropometric measurements were obtained to measure the impact of the snacks on growth, as was the goal of the current study. However, because of the diligence of the Murphy researchers in gathering information on total intake (both at home and at school), positive
results of increased energy intakes among participants were able to be documented and reported. Murphy et al. [13] reveal the necessity of measuring food intake from the home food supply to correctly evaluate the impact of a feeding program on total nutrient intake [13]. Measuring home intake and more diligently recording school intake would drastically improve the methods of the current study.

The positive results reported by Hall et al. [14], when compared with the results of the current study, can possibly be attributed to the greater caloric content of the Hall snack (300 kcals) and its fortification with Vitamins A and D, iron and zinc. Another factor to consider is that participants in the Hall study [14] were dewormed at least once, which could have encouraged their weight gain by allaying diarrheal symptoms. The exact presence of diarrheal illness among the current study participants is unknown, but helminthic disease among children in Tanzania is not uncommon; additionally, a study by Tetala et al. [22] has linked a high prevalence of underweight and stunting with a high prevalence of schistosomiasis infection [22]. Administration of a deworming treatment among individuals with confirmed cases of parasitic infections may improve the impact of the current supplemental snack program.

Both the Walingo et al. study [12] and the Pappas et al. study [6] provided school meals, as opposed to school snacks, which make it difficult to compare their results to those of the current study. This difficulty stems from the drastic difference in the amount of calories provided during their feeding programs. Walingo et al. [12] provided a meal that supplied 841 calories, and the Pappas et al. [6] meal provided 1/3 of daily caloric needs for primary school aged girls [6]. Both of these studies reported significant decreases in the prevalence of underweight, stunting, and wasting among their participant groups [12, 6], but the effect of
these calorically dense meals cannot be compared to the effect of a 130 kcal snack. However, an interesting variable that was measured in the Walingo et al. study [12] was parental employment status; it was found that pupils from households in which parents were employed tended to have better nutritional status than those whose parents were unemployed [12]. This finding, which highlights the interaction of poverty and nutritional status, can be used to make the case for external-source funding for feeding programs in impoverished areas like Roche village [12].

Exploration of Findings

Based on environmental observations and in comparison to other school feeding studies, the results of the statistical analysis, which specify a low prevalence of malnutrition among the sample and subset, are unanticipated and merit explanation. One reason malnutrition seems only very mildly present could be that the most malnourished children were not well enough to come to school, and thus were not included in the sample. Statistics specify that 43.8% of children less than five years of age are stunted, which indicates a state of chronic malnutrition [23]. It is possible that children are so severely malnourished before they are of school-age that they do not attend school or do not survive beyond five years of age. Another explanation could be errors in anthropometric measurements due to examiner error, a result of inadequate training, instrument error, and/or difficulties in making the measurement [20]. Another aspect to consider is the specific method employed to determine specific birth dates for participants. As previously mentioned, it is not uncommon for children in Roche village to be unaware of their exact birth date, but only know what year they were born or how many
years old they are. Since EpilInfo requires a precise month, date, and year format (xx-xx-xxxx) for date of birth, Village Life board members decided to set defaults for the commonly unknown month and date details. Students who can only report a year of birth or age in years, which is the majority, are assigned a birth date of 12-31-xxxx (December 31, xxxx), and then their appropriate birth year is inserted. As age is a factor in determining weight-for-age and height-for-age z-scores, this practice provides the potential for ages to be erroneous by up to twelve months, resulting in inaccurate z-scores. For example, if student A is assigned a birth date of 12-31-2001 when his actual date of birth is 1-1-2001, he is provided with almost twelve months of “catch-up” time to grow when referencing his anthropometric measurements to growth standards.

The aforementioned limitation regarding lack of data on the usual diet of participants brings to light another variable that has the potential to influence outcomes of the intervention. Seasonal rainfall and agricultural patterns can lead to great variations in food availability and disease transmission, especially malaria [15]. Both the food supply and prevalence of disease could have differed from baseline to follow-up, as baseline observations were conducted in July, during the dry season, and follow-up observations were conducted in October, during the rainy season. It is possible that these two factors, food supply and rates of disease transmission, have the potential to influence the pliant nutritional status indicators of height-for-age, weight-for-age, and weight-for-height. As a result, it is probably best to make comparisons between measurements that were taken during the same seasons, if not the same months.
An added point to reflect on regarding statistical analysis involves the kurtosis and skewness of the samples. The skewness values were positive, indicated by a clustering of scores to the left at the low values. Further, the kurtosis values were below zero, which is representative of a distribution that is relatively flat, with too many cases in the extremes. Therefore, even though scores signified a low prevalence of malnutrition, the distribution of the samples demonstrates that scores trend toward the lower half of normal.

