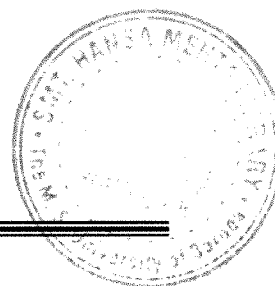# Summary and Conclusion

Chapter V

SUMMARY AND CONCLUSION

Iron Deficiency Anemia (IDA) is a significant global health problem through out the life cycle especially among women and adolescent girls. The period of pre-adolescence and early adolescence is a vulnerable period for anemia due to high nutrient demands for the period of rapid adolescent growth spurt. Iron deficiency in early adolescence may not only lead to anemia but may have other adverse effects which are not adequately studied. Girls with iron deficiency may show compromised height and BMI gains. They may have a poor appetite which may reduce food intake, especially calories. Iron also has a key function in oxygen transport and in neurotransmitter function. Anemia may adversely affect physical work capacity and cognition. Therefore, anemia may also produce scholastic under-achievement and behavioral disturbances in school children.

Our earlier research with daily iron-folic acid supplementation indicates positive impact on hemoglobin levels and growth (BMI) among younger and older adolescent girls. Intermittent IFA (once weekly) supplementation has been recommended at national level and forms a part of anemia control strategy for adolescent girls in Gujarat, in secondary schools. Inadequate information is available on various functional benefits of IFA supplementation such as benefits on adolescent growth, physical work capacity and cognitive abilities. Twice weekly IFA may show better impact than once weekly IFA, and this needs to be investigated. Further, young girls entering the rapid phase of adolescent growth spurt, who are available in primary schools, need to be included in IFA interventions.

Methodology

The present research was undertaken with the broad objective **to study the impact of daily and intermittent (once and twice weekly) iron folic acid supplementation on hemoglobin levels, pubertal growth, food and nutrient**

intake, cognitive function and physical work capacity among underprivileged primary school going girls in early adolescence (9 –13 years) of Vadodara.

The specific objectives are mentioned with each phase of the study.

Site of the Study and Sample Selection

Vadodara Municipal Corporation Primary Schools having only girl students; having a primary section catering to 9-13 year old girls (Standard V and VI), and similar school timings (morning shift) were selected as the universe for sampling. From a sampling frame of 17 primary schools, four schools were randomly selected and all the girls studying in Standards V and VI were enrolled in the study.

The study was designed as an experimental-control, semi longitudinal study, where the impact of three types of intervention (given over one year) was compared.

1. Iron-folate supplementation given once a week
2. Iron-folate supplementation given twice a week
3. Iron-folate supplementation given daily

The fourth group was the control group.

In addition to the LIG schools, one morning school catering to girls from high-income (HIG) families was purposively selected to be able to compare the cognitive functions and physical work capacity of the LIG girls with that of the girls from the well-to-do families of Vadodara. In the HIG school all the girls studying in standards V, VI and VII were enrolled (N=69) to match the age group in LIG schools i.e. 9 to 13 years. As explained for LIG schools, similar data were also collected in HIG school twice, with a gap of one year.

Prior permission and approval for the study was obtained from the Primary School Board, Vadodara and the schools were explained the purpose of the study. Informed consent was taken from the students and their parents. Girls who had attained their

menarche prior to, or, during the study were excluded, though they did receive IFA supplements.

Experimental Design Of The Study

In the three experimental schools, intervention was carried out for one year. These schools were supplemented with IFA tablets (100 mg elemental iron + 0.5 mg folic acid) as indicated below.

- School E1: IFA-1Wkly, girls received IFA tablets once a week
- School E2: IFA-2Wkly, girls received IFA tablets twice per week
- School ED: IFA-Daily, girls received IFA tablets daily

The control school (CS: No-IFA) did not receive any intervention but participated in the baseline and post intervention data collection. After a period of one year post intervention data was collected.

The study was divided into three main phases:

Phase A, the baseline survey – in which data was collected on the girls socio-economic characteristics, nutritional status, perceptions regarding anemia, cognitive abilities and physical work capacity.

