Physical Work Capacity of Young Underprivileged School Girls: Impact of Daily vs Intermittent Iron-Folic Acid Supplementation – *A Randomized Controlled Trial*

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Objectives: To assess impact of daily and intermittent iron-folate (IFA) supplementation on physical work capacity of underprivileged schoolgirls in Vadodara.

Design: Randomized controlled trial.

Setting: Municipal Primary schools.

Participants: Schoolgirls (*n*=163) in the age group of 9-13 years.

Intervention: Three randomly selected schools were given IFA tablets (100 mg elemental iron + 0.5 mg folic acid) either once weekly or twice weekly or daily for one year. The fourth was the control school.

Outcome Measures: Hemoglobin, modified Harvard's Step test for physical work capacity.

Results: All three IFA supplemented groups showed significant improvement in number of steps climbed and recovery time compared to controls; with impact being relatively better in girls with higher Hb gain (>1 g/dL) *vs.* lower Hb gain. Similarly, higher the frequency of dosing better was the impact- it being the best in daily IFA group. Twice weekly IFA was as good as daily IFA under conditions of good compliance.

Conclusion: Twice weekly IFA supplementation is comparable to daily IFA in terms of beneficial effects on physical work capacity in young girls.

Keywords: *Anemia, Iron-folate supplementation, Physical work capacity, School girls.*

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Besides being a major threat to safe motherhood, iron deficiency anemia (IDA) in adolescent girls contributes to poor growth, lowered resistance to infections, poor cognitive development and most importantly, decreased work capacity(1). In IDA, physical work capacity (PWC) is compromised due to decrease in hemoglobin, which reduces the availability of oxygen to the tissues, and hence certain tissues and organs that require much oxygen like heart may suffer, resulting in diminished capacity to perform energy consuming tasks(1,2). The concentration of myoglobin in skeletal muscle is reduced limiting the rate of diffusion of oxygen from erythrocytes to mitochondria(1). Thus, work output, endurance and maximal work capacity are impaired in iron deficient states.

To combat anemia, initiation of iron supplementation in the adolescent years has been recommended. Once weekly administration of iron-folate (IFA) supplements given to adolescent school girls under supervised conditions has been found to be effective and practical for raising hemoglobin levels among girls in Indian studies(3-4). Daily IFA has also shown positive impact on growth of school children and adolescents(5-6). However, little is known about the benefits of IFA supplementation on physical work capacity of young school going adolescents entering the pubertal growth spurt. In adolescent girls, with high social expectations of meeting the demands of domestic work and school, decreased PWC may compromise their quality of life. We studied the impact of intermittent (once and twice weekly) and daily IFA supplementation on physical work capacity of underprivileged schoolgirls in early adolescence (9-13 years) in Vadodara.

METHODS

This was an experimental-control semi-longitudinal study; an efficacy trial to assess impact of iron folic acid supplements on physical work capacity. Prior permission from the Primary School Board, Vadodara, and informed written consent from students and their parents were taken. The departmental ethical committee cleared the study.

Sampling: Using accepted procedures, desired sample size was calculated(7); which came to 46 per group. Allowing for dropouts, each study group required about 60 subjects of age 9-13 years; which were available in standards V and VI per school. Thus, four schools were randomly selected from a sampling frame of 17 schools (all Municipal primary schools for girls in the morning shift), and all consenting girls studying in Standards V and VI were enrolled. Students in all four schools had similar socioeconomic, home and school environment.

Intervention: Three schools were randomly selected as experimental schools (ES) and were given IFA tablets (100 mg elemental iron +0.5 mg folic acid) either once weekly (IFA-1Wkly) or twice weekly (IFA-2Wkly) or daily (IFA-Daily) for one year. The fourth was the control school (No-IFA). Girls were not dewormed prior to the intervention. The investigators, with assistance from the class teachers / monitors, ensured regular supervised distribution and compliance of IFA in all intervened schools. The tablets were distributed immediately after the tiffin break (short recess) to ensure they were not taken on empty stomach.

Data collection: Pre and post intervention hemoglobin data were collected on all girls. In view of the limited working school days and the time required to conduct physical work capacity test, a random 60% sample (n=240) was selected. From this, data of 163 girls was available pre and post intervention; after also excluding girls who had attained menarche during the study, though they did receive IFA supplements. None of the girls suffered from illnesses which might affect work capacity except one girl, who had asthma and was unwilling to participate. Further, none of the girls was involved in athletics/sports on a regular basis.

