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Original Research Article

EFFECT OF WEEKLY IRON FOLIC ACID SUPPLEMENTATION ON ANEMIA AMONG SCHOOL GOING CHILDREN FROM 11-19 YEARS OF AGE IN CENTRAL INDIA

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Abstract

Background: Anemia affects 52% of Indian women and 25% of men, with higher rates in Madhya Pradesh. The heightened risk of iron deficiency and anemia in adolescents stems from their accelerated iron requirements, driven by the rapid growth during puberty. Adolescent girls, due to menstrual blood loss, are especially vulnerable. The Anemia Mukt Bharat initiative targets girls but faces systemic challenges, necessitating multifaceted interventions and further research. **Materials and Methods:** A one-year cross-sectional study in central India surveyed 192 consented students (6th to 12th grade) using a pretested questionnaire. Data on demographics, health awareness, and exercise were collected. Anemia prevalence (categorized by hemoglobin levels) was analyzed using SPSS. **Result:** A study with 191 school children (grades 6-12) receiving weekly Iron and Folic Acid (IFA) supplementation showed significant anemia improvements regardless of gender, background, or income level, highlighting the broad effectiveness and importance of diverse healthcare factors. **Conclusion:** The study highlights widespread adolescent anemia, primarily due to iron deficiency. It emphasizes the importance of interventions like iron supplementation, improved healthcare access, and hygiene practices in reducing anemia prevalence.

INTRODUCTION

Anemia stands out as a predominant global nutritional disorder, affecting approximately one in four individuals aged 10 to 24, totalling around 430 million people. Most cases are concentrated in low- and middle-income countries.[1] This critical developmental period, bridging childhood and adulthood, is adversely impacted by anemia, negatively influencing work capacity, neurocognitive development, maturation, and susceptibility to infections.[2-4]

In India, the burden of anemia is significant, with an estimated 52% of women and 25% of men affected. Certain subpopulations experience even higher prevalence rates, notably adolescent girls (59.1%) and pregnant women (52.2%). Madhya Pradesh grapples with some of the highest anemia rates in the country, affecting approximately 52.9% of pregnant women and 58% of adolescent girls. As per the data of National Family Health Survey (NFHS-5) 2019-21, the prevalence of anemia among adolescents in central India is alarmingly high, ranging between 30% and 60%, exceeding the national average of 39.6% for girls and 17.6% for boys. Additionally, rural areas have higher rates of anemia (30.5%) compared to urban areas (26.8%). The NFHS-5 data highlight that the lower socioeconomic group reports the highest prevalence of anemia among adolescent females (59.1%), while the wealth quintile reports the lowest prevalence among adolescent males (10.4%).[5]

The heightened risk of iron deficiency and anemia in adolescents stems from their accelerated iron requirements, driven by the rapid growth during puberty. This growth leads to an increased lean body mass, blood volume and red cell mass. These factors heighten the demand for iron to support myoglobin in muscles and hemoglobin in blood. Notably, adolescent girls face heightened vulnerability to iron deficiency anemia due to the regular loss of 13-15 mg of iron each month, equivalent to 0.4-0.5 mg of iron daily, through menstrual blood.[6-8]

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Research indicates that anemia cases in adolescents rises with age, most notably during the period of most rapid growth, typically in 12-15 years age when iron requirements are at peak. The Comprehensive National Nutrition Survey (CNNS) points to a notable increase in anemia prevalence in older adolescents. Additionally, female adolescents aged 12 years and above demonstrate a higher occurrence of anemia in comparison to their male counterparts.[9,10]

Anemia has a substantial effect on growth and development of school-age children, particularly in the case of IDA, which is independently linked to diminished cognition, learning ability, and lower academic achievement, particularly in adolescent girls.[11-15] IDA also disrupts oxidative energy production in skeletal muscle, resulting in inefficient glucose oxidation and reduced physical exercise capacity. This, in turn, affects overall work performance.

During adolescence, Iron Deficiency Anemia (IDA) not only impacts physiological changes but also compromises the immune response, heightening susceptibility to infections. Adolescent girls, in particular, face increased vulnerability to anemia because of heightened growth demands, insufficient dietary intake, susceptibility to helminth infestation, and significant loss of iron during menstruation. Unfortunately, the nutritional needs of girls during adolescence are frequently overlooked, leading to stunting and overall poor health. Consequently, anemia becomes a major consequence of both physiological changes and nutritional neglect during this critical period.