The *specific objectives* of this phase were:

- ➢ To assess the present nutritional status of schoolgirls in early adolescence (9 –13 years) with respect to the prevalence of undernutrition, anemia, morbidity and food intake.
- ➢ To measure specific aspects of physical work capacity and cognitive function (concentration, attention, and memory) in the study girls.
- ➢ To determine the perceptions of the girls regarding anemia, its causes, adverse effects and prevention.

The sample size and methods are summarized in **Table 5.1**. Before and after the intervention, data on hemoglobin, height and weight was collected on all girls willing and available in V and VI standards. As considerable time was required to conduct four cognitive tests and the step test (along with the other indicators), a

random sample was selected for these tests. All the methods were pre-tested in a different school with a similar setting. Cognition tests and physical work capacity test were then modified and adopted for this age group.

Table 5.1: Study Indicators and Tools for Data Collection

Sr. No	Indicators	Tools	Reference	Sample size
1	Socio-Economic Status	Structured questionnaire	Bernard (1991)	358
2	Morbidity	Structured questionnaire	Bernard (1991)	358
3	Weight and Height	Standard methods	Gibson (1989)	358
4	Hb estimation	Cyanmet-hemoglobin method	INACG (1985)	334
5	Food and Nutrient Intake*	Dietary recall method Food frequency	Thompson and Byers (1994)	160
6.	Cognitive abilities* • *Digit Span:* measures the short-term memory; sequencing and concentration. • *Visual Memory Test:* assesses the ability to remember non-verbal material and memorizing capacity • *Clerical Task:* tests attention, concentration and discrimination ability. • *Maze:* measures visual-motor coordination; fine motor coordination, following directions and speed.		WISC tests, Bhatt (1973) Department studies Kanani, Singh and Zutshi (1999)	240
7.	Physical Work Capacity* The girls were asked to climb up and down a set of five steps for three minutes as fast as they could for three minutes.	Modified Harvard's Step Test	Skubie and Hodgkins (1964)	240
8	Perception of girls *	Semi structured interview	Bernard (1991)	80

* Random sample

Phase B comprised the intervention with ongoing process evaluation.

The *specific objectives* of this phase were:

➤ To distribute Iron Folic Acid tablets to the girls in the different experimental schools (daily, once weekly and twice weekly) over a period of one year, as shown in the experimental design.

➤ To study the compliance of various intervention schedules in the schools.

> To study and compare the benefits and side effects experienced by the girls following the various iron folic acid supplementation regimens.

Out of four schools, three schools were randomly selected as experimental schools (ES group) and were supplemented with IFA tablets (100 mg elemental iron + 0.5 mg folic acid) either once weekly or twice weekly or daily for one year. The fourth control school did not receive any intervention. The investigator supervised the distribution and recording of compliance in all the schools. The class-monitor/class teacher assisted and maintained compliance registers. The benefits and side effects experienced were recorded by the investigator.

Phase C was the impact evaluation – post intervention data collection - of the IFA supplementation trial.

The *specific objectives* of this phase were:

> To study the impact of various IFA interventions given to the young school girls

    a) on the prevalence of anemia

    b) on growth in terms of weight-for-age, height-for-age and BMI

    c) on food and nutrient intake

    d) on cognitive function

    e) on physical work capacity

> To compare the relative impact of IFA supplementation among the daily, once weekly and twice weekly groups.

Post intervention data was collected with regard to change in hemoglobin status, growth in terms of height gain and BMI, food and nutrient intake, cognitive function test scores and physical work capacity measured as number of steps climbed and recovery time.

Data Analysis

Mean, median and standard deviations were calculated for hemoglobin (Hb), height-for-age, weight-for-age, BMI, food intake and intake of selected nutrients, cognitive function test scores and steps climbed and recovery time before and after the intervention. The changes in each indicator of impact (pre to post) in each group (ES and CS) were measured and compared. Girls with good compliance were defined as those who consumed $\geq 70\%$ of the tablets given. Percentages were calculated for prevalence of anemia (Hb <12 g/dl), stunting (Height-for-age <5th percentile of CDC Std. 2005) and undernourished (BMI <5th percentile of Must et al Std. 1991).

Post intervention, all analysis was done on the final data set comprising of only those girls for whom data was available at both the pre-intervention and post-intervention phases. All the data were coded, entered and analyzed in Epi Info, Version 6.04-d.

