

# Management of Iron Deficiency Anemia among adolescent girls through the intervention of Fe-Vit C-Rich Powder Mix

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**Abstract:** Nutritional anemia is a significant public health concern in India, affecting over 60% of adolescent girls. Inadequate intake of iron-rich foods with low bioavailability of non-heme iron has been considered the primary cause of iron deficiency in developing nations. The present study was an interventional study conducted among 479 rural adolescent girls in the age group of 10-19 years in Bisrakh and Dadri Blocks of the District Gautam Budh Nagar, Uttar Pradesh, to investigate the effectiveness of synergistic relationships between nutrient combinations to increase the absorption and bio-availability of non-heme iron and the impact of Nutrition Education to combat iron deficiency anemia. Experimental Group III exhibited the highest increment of their hemoglobin levels (1.67g/dl) after the intervention of both Nutritional Intervention and Nutrition Education for three months. All three experimental groups exhibited an increase in knowledge scores after receiving information regarding Nutrition, compared to those in the Control Group. It was observed that more than 63% of the adolescent girls in experimental Group I had increased their knowledge score after obtaining the information related to nutrition and an Iron vitamin C-rich diet.

KEY WORDS: Anemia, Nutrition, Adolescent, Non-heme iron

## 1. INTRODUCTION

Anemia is one of the most prevalent and intractable nutritional deficiency disorders, predominantly triggered by iron deficiency, exerting a substantial impact on human health, social development, and economic growth. In anemic conditions, the number and size of Red Blood Cells (RBC) or the hemoglobin concentration drops below the limit, which decreases the blood's capacity to supply oxygen to the body.

It occurs when the normal hemoglobin level falls below 12 g/dl in women and 13 g/dl in men or when the usual number of red blood cells falls below 4.2 million/ $\mu$ l [1]. This condition may result from the inability of the erythropoietic tissue to maintain a normal hemoglobin concentration because of an inadequate supply of one or more nutrients, leading to a reduction in the total circulating hemoglobin. It occurs when the normal hemoglobin level falls below 12 g/dl in women and 13 g/dl in men or when the usual number of red blood cells falls below 4.2 million/ $\mu$ l [1]. This condition may result from the inability of the erythropoietic tissue to maintain a normal hemoglobin concentration because of an inadequate supply of one or more nutrients, leading to a reduction in the total circulating hemoglobin.

Worldwide, nutritional anemia is a major contributor to the global burden of disease and affects children, adolescent girls, and women of reproductive age. It accounts for about 50% of all cases of anemia in women and remains a precursor to iron deficiency anemia, which is one of the leading causes of years lived with disability [2]. The prevalence of iron deficiency anemia is exceedingly higher in underdeveloped countries due to low socioeconomic levels and limited access to healthcare facilities [3]. Although it occurs in all age groups, the incidence is higher among women of childbearing age [4]. The primary factor contributing to the high occurrence of anemia is the poor consumption of foods containing high amounts of bio-available iron [5]. The other reasons that are responsible for the increasing prevalence of anemia among adolescents are under-nutrition, inadequate intake of iron, consumption of high amounts of phytates or oxalates in the diet, excessive blood loss during menstruation, hookworm infestation, and adolescent pregnancy.

In India, the prevalence of anemia among adolescent girls was 56%, and this amounts to an average of 64 million girls suffering from anemia at any point in time [6]. The National Family Health Survey (NFHS) - 5, conducted in India in the year 2019-2021, reported the prevalence of anemia among all

rural women in the age group of 15-19 even higher (60.1%) [7]. Anaemia has been found in over 50% of girls between the ages of 12 and 15, when needs are at their highest, indicating that this age group has the highest prevalence [8, 9, 10, 11]. From the preadolescent level of about 0.7 to 0.9 mg per day to as much as 1.40 to 3.27 mg per day for girls and 1.37-1.88 mg per day for boys, the quantity of iron required by adolescents has greatly increased [12]. According to WHO/UNICEF/UNC, anemia affects 1.62 billion people globally in which 24.8% are anemic adolescents [13]. Because maintaining a positive iron balance among female adolescents is difficult due to speedy pubertal growth spurts and maturation, accompanied by greater iron needs [14]-[15]. The scenario has not changed over the past sixty years, as the prevalence of iron deficiency anemia among adolescent girls has continued to increase [16].