India encounters challenges in achieving the targets set by the World Health Assembly for reducing anemia by 2025.[16] The Anemia Mukt Bharat strategy, initiated in 2018,[17] aims to combat anemia by specifically emphasizing iron and folic acid supplementation for adolescent girls. This strategy presents a crucial opportunity to disrupt the cycle of anemia between generations before the onset of pregnancy. However, there is a pressing need to improve the supply chain mechanism of iron and folic acid (IFA) and make sure the effective implementation of the program through consistent training at all the levels. While iron and folic acid (IFA) supplementation stands as a primary intervention to manage anemia, its efficacy may extend to only 50% of adolescents with anemia and prevent anemia in those who are not yet affected.

The Government of India tackles the nutritional challenges faced by adolescent females, including anemia, through several flagship schemes and programs. These initiatives include, the Integrated Child Development Services (ICDS) scheme, the Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (RGSEAG)-SABLA, and more recent endeavors like Anemia Mukt Bharat and POSHAN Abhiyaan.

However, addressing anemia requires more than just the Iron and Folic Acid (IFA) program or improvements in dietary intake. Ineffective coordination, underfunding, inadequate counseling, suboptimal program implementation and low visibility of the national anemia control program may have contributed to the insufficient handling of anemia among school-age children. Effective collaboration and coordination across governmental departments, such as education, health, sanitation, and water supply, are essential. The promotion of adequate Water, Sanitation, and Hygiene (WASH) practices, the control of diarrhea using oral rehydration solution (ORS) along with zinc supplementation and the adoption of toilets need to be emphasized to reduce the anemia prevalence caused by chronic inflammation and environmental enteropathy (EE).

Hence, further research needs to be conducted to comprehend the factors influencing anemia among the adolescent age group in India. This will aid in effectively addressing the increasing issue of anemia among this.

MATERIALS AND METHODS

A cross-sectional descriptive study was conducted in central India over one year, targeting students from 6th to 12th grade who provided consent. The sample size of 192 was determined using Scott et al. [4] procedure for computing a population proportion, with a 39.6% prevalence of iron deficiency and a 95% confidence level.

Data collection utilized a pretested semi-structured questionnaire covering various demographic factors, including age, gender, ethnicity, economic status, education level, and other relevant socioeconomic factors. Additionally, information on awareness of health facilities, anemia prevention, and management was gathered. Participants' exercise routines, frequency, and intensity of physical activities were also documented. The primary outcome variable, anemia, was categorized based on hemoglobin levels: severe (<7 gm/dl), moderate (7-9.90 gm/dl), mild (10-11.90 gm/dl), and normal (≥12 gm/dl).

Data analysis was performed using Microsoft Excel and SPSS version 25 for PC. Quantitative data were presented using mean and standard deviation, with the unpaired student's t-test examining differences between comparable groups. Qualitative data were represented in percentages. Differences between proportions were assessed using the Chi-square test/Fisher's exact test, with a significance level set at $P < 0.05$.

RESULTS

This study enrolled 191 school-going children in grades 6 to 12 for a weekly Iron and Folic Acid (IFA) supplementation intervention. Consent was obtained from both students and their class teachers. Initial and follow-up visits assessed hemoglobin (Hb) levels and collected anemia-related information.

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Demographic distribution in [Table 1] revealed an even age group distribution, balanced gender representation (50.3% males, 49.7% females), and a majority from rural backgrounds (93.2%). Most participants reported a family income of Rs 10,000 or more (77.5%) and parents' diverse educational backgrounds.

[Table 2] presented participants' dietary patterns, physical activity, and awareness about anemia. A majority followed a vegetarian diet (95.8%), consumed leafy greens at least twice a week (75.9%), and fruits twice a week or more (84.8%). Tobacco use was rare (1.0%), and most engaged in regular physical activity (89.0%). Health-related factors included a significant proportion with prior anemia diagnoses (77.5%) and good personal hygiene practices.

[Table 3] detailed the impact of IFA supplementation, showing improvements in anemia categories, with only 13.1% remaining moderately anemic post-intervention. Mean Hb levels significantly increased from 9.07 gm% to 11.49 gm%.

[Table 4] explored factors associated with anemia improvement. Weekly IFA supplementation benefited both genders, across rural, urban, and tribal backgrounds, and income levels. Significant enhancement occurred in the 17-19 year age group. Associations were found with physical activity and information/education. Tobacco consumption showed no significant association, likely due to limited participants. A significant association with anemia correction was observed for a vegetarian diet, while non-vegetarian associations weren't calculated due to limited representation. Green leafy vegetable consumption had minimal impact, whereas frequent fruit consumption significantly enhanced IFA effects. Significant improvement was noted in those consuming IFA tablets 4-5 times a month. Albendazole tablet roles and personal hygiene showed minimal impact. Availability of toilet facilities was significantly associated with IFA supplementation receipt.

