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Original Research Article

Effect of Iron Supplementation Along with Vitamin C and Nutrition Counseling on the Anaemic Status of Adolescent Girls

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ABSTRACT

Effect of weekly iron and vitamin C supplementation along with nutrition counseling on the anaemic status of sixty adolescent girls in the age group of 16-18 years from the middle-income group was studied. For supplementation, the subjects were divided into two groups of 30 each i.e. Iron Folic Acid Supplementation alone (IFA group) and Iron Folic Acid along with natural source of vitamin C i.e. Amla Powder (IAP group). Nutrition education was imparted to all the subjects, at a weekly interval, for three months period. Results of the study showed that there was no change in the anthropometric profile of the subjects after the study. Consumption of cereals, pulses, GLVs and milk and milk products was significantly ($p \leq 0.01$) increased in both the groups after the study. Consequently, a significant increase ($p \leq 0.01$) in the intake of energy, protein, riboflavin, niacin, calcium, iron and vitamin C was observed in both the groups. After the study, reduction in the percentage of subjects with the signs and symptoms of anaemia was observed. Haematological profile of the subjects indicated that the increase in the haemoglobin level was higher in the group IAP (from 10.1 ± 0.13 to 11.70 ± 0.09g/dl) compared to group IFA (from 9.9 ± 0.12 to 10.32 ± 0.09 g/dl). After imparting nutrition education gain in KAP score was 9.9 and Quantum of improvement was more than one and a half times in all the subjects. Consequently, the consumption of iron and vitamin C rich foods was increased after nutrition education, which led to reduction in the signs and symptoms of anaemia among the subjects. Majority of the subjects, who were found to be moderately and mildly anaemic before the counseling, became marginally anaemic (30%) after the counseling. Twenty six percent of the subjects became non-anaemic after the counseling. Therefore, it can be concluded that nutrition counseling and weekly iron supplementation along with natural source of vitamin C is more beneficial than Iron Folic Acid Supplementation alone, to restore normal levels of red blood cells, haemoglobin, and iron. This can help in preventing iron deficiency anaemia in the young adolescent girls.

Keywords: Iron, Anaemia, Supplementation, Amla Powder, Vitamin C, Nutrition Education, Nutrition Counseling, Nutritional Status, Adolescent Girls.

INTRODUCTION

Today, Iron Deficiency Anaemia is the most common micronutrient deficiency in the world, bringing serious economic consequences and obstacles to national development. It affects the lives of many millions of human beings throughout their life cycle, especially women of child-bearing age who have blood loss through menstruation; pregnant or lactating women who have an increased requirement for iron; infants, children, and adolescents in rapid growth phases; and people with a poor dietary intake of iron. Adolescence is the transition period between childhood and adulthood; a window of opportunity for the

improvement of nutritional status and correcting poor nutritional practices. This period prepare the adolescent girls for the nutritional demands of pregnancy and lactation that they may experience in later life.

According to The National Family Health Survey (2005-06), the prevalence of anaemia in children in India is as high as 79%, while 56% of adolescent girls are anaemic. In Punjab, 41% of women suffer from anaemia (Raman and Sarma 2003). One of the commonest causes of maternal deaths (20%) in this country during pregnancy is severe anaemia (Bamji *et al* 2003). A major threat to safe motherhood, it contributes to low birth weight, reduced immune-competence, poor cognitive development, behavioral complications and decreased work capacity. Poor nutritional status and anaemia in pregnancy have consequences that extend over generations. Thus, in these adolescent girls, the mothers-to-be, who will usher the next generation, pregnancy, only serves to aggravate their pre-existing anaemia.

Though supplementation with iron folic acid remains cornerstone in the treatment and prevention of anaemia, addition of vitamin C has its other added advantages. Ascorbic acid reverses the effect of dietary inhibitors and is one of the most powerful known promoters of non-heme iron absorption, which forms the bulk of Indian's diet. Amla is among the highest known land source of vitamin C, 100 gm of Amla contains about 700 mg of vitamin C, which is thirty times the amount found in oranges. Policies for combating micronutrient malnutrition must be firmly rooted in food based rather than drug based approaches. Nutrition intervention strategies that includes dietary diversification, supplementation, nutrition education and fortification of staple foods with bioavailable iron, is the best tool to combat Iron Deficiency Anaemia. Emphasis should be made on imparting nutrition education to improve the diet through increased intake of fruits and vegetables rich in iron and vitamin C. Taking into consideration the role of nutrition education and beneficial effect of vitamin C in preventing anaemia, the present study was planned.

MATERIALS AND METHODS

Materials

Chakaiya variety of Amla (18 kg) containing the highest amount of vitamin C (678mg/100g) was procured from Research station, Balowal, PAU.

