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Micronutrient Initiative Project, Pilot Project – 1

School-based Iron+Folic Acid Supplementation for Adolescent Girls Manica Province, Mozambique

Project Summary & Endline Evaluation
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Prepared by Julie Roley, M.P.H.

Avenida Tomás Nduda 1489, CP 1854, Maputo, Moçambique
Tel: (258-1) 48 63 12, Cell: 082 31 1957, Fax: 49 31 21
e-mail: smeershoek@hki.org

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1. Introduction

1.1 Background & Justification

Although improvements have been made since the end of civil war in 1992, Mozambique remains one of the poorest countries in the world, characterized by low health and economic indicators, high morbidity, high maternal and child mortality rates and lost livelihoods resulting from poor primary education and reduced economic output. These include an estimated infant mortality rate of 135/1000, under-five mortality rate of 201/1000, maternal mortality rate estimated between 1,000 – 1,500/100,000 and stunting prevalence of 36%. (1-3)

Because of its strategic location, Manica Province suffered particularly during civil war. Food insecurity related to poverty, climactic inconsistency and high HIV/AIDS prevalence hinder progress. Most Manica residents are subsistence cultivars producing primarily maize, sorghum, millet, groundnuts and beans. A 'lean season' encompasses much of the year, typically occurring between Oct/Nov and April/May. Malnutrition is prevalent. New national-level data show that 50% of reproductive age women and 74% of under-five children are anemic, and 70% of under-five children are vitamin A deficient. (4) Data from a 1998 MOH/HKI survey show malnutrition rates in Manica Province are similar to the rest of the country. (5)

Manica also has the highest fertility rate in Mozambique at 7.6. Early marriage and parity are frequent and girls commonly drop out of school. In rural Manica Province only 30% of students age 12-18 are girls and 47% of girls between 15-19 have had a child or a pregnancy. (2, 6) In Mozambique, low literacy levels among women have been associated with poor health of children. This association was even stronger among women who did not complete primary education (class 7). (7)

It is known that anemic women are at greater health risk. These include risk of hemorrhage-attributable death at delivery, low-birth weight babies, post-partum infection and higher perinatal mortality risk. Anemia during pregnancy may also impair fetal development, with long-term negative effects potentially impairing immunity, growth, physical capacity, educability, and productivity. (8-10) In Mozambique all pregnant women should receive iron+folic acid supplements daily (60 mg/400 micrograms), beginning at first prenatal contact until delivery, provided through the national health system. (11) Although most women attend at least one prenatal consultation, supply shortages and poor adherence keep facility-based iron+folic acid coverage sub-optimal. (12) Supplements are currently not available to adolescent girls unless they are pregnant. Studies have shown however that maternal and fetal risks associated with anemia are greater if a woman enters pregnancy with depleted iron stores. (9-10, 13-14) Experts currently recommend iron+folic acid supplements for anemic non-pregnant women and high-risk groups such as adolescents and multi-parous women. (15)

When the prevalence of anemia in a high-risk group is >20%, anemia is considered to be high public health significance [1] (16) Anemia and iron-deficiency are clearly substantial public health concerns among reproductive-age girls and women in Manica Province.

School-based delivery programs have been used in various settings to address health deficiencies among school-aged populations and support the health care system. Schools

[1] Sub-clinical iron-deficiency, often 2 times the level of anemia in vulnerable populations also has adverse effects.

offer a built-in structure and are opportune for introduction of health messages. School-based delivery of iron+folic acid has also been shown to be efficacious (17).

Therefore, HKI, in conjunction with Provincial Health and Education Directorates (DPS, DPE) designed this pilot project of iron+folic acid supplementation and nutrition education targeted to adolescent schoolgirls in 12 schools in Macossa and Guro districts. It is hoped this program will prove effective and thus be scaled up to other schools both within the province and Mozambique, reinforcing the current health center-based system for pregnant women.

1.2 Objectives

The main goal of this project is to test the feasibility and impact of school-based weekly iron+folic acid supplementation and nutrition education targeted to adolescent girls in Manica Province. Specifically, it aims to:

1) Ensure 85% coverage with iron+folic acid supplementation of adolescent girls in program schools;

2) Ensure that 80% of girls receiving supplements consume >75% of them;

3) Improve teachers', girls', and boys' knowledge of anemia, iron deficiency, and nutrition in general, with emphasis on micronutrients;

4) Decrease the prevalence of anemia among participating girls;

5) Assess the effectiveness in improving hemoglobin concentration of a 6-month weekly supplementation scheme vs. a 9-month weekly supplementation scheme;

6) Document lessons learned and make recommendations for program improvement and replication.

2. Methods

2.1 Project Design

This project was designed to assess the effectiveness of varying duration of supplementation therefore no placebo group was included. Instead of denying supplements for an extended period to a control group, a 3-month delay in supplementation initiation to Group 2 serves as a 'control period'. It was desired to assess the two supplementation schedules with regard to process and hemoglobin concentration outcomes. If the shorter time is effective, time and resources might be saved in future program cycles.