In summary, the study demonstrated the positive impact of weekly IFA supplementation on anemia, especially in the 17-19 year age group. Factors such as gender, background, and income level did not affect the supplementation's efficacy, emphasizing its universality. Dietary patterns, physical activity, and information/education played crucial roles in anemia improvement. The study highlighted the multifaceted nature of anemia correction, showcasing the importance of infrastructure and diverse factors in healthcare delivery. The comprehensive findings contribute valuable insights to addressing anemia in school-going children.

Table 1: demographic profile and socioeconomic status of study participants.

		Frequency	Percent
Age	11-13 Year	66	34.6%
	14-16 Year	62	32.5%
	17-19 Year	63	32.9%
Gender	Female	95	49.7%
	Male	96	50.3%
Residence	Rural	178	93.2%
	Urban	6	3.1%
	Tribal	7	3.7%
Family Income	<10000	43	22.5%
	10000	148	77.5%
Father/mother Occupation	Not working	6	3.1%
	Farmer	165	86.4%
	Labour	14	7.3%
	Shopkeeper	1	0.5%
	Job	5	2.6%
Education of Father/mother	Illiterate	41	21.5%
	Primary and Middle	24	12.6%
	High school and higher Secondary school	114	59.7%
	Graduation	12	6.3%
Total		191	100.0%

Table 2: Diet, physical activity, personal hygiene, knowledge and awareness of study participants

		Frequency	Percent
Dietary Habits	Non-vegetarian	8	4.2%
	Vegetarian	183	95.8%
Frequency Of Consuming Leafy Green Vegetables	Once A Week	46	24.1%
	≥ 2 per week	145	75.9%
Frequency Of Consuming Fruits	Once A Week	29	15.2%
	≥ 2 per week	162	84.8%
Do you use tobacco or any tobacco products?	No	189	99.0%
	Yes	2	1.0%
Do you engage in regular physical activity or exercise?	No	21	11.0%
	Yes	170	89.0%
Personal Hygiene (Trimmed Nails, Handwashing, Wearing Slippers)	No	4	2.1%
	Yes	187	97.9%
Do You Have Toilet Facilities at Home?	No	4	2.1%

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	Yes	187	97.9%
Have you ever been diagnosed with anaemia?	No	43	22.5%
	YES	148	77.5%
How easy is it for you to access healthcare services in your area?	Difficult	91	47.6%
	Somewhat easy	74	38.7%
	Very Difficult	3	1.6%
	Very Easy	23	12.0%
Have you had a recent health check-up (within the past 1 year)?	No	157	82.2%
	Yes	34	17.8%
Have you received information or education about anaemia and its prevention?	No	35	18.3%
	Yes	156	81.7%
	Twice a Week or More	162	84.8%
IFA (Iron and Folic Acid) Supplementation	4-5 Times a Month	28	14.7%
	Not Specified	159	83.2%
	Did Not Take IFA	4	2.1%
Have You Taken Albendazole Medication?	No	34	17.8%
	Yes	157	82.2%

Table 3: Improvement in Anemia after IFA supplementation

Anaemia Category	Anaemia Before Intervention		Anaemia After Intervention		P Value
Normal	2	1.1%	73	38.2%	<0.001
Mild	31	16.2%	93	48.7%	
Moderate	156	81.6%	25	13.1%	
Severe	2	1.1%	0	0	
Mean Hb (Mean ± SD)	9.07 ± 1.03		11.49 ± 1.44		<0.001

