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Supplementary Feeding Utilizing Climate-smart Indigenous Vegetables from School Gardens with Iron Fortified Rice Improved Nutritional Status of Schoolchildren

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This study evaluated the effectiveness of supplementary feeding in improving weight, vitamin A (VA), and hemoglobin levels of children using vegetables from school gardens and iron fortified rice (IFR). A cluster randomized controlled study using multi-stage sampling involving 6–8 year old underweight (WAZ <–2 SD) and/or anemic (hemoglobin <12 g/dL) schoolchildren in three public schools in Cavite province was conducted. School 1 and School 2 received lunch with standardized one-dish vegetable recipe; however, School 1 and School 2 had IFR (GIFR) and ordinary rice (GOR), respectively. School 3 (SNK) served hot soups or native delicacies as snacks available in the school canteen. Eighty (80) children in each group participated in the feeding every school day, 5 days a week for 120 days. Data on weight, hemoglobin, and serum retinol concentration for vitamin A (VA) levels were collected before and after the study using standard methods. Basal and endpoint mean weight was similar between groups; however, within group mean increment was significantly higher in GIFR and SNK than in GOR (*p*<0.05). Translating the results to prevalence of underweight at endpoint, the decrease in GOR was significantly higher than the decrease in GIFR and SNK (*p*<0.05). Basal mean hemoglobin levels were similar between groups; at endpoint, mean increment in GIFR 1 was significantly higher than in GOR. Baseline prevalence of anemia was significantly lower in SNK than in the two schools (*p*=0.05). At endpoint, only GIFR had a significant decline between time periods (*p*=0.000). Baseline mean VA was significantly lower in GIFR than in SNK (*p*=0.027); at endpoint, mean level was significantly higher in GIFR than in SNK (*p*=0.003). Supplementary feeding is effective in improving the weight of schoolchildren. The model of linking the use of vegetables from school garden had improved VA levels and the use of IFR has increased hemoglobin level.

Key words: iron fortified rice, nutritional status, supplementary feeding, vegetables from school gardens

INTRODUCTION

The Philippine National Nutrition Survey conducted by the Food and Nutrition Research Institute (FNRI) revealed the prevalence of the following among children aged 5–10 years old: underweight (32.0%), stunting (33.6%), and wasting (8.5%) (FNRI-DOST 2011). Anemia prevalence among schoolchildren aged 6–12 years was 20% (FNRI-DOST 2008).

To address undernutrition among schoolchildren, the Philippines had implemented school nutrition programs that included deworming, school feeding, and vegetable gardening.

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Deworming is a regular national program of the Department of Education (DepEd) administered twice a year, usually in July and January, starting 2007 until 2010 (DepEd 2007). In 2011, the deworming activity was included in the Guidelines on the Implementation of the Breakfast Feeding Program as a complementary activity (DepEd 2012).

School feeding is also one of the government's interventions to address persistent malnutrition among children. In the Philippines, the DepEd feeding program was launched in 1997 to address short-term hunger among public school children. Through the years, the program underwent changes in target beneficiaries, coverage, delivery mode, and focus – from addressing short-term hunger to that of addressing undernutrition.

In 2006, the DepEd Food for School Program (FSP) had targeted families with a Grade 1 child attending the day care center (DCC) to receive 1 kg of rice per day. In 2008, the target was extended to cater to Grades 1–3 in the top 100 poorest municipalities within the top 20 most food-poor provinces. The program also had on-site feeding that provided the children with vegetable-based noodles, coco *pandesal*, milk, and egg per day of in-school. This program was complemented by activities like training of parents on desirable food, health and nutrition practices, sustainable food production/ gardening technologies, and livelihood/ self-sufficiency projects.

In 2011, DepEd launched the Breakfast Feeding Program (BFP) targeting undernourished children in kindergarten and Grades 1–3 (DepEd 2012). The program was renamed School-based Feeding Program (SBFP) in 2012 so as not to limit the feeding to breakfast time. SBFP also restricted the coverage of the program to severely wasted (SW) children in kindergarten and Grades 1–6 in selected public elementary schools. The goals of the SBFP are: (1) to rehabilitate at least 70% of SW beneficiaries to normal nutritional status at the end of the 100–120 feedings days; (2) to ensure 85% to 100% classroom attendance of beneficiaries; and (3) to improve the children's health and nutrition values and behavior. For schools not targeted in the supplementary feeding program, the funds for feeding come from the 35% proceeds of the school canteen (DepEd 2007).

Evidences from previous studies suggest that school feeding programs have multiple positive associations including weight reduction in obese children, improved eating habits of students (Doak *et al*. 2006, Flodmark *et al*. 2006), reduced school dropout rates and improved attendance (Jukes *et al*. 2008), and improved academic performance (Belot & James 2011). A Cochrane review of 18 school feeding studies found a significant improvement in weight gain (Kristjansson *et al*. 2007).

The *Gulayan sa Paaralan* Program in 2007 was envisioned to support the continuous supply of vegetables for the SBFP and other feeding programs. Also, this is to raise awareness on the health and nutritional benefits of vegetables, as well as economic benefits by encouraging more household and community gardens (DepEd 2007). However, the disconnect or the lack of effective integration between school gardens and the SBFP remains. Moreover, the use of iron fortified rice (IFR) has been proven to be efficacious in reducing anemia prevalence (Angeles-Agdeppa *et al*. 2008) but had not been served in supplementary feeding programs. Food fortification is generally considered to be one of the known long-term and cost-effective strategy to alleviate micronutrient deficiency (Grier & Bryant 2005). This study has modeled an intervention to integrate gardening, supplementary feeding, and nutrition education to enhance the existing program of DepEd. While feeding children in school has long been implemented, recent DepEd policy innovations have expanded to focus on the delivery of healthy meals to schoolchildren.

This study aimed to evaluate the effectiveness of supplementary feeding in improving the weight and vitamin A (VA) and iron status of children through the use of vegetables from school gardens and IFR.

