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The Effect of a Nutrient Fortified Oat Drink on Iron, Zinc, Vitamin A, and Vitamin C Status among Filipino Children

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***Abstract*—**The effectiveness of consuming a nutrient fortified oat drink on iron, zinc, vitamin A and vitamin C status was assessed among a cohort of school-aged Filipino children. Ultimate study implementation permitted only a within-subject comparison of change in nutritional status after four months of consuming a nutrient fortified oat drink. Thirty-eight anemic children (5-8 years) consumed an oat drink fortified with iron as NaFeEDTA, zinc, vitamin A and vitamin C for 120 days. Height, weight, serum nutrient levels, anemia status and dietary intake were assessed pre and post intervention. Thirty-four anemic children completed the intervention. After 4 months of intervention, prevalence of anemia decreased by 68% and significant improvements in iron and vitamin A status were observed. Results demonstrate the effectiveness of the fortified oat drink in alleviating anemia in young children and highlight the value of fortification programs

***Keywords*—**Anemia, Children, Fortified Oat Drink, Nutrient status

I. Introduction

MICRONUTRIENT malnutrition is widespread and impacts approximately two billion people or over 30% of the world's population [1].In developing countries like the Philippines, deficiencies in energy, protein, and micronutrients remain prevalent among young children. Results of the National Nutrition Survey reported that among 6-10 year old schoolchildren, 32% were underweight and 33.6% were under-height. In addition, the prevalence of anemia among 6 – 12 year olds was 19.8 %, while vitamin A deficiency was 11.1%, and vitamin C deficiency was 21.6% [2]. The 2008 National Nutrition Survey on Food Consumption also reported that 13.5%, 21.5%, and 30.2% of surveyed households were not meeting 80% of the Recommended Energy and Nutrient Intakes (RENI) [3] for iron, vitamin A and vitamin C, respectively [2]. Therefore, the available data indicates that Filipino children are likely to be at risk of several micronutrient deficiencies, specifically: iron, vitamin A, and vitamin C. As iron and zinc deficiency usually co-exist, zinc deficiency is also likely in the population [4].

As food fortification is the most feasible, cost-effective, and sustainable way to improve the micronutrient status of children [5], and a recent study determined that regular consumption of a multi-micronutrient fortified ready-to-drink beverage resulted in a decline in rates of anemia [6], fortification was considered a good strategy to help alleviate these nutrient deficiencies in a young Filipino population.

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Additionally, as oats provide a source of whole grains and a flavoured oat drink is likely to appeal to young children, a powdered oat drink mix was used as the base food for fortification. Each drink mix was fortified with a third of the RENI for micronutrients of concern in the Filipino population (iron, zinc, vitamin A and vitamin C), as per the recommendations of the food fortification regulations in the Philippines.

Most whole grains, including oats, are high in phytates which decrease the absorption of minerals like calcium, zinc and iron. Hazell and Johnson [7] estimated iron diffusibility from oatmeal to be about 5% and demonstrated that phytate content was negatively associated, while ascorbic acid content was positively associated with iron diffusibility. Cook et al., [8] measured iron absorption in adults from several infant cereals including oats and reported that oats contain about 3-5% phytic acid and 22 – 25 mg/kg iron. Results of the study indicated that only 0.5% of the iron was absorbed from a 50g portion of the oat cereal fortified with 2.5g iron as FeSO4.

As bioavailability of iron in the presence of high phytate levels can be improved with the addition of ascorbic acid, fortification with NaFeEDTA, or addition of phytase to a product [9] the oat drink was fortified with vitamin C and iron as NaFeEDTA.

This study investigated the impact of consuming a fortified oat drink daily over a four month period on the improvement of iron, zinc, vitamin A and vitamin C statusand prevalence of anemia in a population of school age Filipino children. Specifically the study: assessed the hemoglobin and serum ferritin levels of children before and after the intervention; compared the serum zinc, vitamin A and C status of children before and after the intervention; compared weight and height changes in the children before and after the intervention; and determined changes in nutrient intakes in the group overtime.

II. Subjects and Methods

A. Study Design and Participants

The study followed a randomized, double-blind, placebo-controlled, parallel-group design. Participants were recruited from 4 elementary schools in Cubao, Quezon City, Philippines. The protocol was approved by the FNRI Institutional Ethics Review Committee. Administrators at each school were oriented to the study to motivate them to actively participate. Scheduled orientations to discuss the purpose and study details with parents were conducted in the 4 schools. Roles and responsibilities of parents/caregivers, especially during weekend feeding were also explained. After the orientation, a letter of consent to participate in the 120-day feeding period was solicited from each individual parent/guardian.