Table 4: gender wise analysis in improvement in anemia after ifa supplementation

Variable		Intervention	Anaemia Category				P Value
			Normal	Mild	Moderate	Severe	
Gender	Female	Before	2 (2.1%)	13 (13.7%)	78 (82.1%)	2 (2.1%)	0.004
		After	29 (30.5%)	51 (53.7%)	15 (15.8%)	0	
	Male	Before	0	18 (18.8%)	78 (81.3%)	0	0.045
		After	44 (45.8%)	42 (43.8%)	10 (10.4%)	0	
Place of Residence	Rural	Before	1 (0.6%)	28 (15.7%)	147 (82.6%)	2 (1.1%)	<0.001
		After	67 (36.6%)	88 (49.4%	23 (12.9%)	0	
	Tribal	Before	1 (14.3%)	1 (14.3%)	5 (71.4%)	0	0.478
		After	4 (57.1%)	2 (28.6%)	1 (14.3%)	0	
	Urban	Before	0	2 (33.3%)	4 (66.7%)	0	0.687
		After	2 (33.3%)	3 (50%)	1 (16.7%)	0	
Age Group	11-13 Year	Before	1 (1.5%)	11 (16.7%)	54 (81.8%)	0	0.367
		After	20 (30.3%)	38 (57.6%)	8 (12.1%)	0	
	14-16 Year	Before	1 (1.6%)	9 (14.5%)	52 (83.9%)	0	0.087
		After	25 (40.3%)	32 (51.6%)	5 (8.1%)	0	
	17-19 Year	Before	0	11 (17.5%)	50 (79.4%)	2 (3.2%)	0.01
		After	28 (44.4%)	23 (36.5%)	12 (19.1%)	0	
Income	<10000	Before	2 (4.6%)	14 (32.6%)	26 (60.5%)	1 (2.3%)	0.007
		After	16 (37.2%)	21 (48.8%)	6 (14%)	0	
	≥10000	Before	0	17 (11.5%)	130 (87.8%)	1 (0.7%)	0.013
		After	57 (38.5%)	72 (48.6%)	19 (12.8%)	0	
Physical Activity	Yes	Before	1 (0.6%)	25 (14.7%)	142 (83.5%)	2 (1.2%)	0.002
		After	60 (35.3%)	86 (50.6%)	24 (14.1%)	0	
	No	Before	1 (4.8%)	6 (28.6%)	14 (66.7%)	0	0.167
		After	13 (61.9%)	7 (33.3%)	1 (4.8%)	0	
IEC received about Anaemia	Yes	Before	2 (1.3%)	23 (14.7%)	129 (82.7%)	2 (1.3%)	<0.001
		After	59 (37.8%)	76 (48.7%)	21 (13.5%)	0	
	No	Before	0	8 (22.9%)	27 (77.1%)	0	0.252
		After	14 (40%)	17 (48.6%)	4 (11.4%)	0	
Dietary Habits	Vegetarian	Before	2 (1.1%)	31 (16.9%)	148 (80.9%)	2 (1.1%)	<0.001
		After	72 (39.3%)	87 (47.5%)	24 (13.1%)	0	
	Non-vegetarian	Before	0	0	8 (100%)	0	NA
		After	1 (12.5%)	6 (75%)	1 (12.5%)	0	
Consumption of green leafy vegetables	Once in a week	Before	1 (2.2%)	10 (21.7%)	34 (73.9%)	1 (2.2%)	0.018
		After	19 (41.3%)	21 (45.7%)	6 (13%)	0	
	≥2 in a week	Before	1 (0.7%)	21 (14.5%)	122 (84.1%)	1 (0.7%)	0.02
		After	54 (37.2%)	72 (49.7%)	19 (13.1%)	0	
Consumption of green leafy vegetables	Once in a week	Before	1 (3.4%)	6 (20.7%)	21 (72.4%)	1 (3.4%)	0.103
		After	13 (44.8%)	11 (37.9%)	5 (17.2%)	0	
	≥2 in a week	Before	1 (0.6%)	25 (15.4%)	135 (83.3%)	1 (0.6%)	0.005
		After	60 (37%)	82 (50.6%)	20 (12.3%)	0	
IFA (Iron and Folic Acid) Supplementation	4-5 times a month	Before	2 (1.2%)	26 (15.9%)	134 (81.7%)	2 (1.2%)	<0.001
		After	67 (40.9%)	79 (48.2%)	18 (11%)	0	
		Before	0	4 (17.4%)	19 (82.6%)	0	0.003

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	Not Specified	After	4 (17.4%)	13 (56.5%)	6 (26.1%)	0	
	Did Not take IFA	Before	0	1 (25%)	3 (75%)	0	0.513
		After	2 (50%)	1 (25%)	1 (25%)	0	
Albendazole medication?	Yes	Before	1 (0.6%)	19 (12.1%)	135 (86%)	2 (2.9%)	0.003
		After	58 (36.9%)	78 (49.7%)	21 (13.4%)	0	
	No	Before	1 (2.9%)	12 (35.3%)	21 (61.8)	0	0.041
		After	15 (44.1%)	15 (44.1%)	4 (11.8%)	0	
Personal Hygiene	Yes	Before	1 (0.5%)	29 (15.5%)	155 (82.9%)	2 (1.1%)	<0.001
		After	70 (37.4%)	92 (49.2%)	25 (13.4%)	0	
	No	Before	1 (25%)	2 (50%)	1 (25%)	0	0.135
		After	3 (75%)	1 (25%)	0	0	
Toilet facilities at home?	Yes	Before	2 (1.1%)	30 (16%)	153 (81.8%)	2 (1.1%)	<0.001
		After	72 (38.5%)	90 (48.1%)	25 (13.4%)	0	
	No	Before	0	1 (25%)	3 (75%)	0	0.75
		After	1 (25%)	3 (75%)	0	0	