Preparation of Amla Powder

To process Amla fruits into powder, they were washed thoroughly with running water, wiped with a clean cloth and then dried in a cabinet. The semi dried fruits were first de-stoned and then dried completely in a cabinet drier. The dried fruits were then grinded in the grinder and sieved to obtain a fine powder. The powder so obtained was seal packed in air tight containers to avoid any chances of exposure to atmospheric conditions and moisture re-absorption.

Subjects

The present study was conducted to examine the effect of iron and vitamin C supplementation on the anaemic status of adolescent girls selected from Government Senior Secondary School, Bharat Nagar Chowk, Ludhiana. Initially, hundred girls were screened for the haemoglobin values from which sixty anaemic adolescent girls in the age group of 16-18 years were selected for the study. The subjects were divided into two groups of thirty each, according to the supplementation provided to them. The subject's willingness to take part in the supplementation trial was also ascertained.

Interview Questionnaire

A well-structured questionnaire-cum-interview schedule was developed to elicit the general information, socioeconomic status, food habits, meal pattern, dietary intake and anthropometric profile of the subjects.

Assessment of Nutritional Status

Nutritional status was assessed through dietary intake, anthropometric

measurements, clinical examination and haematological Profile of the subjects.

Dietary Survey

Food Habits: Information regarding the food habits, meal pattern, food likes & dislikes etc was recorded.

Dietary Intake: Information pertaining to food intake of the respondents was recorded by 24-hour recall-cum-food frequency questionnaire for three consecutive days. The amount of each food item was tabulated and then average daily intake of each food item was calculated. The nutrient intake was calculated using MSU Nutriguide Computer Programme (Song *et al* 1992).

Anthropometric Assessment

Height and weight of the subjects was measured before and after the study, using standard method given by Jellife (1966). The body mass index (BMI) was measured using standard formula and the subjects were classified on the basis of BMI classification given by WHO (2005).

Categories of Body mass index(kg/m^2)	Risk of co-morbidity
Underweight(< 18.5)	Low (but risk of other clinical problems)
Normal(18.5-24.99)	-
Overweight (≥ 25.00)	Average
Pre obese (25-29.99)	Increased
Obese I (30-34.99)	Moderate
Obese II (35-39.99)	Severe
Obese III (≥40)	Very severe

Haematological Profile

The biochemical assessment of the subjects was done for haemoglobin (Hb), packed cell volume (PCV) and red blood cell count (RBC). The haemoglobin was determined by using cyanmethemoglobin method of Dacie and Lewis (1989). The erythrocyte indices were calculated that includes mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular volume (MCV). On the basis of haemoglobin levels, the subjects were categorized according to WHO classification (1972).

1. Anaemic: Haemoglobin Level < 12 g/dl
2. Non- anaemic: Haemoglobin Level ≥ 12 g/dl

Supplementation of the Groups

The selected anaemic subjects were divided into two groups of thirty each according to the type of supplementation given. Diet of group IFA was supplemented with Iron-Folic Acid alone in the form of tablets viz. Fefol containing 150mg of dried Ferrous Sulphate and 500µg folic acid. Diet of group IAP was supplemented with Iron-Folic acid tablet along with Amla powder i.e. 5g containing 50mg of vitamin C. De-worming of all the subjects with single dose of Albendazole (400mg) was done in the beginning of the study.

Clinical Examination

Information on various signs and symptoms of anaemia like paleness of skin, pale conjunctiva, paleness and smoothness of tongue, flat or spoon shaped nails, etc were recorded as prescribed by Jeliffe (1966).

Nutrition Counseling

All the subjects were imparted nutrition education on the importance of iron through lectures, leaflets, demonstrations, flashcards etc, for a period of three months, at a weekly interval. A questionnaire was developed to pretest the nutrition knowledge of the subjects. A structured KAP questionnaire (knowledge attitude practices) was used to assess knowledge score about anaemia. For evaluating the questionnaire, one score was awarded for each correct and 0 for each wrong answer. After a gap of four weeks, a post test was conducted to calculate gain in knowledge, using the following equation:

Gain in knowledge = score of post-test - score of pre-test

$$\textbf{Quantum of improvement} = \frac{\textbf{Post test score}}{\textbf{Pre test score}}$$

Statistical Analysis

The data on food and nutrient intake, anthropometric measurements and blood

analysis of the subjects was analyzed statistically using percentage, mean, standard error and t-test (*Singh et al* 1991).