Adolescent girls are more susceptible to nutritional anemia because the adolescent stage marks the start of the menstrual cycle. It has been associated with the most rapid growth acceleration throughout adolescence when requirements are at their peak. Accordingly, inadequate intake, absorption, and utilization of iron, increased blood loss or excretion, decreased iron storage, and anomalies in the release from stores may contribute to iron deficiency. Adolescence is a crucial stage for attainment of healthy dietary consumption and physical activity behaviors, which can follow throughout the life course. They are vulnerable to acquiring iron-deficiency anemia also because of the increase in blood volume and muscle mass that occurs around puberty followed by regular menstruation, which increases the body's demand for iron. It is well stated that pre-pregnancy maternal malnutrition with low iron stores puts infants at great risk for being born preterm with low iron stores and hemoglobin levels, low birth weight, or small-for-gestational-age, and subsequently increases the risk of stunting during early childhood. In India, a predominantly vegetarian diet and poor absorption of iron means that despite the consumption of a balanced diet, iron supplementation is required to prevent and control anemia.

The strategy of food supplementation is a direct intervention to solve the problem of iron deficiency anemia. This strategy focuses on improving the availability, access, and consumption of vitamin and mineral-rich foods. The benefits of food supplementation strategies are not only restricted to the improved intakes of specific nutrients but also help in improving overall diet and health status.

## 2. MATERIALS AND METHODS

In Phase I, the Nutritional Status and the prevalence of anemia among 479 adolescent girls were assessed

using a cross-sectional survey design and the Multistage sampling method. The socioeconomic features and the level of nutrition knowledge were also assessed to provide the empirical basis for designing a nutrition education program to improve the nutritional status of adolescent girls.

In phase II, the Nutrition Intervention package was developed, including the development of Fe-VitC Supplement Powder Mix and Nutrition Education ICT materials to overcome the prevalence of anemia among adolescent girls. Before this exercise, valid and reliable instruments were developed for assessing their food and nutrient intake, nutrition knowledge, and socio-economic features [17].

In Phase III, a Quasi-Experimental (pre-test and post-test control group) Descriptive Design was employed for the efficacy assessment of the Nutrition Intervention Package. Before starting the data collection, a total of 42 adolescent girls (10% of the total sample size) were randomly selected to conduct the pilot study. The content validity and reliability of the tool were obtained by experts in the field. Permission from the Principal of the school for conducting the present study was obtained, as well as the Voluntary written informed consent or thumbprint obtained from the parents of the study subjects.

## 3. RESULT AND DISCUSSION

The anemia was prevalent among 63.88% of the study subjects, ranging from mild (49.35%), moderate (46.73%), and severe grades (3.92%) among anemic adolescent girls. The range of hemoglobin levels among adolescent girls in the present study ranges from 6.4 to 13.8 g/dl, with the mean hemoglobin level being  $10.84 \pm 1.70$ g/dl. The prevalence of mild, moderate, and severe anemia among adolescent girls (479) was 31.52%, 29.84%, and 2.51 %, respectively.

The developed Iron-vitamin C Supplement Powder Mix containing 30g of rice flakes powder, 10g garden cress seeds, 5g cauliflower leaves powder, 5g of turnip leaves powder, and 5g amla powder, selected through RSM received the highest acceptance score of 8.76, chosen for further study for proximate analysis, shelf-life, and storage stability.

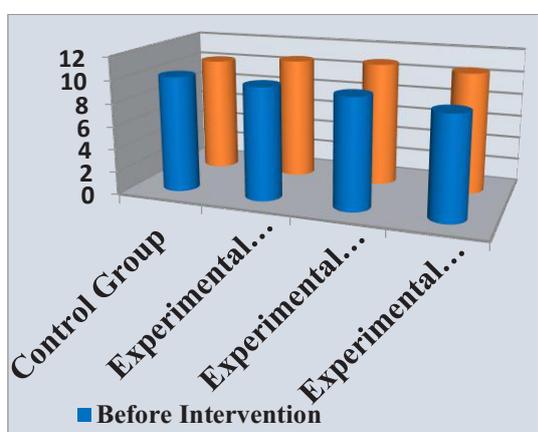
The total phenolic content present in the sample extract of Fe-VitC Sppl Powder Mix was found to be 180.02 mg GAE/g of powder (mg Gallic acid equivalents per gram weight). The results revealed that the extract exhibits high antioxidant activity. At the concentration of 500 $\mu$ g/ml, the extracts showed 91.8% scavenging activity by DPPH methods. The results of antioxidant activity showed a decrease in the concentration of free radicals DPPH due to the

scavenging ability of soluble constituents in the methanolic extracts of the food products.

### Impact of Nutritional Intervention and Nutrition Education

It was found that 44% of the study subjects became non-anemic. There was a 25% reduction in the case of moderate anemia. The case of severe anemia was not reported, however, it was prevalent among 22% of the study subjects before intervention. Similarly, in the case of Experimental Groups I and II, 13% and 22% of the study subjects became non-anemic even after the intervention of either nutrition education or nutrition intervention.

**Fig 1 : Increase in Mean Hemoglobin levels of Study Subjects of different Experimental Groups after Nutritional intervention and Nutrition Education**



All three Experimental Groups (Experimental Group I, Experimental Group II, and Experimental Group III) showed an improvement in their hemoglobin level. After the intervention, the mean Hb increment among all three experimental groups was significantly higher ( $p < 0.01$ ) than Control Group.