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A total of 374 schoolchildren submitted signed parental consent for screening and 346 qualified to participate in the screening process. Screening included measures of height and weight, calculated BMI for age, clinical examination and blood extraction for hemoglobin analysis (and later baseline nutrient analysis). A parent/guardian also completed an interview to determine socio-economic status.

All anemic children, defined as hemoglobin (Hb) levels > 70 g/L to < 120 g/L [10], between 5-8 years of age withC-reactive protein (CRP) levels < 10mg/L, not suffering from diarrhea, respiratory infection or fever at the time of interview or during the last two weeks, without a history of blood disorder or malaria, who had not participated in any feeding program for the past 4 months, and those who had written signed parental consent were recruited for the study.

Exclusion criteria included: children < 5 years and > 8 years, undergoing treatment for any chronic ailment, diagnosed as suffering from any chronic illness, with reported or current history of blood abnormalities/ hemoglobinopathies, with normal Hb level (Hb $\geq$120.0 g/L) or very low Hb (Hb< 70.0 g/L) and with high CRP (> 10mg/L). Children with very low Hb levels were referred to a physician for treatment.A total of 76 anemic children were considered eligible to participate in the study.

Qualified children were randomly allocated into 2 groups. Group 1 (n=38)received the fortified oat drink and Group 2(n=38) received the unfortified oat drink. The powdered drink mixes were packaged in foil packets and coded by color and number. Each child wore color coded identification cards indicating their corresponding number code. Codes were revealed to the Research Team after data analysis.

Retrospectively, it was determined that unfortified product for the control group had erroneously been fortified. Subjects in the fortified treatment arm did receive the correct product as verified by chemical analysis of study product before and after the intervention. Therefore, only data from the fortified treatment arm (n=34) was analyzed for within subject change in nutritional status from baseline to the end of the 4 month intervention.

The intervention was for one hundred twenty feeding (120) days or approximately 4 months. Subjects consumed intervention products from Monday to Friday under a supervised regimen in a central feeding location at each school. Research Assistants (RA) prepared 1 foil pack of dry oat drink mix (28g) by adding 50 mlhot and 100 ml cold water and stirring for a few minutes until all the powdered mix was dissolved. Children consumed the entire test drink completely under the direct supervision of the study staff. Oat drink consumption compliance was checked and recorded every day by the RA. For weekend feeding, a take home allocation was given with strict preparation and feeding instructions to parents. The actual intervention was conducted from August to December 2011.

Sample size for within subject comparison of change in nutritional status from baseline was calculated using a difference of 80g/L of hemoglobin with a standard deviation of 90.5 g/L, 95% confidence interval and 90% power revealed that a minimum difference of 51.05 g/Lwas required to achieve significant difference between baseline and post intervention at the 5% significance level. This yielded a minimum sample size of 30 children.