MATERIALS AND METHODS

Research Design

A cluster randomized controlled design using multistage sampling was employed in the study. This study was conducted in the province of Cavite with a total population of 2,856,765 and an area of 1,297.6 km^2. DepEd Cavite province had 280 public elementary schools distributed in 27 districts. All schools were clustered per district. In each district, schools were classified with and without school gardens. About 72 (26%) had school gardens and 208 (74%) schools had either no garden or non-functional garden. Out of the 72 schools with garden, only 27 schools or 1 per district were practicing bio-intensive gardening (BIG). The 27 schools were then stratified based on population either <700 or >700 schoolchildren and targeted school with supplementary feeding as identified by DepEd. Two schools were randomly selected from the 15 schools that had >700 schoolchildren with school feeding. These two schools served as the study sites. One school from the stratum without functional garden served as the reference school. This school was not in the list of schools with supplementary feeding; hence, the funds came from the proceeds of the canteen. Snacks were served to the children instead of lunch because of fund constraint.

School garden was classified as functional if BIG approach was employed: use of organic fertilizers (*kakawate*-based), with at least 200 m^2 garden bed, deep dug at least one foot; with good water source; with proper drainage system; and use of mulch to protect soil.

The two selected schools practicing BIG received supplementary feeding every school day 5 days a week for 120 days (approximately 6 months). Schools 1 and 2 both got lunch with a standardized one-dish vegetable recipe; however, School 1 and School 2 received IFR (GIFR) and ordinary rice (GOR), respectively. School 3 (SNK), the school with non-functional garden, received snacks either as hot soups or native delicacies that were available in the school canteen. The lunch in GIFR and GOR were served in a designated feeding room under a supervised regimen by a research assistant in each school. The snacks in the SNK were served inside the classroom under the supervision of the teacher. Volunteer parents of children in GIFR and GOR were responsible in food preparation, cooking, serving, and other post-meal activities.

Study Population and Sample Size

The sample size was calculated based on mean weight of 18.0 kg and 1.7 kg SD as reference value. Assuming a minimum increase of 1.2 kg with 90% power test at 5% level of significance, the sample would be 42 for each group (Angeles-Agdeppa 2006). However, if hemoglobin level (Hb) was used as an index for consideration, the sample size was calculated to detect a minimum change of 7 g/L in Hb concentration with an estimated SD of 9 g/L, a confidence interval of 95%, and a power of 90% with thirty-five children per group were needed for this study (Angeles-Agdeppa *et al*. 2008). The calculated sample size for weight as an index was used since this is higher than using Hb. The sample size per group was increased to 80 children to allow higher attrition rate and maintain a high power to detect significant difference between groups at end of the study (Dawson-Saunders & Trapp1994). The sample size was attained on an enrollment basis wherein 1,300 children were screened for weight-for-age Z-score (WAZ) and anemia as indicated by hemoglobin level.

Children aged <6 years and >8 years, those undergoing treatment from any chronic illness, those with reported or current history of blood abnormalities/ hemoglobinopathies, those with Hb <7 g/dl, and those without parental consent to participate were excluded in the study. Schoolchildren who were 6–8 years old, those who are underweight with WAZ less than 2SD (WAZ <–2 SD) and/or anemic (Hb <12 g/dl) with parental consent, and those who are not participants of other feeding programs were included in the study.

A face-to-face interview of parents/caregivers of children using pre-tested questionnaires were administered by trained research assistants to obtain food intake information and household socio-economic and demographic data.

Anthropometric measures included weight, height, and mid-upper arm circumference (MUAC). Weight of children was measured using a calibrated Detecto weighing scale (Webb City, MO, USA) and recorded to the nearest 0.1 kg. Height was measured using a microtoise (Depose, France) posted flat against the wall. All children were in light clothing and barefooted during measurements. The equipment was calibrated every measurement day. MUAC was measured using an unstretchable tape measure (Ergonomic Circumference Measuring Tape – SECA) (Gibson 1990).

Non-fasting whole blood (about 5 mL) was collected via venipuncture method by experienced registered medical technologists from the FNRI. All samples were collected in the morning at the schools. Venous blood was extracted using a disposable syringe gauge 22–24 and transferred to two Becton-Dickinson BD Vacutainer® PLUS Blood Collection Tubes. Serum samples were aliquoted into labeled polyethylene microcentrifuge tubes separately for each biochemical analysis. Hb was analyzed in the field while all serum samples were transported in a cool box with wet ice to the FNRI laboratory, where these were stored immediately at –80 °C until analyzed.

Serum C-reactive protein (CRP) was analyzed qualitatively using latex test kit by determining the presence or absence of agglutination (Plasmatec Laboratory Products Ltd.). Normal CRP concentration was defined as <6 mg/L. Above this value denotes presence of infection. Hemoglobin was analyzed on-site using a portable spectrophotometer by cyanmethemoglobin method. Anemia among children in this study was defined as having Hb level ranging from >70 g/L to < 120 g/L (WHO 1972). Baseline and endpoint serum ferritin (SF) and serum VA were analyzed at the same time after the intervention was completed. SF was measured using coat-a-count ferritin IRMA, which employs immunoradiometric assay procedure. VA (serum retinol) was measured using an isocratic elution high-performance liquid chromatography (HPLC) method. Iron deficiency was defined as SF level <30 ng/ml (WHO 2001). Vitamin A deficiency (VAD) was defined as VA <10 μg/dl and insufficiency as VA within 10–19 μg/dl (WHO *et al*. 1982).

A two-day, non-consecutive, 24-hour food recall was collected among parents/caregivers of children participating in the study. Food models and household measures were used for better estimates on food intake.

Albendazole (400 mg), a safe and effective drug for the treatment of the helminthiasis or parasitism involving round worms and even problematic infections such as echinococcosis (WHO 2011), was administered prior to the feeding study. However, not all children were dewormed because of the refusal of parents to subject their children for deworming.