Both primary schools EP1 and EPC were chosen for participation.[2] The 12 schools were elected with help of district education officials (DDE) with access during rainy season as primary criteria. Six schools from each Macossa and Guro districts were chosen.

Schools were randomly allocated into 9 and 6-month comparison groups with specification that an equal number of schools from each district be represented in each group. By-school randomization was elected because this project means to assess effectiveness of delivery of iron supplements in schools in these zones and because varying supplementation schedules by girl within schools would be an extreme burden on teachers and school officials.

[2] EP1 schools include classes to grade 5; EPC includes EP1 plus grades 6 and 7.

Due to school holidays and time constraints, in the end, a total of 8 months supplementation was possible for the first group and 5 months for the second group. Throughout this report, references to comparison Groups 1 and 2 apply to '8 months' and '5 months' groups respectively.

2.2 Intervention and Project Activities

Girls in Group 1 schools received iron+folic acid supplements once a week beginning in February and continuing through the end of the school year in October. Girls in Group 2 schools began receiving supplements in May and continued until the end in October.

Hemoglobin concentration was measured a total of four times, in May 01, and January, May and October 02. Girls also responded to a questionnaire in May 01 and October 02, relating to knowledge of anemia, iron-rich foods, illness, menstruation, and socio-economic characteristics (SES).

A sub-sample of boys was included in October 02 for anemia prevalence figures on boys in pilot schools.[3]

Mebendazol was given to all girls in January, and again to all students (including boys) in August.[4]

Two teacher-training seminars were held, one half-day seminar on technical aspects of supplementation and one 3-day seminar on nutrition education. A total of 26 teachers from the 12 schools were trained. Those trained informed the remaining teachers and staff in their respective schools about program activities and details.

Teacher evaluations were administered at the time of the October 02 survey.

Printed nutrition-education booklets, including detailed sections on micronutrients, were produced for both teachers and students grade 4 and up. The teacher booklet was designed to assist with incorporation of nutrition messages into curriculum. A card game with pictures of foods/concepts was also created.

HKI personnel regularly visited schools to address problems, answer questions and encourage school officials. Supplementation distribution forms (monitoring tools) were collected during these visits and stock evaluated.

The 12 participating schools are shown below in table 1.

[3] During the project, school and Provincial Health officials requested to include boys in supplementation to reduce mistrust of programs aimed solely at girls, and avoid excluding boys in high malnutrition/morbidity regions where anemia is likely universal.
[4] All boys and girls attending school were given Mebendazol in August, as the risk of re-infection is high in populations with high endemic rates of parasitic infections.

Table 1: Participating Schools

	School	District	Level
Group 1[1]			
	Guro Sede	Guro	EPC
	Tseretze Khama	Guro	grades 1-4
	Nhamassunge	Guro	EP1
	Catique Nzaia	Macossa	EP1
	Mussungadze	Macossa	EP1
	Nhamagua	Macossa	EP1
Group 2[2]	Mungari	Guro	EPC
	Mandie	Guro	EPC
	Chivuli	Guro	EP1
	Dunde	Macossa	EP1
	Malimanao	Macossa	grades 1-3
	Macossa Sede	Macossa	EPC

[1] Schools receiving supplements for 8 months.
[2] Schools receiving supplements for 5 months.
EP1 = Primary school, grades 1-5.
EPC = Primary school plus grades 6 or 7.

2.3 Data Collection

2.3.1 Hemoglobin Measurements and Questionnaires

A baseline survey was carried out May 28 to June 7, 2001 in selected schools, with trained interviewers (both men and women), HKI project and provincial coordinators, DPS representatives, and support staff. Girls between ages 10-18 were interviewed with regard to anemia/nutrition knowledge, illness, menstruation status, and SES-related questions. Hemoglobin concentration was measured for all girls unless refused.

Because of delays and impending end of year school holidays in 2001, hemoglobin concentration for all girls ages 10-18 enrolled in the 12 schools was again measured from January 28 to February 7, 2002, to ensure accurate hemoglobin data before the start of supplementation (in mid-February, 2002). These measurements then became the project baseline data. Girls were not interviewed again.

The midline survey took place May 13 - 24, 2002, just before the start of supplementation of Group 2. Hemoglobin concentration was measured for all girls ages 10-18 in the 12 schools. This measurement provided the three-month 'control period' by which the duration of supplementation was compared.

The endline survey was carried out 14 - 24 October 2002, just before the end of the school year. Hemoglobin concentration was measured and questionnaires again administered for all participating girls between 10-18 years. Hemoglobin measurements were also taken for a sub-sample of boys of the same age range at this time.

The final project population is derived from those girls present for January, May and October 02 hemoglobin measurements for whom a complete set of information is available. These girls are included in analysis relating to anemia and hemoglobin concentration. All girls who responded to questionnaires relating to anemia knowledge, SES, illness, menstruation, etc., in the May 01 and October 02 surveys are included in results and analysis not related to hemoglobin concentration. As these surveys took place in different school years, girls were interviewed were not exactly the same. Analyses related to supplement distribution and adherence include girls who were present for both January and October 02 measurements.

All field investigators were experienced interviewers competent in local dialects, and were adequately trained to minimize the risk of hemodilution of blood samples.