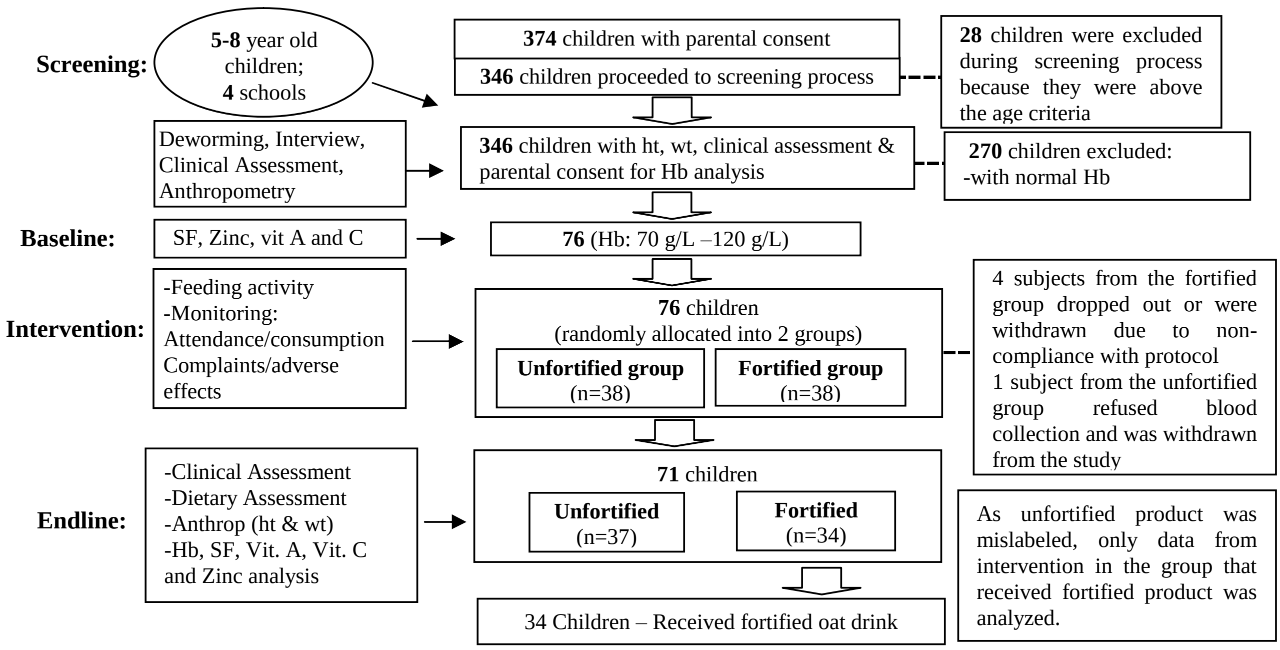

Fig. 1 Operational Flow of the Study

B. Fortified Oat Drink

The test drink mixes were prepared by PepsiCo Asia Services Ltd., Bangkok, Thailand. Test products were packed and sealed in individual foil packets providing 28 g /serving of vanilla flavored powdered instant oat drink mix labeled with a unique 3-digit identifier/ code and a color code. The product consisted of a dry oat drink mix made with oats, sugar, skim milk, maltodextrin, iodized salt, and flavoring.

One product was fortified with 3.25mg of iron (NaFeEDTA), 2.34mg zinc (zinc oxide), 225mcg RE of vitamin A and 45mg vitamin C, to ensure 3 mg iron (as NaFeEDTA) (33% RENI), 2 mg zinc (37% RENI), 133 mcg RE vitamin A (33% RENI) and 30 mg vitamin C (100% RENI) per 28g serving. The other test product was not fortified.

Both test product mixes were analyzed for nutritional composition before and after the intervention. Analysis of products after the intervention revealed that some unfortified product contained fortification.

It was determined that at some point during product production the fortified drink mix recipe was erroneously prepared instead of the unfortified recipe.

TABLE I
NUTRIENT CONTENT OF THE FORTIFIED OAT DRINK MIX AS ANALYZED BEFORE START OF THE STUDY

Nutrients	Fortified Oat Drink per 100g	Fortified Oat Drink per 28g
Energy (kcal)[2]	400.0	112
Protein (g)[2]	6.83	1.9
Fat (g)[2]	4.27	1.19
Carbohydrates (g)[2]	83.63	23.42
Iron (mg)[2]	13.2	3.69
Vitamin A (µg RE)[2]	659.67	184.7
Calcium (mg)[2]	103.3	28.92
Zinc (mg)[1]	8.61	2.41
Vitamin C (mg)[1]	134.24	37.59

[1] SGS Lab, Thailand; [2] FNRI Laboratory, Philippines.

C. Field and Laboratory Methods

Parents/caregivers of the children were interviewed face-to-face using a pre-tested structured questionnaire. The general profile of the child, as well as health or clinical data, nutrition related data, food intake and socio-economic-demographic data were collected.

Dietary assessment for one weekday and one weekend day was collected during face-to-face interviews with a parent/caregiver of the child pre and post intervention using 24h food recall questionnaires.

Quantity of intake was estimated using standard household measures that were available to each RA during the interview. Food intake was computed and translated to mean nutrient intake using the Philippine Food Composition Table [11] and the Individual Dietary Evaluation System (IDES) developed by FNRI.

During screening, clinical assessment of all 346 children was conducted. Children's skin, conjunctiva, buccal mucosa and palm/nail bed were examined. Illnesses experienced by the children in the preceding 2 weeks were noted. Intake of vitamins and other medications by the children were recorded.The ears, eyes, nose and throat were examined and observations were recorded.

The Department of Education administers 400mg of Albendazole twice a year, every June to July and between February and March, to all school children. Prior to start of the study in August 2011, 66 of the children had already been dewormed. The remaining 10 children were given 400mg of Albendazole prior to the start of the intervention.