Supplementary Feeding

A three-week standardized cycle menu of indigenous vegetables (*kulitis, talinum, upo, kalabasa, alugbati, sigarilyas*, *malunggay,* etc.) was developed by the FNRI (Angeles-Agdeppa *et al*. 2015). The types of indigenous vegetables usually planted in the school gardens were considered in the development of the recipes. The nutrient contents of the recipes were computed and some had met at least 30% of the daily requirement for iron and VA with an energy yield ranging 85–533 kcal and total protein content ranging 4–15 g or 16–60 kcal (Table 1). These recipes had undergone standardization, acceptability, and likeness evaluation by trained taste panelists of FNRI-DOST and to some schoolchildren. Modifications were done based on panelists' comments and children's left-overs. One cup of cooked ordinary rice yields 200 kcal of energy and iron content of 1 mg. IFR provided an additional 0.6 mg of iron. By calculation, the energy yield from the rice and the vegetable recipes ranged 272–720 kcal. The energy requirement for children aged 4–6 and 7–9 years old ranged 1410–1600 kcal/d, as established in the recommended daily nutrient intake (RENI) in 2002 (Barba & Cabrera 2008). The energy yield from the recipes including the rice provided 17–51% of the total requirement of the children per day. The iron content of the recipes ranged 1–5 mg.

Table 1. Estimated nutrients content per serving portion of the recipes used in the supplementary feeding and recommended energy and nutrient intakes per day.

Name of Recipe	Energy (kcal)	Protein (g)	Iron (mg)	Vit. A (µg RE)
Pinaupong manok	85	5	1	113
Veggie fish *sinigang*	130	12	2	122
Lumpiang gulay	276	4	2	🟩 257
Cheezy pork *embutido*	359	12	2	🟩 152
Squash *siomai*	178	7	1	56
Misua, *patola*, at *kulitis*	142	8	🟩 5	🟩 1657
Ginataang gulay express	🟩 533	🟩 15	🟨 3	🟩 458
Muskadsilog	233	6	🟨 3	🟩 221
Gisadong talinum at galunggong	251	8	2	🟩 160
Ginataang sigarilyas at kalabasa	🟨 461	🟨 13	🟨 3	🟩 153
Gisadong munggo at talinum	212	🟩 15	🟩 4	61
Tahong with cassava and *malunggay*	164	4	2	🟩 158
Linubihang munggo	269	10	2	61
Utan	110	7	2	🟩 3061
Miki with *togue*	240	9	2	100
Snack				
Champorado	298	6.7	2.2	24
Lugaw with egg	241	7.3	2.1	96
Chicken *arroz caldo*	210	6.4	1.3	10
Sopas (macaroni soup)	230	8.1	1.9	163
Ginataang munggo	306	6.3	1.4	1

Energy and Nutrient	RENI[a]	
	4–6 y.o.	7–9 y.o.
Energy (kcal)	1410	1600
Protein (g)	38	43
Iron (mg)	9	11
Vitamin A (µg RE)	400	400

🟨 – 1/3 RENI of 4–6 years old was met
🟩 – 1/3 RENI of both age groups (4–6 years old and 7–9 years old)
[a]Recommended Energy and Nutrient Intake 2002 (Barba & Cabrera 2008)

Computing the total iron content of the meal (combined iron content of ordinary rice and the recipes) showed that iron intake ranged 2.2–6.2 mg in GOR and 2.8–6.8 mg in GIFR. The recommended iron requirement of 4–6 and 7–9 year old children ranged 9–11 mg/d. The meal contributed about 25–76% of the total requirement per day. Protein yield amounts to 4 g per one cup of rice and 4–14.3 g from the recipes. Total protein content of the meal ranges 8–18.3 g, contributing 19–48% of the RENI (38–43 g) (Barba & Cabrera 2008). Plate waste of each individual child was weighed and deducted from the calculated weights of the menu to get the actual consumption. All data were recorded in a developed case report form.

The snacks of the SNK had an energy yield ranging 210–306 kcal and protein content of 6–15 g, providing 13–22% of the daily requirement for energy and 14–39% for protein. Since these recipes were not standardized, estimation on calorie yield was only based on reported amount served to children. The snacks served were soup like macaroni soup; congee (*arroz caldo* with chicken or egg); native cakes like sweetened glutinous rice (*biko, tikoy*); *champorado*; and *ginataang munggo.*

The lunch and morning snacks were conducted during Jul–Dec 2013 every school day, Monday to Friday, for 120 days.

Compliance to feeding was done by trained research assistants in GIFR and GOR. In the SNK, the classroom teacher recorded the data and was retrieved every month by the research assistants.

Ethical Considerations

The study was approved by the FNRI Institutional Ethics Review Committee and was carried out in accordance with the Declaration of Helsinki, guided by the Council for International Organizations of Medical Sciences Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS 2002) and the National Guidelines for Biomedical/Behavioral Research (PNHRS 2011). The parents were clearly informed of the objectives, procedures, risks, and benefit that their children may encounter during participation in the study. Individually signed parental Informed Consent Forms (ICF) were obtained. Children aged ≥ 7 years old were asked to sign an Assent Form.

Any adverse events (AEs) and/or complaints experienced by the children based on self-report were recorded in a prescribed AE Form. As per protocol, any reported AE – such as abdominal pain, diarrhea, or gastric irritation – was to be referred to the study physician. However, during the course of the study, no serious AEs were reported.

All children identified as severely anemic (Hb <7 g/dl) during screening and those who remained anemic after the study were referred to the nearest government health facility for further management. Children in GOR and the SNK were given 5 kg of IFR at end of the study.

Statistical Analysis

Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). The anthropometric Z-scores were computed relative to the Child Growth Standards (CGS) reference population (WHO 2007) using Epi-Info Nutrition (2013). In this study, the cut-offs of WAZ <–2 SD, height-for-age Z-score (HAZ) <–2 SD, and weight-for-height Z-score (WHZ) <–2 SD were used to define underweight, stunting, and wasting, respectively (WHO 2007).