Major Findings of the Study

Section I: Baseline Survey

Before initiating the interventions, a baseline survey was done to assess the present nutritional status of schoolgirls in early adolescence and to measure specific aspects of physical work capacity and cognitive function.

Table 5.2: Prevalence of Anemia, Stunting and Undernutrition among the Primary School Girls

Age (Years)	N	Percentage Girls	
		N	%
Anemia (Hb <12 g/dl)	334	228	68.3
Height (Below 5th %tile CDC Std)	358	124	34.6
Weight (Below 5th %tile CDC Std)	358	221	61.7
BMI (Below 5th %tile Must et al Std)	358	205	57.3

Reference Standard for Height and Weight: CDC (2005), Reference Standard for BMI: Must et al (1991)

Overall, the prevalence of anemia (Hb <12g/dl) was 68.3% and the mean hemoglobin (Hb) was 11.32 g/dl in the girls (**Table 5.2**). None of the girls was

severely anemic (Hb <7 g/dl). About one-third of the girls were stunted (Height <5th percentile CDC Std.) and two-third of the girls had weight-for-age below 5th percentile CDC standard. More than half of the girls had BMI <5th percentile of the Must et al standards.

With regard to food intake, the intake of cereals and pulses was <50% of the RDA. The intake of green leafy vegetables and milk was very low (<10% RDA). Frequency and quantity of consumption of these foods was equally poor. Overall the girls did not frequently consume iron and vitamin C rich foods and those that did consumed inadequate amounts. The mean intake of calories and proteins was found low (just about 50% of RDA) suggesting inadequate quantity of food consumed. Dietary iron and β-carotene intake was <30% of RDA. Nearly half of the girls (45%) had dietary iron intake below 25% RDA.

In all the cognitive function tests, mean scores were significantly better (p<0.001) in HIG girls compared to LIG girls. The non-anemic girls scored higher than their anemic counterparts, the difference being significant in digit span and visual memory tests. It was observed that anemic girls, whether in the well-nourished group or the undernourished group, showed a poorer performance on cognitive function test scores.

The LIG girls climbed lesser number of steps than HIG girls. However, the mean recovery time (RT), was similar in both the groups. The mean number of steps climbed was higher in non-anemic girls than in anemic girls. RT was significantly higher (p<0.001) for anemic girls, i.e. anemic girls took longer than non-anemic girls to return to their basal pulse rate after finishing the step test.

A summary picture of the deleterious effect of anemia is given in **Table 5.3**. Thus, anemia is likely to adversely affect growth in terms of BMI, physical work capacity and cognition in young adolescent girls undergoing pubertal development.

Table 5.3: Deleterious Effects of Anemia on School Girls

Indicators	Anemic[1]		Non anemic[2]	
	N	Mean ± SD	N	Mean ± SD
Hemoglobin (g/dl)	228	10.69 ± 1.01	106	12.68 ± 0.57
BMI (% Must et al Std)	228	83.5 ± 8.97	106	85.8 ± 11.42
Digit Span	171	6.28 ± 2.09	59	7.57 ± 1.94
Visual Memory Test	171	0.50 ± 0.21	59	0.61 ± 0.22
Maze Test	171	10.52 ± 4.60	59	11.81 ± 4.89
Clerical Task	171	0.61 ± 0.20	59	0.64 ± 0.20
Steps Climbed	171	171.81 ± 42.48	59	174.91 ± 34.59
Recovery Time[+]	171	3.44 ± 0.97	59	2.55 ± 0.79

[1]Hb <12 g/dl, [2]Hb >11.99 g/dl, +in minutes,

Section II: Feasibility and Compliance With IFA: A Process Evaluation

This section presents the results related to compliance and feasibility of supplementation with iron folic acid. In all the data presented in this section, only those girls were included for whom both before and after intervention data was available.

Overall the mean compliance was 71% to 75% of the total number of tablets distributed in the various treatment groups. The compliance was highest with twice weekly IFA supplementation groups, followed by daily group and then once a week supplementation. On most days, the tablets were distributed, after the lunch break, to make sure that the girls do not take the tablet on empty stomach.