Albendazole is a safe and effective drug for the treatment of the helminthiasias or paratism involving round worms and even problematic infections such as echinococcosis. It is one of the most widely used deworming drugs for adults and children. The 400 mg single dose for children 2 years old and above has been established to be safe and effective for 4-6 months. The current program of the Department of Education is to deworm schoolchildren every 6 months, since possible re-infestation rate occurs between 4 to 6 months.

Anthropometric measures included weight, height and nutritional status pre and post intervention. Weight was measured to the nearest 0.1 kg in lightweight clothing without shoes using a calibrated Detecto weighing scale (Wedd City, Mo. USA). Height was measured to the nearest 0.1 cm while children were barefoot and standing straight upright with their back flat against a wall using Microtoise (Depose, France). Nutritional status was assessed using the Anthro Plus Software of WHO to derive BMI, weight-for-height z-score (WHZ), height-for-age z-score (HAZ), weight-for-age z-score (WAZ) (WHO Reference 2007 for school-aged children and adolescents (5-19 years old).

Biochemical assessment included measures of Hb, serum ferritin, serum zinc, vitamin A and vitamin C and CRP. Non-fasting blood samples (about 5 mL) were collected at screening (baseline) and after 4 months of intervention (endline). All samples were collected in the morning and processed immediately for Hb using a portable spectrophotometer (Odyssey 2800 by Hach) and CRP using Humatex CRP. Separation of serum from red blood cells was conducted within hours of collection. Serum samples were transported in a cool box with wet ice to the FNRI laboratory and stored immediately at -800 C until analysis. Baseline and endline serum ferritin, serum zinc, serum ascorbic acid, and serum vitamin A were assessed at the same time after the intervention was complete.

Serum ferritin was measured using COAT-A-COUNT FERRITIN IRMA which employs Immunoradiometric Assay Procedure [12]. Vitamin A (retinol) was measured using an isocratic elution high performance liquid chromatography (HPLC) method [13]. Serum zinc was determined by atomic absorption spectrometer [14,15]. Ascorbic acid (vitamin C) was measured spectrophotometrically [16].

D. Statistical Analysis

The One-sample Kolmogorov-Smirnov test was employed to test the normality of distribution for all anthropometric and biochemical measurements. For non-normally distributed data, percentiles (median, 25th and 75th percentile) were used in describing the distribution of the data. For the non-parametric comparison, Wilcoxon Signed rank test was used to compare two related samples (e.g. serum ferritin, Vit A, C and calcium intakes).

For the normally distributed data, within subject comparison of change from baseline to endline for biochemical and anthropometric indicators for the fortified treatment group was calculated using paired t-test [17,18]. Anemia was defined as Hb > 70 g/L to < 120 g/L [10]. Iron deficiency was defined as serum ferritin level < 15 ng/ml [19].

Vitamin A deficiency was defined as serum retinol <10µg/dl and insufficiency as serum retinol between 10-19 µg/dl [20]. Zinc deficiency was defined as serum zinc level <65µg/dl [21] while vitamin C deficiency was defined as ascorbic acid <0.30 mg/dL [22].

III. Results

A. Profile of Subjects

A total of 374 children had parental consent to participate in the study. However, 28 children were excluded because they were over-age. The remaining 346 children were screened for anemia and for the absence of infection (CRP <10 mg/L). After evaluating inclusion / exclusion criteria, a total of 76 (22%) children qualified for the study and were divided into two groups of 38 participants each.

Four children from the fortified treatment group were withdrawn from the study due to non-compliance to feeding protocol and one child from the control group refused blood collection at end of the study and was withdrawn at that time. Demographic data from the families of the 38 children enrolled and anthropometric and biochemical assessments of the 34 children who completed the fortified treatment arm are presented.

Table II shows the demographic and socioeconomic characteristics of households in the fortified treatment group.

TABLE II
Demographic and Socio-Economic Characteristics of Households in the Treatment Group