Food intake was translated to nutrient intake using the Individual Dietary Evaluation System (IDES) software. IDES is an in-house program developed by the FNRI that converts all food items to a common state that would facilitate the computation to nutrient content. Means and SD were computed for each nutrient. Energy, protein, and iron intakes was computed as the sum total of the yield from rice and the recipes, and these were compared with the requirement per nutrient using the values in the RENI 2002 (Barba & Cabrera 2008). All vegetables from the garden used in the supplementary feeding were costed based on current market price in the area.

Encoding was done using Epi-Info Version 3.5.1. Descriptive analysis, analysis of variance (ANOVA), and Scheffe's test was done using the same software. Shapiro-Wilk test was done to determine the distribution of data *i.e*., anthropometric measures and nutrient intakes. Data that were not normally distributed *i.e*., SF, vitamin C, and calcium were log transformed and are hence expressed in geometric means. ANOVA was done to determine the significant differences among groups for continuous variables; likewise, Scheffe's test was done to determine which of the groups were significantly different from each other. Paired t-test was also done to determine the significant change between time periods *i.e*., baseline and endpoint. Fisher's exact test and McNemar change test was done using SPSS (version 20). Fisher's exact test for proportions was done to determine which of the groups were significantly different from each other, while the McNemar change test was used to determine the significant change in the proportion of children between time periods.

RESULTS

Of the total 240 children qualified to participate in the study, a complete data set from baseline to endpoint was obtained from only 221 children. Reasons for drop-out were: transfer of residence (GIFR=8.8%; GOR=7.5%), refusal to continue (SNK=6.3%), or sickness/illness (GOR=1.2%) (Figure 1). Test for differences revealed that weight and Hb level of drop-outs have not significantly affected the values of the remaining subjects. The proportion of children that dropped out from the study was not significantly different among schools.

Majority of the parents had high school education (64% mother, 63% father) and the major occupation was unskilled related work (53.9%) such as laborers. About 44%–58% of the households were poor, which means they were earning below Php 1,577.92/capita/mo (NSCB 2012); 19% were living in shanties and tenements, 23%

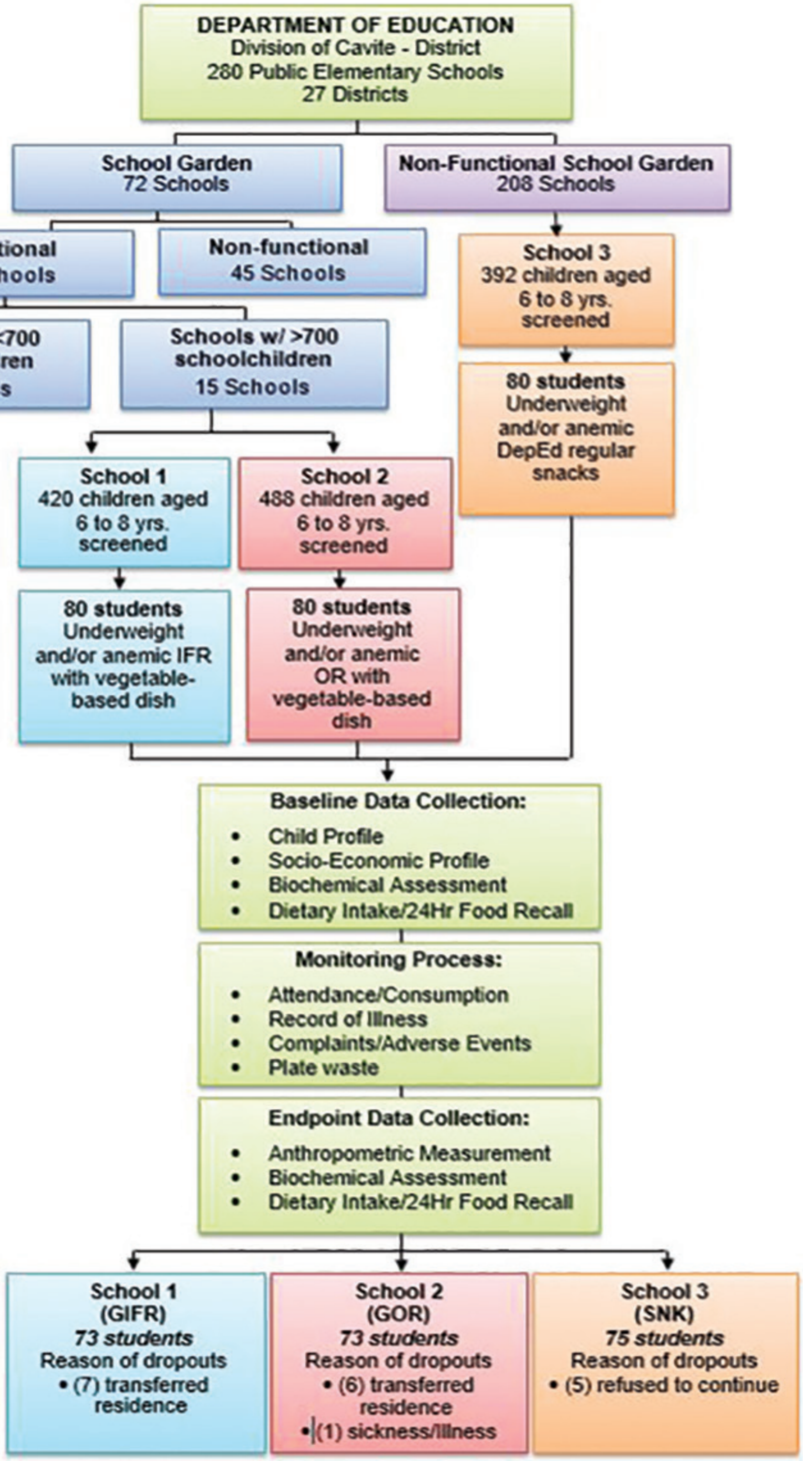

Figure 1. Operational flow of the study.

had poor garbage system, and 24% had poor waste disposal system. Monthly family income was significantly different between schools (p=0.03), with GOR having the highest family income of Php 12,024 (±11,801) with daily food expenditure of Php 236.58 (±103.00) (Table 2).