With regard to the benefits experienced and reported by the girls, a majority of the girls reported feeling energetic, having improved appetite and weight gain, reduced pallor and an overall feeling of wellness. Very few girls experienced any kind of side effect after taking the tablets. The most common side effects experienced due to consumption of IFA tablets were stomach ache, vomiting/nausea, headache, giddiness, loose motions and uneasiness. A majority of the girls who experienced side effects were from those receiving daily supplements.

With regard to interest of the class teachers, they were highly motivated and enthusiastic about the IFA supplementation, especially in twice weekly and daily school. Thus, compliance was better in IFA-2Wkly and IFA-Daily than IFA-1Wkly, mainly because of better students and teacher's cooperation. Further, though the girls experienced some side effects with IFA tablets, the benefits were much more as expressed by the girls themselves.

Section III: Impact Evaluation of Iron-Folic Acid Supplementation

This section composes the impact of the three experimental (ES)* groups vs. controls (CS group) and also compares relative impact within the ES groups.

Impact on Hemoglobin (Hb)

Table 5.4 gives the key results as regards impact on hemoglobin levels.

All the three ES groups had significantly higher Hb gains than CS group after the intervention. Within ES groups, the increment in the mean Hb was highest in IFA-2Wkly and was comparable to IFA-Daily. The mean Hb increments among initially anemic girls in all the supplemented groups were significantly higher (p<0.001) than those among initially non-anemic girls. IFA-2Wkly and IFA-Daily anemic girls had significantly better Hb gains than in IFA-1Wkly.

Table 5.4: Impact on Hemoglobin Levels After the Intervention

Study Groups	All Girls (9-13 yrs)		Good Compliance		Initially Anemic[1] Girls	
	N	Mean Change ± SD	N	Mean Change ± SD	N	Mean Change ± SD
IFA-1Wkly (E1)	65	0.62 ± 0.88	32	0.90 ± 1.03	46	0.98 ± 0.65
IFA-2Wkly (E2)	89	0.97 ± 1.23	64	1.22 ± 1.23	61	1.55 ± 1.03
IFA-Daily (ED)	59	0.93 ± 1.38	37	1.53 ± 1.35	34	1.89 ± 1.07
No-IFA (CS)	41	0.03 ± 0.24			30	0.50 ± 0.22

[1]Hb < 12 g/dl

*Once weekly IFA (IFA-1Wkly: E1), Twice weekly IFA (IFA-2Wkly: E2), Daily IFA (IFA-Daily: ED)

The trend was similar when minimum 1 g/dl Hb gain was considered, with a higher proportion gaining ≥1g/dl Hb in IFA-2Wkly and IFA-Daily compared to IFA-1Wkly. Among girls with good compliance, girls who gained higher extent of Hb were higher in IFA-Daily and IFA-2Wkly compared to IFA-1Wkly.

The percentage reduction in anemia was 66.6% in IFA-Daily and 63.9% in IFA-2Wkly, with less reduction in IFA-1Wkly (41.3%). The prevalence of anemia in the No-IFA group remained the same. There was a significant shift from moderate anemia to mild anemia and further to non-anemic status in the intervened groups. A non-significant shift was seen in the No-IFA group from moderate to mild anemia.

Therefore, iron folic acid supplementation significantly improved the Hb levels in all the three intervention regimens. The IFA-2Wkly and IFA-Daily groups consistently showed better impact than IFA-1Wkly.

Impact on Growth

The increments in height, weight and BMI were significantly better among the intervened groups compared to the controls. The mean increment in height was similar among the three intervened groups i.e. IFA-1Wkly, IFA-2Wkly and IFA-Daily. However, girls receiving IFA-2Wkly and IFA-Daily had relatively better weight and BMI gains than girls receiving IFA-1Wkly. Within the good compliance group, the trends were similar. **Table 5.5** gives the key results as regards impact on height and body mass index.

When BMI was expressed as percent Must et al standard, the improvement was higher in ES groups compared to CS after the intervention. IFA-2Wkly and IFA-Daily had similar and higher gains compared to IFA-1Wkly girls (**Figure 5.1**). The mean increment in BMI (% Must et al Std.) was significantly better in good compliance group girls in IFA-Daily (p<0.05) and IFA-2Wkly (p<0.001) than those in poor compliance group. However, the mean change in BMI within good

compliance group though higher in IFA-Daily and IFA-2Wkly groups than IFA-1Wkly, this difference was not significant.