Outcome variables: Hemoglobin levels were assessed using cyanmethemoglobin method(8). Physical work capacity (PWC) of the subjects was assessed using Modified Harvard's Step test (MHST)(9); which has been used in earlier studies on school children in the department and found to be valid(10). The girls were asked to climb up and down a set of five steps as fast as they could for three minutes. The total number of steps climbed up and down was counted. The resting pulse rate was recorded manually before the girls began the test. Post exercise, the time taken (minutes) to revert to the basal pulse rate was also recorded (recovery time). Means and standard deviations were calculated for hemoglobin and PWC. The mean change in each group was calculated and compared between the experimental groups and also with the control group. Girls with good compliance were defined as those who consumed atleast 70% tablets distributed. To compare various intervention groups for statistical significance of impact (P<0.05), ANOVA test and to compare each group with control, students t test was used. All the data were coded, entered and analyzed in Epi Info, Version 6.04-d.

RESULTS

Mean baseline Hb was similar in all groups (P>0.05); being 11 to 11.5 g/dL. Post intervention, all intervention groups had significantly higher mean Hb increment vs. controls, with increment being highest in IFA-2Wkly (0.97 g/dL) followed by IFA-Daily group (0.93 g/dL). IFA-1Wkly showed the lowest increment (0.62 g/dL). However, among the initially anemic girls (Hb<12 g/dL), IFA-Daily group showed highest increment (1.9 g/dL) followed closely by IFA-2Wkly (1.6 g/dL).

Impact on Physical Work Capacity

Number of Steps Climbed: The mean increase in number of steps climbed was significantly higher (and almost twice as high) among supplemented groups (21 to 29 steps) compared to controls (13 steps) (***Table* I**). Within the supplemented groups,

TABLE I CHANGE IN MEAN NUMBER OF STEPS CLIMBED AND RECOVERY TIME-RT (IN MIN) AFTER THE INTERVENTION

Study Groups	*N*	Increase in Number of Steps Climbed (Mean ± SD)	Recovery Time (Mean ± SD)
IFA-1Wkly	43	21 ± 13.53	–0.12 ± 0.73
IFA-2Wkly	42	27 ± 21.33	–0.17 ± 0.73
IFA-Daily	44	29 ± 15.61	–0.48 ± 0.73
No-IFA	34	13 ± 16.26	0.06 ± 0.60
F test		*P*<0.001	*P*<0.01

•***Comparing each experimental group (EG) with control:*** *Increase in steps climbed- all EG were significantly better (IFA-1Wkly P<0.05; IFA 2Wkly P<0.01, IFA-Daily P<0.001); RT: only IFA-Daily was significant (P<0.001).*

•***Within experimental groups:*** *Increase in steps climbed and RT improvement; IFA-Daily was significantly better than IFA-1Wkly (P<0.05).*

IFA-Daily girls had significantly higher ($P<0.05$) increase in number of steps climbed than IFA-1Wkly. IFA-Daily was followed closely by IFA-2Wkly; least impact was seen in IFA-1Wkly.

Recovery time: The improved recovery time (RT), was significantly better in IFA-Daily than No-IFA group (***Table* I**). Although there was decrease in RT in IFA-2Wkly and IFA-1Wkly, this was not significantly better than No-IFA. There was slight increase in the RT of the girls in No-IFA group.

Influence of compliance with IFA: In each treated group, girls with good compliance showed better impact than those with poor compliance and this difference was significant in IFA-Daily. Within good compliance, comparing the groups, the increment in number of steps climbed or recovery time was the best in IFA-Daily but between groups, differences were not significant (***Table* II**). However, within poor compliance, between-group difference was significant, with IFA-Daily showing best impact and IFA-1Wkly showing least impact (increase in RT).

Hemoglobin gain and physical work capacity

***Figure* 1** shows that the mean increase in the number of steps climbed 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 increase in number of steps climbed was highest in IFA-Daily, (which was significantly better than IFA-1Wkly group), followed by IFA-2Wkly. On comparing the change in the recovery time, it was clear the decline in the RT was higher amongst those with higher Hb