EpiInfo 6.4 and SPSS 10.0 were used for data entry and analysis.

2.3.2 Supplement distribution, adherence and record keeping
Trained school representatives (teachers or officials) were in charge of carrying out supplement distribution, teaching nutrition education, record keeping (adherence), and storage and management of stock.

Some challenges were encountered related to the school system itself, which affected distribution and record keeping activities and resulted in different numbers of girls present for each survey. Rather large student fluctuation (normal movement between schools according to school officials) was a primary challenge since the program intended to track uniquely identified girls through several hemoglobin measurements. Students also appear to miss class often and a proportion, especially girls drop out every year although specific information on this is not available. Further, in practice, there are no enrollment processes or official class registries, particular challenges for record keeping, especially with transient student populations. Participation in the program was not compulsory and although girls were encouraged, they were neither forced to take tablets nor come to school on survey days. Levels of enthusiasm and participation varied by school likely related to time and commitment of officials and underscored by staff/resource shortages and resultant motivation challenges.

3. Results

Key results of the baseline (January 02) and midline (May 02) surveys are summarized below followed by endline survey results. For additional details on the first two surveys refer to their respective reports (18-19).

3.1 Baseline Survey (Jan 02)
Hemoglobin concentration was measured for 991 girls. Mean hemoglobin concentration was for Groups 1 and 2 respectively, 125 g/L (±12 SD) and 124 g/L (±12 SD), anemia prevalence 31% and 34%, and mean age 12.1 (±1.8 SD) and 11.7 years (±1.6 SD). Only mean age was significantly different between groups. (Table 2, Annex)

3.2 Midline Survey (May 02)
Hemoglobin concentration was measured for 706 girls. Of the 991 original girls, 285 were lost. Only the girls present for both the January and May 02 surveys were included in analysis. For Groups 1 and 2 respectively, mean age was 12.0 (±1.8 SD) and 11.8 (±12 SD) years; mean hemoglobin concentration was 126 g/L (±14 SD) and 121 g/L (±12 SD); anemia prevalence was 30% and 41%. Hemoglobin concentration was significantly higher and anemia prevalence significantly lower in Group 1 (supplemented) than in Group 2 (non supplemented) (Table 3, Annex).

Results of the midline survey show that between Jan and May 2002, Group 2 (non supplemented) showed a decrease in mean Hb concentration accompanied by an increase in the prevalence of anemia, whereas in Group 1 (supplemented) neither mean Hb concentration nor anemia prevalence showed deterioration (Table 3, Annex). Note that values for January 02 survey in table 3 are slightly different from those presented in table 2 due to girls lost (for more detail see section 3.3.1).

Distribution of tablets appeared to be progressing relatively well by the midpoint. Some schools reported acceptability problems (later overcome), and record keeping and/or stock management was a problem for some teachers. Group 1 girls were receiving supplements for 10 weeks by the midline survey. All (100%) of girls were taking supplements, with a mean of 8 tablets each; 77% of girls had taken at least 75% of possible tablets.

3.3 Endline Survey

3.3.1 Comparison of girls lost and remaining
Hemoglobin concentration was measured for 823 girls in the final survey. Between the January 02 and October 02 surveys, 49% of girls were lost to the program with regard to hemoglobin concentration. Girls who were present for January, May and October 02 surveys are included in final analysis (n=507). Table 4 (Annex) compares age, mean hemoglobin concentration and anemia prevalence for the remaining girls with those lost to the study. Differences between the two were not significant for each of the key variables overall or by comparison group. It is therefore concluded that the girls lost to the project were not significantly different than the girls remaining.

3.3.2 Characteristics of Girls
The two groups differ significantly with respect to some SES characteristics ($p<.05$). Group 1 girls appear to have better living conditions as shown by household water source and proportion of girls reporting improved latrines. (Table 5, Annex) A high proportion of Group 2 girls have the least safe water source, river or lake, while most Group 1 girls have well water. Few of either group has piped water inside the house. More families of girls in Group 2 have a '*machamba*' (field) and own animals than Group 1, general signs of more rural, subsistence-level livelihoods.

Mean ages of girls have fluctuated little during the months even as girls moved in and out of schools and the program. Endline ages are similar to earlier reports; girls are young, nearly 70% 12 years or younger (mean 11.9 years, ±1.7 SD). Fewer older girls reflect both that there are fewer in schools and that only primary schools were included in the project (not shown).

Twenty nine percent of girls have begun menstruation, beginning at age of 12.9 years, ±1.4 SD. There is no significant difference between Group 1 and 2 with regard to menstruation status (not shown).

3.3.3 Mean Hemoglobin Concentration and Anemia Prevalence
Results suggest that iron+folic acid supplement had a positive effect in preventing seasonal increases of anemia prevalence among anemic girls in Manica province. This effect was seen clearly between January and May when Group 1 girls began taking supplements (but before Group 2 began). During this phase, anemia prevalence and hemoglobin concentration improved in Group 1 while they deteriorated in Group 2. Before supplementation began no significant differences existed between Groups 1 and 2 for mean hemoglobin concentration, anemia prevalence nor age. After the first phase of supplementation, between group differences were statistically significant ($p<.05$). (Table 6, Annex) Further, between May and October 02, a significant decline in anemia prevalence and a significant increase in mean Hb concentration occurred in Group 2 once they also began taking iron+folic acid supplements ($p<.05$).