Table 5.5: Impact on Height-for-Age and BMI after the Intervention

Study Groups	All Girls			Initially Anemic[1] Girls		
	N	Height	BMI	N	Height	BMI
		Mean Change ± SD	Mean Change ± SD		Mean Change ± SD	Mean Change ± SD
IFA-1Wkly (E1)	73	6.27 ± 1.59	1.25 ± 1.08	48	6. 33 ± 1.68	1.47 ± 0.89
IFA-2Wkly (E2)	103	6.46 ± 1.95	1.58 ± 0.79	64	6.45 ± 1.56	1.80 ± 0.76
IFA-Daily (ED)	59	6.09 ± 1.29	1.59 ± 0.88	33	6.50 ± 1.22	1.81 ± 0.95
No-IFA (CS)	43	3.69 ± 1.27	1.06 ± 0.87	29	3.59 ± 1.09	1.18 ± 0.79

[1]Hb < 12 g/dl,

Figure 5.1: Mean Increment In BMI (% Must et al Std) Among The School Girls After The Intervention

BMI Reference Standard: Must et al (1991)
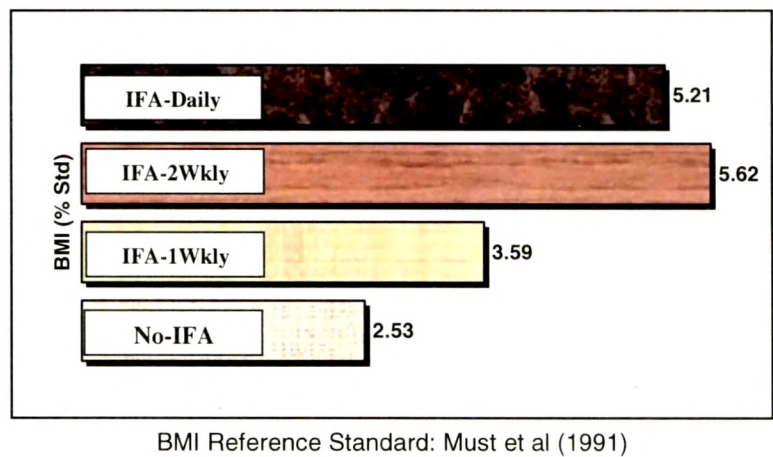
The mean height gain of anemics vs. non-anemics was similar and non-significant in the IFA-1Wkly and IFA-2Wkly groups, while the increment in height in IFA-Daily was significantly higher among anemic girls than in non-anemics. Within anemic girls, ES groups had significantly better height gain compared to controls. The BMI increments were significantly higher among the anemic girls in all the three intervened groups compared to their non-anemic counterparts. Among anemic girls, BMI gains were significantly better in IFA-Daily and IFA-2Wkly than No-IFA.

The gain in height (% CDC Std.) was markedly higher and statistically significant in the groups gaining ≥1 g/dl Hb in all the three intervened regimens. The gain in BMI (% Must et al Std.) in all the three intervened groups were higher amongst those who gained ≥1 g/dl Hb, however, this difference was not significant.

Figure 5.2: Percentage Girls with Normal BMI[1] Before And After The Interventions

[1]BMI ≥ 5th percentile of Must et al standard (1991)
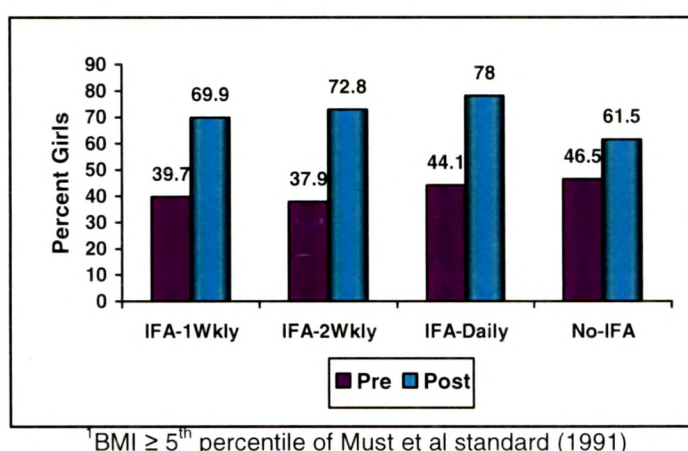
There was a significant reduction in the percentage of girls below normal BMI (above 50%) among the intervened groups, highest reduction being in IFA-Daily followed by IFA-2Wkly and IFA-1Wkly. **Figure 5.2** gives the percentage girls with normal BMI before and after the intervention.