Experimental Group III exhibited the highest increment of their hemoglobin levels (1.67g/dl) after the intervention of both Nutritional Intervention and Nutrition Education for three months, followed by Experimental Group II (1.24g/dl), and Experimental Group I (0.85g/dl), who received Nutritional Intervention and Nutrition Education, respectively.

**Table 1: Percent change in score of nutritional knowledge of Subjects before and after intervention**

Study group	Nutrition Education Intervention	Nutrition Knowledge of Subjects		
		Borderline (< 33%)	Average (33 - 66%)	Adequate (> 66%)

<b>Control group (N = 42)</b>	Before intervention	36 (85.71)	6 (14.29)	0 (0.00)
	After intervention	34 (80.95)	7 (16.67)	1 (2.38)
<b>I Experimental group (N = 46)</b>	Before intervention	34 (73.91)	11 (23.91)	1 (2.17)
	After intervention	0 (0.00)	12 (26.08)	34 (73.91)
<b>II Experimental group (N = 41)</b>	Before intervention	24 (58.54)	15 (36.59)	2 (4.88)
	After intervention	19 (46.34)	8 (19.51)	14 (34.15)
<b>III Experimental group (N = 32)</b>	Before intervention	22 (68.75)	9 (28.13)	1 (3.13)
	After intervention	0 (0.00)	0 (0.00)	32 (100.00)

The best results were observed in Experimental Group III (Table 1), having the Intervention of both Nutritional Intervention of Fe-VitC Suppl Powder Mix and Nutrition Education. More than 43% of the study subjects became non-anemic after Intervention with developed NI and NE. There was a 25% reduction in the case of moderate anemia. The case of severe anemia was not reported after intervention, however, it was prevalent among 22% of the study subjects before intervention.

Similarly, in the case of Experimental Groups I and II, 13% and 22% of the study subjects became non-anemic after the intervention of Nutrition Education and Nutrition Intervention, respectively.

All three experimental groups exhibited an increase in knowledge scores after receiving information regarding Nutrition, compared to those in the Control Group. It was observed that more than 63% of the adolescent girls in experimental Group I had increased their knowledge score after obtaining the information related to nutrition and Iron vitamin C-rich diet.

So, at the end of the third phase of the study, the prevalence of anemia was found to be reduced and the hemoglobin status of the subjects increased to its normal level (Non-anemic). The Nutritional knowledge of the study subjects was also significantly increased after imparting Nutrition Education to them.

The iron status of adolescent girls can be improved significantly by providing systematic education on

food preparation practices that minimize the consumption of inhibitors of iron absorption. The exploitation of underutilized, locally available low-cost green leafy vegetables can provide a way to nutrient and economic security of iron deficiency anemia among adolescents, and help in the formulation of health and nutrition intervention and promotion programs to reduce the prevalence of iron deficiency anemia.

The findings indicated that the most effective, sustainable, and inexpensive technological approach to combat the battle against iron deficiencies is the inclusion of easily available, cheap, and underutilized green leafy vegetables, which maximizes the intrinsic and added food iron without any gastrointestinal side effects. The combination of poorly absorbed plant source non-heme iron and vitamin C-rich food improves the bioavailability of the non-heme iron. Vitamin C has been considered the most potent enhancer of non-heme iron absorption in our body, even in the presence of inhibitors like phytates, oxalates, etc. It converts food ferric iron to ferrous, which increases absorption by 75-98 percent. So, with Iron Supplementation, we have to focus on Vitamin C as well. Vitamin C acts synergistically for the optimal absorption of iron in the body, and thus, iron with vitamin C synergistically will be an effective tool to combat Iron Deficiency Anemia. It is essential to judiciously decide on the food rich in iron, as well as the food vehicles for their bioavailability, to improve the nutritional status of the adolescent population.

Nutrition Education provides awareness of the significance of eating nutritious foods, encourages making healthy dietary choices, and strengthens individual capacity for adopting food and nutrition practices that support good health. Hence, the Nutrition Intervention Package, including iron-rich food supplements and Nutrition Education, helps in the formulation of a health and nutrition intervention and promotion program to reduce the prevalence of iron deficiency anemia among adolescent girls.

#### 4. CONCLUSION

Iron deficiency anemia is a health concern among adolescent girls. One of the major health issues impacting adolescent girls is iron deficiency anemia. Adolescent malnutrition can have serious consequences in adulthood, particularly in the reproductive years. The body can readily absorb iron from animal sources, but non-heme iron needs to be taken with vitamin C to promote absorption. Iron-deficiency-related anemia in adolescent females can be decreased with a multi-dietary approach that includes iron and vitamin C sources in the same meal to increase dietary iron availability.

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