The suggestion of a protective effect is supported by May 01 data where much higher anemia prevalence was seen in both groups (46% and 43%, Groups 1 and 2 respectively). This may relate to normal seasonal variation or food insecurity that was hedged in Group 1 by iron+folic acid supplements between January and May 02. (Figures 1 & 2, below)

Figure 1

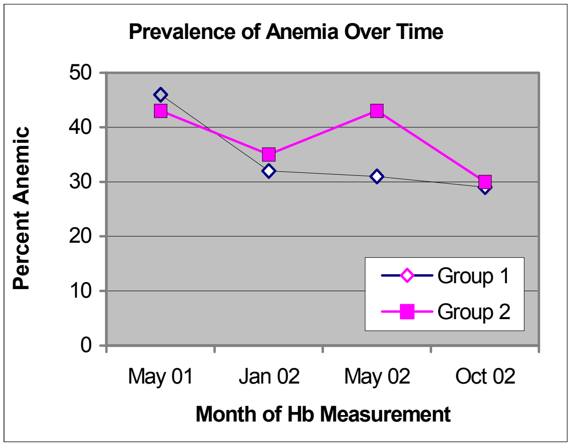
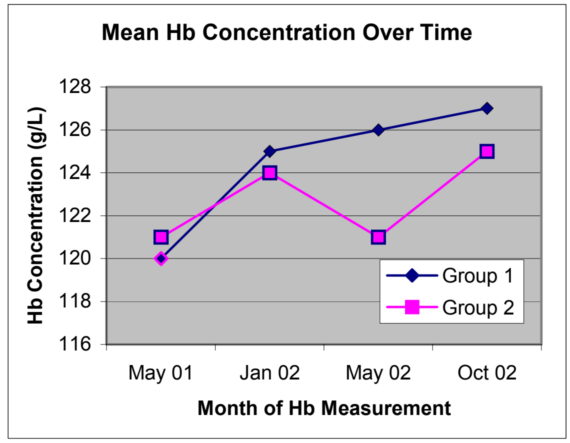


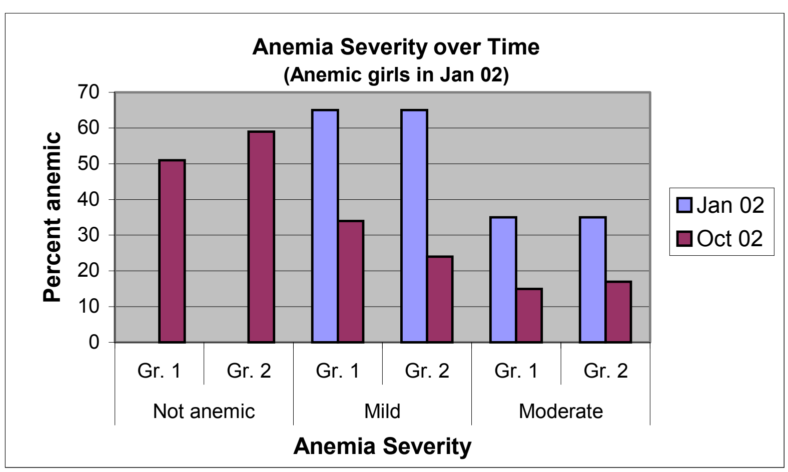
Figure 2



Among girls that were anemic in January 02, mean blood hemoglobin concentration improved significantly between January and October ($p<.05$), resulting in increases of approximately 10 g/L in each group (Table 7, Annex) and over half of these girls no longer anemic in October 02 (Figure 3). When further categorized by severity, mild and moderately anemic girls in both groups also improved significantly during the supplementation period ($p<.05$). (Tables 8-9, Annex) The greatest improvements were seen among moderately anemic girls in both groups, particularly in Group 2.[5]

There were no significant differences in mean hemoglobin concentration between Groups 1 and 2 before or after supplementation among anemic girls. This suggests that iron+folic acid supplements benefited all anemic girls, regardless of supplementation duration (8 or 5 months). In particular, improvements in hemoglobin concentration among anemic Group 2 girls suggest that shorter supplementation periods can have important effects.

Figure 3



[5] Mild anemia defined as blood hemoglobin measures 110 –119 g/L; Moderate anemia defined as blood hemoglobin measures 80-109 g/L. There were no severely anemic girls.

3.3.4 Boys' Results
Hemoglobin concentration was measured in a sample of boys (n=437) during the October 02 survey. The prevalence of anemia among boys was not significantly different than that among girls (26% vs. 29%) after the latter benefited from a 4-8 month weekly iron+folic acid supplementation period (Table 10, Annex). This shows that anemia is a public health problem among boys, and raises questions as to how best address it. a) Anemia in boys could be due (at least partially) to iron deficiency in which case boys would also benefit from a school-based iron+folic acid supplementation program; b) Anemia in boys is mostly non iron-deficiency related but rather of a different etiology (probably malaria given that both girls and boys benefited from deworming treatment); in this, a significant proportion of anemia cases among girls are likely to be of the same (malarial) etiology.