Iron folic acid supplementation in the present study significantly improved height gain in all the three ES groups. However, BMI increments in twice weekly and daily groups were consistently higher than in IFA-1Wkly group. Those with good compliance continued to show similar trends, i.e. IFA-Daily and IFA-2Wkly had significantly higher BMI gains than IFA-1Wkly.

Impact on Food-Nutrient Intake and Appetite

A positive shift in girls' food intake towards higher intakes as % RDA was observed in all the ES groups which were higher than control groups. With regard to cereal and pulses intake, there was a significant (p<0.05) shift in the percentage of girls

consuming more than 50% of the RDA after the intervention in the IFA-Daily group. However, due to wide variations in the food and nutrient intakes, the trend in impact was not consistent.

Appetite: The girls were asked during the course of the intervention, in an open-ended way, regarding how they felt after consuming the tablets. A majority of the girls receiving iron-folate tablets experienced improvement in appetite and expressed that they ate much more now (after taking the tablets) than they ate before the supplementation was started.

With regard to nutrient intakes, increase in energy and protein intakes (as % RDA) in IFA-2Wkly was significantly better than in control girls. Further the mean increment in dietary iron (% RDA) was highest in IFA-Daily. There was a shift in the percentage girls meeting lower RDAs (<50% RDA) for energy and dietary iron to higher RDA levels (>50% RDA) among girl supplemented with IFA tablets compared to the controls. Within the intervened groups, the shifts to better nutrient intakes were seen among IFA-2Wkly and IFA-Daily groups. Again, though a trend towards better nutrient intakes were seen, findings were not consistent in the three intervened groups due to variations in intake.

Impact on Cognitive Function

Table 5.6 gives the key results as regards impact on cognitive abilities.

Overall, IFA-Daily and IFA-2Wkly showed marked improvement in most tests, while IFA-1Wkly consistently showed poor impact. The increments in IFA-Daily and IFA-2Wkly were significantly higher than No-IFA, in all the four cognitive tests; whereas IFA-1Wkly was significantly better than No-IFA group, only in two of the four tests (**Table 5.6**). The IFA-Daily groups with good compliance showed the best impact. Further IFA-2Wkly with good compliance was comparable to IFA-Daily in three of the four tests.

Table 5.6: Mean Change in Cognitive Test Scores in the School Girls

Study Groups	N	Digit Span Test	Visual Memory Test	Maze Test	Clerical Task
		Mean change ± SD	Mean change ± SD	Mean change ± SD	Mean change ± SD
IFA-1Wkly (E1)	43	1.05 ± 1.47	0.191 ± 0.13	3.25 ± 3.39	0.149 ± 0.12
IFA-2Wkly (E2)	42	1.41 ± 1.28	0.198 ± 0.13	4.35 ± 3.16	0.340 ± 0.21
IFA-Daily (ED)	42	2.56 ± 2.05	0.207 ± 0.15	4.07 ± 3.24	0.215 ± 0.14
No-IFA (CS)	34	0.50 ± 1.23	0.079 ± 0.14	1.47 ± 3.12	0.141 ± 0.16

In all the CF tests, the scores were higher among those who gained more than 1 g/dl of Hb than those who gained less, however these differences were not significant. Within those who gained higher extent of Hb, IFA-2Wkly and IFA-Daily had better improvement in scores than IFA-1Wkly. When only initially anemic girls were compared, the trend was similar as in the total sample i.e. IFA-Daily and IFA-2Wkly groups showed higher increments compared to once weekly group and controls.