Variable	N	%
Civil status		
Married	30	81.1
Separated	2	5.4
Single	-	-
Not yet married	5	13.5
Family type		
Nuclear	23	62.2
Extended	14	37.8
Education of mother		
Elementary Undergraduate	-	-
Elementary Graduate	4	10.8
High School Undergraduate	6	16.2
High School Graduate	9	24.3
College Undergraduate	11	29.7
College Graduate	2	5.4
Vocational Graduate	4	10.8
N/A (don't know)	1	2.7
Education of father		
Elementary Graduate	4	10.8
High School Undergraduate	4	10.8
High School Graduate	8	21.6
College Undergraduate	6	16.2
College Graduate	12	32.4
Vocational Graduate	3	8.1
N/A (don't know)	-	-
Occupation of mother		
Service related	7	18.9
Business/self-employed	3	8.1
Professional/technical	1	2.7
Clerical related	1	2.7
Housewife	23	62.2
Unemployed	2	5.4
Occupation of father		
Agriculture	1	2.7
Production	1	2.7
Service related	14	37.8
Business/self-employed	2	5.4
Transportation related	9	24.3
Professional/technical	5	13.5
Clerical related	2	5.4
Overseas Filipino Workers (OFW)	-	-
Unemployed	3	8.1
Source of drinking water		
Waterworks	20	54.1
Deep well-common	-	-
Purified bottled water	17	45.9
Type of garbage disposal		
With garbage collection system	37	100
Waste disposal system		
Water sealed	12	32.4
Sanitary pit privy (de buhos)	25	67.6

Data from 1 subject is missing because parents were not available for the interview and hence, data from 37 children are reported. Almost all of the parent/guardian respondents were married (81.1%) and belonged to a nuclear type of family (62.2%).

Most parents had a high school to college education. Majority of mothers were housewives (62.2%) while the fathers were mostly engaged in service related work (37.8%).

The main source of drinking water in most households was from waterworks (private water supplier with pipelines subcontracted by the govt.). The main type of garbage disposal was through a garbage collection system. The main waste disposal system was sanitary pit privy.

Table III shows the distribution of households in the fortified treatment group based on poverty and food threshold.

Using the 2009 poverty threshold, 37.8% of subject households were below the poverty threshold; 24.3% were food poor. Overall, >50% of the study population was above the poverty line and Not food poor.

TABLE III
Distribution of Households Based on Poverty and Food Threshold in the Treatment Group

Socio-economic characteristics	Fortified Group (n=37)
[1]Poverty threshold	
Poor (≤1,650.17/capita/mo)	14 (37.8%)
Not poor (>1,650.17/capita/mo)	23 (62.2%)

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[1]Food threshold	
Food poor (≤1,152.58/capita/mo)	9 (24.3%)
Not food poor (>1,152.58/capita/mo)	28 (75.7%)

[1] Based on the 2009 poverty threshold and food poverty threshold by regions (NCR district II) of the National Statistical Coordination Board

B. Anthropometric Measurements

Table IV shows results of anthropometric measures. As expected with growing children, the increase in mean height and weight among study children was significantly greater (P<0.001) after 4 months of intervention compared to baseline. Mean HAZ (height-for-age z-score) and WAZ (weight-for-age z-score) also significantly increased within the study periods (P<0.05). Mean HAZ and WAZ before and after the intervention were within the normal height and weight ranges for age, respectively. BMZ (BMI for age z-scores) did not change significantly.

TABLE IV
MEAN ANTHROPOMETRIC MEASUREMENTS OF SCHOOLCHILDREN IN THE FORTIFIED GROUP AT BASELINE AND ENDLINE

Anthropometric measurement/Periods	Fortified Treatment Group (n=34)
Height (cm)	
Baseline	112.0±7.3
Endline	114.7±7.0
Mean Change	2.7 ±2.0
P-value	<0.001[2]
Weight (kg)	
Baseline	19.0±5.3
Endline	20.1±5.9
Mean Change	1.1 ±1.0
P-value	<0.001[2]
Height-for-Age Z-score	
Baseline	-0.97 ±1.06
Endline	-0.73 ±1.01
Mean Change	0.18±0.38
P-value	0.008[1]
Weight-for-Age Z-score	
Baseline	-0.97 ±1.24
Endline	-0.75 ±1.29
Mean Change	0.14 ±0.40
P-value	0.046[1]
BMI-for-Age Z-score	
Baseline	-0.53 ±1.19
Endline	-0.47 ±1.40
Mean Change	-0.08 ±0.77
P-value	0.960

1significant at α=0.05
2significant at α=0.01

C. Clinical Assessment

At baseline, the most prominent clinical manifestations of anemia observed among study children were pale conjunctiva (61.8%) and pale skin (29.4%). The percentage of study children who exhibited clinical manifestations of anemia significantly decreased between baseline and endline (Table V). The decrease that did occur is clinically and significantly relevant for this population.