3.3.5 Distribution of Iron+Folic Acid Tablets
Without enrollment and class registry information, adherence data are difficult to summarize. It is not known for certain what percent of the target population participated in the program. All girls who were present for both January and October 02 surveys are included in distribution/adherence related analysis (n=615), regardless of whether they were also present for the May 02 midline survey. It is at least known they did not leave school altogether. All new girls were allowed to participate (receive supplements) but were not included in final analyses.

None of the schools supplemented the entire number of weeks possible although some did very well. Per records, no school supplemented more than 30 weeks[6]. Additionally, some part(s) of supplementation records were missing for 7 of 12 schools during the program period, therefore adherence figures are likely underestimated. To avoid the bias of a common denominator, total number of weeks a girl could have possibly taken supplements was assessed *per school*. This ranged from 24-30 weeks in Group 1, and 10-16 weeks in Group 2 (means of 25 and 13 weeks, respectively).

Using the above basis for calculation, overall 82% of all possible tablets were consumed, 81% in Group 1 and 83% in Group 2. (Table 11, Annex)

The specific adherence goal was that 80% of girls receiving supplements would consume at least 75% of those distributed. In spite of challenges, this objective was almost met, with 70% and 76% of girls (Group 1 and 2 respectively) taking 75% of distributed tablets.

3.3.6 Anemia Knowledge Among Girls
Respondent knowledge about anemia was higher in October 02 than May 01. The proportion of girls who have ever heard of anemia is four times higher in Oct 02 compared with May 01. The proportion of girls who can correctly name a cause or sign of anemia are also higher in October. (Table 12, Annex)

Responses to 'causes' and 'signs' of anemia were elicited qualitatively, allowing girls to freely answer if they knew. They were only asked of girls who had heard of anemia (emphasizing differences between surveys even more, since few girls had heard of anemia in the May 01 survey).

Girls were also asked what foods they ate *yesterday* to compare beliefs about nutrition with practices. More than 90% of girls ate '*sadza*'[7] and one-fifth to one-third ate fish, chicken, beans, leafy greens or meat. Few ate eggs, milk, or liver. Most consumed only a few

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[6] Possible supplementation weeks calculated at 34 for Group 1, and 18 for Group 2.
[7] The local staple food made with maize flour.

different foods offering limited nutrient variety. Little or no fruits and vegetables were eaten. Responses likely portray typical consumption patterns for these zones (not shown).

Interviewers experienced translation difficulties relating to certain nutrition terms, (eg., 'iron' and 'nutrient') that do not exist or translate easily into local dialects. Different methods were used to collect this information in both surveys, therefore responses are excluded from analysis.

3.3.7 Illness Experience

Girls were asked if they experienced illness symptoms during the past two weeks and if so, what their symptoms were. Those with symptoms were then asked if they missed school because of symptoms. One half of all girls had experienced illness in the previous two weeks, and nearly two thirds of them had missed school (median 2 days). There was no significant difference between groups with regard to illness in previous 2 weeks nor school days missed (not shown).

Of girls who had been ill the greatest number complained of headache and diarrhea. Significantly more Group 1 girls complained of headache (32% vs. 26%), while significantly more Group 2 girls complained of diarrhea (7% vs. 4%) ($p<.05$). There were no significant differences between groups for other illnesses.

Thirty five percent of girls report having had malaria 1-2 times during the last 12 months, and 18% had malaria 3 or more times. The remaining 47% report no malaria experience during this period. Differences between Groups 1 and 2 were not significant. Malaria experience during the previous 12 months was not significantly associated with anemia prevalence. However, more malaria was reported in the January than the October survey, 77% versus 53% (not shown).

3.3.8 Summary of Teacher Evaluations

Teacher interviews took place during the October 02 hemoglobin survey. The format was qualitative and mainly concerned with documenting experiences, opinions and suggestions of teachers in this pilot year.

Overall, teachers felt distribution of iron+folic acid supplements went well and say they noticed better health, attendance and participation among girls. In the beginning, some girls missed school to avoid taking tablets and some parents forbade girls to participate believing tablets were contraceptives. Informational meetings with community leaders resolved misconceptions and most girls resumed participation[8]. A recurring concern for girls, teachers and officials was that tablets cause girls to feel hungry in a region with food shortages. There was also concern about the time required to carry out supplementation, especially in schools with more than 1 'turma' (or session, where students attend school either in mornings, afternoons or evenings), when only one teacher per school must carry out all supplementation activities[9]. A few teachers complained about not having supplement recording forms at one time or other.

According to teachers, students generally understood the student nutrition booklet and its concepts. Comprehension difficulties were mostly related to concepts of 'foods for growth' (proteins) and iodine deficiency, because food examples and illustrations used were not

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[8] Parent/community meetings were also held previous to starting the program in each school but attendance was low.

[9] At least 2 teachers were trained per school in an effort to avoid over-burdening teachers. Equal allocation of duties may have not happened in practice, however.

clear or are not available locally. Teachers suggested different booklets appropriate to language and class level, with local food examples.