Finally, of greatest concern is the observed decrease in weight-for-age and height-for-age z-scores as evidenced by the paired t-test among the subset. Though the majority of the scores are presently within normal ranges, their decline suggests a threat to the nutritional well-being of the population. The occurrence of low weight-for-age in children is a telling marker and has been selected as an indicator of undernutrition, as it combines information on both chronic (height-for-age) and acute undernutrition (weight-for-height) [24]. It is one of the most widely used nutritional indicators and is also the selected anthropometric indicator for the Millennium Development Goals; the fact that it is declining in the study population raises a red flag concerning nutritional status [24]

Limitations

There are a myriad of limitations to this study. Obvious weaknesses include the lack of a control group, the small sample size of the subset, and the reduced reliability of the anthropometric measurements. More obscure limits that warrant elaboration include the study design, the lack of recorded data on actual snack consumption, the potential variations in snack preparation, and the presence of uncontrolled variables.
The non-randomized experimental design of the current study was not ideal. Non-randomized trials are intrinsically weaker research designs because they are prone to a wider range of potential risks for bias; for example, the influence of secular trends, sudden changes in uncontrolled before-and-after studies, or other concurrent events in interrupted time series designs [25]. Obviously, the presence of a randomized control group would have improved the current study design by eliminating such biases. However, establishing a control group where controls are provided by simply not giving food to one group of subjects raises ethical issues, especially if there is a humanitarian need [14]. Even if the basic ethical issue of withholding food could be resolved, for example, in the absence of a humanitarian need, when interventions have long-term implications for treatment, as may be the case with micronutrient supplementation, patients and researchers are often reluctant to have treatments assigned by chance [26]. Still, without adequate controls, it is not possible to assess whether any improvement in nutritional status is due to a school feeding program or would have occurred regardless, perhaps as the result of other development programs or because of secular changes [14].

Although consumption of the school snack by students is monitored by teachers to ensure complete intake without sharing, there is no hard data on how many times per school year each child actually consumes the snack. Attendance records are kept and could have been utilized to review how many days a student was present at school, but even then the assumption is made that uji was prepared every day that child attended school. The preparation of uji is dependent upon the delivery of the ingredients, which arrive via truck from
a neighboring village. The head schoolmaster and several teachers reported that some weeks the truck does not come and, consequently, there can be no uji preparation.

As previously mentioned, uji is prepared by a team of women who take turns cooking the snack throughout the week. Although there is a standard recipe to follow and the women were trained to follow it, there is likely some variation in preparation due to individual techniques or tendencies. It is possible that these variations would alter the nutritive values of uji and thus affect the impact of the intervention.

The field setting nature of this study made it difficult to control for the many variables that persist throughout the course of a school feeding program. In this case, the primary unexamined variable is the usual intake of participant pupils. Although some anecdotal evidence was gathered to get an idea of the typical diet within the village, these recalls had to be performed using a translator and without the use of memory aids. By not assessing usual intake, it is impossible to know the precise role that the school snack served within the individual diet. For example, if a pupil’s caloric intake decreased at home in response to the administration of a school snack, the nature of the school snack is then altered, making it a source of energy replacement rather than supplemental energy. Only if the individual’s intake remained the same would the snack serve its intended purpose of supplying additional energy to the diet.

As touched on by Hall et al. [14], a chronic or acute state of disease or infection can influence the caloric needs of an individual. For example, fever may increase the metabolic rate and, theoretically, result in increased caloric needs for weight maintenance. Given the poor
access to health care services in Roche village, it is possible that a sick child might endure the disease state for a longer period of time than if health care services were readily available, resulting in an increased period of time in which caloric needs remain elevated. Diseases such as malaria and a variety of intestinal parasites, most notably schistosoma haematobium, have been observed quite commonly in Village Life field clinics. Parasitic infections may cause blood loss, reduced appetite, or decreased absorption of nutrients, thereby, adversely affecting micronutrient and overall nutritional status [15]. A disease state or infection is another variable that may compromise the effect of the intervention.
CONCLUSION

Although the study was not ideal, the ability of a school to carry out a feeding program for over two years demonstrates the potential success and essentiality of school feeding programs in rural, impoverished villages. A feeding program in a village like Roche is especially appropriate as there are accessory projects in place such as mobile field clinic visits, water purification education, and mosquito net distribution that also promote the well-being of the population. The success of these collaborative efforts to improve the overall health of the community is likely dependant on their interaction; that is, the success of one program helps to improve the impact of another. A holistic approach to advancing the health status of the community will support the invaluable benefits of nutrition, health, and education that a feeding program can provide.

In the future, it is possible to improve the study design to better evaluate the health status of the population and the impact of intervention. First and foremost, it is crucial to gather data concerning the usual intake of the population being studied. Results of these studies will provide information that can verify the nature of the nutrition problem within a society, if one exists, and thus the effectiveness of the specific solution or intervention can be accurately evaluated [23]. Next, given the field setting nature of the study and limited staff of volunteers, it seems wise to randomly select a sample of pupils that can be closely followed over an extended period of time to monitor changes in their nutritional status while participating in the feeding program rather than attempting to collect and assess data on such a large number of children. The reliability of the measurements could be improved if the same surveyor performed anthropometric assessments on this sample. Additionally, if it could be
carried out without ethical dilemma, the establishment of a control group in another village
would help to further assess the impact of the feeding program.

Undernutrition is one of the most important factors contributing to child morbidity and
child mortality in developing countries [24]. It is vital that this problem be addressed, and an
evidence base exists to support the practice of school feeding as a means to do so. Providing a
meal or snack at school not only supplies nourishment to the students, it also promotes the
emergence of a synergy that is found when communities are encouraged to work across sectors
of health, education and empowerment [6]. At the very least, authors and schoolteachers alike
agree that having meals at school can generate happiness in children, and in turn, positively
affect their well-being [6].
Appendix 1. Depiction of uji preparation and distribution at Roche primary school, October 2009.
Appendix 2. Depiction of data collection in a field clinic at Roche primary school, October 2009.
REFERENCES