TABLE V
PERCENT OF CHILDREN IN THE FORTIFIED TREATMENT GROUP EXHIBITING CLINICAL SIGNS OF ANEMIA

Variables	Baseline % of children (N=34)	Endline % of children (N=34)	P value
Pale skin	29.4 (10)	2.9 (1)	0.012
Pale conjunctiva	61.8 (21)	26.5 (9)	0.012
Pale buccal mucosa	0	0	
Pale palm/nail bed	8.8 (3)	0	

D. Biochemical Assessments

Table VI depicts results of the biochemical assessments pre and post intervention. Mean Hb levels significantly increased from 115.1 g/L to 120.2 g/L after 4 months of intervention with a fortified oat drink mix (p<0.001). Mean serum ferritin and vitamin A levels also significantly increased over the 4 month period. However, no differences were observed in serum zinc or vitamin C levels over the study period. The percentage of children with anemia in the fortified treatment group decreased from 100% to 32% over the intervention period (Figure 2). This represents a 68% decrease in prevalence of anemia over the 4 months of fortification.

At baseline and endline, no child was deficient in iron (serum ferritin (SF) <15 ng/ml). No deficiencies or insufficiencies in vitamin A (serum retinol (SR) <20 μg/dl) were observed pre or post intervention. Two children had low vitamin C levels (<0.30 mg/dL) both at baseline and endline. Zinc deficiency (serum zinc (SZ) <65 μg/dl) was observed in 2 children at baseline and 8 children at post intervention.

TABLE VI
NUTRITIONAL STATUS OF CHILDREN AT BASELINE AND ENDLINE

Biochemical Markers	Treatment Fortified Group (n=34)
Hemoglobin level (g/L) [1]	
Baseline	115.1± 0.37
Endline	120.2 ± 0.77
Mean Change	0.51 ± 0.688
P-value within group	<0.001
Serum ferritin level (ng/ml) [2]	
Baseline	49.0 [36.25, 60.5]
Endline	58.5 [42.75,76.0]
Mean Change	9.5
P-value	0.0031
Serum zinc level (μg/dl)[1]	
Baseline	96.59 ± 37.23
Endline	103.56 ± 48.31
Mean Change	6.97 ± 57.13
P-value within group	0.482
Vitamin A level (μg/dl)[1]	
Baseline	35.68 ±7.07
Endline	38.62 ± 7.91
Mean Change	2.94 ± 8.96
P-value within group	0.003
Vitamin C level (mg/dl)[1]	
Baseline	0.481± 0.16
Endline	0.505 ± 0.15
Mean Change	0.024 ± 0.185
P-value within group	0.458

[1] Mean ± standard deviation (SD)
[2] Median [range]

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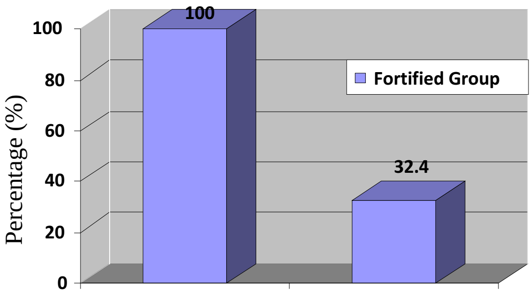

Fig. 2 Prevalence of anemia pre and post intervention

E. Dietary Intake

Results indicate that at baseline only 41.2%, 67.6%, and 26.5% of children in the fortified oat drink group were meeting daily intake requirements for iron, vitamin A and vitamin C, respectively. Nutrient composition of the oat drink was not included in the calculations of usual food intake. Results of food intake from the usual diet of children indicate that mean energy and intakes of vitamin A, calcium, niacin and riboflavin did not differ between baseline and endline (Table VII). Significant decreases were observed in thiamine and vitamin C intakes between time periods.

TABLE VI
ENERGY AND NUTRIENT INTAKE

Nutrient/Periods	Fortified Group (n=34)
Energy (kcal) [2]	
Baseline	1,553 (371)
Endline	1,640.5 (716.5)
Change	87.5
P-value	0.447
Protein (g) [2]	
Baseline	54.7 (18.4)
Endline	52.9 (26)
Change	-1.8
P-value	0.691
Fats (g) [2]	
Baseline	46.55 (16.04)
Endline	45.70 (28.2)
Change	-0.85
P-value	0.167
Carbohydrates (g) [2]	
Baseline	224.70 (60.65)
Endline	254.3 (109.1)
Change	29.6
P-value	0.118
Iron (mg) [2]	
Baseline	9.078 (3.80)
Endline	7.78 (3.81)
Change	-1.298
P-value	0.055
Vitamin A (mcg) [1]	
Baseline	415.0 [288.6, 857.4]
Endline	536.9 [267.1, 1001.8]
Change	121.9
P-value	0.778
Calcium (mg) [1]	
Baseline	380.6 [282.7,569.6]
Endline	339.3 [249.2, 667.8]
Change	-41.3
P-value	0.844
Thiamin (mg) [2]	
Baseline	0.972 (0.445)
Endline	0.84 (0.49)
Change	-0.132
P-value	0.026
Riboflavin (mg) [2]	
Baseline	1.05 (0.636)
Endline	1.02 (0.63)
Change	-0.03
P-value	0.787
Niacin (mg) [2]	
Baseline	16.52 (10.97)
Endline	15.13 (8.21)
Change	-1.39
P-value	0.566
Ascorbic Acid (mg) [1]	
Baseline	23.7 [8.6, 38.7]
Endline	7.1 [3.1, 26.8]
Change	-16.6
P-value	0.014