In all the four tests, the IFA-Daily group, post intervention came close to matching the HIG scores; followed by IFA-2Wkly. The impact was more marked in three of the four tests (VMT, CT and maze compared to Digit Span).

Therefore, girls benefited more from the more frequent dose regimens with IFA-1Wkly supplementation showing least impact.

Impact on Physical Work Capacity (PWC)

The mean increment in number of steps climbed in IFA-Daily and IFA-2Wkly were more than double than that in No-IFA group. IFA-Daily girls had significantly higher ($p < 0.05$) increase in number of steps climbed than IFA-1Wkly. The improvement in recovery time (RT), i.e. decrease in RT, was significantly better in IFA-Daily than No-IFA group. Although there was decrease in RT in IFA-2Wkly and IFA-1Wkly, this was not significantly better than No-IFA.

Table 5.7 gives the key results as regards impact on physical work capacity.

Table 5.7: Change in Mean Number Of Steps Climbed [1] and RT[2] (in min) After MHST After the Intervention

Study Groups	N	Number Of Steps Climbed [1]	Recovery Time[2]
		Mean Change ± SD	Mean Change ± SD
IFA-1Wkly (E1)	43	21 ± 13.53	-0.12 ± 0.73
IFA-2Wkly (E2)	42	27 ± 21.33	-0.17 ± 0.73
IFA-Daily (ED)	44	29 ± 15.61	-0.48 ± 0.73
No-IFA (CS)	34	13 ± 16.26	0.06 ± 0.60

[1]Number of Steps Climbed, [2]Recovery time (in min)

Within good compliance group, the increment in number of steps climbed was highest in IFA-Daily and was significantly better than IFA-1Wkly. IFA-2Wkly group was comparable to IFA-Daily. However, as regards improvement in RT, it was significantly better in IFA-Daily compared to IFA-2Wkly.

The mean increase in the number of steps climbed and the RT improvement was higher among those who gained Hb levels ≥ 1 g/dl compared to those with Hb increase <1 g/dl, the difference being significant in IFA-2Wkly and IFA-Daily groups. In the group which gained ≥ 1 g/dl Hb, the change in the number of steps climbed and RT improvement was highest in IFA-Daily. The trends were similar when only good compliance girls were considered.

The mean increase in the number of steps climbed among anemic (Hb <12 g/dl) girls in all ES groups was significantly better than in CS. Within the intervened groups, increase in number of steps in IFA-Daily was significantly higher than in IFA-1Wkly. In terms of change in recovery time, only those who received daily doses and were initially anemic showed significant decrease in the RT compared to No-IFA, and the other groups.

Thus, girls receiving higher frequency of IFA doses showed better impact in terms of increase in number of steps climbed and decrease in recovery time. The IFA-Daily group showed the maximum impact followed closely by IFA-2Wkly.

Conclusion and Unique Contribution of This Research

To conclude, the present study validates the usefulness of intermittent IFA supplementation for adolescent girls and emphasizes the need for including young girls in early adolescence who are in the rapid phase of development, in anemia control programs.

The results of the study, viewed collectively, lead to the rejection of the hypothesis stated at the onset, which was stated as below:

Among girls in early adolescence from deprived communities and studying in government schools, whether supplemented with iron folic acid (IFA) tablets daily or twice a week or once a week,

    a) there is no significant impact (when compared to controls) on hemoglobin levels, growth (in terms of BMI), food and nutrient intake, cognitive function test scores and physical work capacity (in terms of steps climbed and recovery time).

    b) there is further, no significant difference in impact on the above indicators within the intervened groups, i.e. IFA Daily, IFA twice weekly and IFA once weekly.

Contrary to the stated hypothesis, the study participants (young girls entering adolescence) benefited from iron folate supplementation in several ways, that is, improvement in Hb levels and decrease in anemia, improvement in height and BMI gain and in scores measuring cognitive function and physical work capacity. Though there was a significant improvement in cereal intake in the intervened groups, micronutrient intake from foods was not significantly affected.

Secondly, Daily IFA and twice weekly IFA appeared to be superior to once weekly IFA in terms of improving hemoglobin status, growth in terms of height gain and BMI, cognition and physical work capacity as seen below.