DISCUSSION

Iron deficiency anemia (IDA) stands out as the most prevalent global nutrient deficiency, impacting a significant portion of the human population, with adolescents being particularly vulnerable. This condition not only diminishes the productivity and work capacity of adults but also has adverse effects on the motor and mental development of children and adolescents. Emerging evidence suggests that iron deficiency, even without anemia, can hinder cognitive functions in adolescent girls and induce fatigue in adult women. Additionally, IDA may affect visual and auditory functions, weakly correlating with suboptimal cognitive development in children. Its prevalence is notably pronounced in developing countries, carrying substantial health and economic consequences, marking it as the most widespread form of anemia in these regions. The study under review thoroughly examines the socioeconomic and lifestyle factors influencing the prevalence of anemia among adolescents, emphasizing the need for a holistic understanding of these determinants to design effective interventions.[18]

The study's sample population distribution across various age groups and balanced gender representation, as highlighted and supported by Bodat et al,[19] offers a comprehensive snapshot of the studied cohort. This demographic diversity is crucial for capturing the nuances of anemia prevalence among different age and gender groups.

Significantly, the majority of participants (93.2%) come from rural backgrounds, presenting unique challenges related to healthcare accessibility, dietary practices, and economic opportunities. This demographic insight underscores the importance of tailoring interventions to address the specific needs of adolescents in rural areas.

Economically, a substantial portion of the participants (74.9%) reports a monthly income of 10,000 rupees, placing them in the lower-middle class, aligning with observations from other studies.[19,20] This emphasizes the association between lower-income families and susceptibility to anemia, attributed to limited access to iron-rich foods and the prevalence of monotonous diets among economically disadvantaged children.

Agriculture emerges as the predominant occupation of the participants' parents (86.4%), followed by employees (7.3%). This occupational distribution sheds light on the influence of parental occupations on dietary and lifestyle practices within the household. The economic landscape, coupled with the occupational dynamics, necessitates targeted interventions that consider the socioeconomic context of the families.

Regarding dietary habits, the study reveals a shift from the preference for a mixed diet observed by Bodat et al,[19] with the majority (95.8%) adhering to a vegetarian diet. This shift may have implications for the nutritional diversity of the participants. However, a significant proportion includes green leafy vegetables (75.9%) and fruits (84.8%) in their diet at least twice a week. These dietary practices, while encouraging, warrant further investigation into the overall nutritional adequacy of the participants' diets.

A positive health behavior noted in the study is the engagement in regular physical activity by a substantial proportion of participants (89.0%). Regular physical activity contributes to overall well-being and can influence nutritional status. This aspect aligns with the growing recognition of the role of an active lifestyle in combating health issues.[20-24]

An overwhelming majority (97.9%) demonstrates good personal hygiene practices, including nail-cutting, handwashing, and wearing slippers. However, the intriguing association between the frequency of wearing shoes and the risk of anemia, as highlighted in the study by Shaka et al,[21] introduces a unique dimension to lifestyle factors influencing anemia prevalence. This association merits further exploration to understand the underlying factors contributing to the observed correlation.[25,26]

In contrast to Shaka et al.'s findings, where the lack of shoe-wearing was associated with a higher risk of anemia, almost all participants in this study (97.9%) have access to healthcare facilities at home. Access to healthcare resources can play a pivotal role in preventing and managing health issues. This aspect underscores the significance of examining various lifestyle and environmental factors that may influence anemia prevalence in adolescents comprehensively.[27]

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CONCLUSION

In summary, the study sheds light on a notable and preventable health concern among adolescents, revealing a high overall prevalence of anemia. The findings underscore that anemia poses a moderate public health challenge in this demographic, highlighting the vulnerability faced by adolescents of both genders. Iron deficiency emerges as the primary cause of anemia, as indicated by the study. Furthermore, the research provides valuable insights into the relationship between anemia and the implementation of iron and folic acid supplementation (IFA) within this age group.

The study identifies significant correlations linking improved anemia outcomes to various factors, including the provision of IFA supplementation, the accessibility of healthcare facilities, and personal hygiene practices within families. Notably, participants who received IFA supplementation exhibited enhanced mean hemoglobin (HB) levels post-intervention. These findings underscore the potential positive impact of targeted interventions, such as IFA supplementation programs and improved healthcare accessibility, in mitigating anemia prevalence among adolescents.

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