The mean age of children and gender allocation were similar between groups. The percentage of children who were dewormed was significantly different between groups (p=0.009); SNK had the highest percentage of dewormed children (93.8%), while GOR (84%) and GIFR had the lowest (76.2%).

Table 2. Socio-demographic characteristics of study children by group.

Variable	GIFR [n=80] n (%)	GOR [n=80] n (%)	SNK [n=80] n (%)	Total n (%)
Family type				
Nuclear	49 (61.2)	50 (62.5)	53 (66.2)	152 (63.3)
Extended	31 (38.8)	30 (37.5)	27 (33.8)	88 (36.7)
Type of dwelling unit				
Single house	50 (62.5)	60 (75.0)	64 (80.0)	174 (72.5)
Duplex	8 (10.0)	9 (11.2)	3 (3.8)	20 (8.3)
Apartment/ tenement	11 (13.8)	3 (3.8)	9 (11.2)	23 (9.6)
Makeshift/ *barong-barong*	11 (13.8)	8 (10.0)	4 (5.0)	23 (9.6)
Tenure status of dwelling unit				
Own	28 (35.0)	34 (42.5)	40 (50.0)	102 (42.5)
Rent	27 (33.8)	17 (21.2)	17 (21.2)	61 (25.4)
Free	19 (23.8)	24 (30.0)	19 (23.8)	62 (25.8)
Squat	6 (7.5)	5 (6.3)	4 (5.0)	15 (6.3)
Tenure status of lot being occupied				
Own	8 (10.0)	24 (30.0)	19 (23.8)	51 (21.2)
Rent	26 (32.5)	19 (23.8)	23 (28.8)	68 (28.3)
Free	28 (35.0)	32 (40.0)	23 (28.8)	83 (34.6)
Squat	18 (22.5)	5 (6.3)	15 (18.8)	38 (16.8)
Main type of food storage				
Refrigerator	26 (32.5)	35 (43.8)	24 (30.4)	85 (35.6)
Screened/ enclosed cabinet	15 (18.8)	10 (12.5)	6 (7.6)	31 (13.0)
On table with cover	39 (48.8)	35 (43.8)	49 (69.4)	123 (51.5)
Garbage disposal				
With garbage collection system	64 (80.0)	59 (73.8)	61 (76.2)	184 (76.7)
Open pit then burned	15 (18.8)	15 (18.8)	8 (10.0)	38 (15.8)
Throw anywhere	1 (1.2)	6 (7.5)	11 (13.8)	18 (7.5)
Waste disposal system				
Water sealed	36 (45.0)	70 (87.5)	73 (91.2)	179 (74.6)
Sanitary pit privy	44 (55.0)	9 (11.2)	4 (5.0)	57 (23.8)
Bored hole latrine/ others		1 (1.2)	3 (3.7)	4 (1.7)
Mother's highest educational status				
No education/ elementary level	13 (16.2)	13 (16.3)	10 (12.5)	36 (15.1)
High school level	49 (61.2)	48 (60.0)	57 (71.2)	154 (64.2)
College level	17 (21.2)	19 (23.8)	13 (16.2)	49 (20.4)

Table 2 continuation

Father's highest educational status				
Elementary level	7 (8.8)	12 (15.0)	15 (19.0)	34 (14.2)
High school level	51 (63.8)	45 (56.2)	55 (69.6)	151 (63.2)
College level	22 (27.5)	22 (27.5)	6 (7.6)	50 (20.9)
Occupation of the major bread winner				
Unemployed			2 (2.5)	2 (0.9)
Professional/ technician/ skilled laborer	30 (41.7)	37 (46.3)	38 (47.5)	105 (45.3)
Service/ unskilled worker	42 (58.3)	43 (53.6)	40 (50.0)	125 (53.9)
Source of drinking				
Waterworks	14 (17.5)	34 (42.5)	7 (8.8)	55 (22.9)
Deep/ dug well	8 (10.0)	5 (6.2)	16 (20.0)	29 (12.1)
Purified bottled water	58 (72.5)	41 (51.2)	57 (71.2)	156 (65.0)

Variable	**GIFR Mean (±SD)**	**GOR Mean (±SD)**	**SNK Mean (±SD)**
Household size	6.02 (±2.37)	5.92 (±1.94)	6.43 (±2.98)
No. of children	3.32 (±1.77)	3.25 (±1.36)	3.48 (±1.48)
Monthly family income, (Php)[1]	9,896.92 (±5870.64)	12,023.98 (±11,800.86)	8,560.75 (±5,810.95)
Daily food expenditure	225.38 (±109.97)	236.58 (±103.00)	215.00 (±96.33)

[1]significantly different between groups

Basal and endpoint mean weight was similar between groups; however, within group mean increment in weight was significantly higher in GIFR (1.33±0.72; *p*=0.005) and SNK (1.30±1.72; *p*=0.005) than GOR (0.84±0.59). Translating the results to prevalence of underweight at endpoint revealed that the decrease in GOR was significantly higher (56.2% to 34.2%; *p*=0.002) than the decrease in the GIFR (35.6% to 32.9%) and the SNK group (57.3% to 46.7%).

Mean height were similar between groups at baseline; at endpoint significant increases were observed in all groups (*p*<0.05). There were significant decline in the prevalence of stunting in the GIFR (43.8% to 26.0%; *p*=0.004) and in the SNK (42.7% to 25.3%; *p*=0.011) between time periods but no significant difference was observed between groups.