1Median [range]
2Mean (SD)

IV. DISCUSSION

Anemia, iron deficiency and other micronutrient deficiencies are prevalent in the developing world, especially in women and young children. Anemia affects about 66% of preschool age children in South-East Asia, and about 50% of preschool age children in this region have low serum retinol [23]. In children, anemia is associated with delayed motor and mental development, impaired cognitive function, and reduction in growth rate, weakness, increased fatigue and adverse effects on immune function [24-28]. Anemia affects about 66% of preschool age children in South-East Asia, and about 50% of preschool age children in this region have low serum retinol [23].

Fortification of foods is a feasible, cost-effective, and sustainable way to deliver key micronutrients and improve the micronutrient status of children [5]. Cereal foods are a popular choice for iron fortification programs. However, many grain based products contain phytates which interfere with iron absorption.

Strategies for improving iron absorption from grain based products include fortification with bioavailable forms of iron that are not affected by phytates, like NaFeEDTA, and / or addition of iron absorption enhancers like ascorbic acid (vitamin C) to the fortified food products [9]. These strategies have been successfully employed in several studies [29-31].

In the Philippines, the National Nutrition Survey reported that prevalence of anemia among 6-12 year olds was 19.8 %, while vitamin A deficiency was 11.1%, and vitamin C deficiency was 21.6% (FNRI-DOST, 2008). While the need for fortification programs in this population is apparent, children, by nature, are difficult to feed, therefore this study sought to create a fortified product that was nutritious, tasty and efficacious. This study tested the effects of a powdered oat drink mix fortified with iron, as NaFeEDTA, zinc, vitamin A and vitamin C. The vanilla flavoured fortified powdered oat drink mix was prepared with water to make a drink that children consumed every day for 120 days.

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Results of this study indicated that 22% of the 346 children (6-8 years old) screened at baseline were anemic, which is similar to the reported prevalence of anemia (19.8%) in 6-12 year olds from the Philippine national dataset [2]. Results also indicated that only 41.2%, 67.6%, and 26.5% of children in the fortified oat drink group were meeting daily intake requirements for iron, vitamin A and vitamin C, respectively.

This inadequate intake is comparable to results from the Philippines National Nutrition Survey data which determined that only 11.1%, 22.9% and 30.1% of 6 – 12 year olds were meeting the recommended daily intake (RENI) of iron, vitamins A and vitamin C, respectively. The same survey also determined that only 13.5%, 21.5% and 30.2% of households were meeting the recommended daily intake (RENI) of iron, vitamin A and vitamin C, respectively [2]. Intake of zinc could not be reported because the Philippine Food Composition Table does not yet contain estimates of zinc in foods.

After the 4 month study period, 24 hr dietary recalls showed that mean intakes of vitamin C and thiamine decreased significantly while mean energy intake and intakes of vitamin A, calcium, niacin and riboflavin did not differ between baseline and endline (Table VII).

As anemic children were recruited for this study, all children were anemic at baseline. After 4 months of intervention with a fortified oat drink, mean Hb levels significantly increased from 115.1 g/L to 120.2 g/L ($p<0.001$) and serum ferritin levels increased from 49.0 ng/ml to 58.5 ng/ml ($p=0.003$). At baseline, the most prominent clinical manifestations of anemia observed among children receiving the fortified oat drink were pale conjunctiva (61.8%) and pale skin (29.4%).

After four months of intervention, the percentage of study children who exhibited clinical manifestations of anemia significantly decreased to 26.5% with pale conjunctive and 2.9% with pale skin. The prevalence of anemia decreased from 100% to 32% over the study period. Similar declines have been observed in other clinical studies. Researchers investigating the effect of "home-fortification" with iron and zinc-containing sprinkles on iron and zinc status of anemic infants observed 59% and 69% declines in anemia over a 2 month period [32].