Teachers were positive overall about adding nutrition education into curriculum. They felt that students (and teachers) learned better habits about food variation and further carried these messages to their homes. Most felt teacher booklets were clear and adequate. However, assistance was requested in finding ways to teach difficult concepts. Some teachers had difficulty comprehending parts of the booklet, especially relating to iron and iodine deficiencies.

Most teachers say they included 2 hours of nutrition education into their weekly lessons (required by their schools). Some schools had no specific requirement on integration of nutrition education. Most agreed that the lack of a formal nutrition program mandate and didactic plan made adjusting curriculum and teaching somewhat difficult.

4. Key Findings & Discussion

Iron+folic acid Supplements Exerted Protective Effect on Adolescent Girls
Improved hemoglobin concentrations for Group 1 girls during the 'control period' (February – May) while Group 2 girls worsened suggest iron+folic acid protected supplemented girls from becoming anemic. Further, the sharp improvement in hemoglobin concentration among Group 2 girls after they began taking supplements in May shows an immediate ameliorative effect. Comparably high anemia prevalence from the previous year suggests that seasonality and/or food insecurity may be a factor in nutritional status at that time of year.

Hemoglobin Concentration and Anemia Prevalence Improved Significantly Among Anemic Girls.
When anemic girls only are selected for analysis, hemoglobin concentration significantly improves for all anemic girls, and also when categorized by severity. Over half of anemic girls in January 02 have become non-anemic. In each case, mean improvements were large, especially among moderately anemic girls in Group 2.

Iron+folic acid Supplements Benefited Anemic Girls Independent of Supplementation Duration (8 or 5 months).
This effect was shown by large and significant improvements within anemic girls in both groups, and no significant differences between groups *after* supplementation. Significant improvements in hemoglobin concentration among girls in the 5-month group suggest that even short supplementation periods can benefit anemic girls.

Respondents' Knowledge of Anemia was Higher in October 02 than May 01.
Four times more girls have ever heard of anemia, and more girls can name correct causes or signs of anemia. Some knowledge-related responses were disregarded because of translation difficulties, highlighting need for further research.

Anemia Prevalence Also High Among Boys of the Same Age.
Boys' anemia rates confirm what was presumed but not measured, that boys also suffer from high rates of anemia and are good targets for supplementation programs. Consideration of boys is especially important if educability and growth are program objectives.

Iron+folic acid supplementation to adolescent girls in schools in Manica Province showed considerable impact in protecting non-anemic girls from becoming anemic, and improving hemoglobin concentration among anemic girls. Positive results were seen despite losing almost half the girls to the study, and various delivery and information challenges inherent in new programs.

Even with recording difficulties, missing information and less than optimal adherence, which meant that neither group of girls received the full possible numbers of tablets, the results of our program show that a 3-month school-based weekly supplementation program was effective in preventing seasonal deterioration of the iron status of adolescent girls and the subsequent increase in anemia rates among them. Effectiveness of 8 versus 5-month supplementation duration cannot therefore be compared in the manner that was intended in the study. Further research is necessary to do this.

Contextual factors which may affect anemia, i.e. parasites, SES, and/or concurrent nutrient deficiencies should be considered. Investigation of morbidity wasn't a main objective in this survey, further it was self-reported and subject to related inadequacies. Differences between groups did not appear to systematically favor one group or the other. Malaria experience during the previous 12 months wasn't significantly different between groups. Reported malaria declined between the May 01 to October 02 surveys, and may be important since less malaria might contribute to improved hemoglobin concentration. Hookworm and schistosomiasis were also not investigated in this study, although de-worming activities attempted to limit the effect of worms as a confounder. Provincial Health officials asked that a hookworm prevalence component be added into future programs, feasibility is currently being discussed. Concurrent nutrient deficiencies, especially vitamins B12 and A, may be important but go beyond the scope of this study. Multiple micronutrient supplements may one day address this concern but at the moment there is not yet sufficient scientific evidence on the impact of these supplements.

Water and sanitation conditions (related to SES) may affect hemoglobin concentration through dietary intake and/or illnesses. Better SES in Group 1 is likely skewed due to Guro Sede and Tseretse Khama schools. Both are in the district capital, a larger town on a main transportation route where conditions are somewhat less poor than the zones of other schools. These two schools have the greatest numbers of participating girls.

Although challenges arose relating to nutrition knowledge, the proportionally large improvements in respondent knowledge of anemia (compared with May 01) is heartening. Still, less than 30% of girls say they have heard of anemia. However, most girls in project schools are young. In addition to being less knowledgeable than older girls, pilot project education program and materials were targeted to 4^{th} grade and older. Most importantly, knowledge scores themselves may reflect high anemia rates (educability), underscoring the importance of supplements and nutrition education efforts among anemic populations. Translation difficulties and the fact that respondents to May 01 and October 02 questionnaires are not the same should be kept in mind when interpreting results.