Given below is a comparative picture of the relative impact of IFA supplementation

Indicator	Once Weekly IFA	Twice Weekly IFA	Daily IFA
• Hemoglobin status	+++	+++	+++
• Growth in terms of BMI	+	+++	+++
• Food and nutrient intake	+	+	++
• Cognitive abilities	+	+++	+++
• Physical Work Capacity	+	++	+++
+ Fair impact, ++ Good impact, +++ Best impact			

Recommendations for IFA Supplementation Programs for Primary School Girls

1. Need for Intermittent IFA Supplementation

Considering that the two supplementation regimens, i.e. daily and twice weekly, produced similar increases in hemoglobin, growth and cognition, it is recommended that twice weekly IFA supplements of 100 mg iron + 0.5 mg folic acid be given to primary school girls in early adolescence i.e. age 9 or 10 to 13 or 14 years (Std. V - VII), to improve their iron and folate reserves, prevent iron deficiency anemia and improve their growth, cognitive functions as well as physical work capacity.

Primary schools to reach young adolescents are recommended because young adolescent girls are accessible in primary schools which have high enrolment rates (compared to secondary schools) enabling higher coverage and better impact at less cost. Though the school attendance of girls varies between different regions, yet a large proportion of girls attend primary school and can be reached for such interventions. In some states, primary schools are till standard V and middle schools have standards VI and VII.

Twice weekly IFA is also more feasible and economical than daily IFA and shows similar impact according to the evidence of this study. In daily and twice weekly groups, compliance with IFA tablets was good and side effects were less in the long term and in no case stopped any of the girls from taking the supplements. This suggests that both supplementations were safe and the regimens did not cause poor

adherence or rejections. In particular, problems of side effects and decreased compliance are less likely with twice weekly IFA than daily IFA.

Given below is a comparative picture of the annual cost of IFA tablets per child.

	Annual cost of IFA tablets		
	Once Weekly IFA	Twice Weekly IFA	Daily IFA
Cost of generic IFA tablets per child per year (Rs 35 / 1000 IFA tablets)*	Rs 2.08 per year	Rs 4.16 per year	Rs 14.5 per year

*As obtained from local sources

Therefore, intermittent supplementation with lower budgets can aim to cover larger number of school girls. Besides, girls in school are a captive group and can be reached at less cost compared to community based approaches.

The success of an iron folic acid supplementation program depends significantly on the delivery system. The present study indicates that a school based strategy of twice weekly iron folic acid supplementation is feasible and can be successfully employed as a delivery system for anemia control in primary schoolgirls.

2. Need for Close Supervision
Close supervision is essential in intermittent IFA supplementation and should be ensured whether given in schools or community programs. Supervised supplementation is feasible in school settings with active participation of class monitors and teachers.

3. Advocacy and IEC
Appropriate advocacy is needed to motivate the primary school teachers and principals to support such programs. The fact that IFA is likely to also improve adolescent growth, cognition and physical work capacity (besides reducing anemia), makes a strong case for advocating that girls in early adolescence in primary schools be included in anemia control programs. Effective IEC strategies are also required to

reach the school girls to convince them of the need for IFA and also improve their home diets.

4. Reaching Out of School Girls

One challenge to be overcome is reaching the out of the school girls, which can be done through ICDS. The reach of out of school girls through ICDS has already given good results in Gujarat.

Recommendations for Future Research

- Intermittent (twice weekly) IFA should be further tested in program settings in a larger number of primary schools - and for out-of-school children - to study its various functional benefits. With improving primary school enrolment rates, reaching young girls in pubertal phase of growth, will become more cost-effective over the years. Further research is also needed focusing on how nutrition education be more effectively integrated into such supplementation programs.

- It is long known that vitamin A is required for mobilization of iron status from the liver and that vitamin A supplementation enhances impact of IFA supplementation in reducing anemia. Future research could see the impact, feasibility and integrated cost of IFA given twice weekly with mega dosing with vitamin A (twice in a school year, six monthly) to primary school children – boys and girls – in early adolescence. These could be with or without the MDM program. Operational research on representative samples of schools will help to understand more clearly cost and impact of such integrated interventions.

- Finally, testing effective nutrition-health communication strategies as part of school curriculum is an area for future research which will enhance the impact of all other interventions.