BMI has significantly increased between time periods in the GIFR (0.24 (±0.54; *p*= 0.0004) and in the SNK (0.24 ±0.88; *p*=0.022) while the GOR group had significantly decreased (–0.17±0.62; 0.0210). The prevalence of wasting remained similar between baseline and endpoint in all groups.

Basal mean MUAC was significantly higher in GIFR (15.85±0.86; *p*<0.05) than in the SNK (15.42±0.95). At endpoint, there was no significant intergroup difference in MUAC but intragroup significant increases were seen in GIFR (0.16±0.60; *p*=0.025) and GOR (0.32±0.51; *p*=0.000) between time periods (Table 3).

The proportion of children with normal CRP concentration was similar among groups at baseline and endpoint. No significant change was seen from baseline and endpoint in all groups.

Mean hemoglobin was similar between groups at baseline. At endpoint, mean increment in GIFR was significantly higher (0.49±0.99; *p*=0.032) than in GOR. Although an intragroup mean increase was seen in the SNK (0.24±0.79), this was not high enough to cause a significant intergroup difference. On the other hand, the baseline prevalence of anemia was significantly lower in the SNK (42.7%; *p*=0.000) than in GIFR (65.8%) and GOR (64.4%). However, at endpoint, only GIFR had an intragroup significant decline (65.8% to 47.9%; *p*=0.000). The prevalence in GOR and the SNK remained similar at endpoint, but the prevalence in the SNK was consistently significantly lower (*p*=0.003) than in GOR (Table 4)

No significant difference in mean SF between groups at baseline and endpoint was reported. Iron deficiency was not present among the schoolchildren at baseline and endpoint.

Baseline mean VA was significantly lower in GIFR (30.46±5.58; *p*=0.04) than the SNK (32.62±6.73) but at

Table 3. Anthropometric measurements and biochemical markers of children at baseline and endpoint by school.

Measurement	GIFR Mean (±SD)	GOR Mean (±SD)	SNK Mean (±SD)	*P*
Weight (kg)				
Baseline	16.56 (±1.71)	16.90 (±1.69)	16.45 (±1.64)	0.946
Endpoint	17.90 (±1.86)	17.74 (±1.73)	17.74 (±2.03)	0.392
Difference	1.33 (±0.72)[1]	0.84 (±0.59)[1,2]	1.30 (±1.27) [2]	<0.0001
P[a]	<0.0001	<0.0001	<0.0001	
Height (cm)				
Baseline	110.32 (±5.37)	109.92 (±5.13)	110.52 (±5.01)	0.832
Endpoint	113.67 (±5.50)	113.08 (±5.24)	113.83 (±5.06)	0.776
Difference	3.35 (±0.60)	3.16 (±0.63)	3.31 (±0.72)	0.276
P[a]	<0.0001	<0.0001	<0.0001	
BMI (kg/m^2)				
Baseline	13.60 (±0.84)	14.03 (±0.90)	13.46 (±0.85)	0.858
Endpoint	13.83 (±0.81)	13.86 (±0.82)	13.69 (±0.94)	0.381
Difference	0.24 (±0.54)[1]	–0.17 (±0.62) [1,2]	0.24 (±0.88)[2]	<0.0001
P[a]	0.0004	0.0210	0.0222	
MUAC (cm)				
Baseline	15.85 (±0.86)[3]	15.64 (±0.98)	15.42 (±0.95)[3]	0.021
Endpoint	16.01 (±0.94)	15.96 (±0.92)	15.70 (±2.06)	0.221
Difference	0.16 (±0.60)	0.32 (±0.51)	0.28 (±2.15)	0.752
P[a]	0.0253	<0.0001	0.2629	

[a] significance within group; [1,2,3] significantly different between groups

Period	GIFR Mean (±SD)	GOR Mean (±SD)	SNK Mean (±SD)	*P*
Hemoglobin (g/dL)				
Baseline	12.60 (±0.96)	12.52 (±0.77)	12.75 (±0.91)	0.304
Endpoint	13.09 (±0.71)[1]	12.64 (±0.86)[1,2]	12.93 (±0.84)[2]	0.003
Difference	0.49 (±0.99)[1]	0.12 (±0.70)[1]	0.24 (±0.79)	0.028
P[a]	0.0001	0.1400	0.0120	
Serum ferritin (mg/mL)				
Baseline	37.00 (±22.25)	38.42 (±19.24)	36.44 (±25.99)	0.862
Endpoint	40.24 (±23.95)	43.78 (±33.49)	37.90 (±23.15)	0.425
Difference	3.24 (±20.15)	5.36 (±31.05)	1.46 (±22.03)	0.640
P[a]	0.177	0.145	0.572	
Vitamin A (µg/dl)				
Baseline	30.46 (±5.58)[3]	30.15 (±5.63)	32.62 (±6.73)[3]	0.0267
Endpoint	32.29 (±5.52)[3]	30.42 (±5.98)	29.00 (±5.76)[3]	0.0028
Differencew	1.83 (±6.60)	0.27 (±5.86)	-3.62 (±5.21)	0.4989
P[a]	0.6697	0.9524	0.0606	

[a] significance within group; [1,2] significantly different between groups

Table 4. Prevalence of underweight, stunting, wasting, anemia, and normal CRP status among children at baseline and endpoint by school.