A lack of documentation of problems from the May 01 survey, especially relating to language/translation challenges, unfortunately means that some errors were repeated. In-depth qualitative work is planned to identify appropriate language and communication messages about nutrition for the classroom, within local context(s). Plans are also proposed to research and update nutrition booklets as to content and comprehensibility, including didactic assistance for teachers, ideally in conjunction with Ministry of Education (MOE) or DPE.

Weaknesses related to this project include:

- Girls responding to October 02 questionnaires may not have been the same girls as in the May 01 survey, limiting comparisons between the two.

- Pregnancy status of girls assumed negative but not asked (for sensitivity reasons). This is potentially important since pregnancy could affect hemoglobin measurements.

- Further in-depth qualitative research needed regarding:
  - Translation and use of nutrition and anemia-related terminology
  - Nutrient-rich *and* available local foods for use in education materials

- Production delays of education materials mean that nutrition education messages may have been delayed. Further, booklets are targeted for the 4th class and above since younger students often do not speak Portuguese. Since girls often leave school early, younger girls may miss nutrition messages.

5. Conclusion

This school-based iron+folic acid supplementation and nutrition education pilot ended on a positive and promising note with regard to both improvement of hemoglobin concentration of adolescent girls and in the delivery process. Further, greater benefits can reasonably be expected if delivery is improved and girls receive weekly supplements consistently during the intervention period. This will require adjustments at both the program and school-level, leading to quantifiable, valid and replicable results. Further commitment from health and education directorates is required for prioritization and sustainable integration of nutrition education into regular curriculum.

6. Recommendations for Improvements / Future Planning

- Supervisor/advisor based at district level is needed to support program activities and ensure proper monitoring, especially in the beginning stages of the program.

- Work closely with school officials and teachers to strengthen the supplementation and record keeping process within their setting. Effective, simple record keeping tools and training on their completion are necessary. Flexibility and regular review of tools are important, allowing for adjustments as specific needs become clearer.

- Re-assess program impact of supplementation duration (5 vs. 8 months) once proper registration mechanisms are in place and majority of girls adhere to full weekly supplementation program.

- Strengthen program with in-depth qualitative research related to nutrition terminology, education messages and materials. Special attention should be given to specific local dialect, cultural and regional constraints (such as access and availability to certain foods, beliefs, etc). Review program indicators relating to nutrition terminology to assure outcomes are realistic and attainable.

- Review and revise student materials as to class/age/comprehension levels.

- Assure enough teachers per school are trained to cover '*turmas*' with least burden or lost classroom time.

- Iron+folic acid supplements and adherence registries must be assured in schools and properly accounted for.

- Integrate programming where possible especially when minimal extra effort or investment is required. Hygiene and malaria education/awareness can be included with nutrition curriculum. De-worming and schistomiasis control can be added periodically to the iron+folic acid regimen. Discuss combining efforts with partner organizations with shared objectives.

- Develop an awareness-building and social promotion plan relating to anemia and nutrition. HKI will soon begin promoting iron-related programs with the "*Ferro é Força e Futuro*" theme (Iron is Strength and Future), linking iron to current and future health. This is especially valuable here where 'iron' doesn't easily translate into local dialects.

- Before beginning the program in new schools (or each program year), hold information sessions for parents, families and community members/leaders to address misconceptions and improve participation and adherence.

- Invest in small, low cost incentives such as bicycles, t-shirts or pens for teachers and key people to show appreciation for their cooperation and roles in operationalization of the program.

- Continue discussion of commitment / program sustainability with DPS/DPE and school officials. Encourage Education directorate to add nutrition education into regular curriculum and provide teachers with didactic plan.

- Continue to stress the link between iron (and deficiency prevention) with long-term socially desirable outcomes in health, education and productivity when promoting nutrition programs. In school-based programs particularly, the link between iron and 'educability' is a natural one.

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Annex

Table 2: Characteristics of Girls by Comparison Group (Jan 02)

	n	Mean Hb (g/L)	sd	% Anemic	Mean age	sd
Group 1	493	125	±12	31	12.1	±1.8
Group 2	498	124	±12	34	11.7	±1.6
Signif:		ns		ns	p < .05	ns

Table 3: Mean Hemoglobin Concentration and Percent Anemic by Comparison Group (May 02 Midline Survey)

	Nº of Girls	Jan 02	sd	May 02	sd	*Signif*
Mean Hb (g/L)						
Group 1	359	126	±13	126	±14	ns
Group 2	347	124	±13	121	±12	ns
Signif:		ns		p < .05		
Percent Anemic [1]						
Group 1	359	30		30		ns
Group 2	347	35		41		ns
Signif:		ns		p < .05		

[1] Anemia defined as blood hemoglobin < 120 g/L.

Table 4: Comparison of Study Girls and Those Who Dropped Before Supplementation (Jan 02)

	n	Mean Hb (g/L)	sd	% Anemic	Age	sd
Group 1						
Current girls	256	125	±13	32	11.9	±1.7
Lost girls [1]	237	125	±11	31	12.2	±1.9
Significance:		ns		ns	ns	
Group 2						
Current Girls	251	124	±13	35	11.9	±1.6
Lost girls [1]	247	124	±11	33	11.7	±1.8
Significance:		ns		ns	p < .05	
Totals						
Current Girls	507	125	±13	33	11.9	±1.8
Lost girls [1]	484	125	±11	32	11.8	±1.7
Significance:		ns		ns	ns	

Group 1 = 8 month iron+folic acid recipients

Group 2 = 5 month iron+folic acid recipients

[1] Ages for 14 lost girls unknown.