While the decline in incidence of anemia in this trial was significant (68%) and clinically meaningful, there were still a high percentage of children (32%) with anemia after the 4 month intervention. Similarly, in a trial using NaFeEDTA fortified fish sauce in the diets of Vietnamese women, while prevalence of anemia was significantly decreased over a 6 month period, 20% of the test population was still anemic at the end of the trial [33].

In a second study in the same population, the women consumed the fortified fish sauce over an 18 month period and residual iron deficiency anemia was only 4% [34]. Hence, it is possible, that if the present study intervention period had been extended, the incidence of anemia may have been reduced even further.

Results of the within subject analysis showed that while all children who completed the intervention arm (n=34) were anemic at baseline, none were deficient in iron(SF <15 ng/ml) at baseline or endline, 5% (n=2) were deficient in vitamin C at baseline and endline, 5% (n=2) were deficient in zinc at baseline and 23% (n=8) at endline. None of the children were deficient or insufficient in vitamin A before or after the intervention.

This data contrasts somewhat with that reported in the Philippines National Nutrition Survey where prevalence of vitamin A deficiency in the population was 11%, and vitamin C deficiency was 22%. However, the rate of zinc deficiency was similar to rates found among Filipino children aged 6 months to <5 years which indicated a zinc deficiency rate of 22% among males and females [2]. Angeles-Agdeppa and co-workers [6] observed a decline in the prevalence of zinc deficiency from 19.6% to 2.2% among children after consumption of a multi-micronutrient fortified beverage.

As no significant difference in usual dietary iron intake was observed (excluding the iron from the oat drink) results from this study confirm that the iron-fortified oat drink contributed to the increase in serum ferritin and Hb levels and to the reduction of anemia.

At baseline and endline, no child was deficient or had low levels of vitamin A (SR <20 µg/dl), however, mean serum vitamin A levels of the study children significantly increased from baseline (35.68 □g/dl) to endline (38.62 □g/dl; P = 0.003). As the dietary intake of vitamin A increased slightly (by 121.9 mcg), though not significantly, from baseline to end of the study, it is likely that the significant change in serum vitamin A levels was due to a composite effect of the vitamin A in the oat drink and a slight increase in vitamin A intake from other food sources. This positive impact is important, because of the role of vitamin A in hemoglobin synthesis; maintenance of adequate levels of iron in plasma to supply the different body tissues with proper amounts of this essential mineral [35-36].

After four months of intervention, there were no differences in serum vitamin C levels compared to baseline. Biochemical analysis indicated that two children had low vitamin C levels (<0.30 mg/dl) at both baseline and after the intervention period. Significant decreases ($p = 0.014$) were observed in dietary vitamin C intakes (exclusive of the vitamin C in the oat drink) between time periods. It should be noted that vitamin C in the oat drink was added to disrupt the inhibitory action of phytate on iron absorption [9].

Trinidad et al. [37] reported that addition of 45mg vitamin C to an oat drink fortified with iron, zinc and vitamin A at the same levels as used in this study improved the absorption of iron by an additional 1.5% compared to a fortified oat beverage without the vitamin C.

While mean zinc levels were not different between baseline and endline, the absolute number of children with zinc deficiency increased from 2 at baseline to 8 children after 4 months of intervention. Dietary zinc intake was not calculated because zinc is not yet included in the Philippine Food Composition Table [11].

As no information about dietary zinc intake is available over the study period, it is difficult to determine any impact of the oat drink vs. changes in usual dietary nutrient intake on the zinc status of the children.

Overall, children who consumed a fortified oat drink over a period of 4 months, had improved iron and vitamin A status compared to baseline measures and prevalence of anemia was reduced from 100% to 32%. Although vitamin C and zinc levels did not significantly improve, in general these children were not deficient in these nutrients at baseline. However, these are important nutrients to consider in fortification strategies as vitamin C has been shown to increase absorption of iron from oat based products and zinc deficiency is often found in anemic populations, including this one.

V. Conclusion

After 4 months of intervention with an oat drink fortified with iron as NaFeEDTA, zinc, vitamin A and vitamin C, prevalence of anemia decreased by 68% and significant improvements in iron and vitamin A status were observed in a young Filipino schoolchildren. This study demonstrates the effectiveness of the fortified oat drink in alleviating anemia in young children and highlights the value and effectiveness of fortification programs.

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