Nutritional Status	GIFR [n=73] n (%)	GOR [n=73] n (%)	SNK [n=75] n (%)	X^2 Test
Underweight				
Baseline	26 (35.6)[1,3]	41 (56.2)[1]	43 (57.3)[3]	0.013
Endpoint	24 (32.9)	25 (34.2)	35 (46.7)	0.162
P^a	0.824	0.002	0.169	
Stunted				
Baseline	32 (43.8)	27 (37.0)	32 (42.7)	0.667
Endpoint	19 (26.0)	18 (24.7)	19 (25.3)	0.982
P^a	0.004	0.078	0.011	
Wasted				
Baseline	6 (8.2)	11 (15.1)	15 (20)	0.124
Endpoint	8 (11.0)	11 (15.1)	14 (18.7)	0.421
P^a	0.727	1.000	1.000	
Anemia				
Baseline	48 (65.8)[3]	47 (64.4)[2]	32 (42.7)[3,2]	0.000
Endpoint	35 (47.9)	45 (61.6)[2]	27 (36.0)[2]	0.008
P^a	0.000	0.500	0.063	
CRP concentration within normal ranged				
Baseline	70 (95.9)	71 (97.3)	68 (90.7)	0.982
Endpoint	70 (95.9)	68 (93.2)	70 (93.3)	0.894
P^a	1.000	0.453	0.774	

[a]significance within group; [1,2,3]significantly different between groups

endpoint, mean level was significantly higher in GIFR (32.29 ±5.52; p=0.003) than in the SNK (29.00±5.76) (Table 3). Mean level in the GOR had slightly increased from baseline to endpoint, while the SNK had a slight decline. VAD was not observed among the schoolchildren at base and end of the study.

Mean difference in energy and nutrient intake of children had no significant change between time periods in all groups (Table 5**).** Majority of the children in all schools were able to attend 90–120 feeding days. Plate waste only occurred during the first two weeks of the supplementary feeding, with weight ranging 50–65 g vegetables.

DISCUSSION

Nutrition-sensitive programs like supplementary feeding draw on complementary sectors such as agriculture, health, education, water, and sanitation to affect the underlying determinants of nutrition including poverty, food insecurity, water, and sanitation services (WHO 2001) that are often implemented at large scale and can be effective at reaching poor populations (WHO *et al*. 1982).

SBFP is an expensive nutrition specific program. To complement and lessen the cost, school gardens are being promoted for use in feeding programs. However, during the study period, the disconnect between the school supplementary feeding and school gardening programs of DepEd was evident due to some lacking components like how to utilize the garden produce in a way that children would like it. It is a well-known fact that some children evade the consumption of vegetables. To address this issue, the researchers developed standardized vegetable-based recipes using the school garden produce. These recipes were colorful, attractive, and suitable for the taste of children. Some of these recipes had provided at least 30% of the recommended nutrient intake for iron and VA, 17–51% for energy, and 19–48% for protein (Table 1). Given this scenario, this study aimed to evaluate the

Table 5. Mean energy and nutrient intakes of children at baseline and endpoint by school.

Energy and Nutrient	GIFR	GOR	SNK	ANOVA *F*-test
	Mean (±SD)	Mean (±SD)	Mean (±SD)	
Energy				
Baseline	1359 (±456)	1299 (±434)	1331 (±504)	0.760
Endpoint	1340 (±598)	1206 (±480)	1308 (±501)	0.639
P[a]	0.8352	0.1770	0.7578	
Protein				
Baseline	43.61 (±18.83)	40.46 (±14.20)	41.93 (±17.03)	0.604
Endpoint	43.76 (±20.36)	37.84 (±15.74)	43.64 (±22.32)	0.351
P[a]	0.9637	0.3115	0.5853	
Calcium				
Baseline	317.72 (±206.07)	313.10 (±168.84)	294.96 (±162.87)	0.586
Endpoint	366.84 (±263.21)	311.90 (±204.29)	307.12 (±212.59)	0.288
P[a]	0.2186	0.9727	0.7026	
Iron				
Baseline	7.50 (±3.57)	8.44 (±4.88)	7.38 (±3.42)	0.917
Endpoint	7.78 (±4.14)	8.66 (±7.72)	7.22 (±3.73	0.332
P[a]	0.6894	0.8395	0.7931	
Vitamin A				
Baseline	311.07 (±222.78)	439.47 (±309.40)	331.36 (±293.90)	0.192
Endpoint	394.46 (±470.53)	410.65 (±318.71)	290.37 (±205.88)	0.147
P[a]	0.1766	0.5986	0.3453	
Vitamin C				
Baseline	19.43 (±35.39)	29.96 (±38.24)	21.38 (±21.05)	0.066
Endpoint	41.67 (±91.90)	31.04 (±46.10)	18.93 (±24.39)	0.513
P[a]	0.0589	0.8739	0.5176	
Thiamin				
Baseline	0.70 (±0.38)	0.79 (±0.52)	0.77 (±0.58)	0.340
Endpoint	0.76 (±0.48)	0.71 (±0.39)	0.68 (±0.40)	0.885
P[a]	0.4187	0.3161	0.3144	
Riboflavin				
Baseline	0.71 (±0.45)	0.73 (±0.37)	0.65 (±0.39)	0.520
Endpoint	0.78 (±0.57)	0.76 (±0.62)	0.84 (±0.89)	0.498
P[a]	0.4714	0.7392	0.0923	
Niacin				
Baseline	11.48 (±5.31)	10.92 (±4.24)	11.83 (±5.84)	0.828
Endpoint	12.71 (±7.38)	11.83 (±5.65)	13.97 (±16.03)	0.684
P[a]	0.2769	0.3044	0.3004	

[a] significance within group

effectiveness of supplementary feeding in improving the weight, VA, and iron status of children using vegetables from school gardens and IFR (Table 1).

This study revealed significant increases in weight in all groups between time periods. This confirms the benefit of supplementary feeding program on improving weight of children. In any feeding activity conducted among undernourished children, the first response is improvement in weight. A previous study had found moderate to high quality evidence for the effectiveness of supplementary food in treating moderate acute malnutrition in children from low- and middle- income countries (Lazzerini *et al*. 2013, Huybregts *et al*. 2012, Best *et al*. 2011). Supplementary feeding programs for children have the intermediate goal of curing (or at least ameliorating) existing undernutrition, while others aim to prevent undernutrition (Kristjansson *et al*. 2016). It is recommended for supplementary feeding programs to be generally designed to meet 40–50% of the estimated gap between the child's energy needs and the energy they are receiving from usual meals (Kristjansson *et al*. 2016) for it to be more effective. In this study, the lower limit of energy provided only 17% for the GIFR and GOR schools and 13% for the SNK, but significant increase in weight was still observed in all groups.