RESULTS AND DISCUSSION

Socioeconomic Status

Majority of the subjects i.e. 80% belonged to nuclear family and the rest 20% were from joint family. It was observed that 55% of the fathers were engaged in agriculture and 35% were engaged in service. Only 10% were engaged in business. Regarding the occupation of the mothers, majority (88.33%) were housewives, 8.33% were in service and the rest 3.33% were engaged in self-employment. It was observed that 13.33% of the subjects had monthly per capita income ranging between Rs 5000 and Rs 7000, and 63.33% between Rs 7000 and Rs 9000. The rest 23.33% had monthly per capita income up to Rs 5000 (Table 1).

Table 1: General information of the subjects (N = 60).

Parameters	Frequency	Percentage
Type of family		
Joint	12	20
Nuclear	48	80
Father's occupation		
Agriculture	33	55
Service	21	35
Business	6	10
Mother's occupation		
Housewife	53	88.33
Service	5	8.33
Self employment	2	3.33
Per capita income		
< 5000	8	13.33
5000 to 7000	38	63.33
7000 to 9000	14	23.33
Food habit		
Vegetarian	52	86.66
Non-vegetarian	8	13.33
Number of meals a day		
2	7	11.66
3	48	80
4	5	8.33
Skipping of meals		
Breakfast	35	58.33
Lunch	9	15
Dinner	11	18.33
Regular meals	5	8.33
Food preference		
Sweet	32	53.33
Salty	26	43.33
Sour	2	3.33

Assessment of Nutritional Status

Dietary Survey

Food Habits

Results of the study showed that majority of the subjects (86.66%) were vegetarian and only 13.33% were non - vegetarian. It was observed that 58.33% of the subjects skipped breakfast, 18.33% skipped dinner, and 15% skipped lunch, while only 8.33% had regular meal. Similar results has been shown by a study conducted on anaemia disease and the diet system of the female students in which 36.8% of the secondary school students ate three meals daily and 42.5% neglected taking breakfast (Amer *et al* 2007). It was observed that majority of the subjects (53.33%) preferred sweet foods, 43.33% salty foods and only 3.33% liked sour foods (Table 1).

Dietary Intake

The mean daily intake of foods by the subjects is presented in the Table 2. The mean daily nutrient intake of the subjects is presented in the Table 3.

Results of the study indicated that there was inadequate consumption of cereals, pulses, green leafy vegetables, milk and milk products, roots and tubers, fruits and non vegetarian food (meat, egg and fish) in the diets of the subjects before and after the counseling (Table 2), although there was a significant increase in the mean daily intake of all the food groups. Gaganpreet (2000) also reported that there was significant increase in the consumption of cereals, pulses and other vegetables after nutrition education. Correspondingly, the mean daily intake of energy, protein, iron, niacin, and vitamin B_{12} was below RDAs, whereas the intake of riboflavin, folic acid and calcium was above the RDAs in all the subjects before and after the counseling (Table 3). Rao *et al* (2006) also reported that the mean intake of all the foodstuffs, especially the income elastic foods such as Pulses, Milk & Milk products, Oils & fats and Sugar & Jaggery were lower than the recommended levels of ICMR. Similar results have been shown by the study conducted by Suliga 2006, Gautam *et al* 2008 which indicated that the intake of calories, protein, folic acid and iron was

found to be less than the RDAs in 100%, 91.2%, 98.2%, 99.1% and 65.8% of women respectively.

Table 2: Mean daily food intake of the subjects before and after the study (N = 60).

Food group	Group (n = 30)	Before	After	t value	ICMR (1999)
Cereals (g)	IFA	236 ±4.73	254 ± 5.07	2.934**	300 g
	IAP	243± 4.29	261± 6.38	3.112**	
Pulses (g)	IFA	54± 1.03	60 ± 1.44	3.479**	60 g
	IAP	56± 1.59	61± 1.65	3.007**	
GLVs (g)	IFA	33±1.26	42 ± 1.80	3.900**	100 g
	IAP	34± 1.19	43± 1.66	4.339**	
Root & Tubers (g)	IFA	82 ± 1.93	87 ± 2.14	1.487 ^{NS}	100 g
	IAP	84 ± 1.95	90 ± 1.38	3.147**	
Other Vegetables (g)	IFA	124 ± 6.23	130 ± 5.27	1.969 ^{NS}	100 g
	IAP	126 ± 7.30	137 ± 5.51	3.300**	
Fruits (g)	IFA	44 ± 1.67	52 ± 1.64	5.579**	100 g
	IAP	49 ±2.54	54 ± 2.57	2.075*	
Milk and Milk Products (g)	IFA	373±11.45	405 ±12.08	2.963**	500 g
	IAP	376 ±12.56	423 ±10.18	6.256**	
Fats & Oils (g)	IFA	23.3 ± 0.44	24.2 ± 0.37	1.769 ^{NS}	25 g
	IAP	24.0 ± 0.49	25.1 ± 0.40	2.473*	
Sugar & Jaggery (g)	IFA	24±0.52	23 ± 0.59	2.450*	30 g
	IAP	23 ± 0.58	23 ± 0.57	2.002 ^{NS}	
Meat ,Egg and Fish (g)	IFA	9 ± 1.67	10 ± 1.63	1.409 ^{NS}	30 g
	IAP	10± 2.50	13 ± 2.43	1.282 ^{NS}	

** Significant at 1% , IFA - Group receiving Iron Folic Acid only, * Significant at 5 %, IAP - Group receiving Iron Folic Acid + Amla Powder, ^{NS} Non significant.