Table 5: Description of Girls by Selected Household Characteristics (Oct 02)

	Group 1 % (n=382)	Group 2 % (n=441)	*signif*
Household Water Source			
Piped in House	2	2	ns
Well	75	48	p<.05
Tap	15	10	p<.05
River/lake	8	40	p<.05
Households with Improved Latrine [1]	17	6	p<.05
Household Owns Machamba	97	99	p<.05
Household Owns Animals [2]	77	92	p<.05

[1] "Improved latrine" is either toilet inside house or cemented pit, compared with non-cemented toilet (pit/no-pit) or no toilet.

[2] "Animals"refers to non-domestic animals used for work, food or sale.

Table 6: Mean Hemoglobin Concentration and Percent Anemic by Comparison Group (all girls)

	Nº of Girls	Jan 02	sd	May 02	sd	Oct 02	sd	*Signif* [2]
Mean Hb (g/L)								
Group 1	256	125	±13	126	±14	127	±13	ns
Group 2	251	124	±13	121	±12	125[3]	±12	ns
Signif:		ns		p<.05		ns		
Percent Anemic [1]								
Group 1	256	32		31		29		ns
Group 2	251	35		43		30[3]		ns
Signif:		ns		p<.05		ns		

[1] Anemia defined as blood hemoglobin < 120 g/L.

[2] Within-group significance applies to January and October surveys.

[3] Difference in May and October surveys significant.

Table 7: Mean Hemoglobin Concentration by Comparison Group (anemic girls) [1]

	Nº of Girls	Jan 02	sd	May 02	sd	Oct 02	sd	*Signif* [2]
Mean Hb (g/L)								
Group 1	81	111	± 7	118	± 15	120	± 12	p < .05
Group 2	87	110	± 8	115	± 13	121	± 13	p < .05
Signif:		ns				ns		

[1] Anemia defined as blood hemoglobin < 120 g/L.

[2] Applies to January and October surveys.

Table 8: Mean Hemoglobin Concentration by Comparison Group (mildly anemic girls) [1]

	Nº of Girls	Jan 02	sd	May 02	sd	Oct 02	sd	*Signif* [2]
Mean Hb (g/L)								
Group 1	53	115	± 3	122	± 13	123	± 11	p < .05
Group 2	56	115	± 3	117	± 10	122	± 11	p < .05
Signif:		ns		p < .05		ns		

[1] Mild anemia defined as blood hemoglobin < 110 - 119 g/L.

[2] Applies to January and October surveys.

Table 9: Mean Hemoglobin Concentration by Comparison Group (moderately anemic girls) [1]

	Nº of Girls	Jan 02	sd	May 02	sd	Oct 02	sd	*Signif* [2]
Mean Hb (g/L)								
Group 1	28	104	±5	109	± 14	114	± 12	p < .05
Group 2	30	103	±6	114	± 13	119	± 15	p < .05
Signif:		ns		ns		ns		

[1] Moderate anemia defined as blood hemoglobin < 80 - 109 g/L.

[2] Applies to January and October surveys.

Table 10: Age, Mean Hemoglobin Concentration, and Anemia by Sex (Oct 02)

	n	Mean Age [1]	sd	Mean Hb (g/L)	sd	% Anemic [1]
Girls	507	11.9	± 1.7	126	± 15	29
Boys	437	12.7	± 1.9	129	± 12	26
Signif		p < .05		p < .05		ns

[1] Anemia defined as blood hemoglobin < 120 g/L.

Table 11: Distribution of Iron+folic acid by Comparison Group (Oct 02)

	n	N° Tablets Distributed	% of Possible Tablets Taken/Grp	Median N° Tablets per Girl	Percent Taking 75% of Possible Tablets
Group 1	302	6,267	81	21	70
Group 2	313	3,406	83	10	76
Total	615	9,667	82	15	73

Table 12: Comparison of Girls' Anemia and Iron Knowledge

	May 01 [1] % (n=789)	Oct 02 [2] % (n=822)
Ever heard of anemia		
Group 1	10	30
Group 2	3	27
Total	7	28
Knows one cause of anemia [3] *		
Group 1	5	42
Group 2	1	39
Total	4	40
Knows one sign of anemia [4] *		
Group 1	5	47
Group 2	2	38
Total	4	42

[1] Numbers of girls: (May 01) Group 1: n=443, Group 2: n= 354.

[2] Numbers of girls: (October 02) Group 1: n=382, Group 2: n=440.

[3] Correct causes were one or more of: inadequate diet, pregnancy, iron deficiency, malaria, menstruation, or parasites.

[4] Correct signs were one or more of: fatique, weakness, or pale lips, tongue, palms of feet and hands, and/or eyelids.

* Causes and signs of anemia were asked only of girls who had heard of anemia (May 01 n=55, Oct 02 n=234)