A question lingers on why the SNK group had significantly increased in weight relative to the two schools that received lunch. The significantly higher percentage of dewormed children in the SNK than in the other two schools might have contributed to the significant weight gain at endpoint in this group because of effective absorption of nutrients. Helminth burdens are most intense during the years of schooling (Allen & Gillespie 2001), and deworming had been significantly found to improve physical growth with positive effects on school participation rates (Bundy *et al*. 2009, Kazianga *et al*. 2009). The program of the DepEd on twice a year deworming is a very good approach towards having beneficial effect in improving health and nutritional status of children. It has been well-founded that complimentary health and nutrition services like deworming with school feeding can lead to better nutritional outcomes in schoolchildren than school feeding alone (Allen & Gillespie 2001, Bundy *et al*. 2009). However, the low percentage of dewormed children in the other two schools is a cause of concern that needs effective approaches to convince parents to subject their children for deworming. Another reason might be the conduct of orientation of the project wherein communicating the goals and activities of the study to the participants' parents or caregivers could have caused an intervention bias that led the parents in the SNK to modify and improve their provision of maternal care better than the two other schools.

A closer look on the results, however, revealed that although there was a higher significant mean increase in weight in the GIFR and SNK at endpoint, this did not translate to the reduction in underweight in these two groups whereas the GOR had significantly reduced prevalence. The GOR group had a high percentage of underweight at baseline so children might have responded immediately with the lunch, thus yielding higher energy than the snacks given in the SNK. Energy content in the SNK might be insufficient to cause the conversion of undernutrition to normal status. The GIFR group – given the same meal as that of the GOR – had slight reduction in the prevalence of underweight condition, which could be attributed to the low percentage of dewormed children at baseline. Worm load might have an effect in the utilization of energy (Allen & Gillespie 2001, Bundy *et al*. 2009).

The lack of inter-group mean difference in height increment reflected that stunting could not be addressed by a single intervention alone but by a mix of nutrition, food, and health programs like personal hygiene and environmental sanitation. Our study revealed that 23% had poor garbage system and 24% had poor waste disposal system. Poor environmental sanitation could be the focus of nutrition sensitive interventions in these schools because, if left unsolved, it might lead to frequent attacks of illness and helminthes infestation. Stunting (low height-for-age) reflects a chronic form of undernutrition where the child has been exposed to the cumulative effects of undernutrition and infections since and even before birth. This measure can therefore be interpreted as an indication of poor environmental conditions or long-term restriction of a child's growth potential (WHO 2010). This requires new and more aggressive interventions with focus on coupling effective nutrition-specific and nutrition-sensitive interventions to address both the immediate and underlying causes of undernutrition (Josshi *et al*. 2011).

The consumption of IFR in GIFR had significantly improved the Hb level of children, resulting in significant reduction in anemia prevalence (from 65.8% to 47.9%). This confirms the findings in previous studies wherein IFR had been effective in increasing Hb level among schoolchildren (Angeles-Agdeppa *et al*. 2008). Moreover, the effectiveness of iron food fortification in battling iron deficiency anemia has been proven in previous studies in the Philippines (Angeles-Agdeppa *et al*. 2008). SF levels in all groups were remarkably at low normal at baseline especially in GIFR, which explains why children had slightly higher baseline-to-endpoint increment (37.00±22.25 to 40.24±23.95 mg/mL). Iron absorption from a meal is very inefficient under condition of sufficiency. Moreover, various pathologies can influence the relationship between the rate of iron absorption and body iron levels. Absorption of dietary iron by the proximal intestine is thus accurately regulated by cellular and systemic factors to ensure that overall body iron levels are maintained at adequate levels (Gulec *et al*. 2014).

VA levels in all groups were similar at baseline and endpoint. VA plays a role in the release of iron from the liver for use by the different tissues (Mejía & Chew 1988). Relating this observation with iron status, it implies that iron stores were available for hematopoiesis because of VA adequacy. The slightly higher increment in mean serum VA levels in GIFR and GOR might have been contributed by the consumption of vegetables from the developed recipes, which had provided at least 30% and more of the recommended intakes for VA. The SNK school had decreased VA level, which might have been attributed to the types of snacks served (*i.e*., more on calorie-rich foods). The developed standardized recipes utilizing the vegetables from the school gardens had trained children to consume vegetables since no plate waste was seen after two weeks.

A factor on poverty limits food choices and therefore the economic capacity to obtain food from available supply would be limited (Kanjilal *et al*. 2010). In this study, there was a high percentage (44–58%) of poor households (NSCB 2012), particularly those living in shanties and tenements (19%). In situations where there is food insecurity, food supplementation should be designed to address the requirement gap in energy and other nutrients.

LIMITATIONS OF THIS STUDY

Since this study did not have a supervised regimen in the SNK group, there might be an over- or under- estimation of intake of children that might have affected the results of the study.

CONCLUSION

Supplementary feeding is effective in improving the weight of schoolchildren. The model of linking the use of vegetables from school garden had improved VA levels and the use of IFR has added benefit in increasing Hb.

RECOMMENDATIONS

More effective efforts should be conducted to increase the rate of dewormed children. There is a need to capacitate supplementary feeding coordinators on proper food handling, food safety, and basic nutrition concepts to promote change in serving healthy school meals utilizing school garden produce and to encourage children's lifelong healthy eating habits. Sustainability efforts to involve multi-sector actions of partner organizations to link school meals with other key enhancing factors – including nutrition education; school gardening; environmental sanitation; family, school, and community involvement; use of IFR in wider scale; and technical support to help schools – could achieve an overall improved health and nutritional status of schoolchildren.

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