TABLE II NUMBER OF STEPS CLIMBED AND RECOVERY TIME (IN MIN) AFTER MHST IN GIRLS WITH GOOD COMPLIANCE AND POOR COMPLIANCE

Study Groups	*N*	Good Compliance[1] Initial	Good Compliance[1] Final	Mean change (A)	*N*	Poor Compliance[2] Initial	Poor Compliance[2] Final	Mean change (B)	*'P'* Value A vs B
Number of Steps Climbed (Mean ± SD)									
IFA-1Wkly	26	171±28.27	195±24.43	24±14.34	17	166±20.03	184±20.56	18±11.06	>0.05
IFA-2Wkly	30	181±40.56	208±31.48	29±24.69	12	178±39.57	201±30.24	23±15.05	>0.05
IFA-Daily	27	188±32.59	221±28.71	34±14.35	15	191±34.45	212±2 5.18	22±15.77	<0.05
P Value				>0.05				>0.05	
Recovery time (RT) (Mean ± SD)									
IFA-1Wkly	26	3.88±0.86	3.50±0.94	–0.38±0.69	17	3.88±0.78	4.17±0.08	0.29±0.58	<0.01
IFA-2Wkly	30	2.76±1.07	2.53±0.63	–0.23±0.77	12	2.75±0.75	2.75±0.75	0.00±0.60	<0.05
IFA-Daily	27	3.29±0.95	2.59±0.64	–0.70±0.77	15	2.46±0.64	2.26±0.59	–0.20±0.41	<0.05
P Value				>0.05				<0.05	

Values are Mean ± SD; [1]Compliance of 70% of IFA dose, [2]Compliance of < 70% of IFA dose.

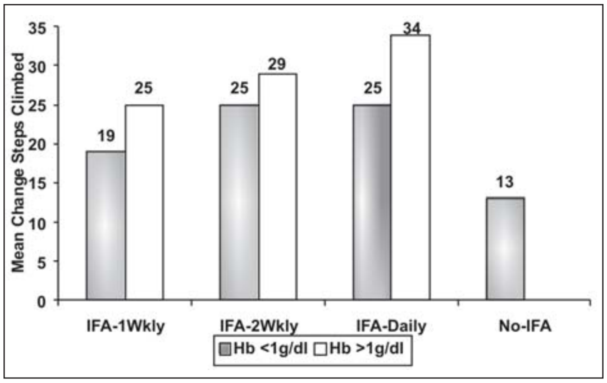

FIG. 1 *Mean change in steps climbed - girls with Hb gain>1 g/dL vs. girls with Hb gain< 1g/dL.*

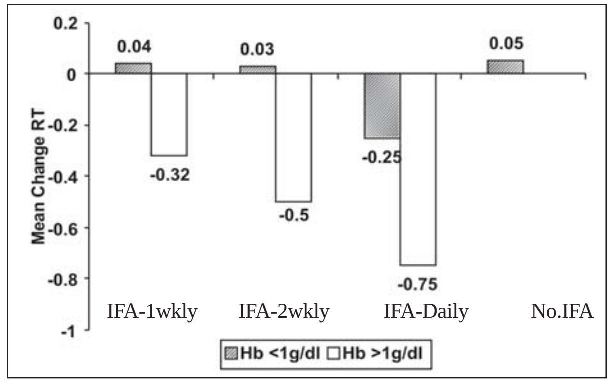

FIG. 2 *Mean change in recovery time- girls with Hb gain>1 g/dL vs. girls with Hb gain <1g/dL.*

increments (***Fig.2***). Further, more frequent the dosing, better the impact. The trends were similar when only good compliance girls were considered.

Initial level of anemia and physical work capacity

Considering only anemic girls (Hb <12 g/dL), the mean increase in the number of steps climbed in all intervened groups was significantly better than in controls (***Fig.* 3**). Within the intervened groups, increase in number of steps in IFA-Daily was significantly higher than in IFA-1Wkly. The differences in the increase in steps among anemic girls in IFA-2Wkly and IFA-1Wkly were non-significant. 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. Therefore, daily supplementation of iron folate tablets significantly improved the work capacity among anemic girls in terms of increase in number of steps climbed and decrease in recovery time.

DISCUSSION

The findings of this study indicate that among the intervention groups (as compared to controls), the IFA-Daily group showed the maximum impact followed by IFA-2Wkly as regards improvement in PWC in terms of significantly higher increase in the number of steps climbed and improvement (reduction) in recovery time (RT). IFA-1Wkly showed least impact; though it was better than control. These trends remained when subgroups like 'girls with good compliance', and 'anemic girls' were considered. Girls who gained more Hb (>1 g/

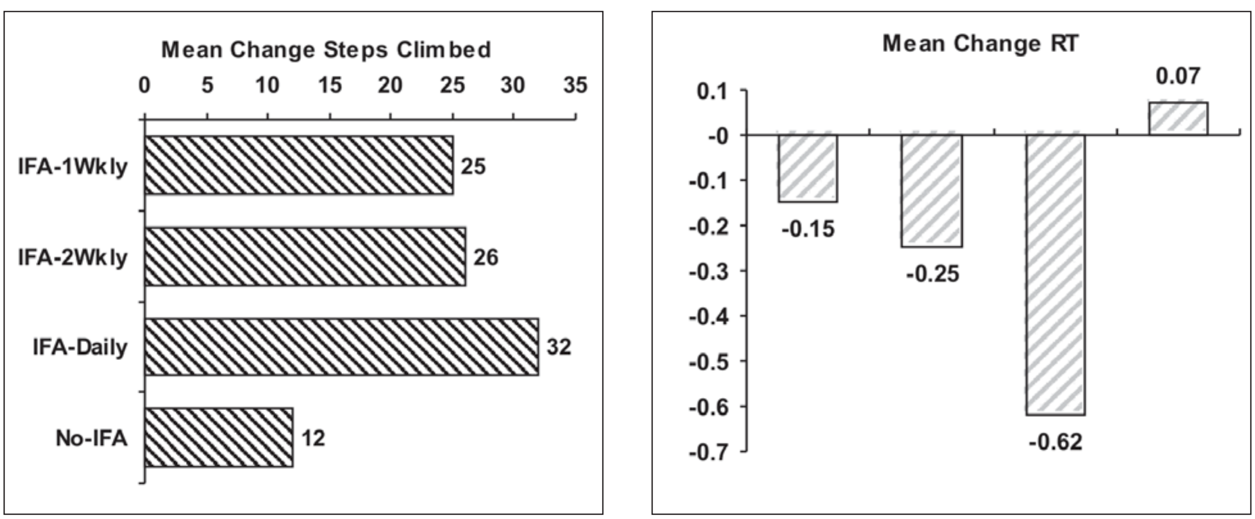

FIG. 3 *Number of steps climbed and recovery time in initially anemic girls after the intervention.*

WHAT IS ALREADY KNOWN?

- Daily and once-weekly iron-folate supplementation improve hemoglobin levels among adolescent girls.

WHAT THIS STUDY ADDS?

- Intermittent iron folate supplementation (daily and twice weekly) significantly improves work capacity and decreases recovery time among school girls compared to once weekly and anemic girls benefit more from Daily IFA supplementation

dL) showed better improvement in PWC *vs.* those who gained Hb<1 g/dL; in all treated groups. Higher the frequency of IFA supplementation (daily and twice weekly), better the improvement in hemoglobin and PWC.

Data on impact of IFA on PWC among school children and adolescents is scanty in literature. Supplementation of 60 mg iron per day to non-pregnant female workers in Beijing reduced mean heart rate, and increased the production efficiency. Iron supplementation enabled the female workers to do the same work at lower energy cost(11). A randomized double-blind placebo-controlled trial has been reported in Sri Lanka(12) on 20-60 years old female tea estate workers. The first study group received 200 mg FeSO4 for 1 month and the second study group received 200 mg FeSO4 for 3 wks. There was a net increase of 1.5 g/dL in Hb level. The amount of tea picked increased by 1.2%. The heart rates were significantly lower after supplementation. In South India, young adult women given 60 mg of iron for 100 days showed reduced energy expenditure for physical activities like walking, running, climbing, skipping and sweeping. The mean distance covered by anemic women while walking increased from 8 meters/min to 14 meters/min after iron supplementation. The exertion on heart as shown through blood pressure and pulse rate, also reduced after supplementation(13).

In rural Varanasi, UP, India, a study on school children (6-8 years) over one year (170 working days) assessed the impact of iron supplementation (Iron syrup: ferrous gluconate 200 mg) on physical growth, physical stamina, mental function and academic performance(14) and reported that the supplementation did not influence the performance of children on the parameters of Harvard step test; but mean scores for recovery period were better for the supplemented group than controls after a 300 meter run-cum-walk. Studies conducted in this department in Vadodara using Modified Harvard Step Test to assess the work performance of anemic preschool children(15) and using indicators like increase in the number of skips done by school girls with a skipping rope reported a significant improvement in PWC of iron treated subjects compared to controls(10).

Our study has shown that while once-weekly IFA may not suffice; twice weekly IFA has the potential to lead to significant improvement in physical work capacity at less cost and greater feasibility as compared to daily IFA supplements; this however needs to be further explored through randomized control trials on larger samples. Another important observation emerging from this study is that IFA supplementation should be initiated not just in secondary schools as at present is the case in Gujarat, but earlier in primary school (classes V-VII) when children are entering adolescence and when iron demands are high for growth and development.

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