Table 3: Mean daily nutrient intake of the subjects before and after the study (Mean ± SE) (N = 60).

Nutrient	Group (n=30)	Before	After	t value	ICMR (1999)
Energy (kcal)	IFA	1568 ± 29.46	1705 ± 33.64	6.054**	2060 kcal
	IAP	1604± 26.13	1744 ± 16.51	4.317**	
Protein (g)	IFA	57.0 ± 1.60	64.1 ± 1.59	4.675**	63 g
	IAP	58.6± 0.91	65 ± 0.97	4.764**	
Total fat (g)	IFA	47.6 ± 1.07	53.8 ± 0.88	5.804**	40 g
	IAP	51.8 ± 1.06	56.8 ± 1.26	4.908**	
Thiamine (mg)	IFA	1.31±0.09	1.39 ± 0.08	2.334*	1 mg
	IAP	1.35±0.09	1.42 ± 0.09	1.782 ^{NS}	
Riboflavin(mg)	IFA	1.22± 0.06	1.37 ± 0.05	3.584**	1.2 mg
	IAP	1.29±0.06	1.42 ± 0.05	3.147**	
Niacin (mg)	IFA	9.8 ± 0.29	11.2 ± 0.22	4.806**	14 mg
	IAP	10.3± 0.25	11.5 ± 0.15	4.808**	
Folic acid (µg)	IFA	116.3±3.36	132 ± 2.49	4.775**	100 µg
	IAP	125.1±2.82	142.2 ± 2.53	5.500**	
Vitamin C (mg)	IFA	33.82±1.11	42.0 ± 1.38	7.135**	40 mg
	IAP	34.92±1.13	45.8 ± 1.91	5.281**	
Vitamin B_{12} (µg)	IFA	0.49±0.04	0.66 ± 0.06	3.264**	1 µg
	IAP	0.55± 0.05	0.80 ± 0.06	5.123**	
Calcium (mg)	IFA	565.7±20.84	629.6 ± 17.60	3.676**	500 mg
	IAP	682.4±13.82	758.6 ± 11.18	5.937**	
Iron (mg)	IFA	12.1± 0.33	15.0 ± 0.58	4.838**	30 mg
	IAP	15.0 ± 0.68	17.2 ± 0.64	6.205**	

** Significant at 1%, ^{NS} Non significant

Table 4: Per cent contribution of carbohydrates, protein and fat to the total energy intake (N = 60).

Nutrient (g)	IFA (n=30) Percentage		IAP (n=30) Percentage	
	Before	After	Before	After
Carbohydrates	58.41	56.53	56.35	55.73
Protein	14.54	15.03	14.61	14.90
Total Fat	27.32	28.39	29.06	29.31

Per cent contribution of carbohydrates, protein and fat to the total energy intake of the subjects is presented in the Table 4.The dietary carbohydrates contributed 58.41 and 56.35% of energy before the study, while it was found to be 56.53, and 55.73 % after the study in the group IFA and IAP, respectively. The per cent contribution of protein to the total energy in the group IFA and IAP, before and after the study was 14.54 and 14.61% and 15.03 and 14.90%, respectively. Total fat contributed before and after the study were 27.32 and 29.06% and 28.39 and

29.31%, respectively in the group IFA and IAP.

Anthropometric Assessment

Height and Weight

The anthropometric parameters, i.e. Height and Weight are presented in the Table 5. The observed values of weight and height of all the subjects was below the ICMR standards (NCHS). No significant difference was found in the mean heights of the subjects after the study in both the groups. However, in the group IFA and IAP, a statistically significant ($p \leq 0.05$) difference was observed in the mean weights of the subjects.

Table 5: Anthropometric profile of the subjects before and after the study (Mean ± SE) (N = 60).

Group (n=30)	Variable	Before	After	t value	Jellife (1966)
Height (cm)	**Age**				
IFA	16	149.95± 1.19	150.05 ± 1.16	1.000 ^{NS}	162 cm
	17	154.90± 2.43	155.0 ± 2.46	1.000 ^{NS}	163 cm
IAP	16	150.20 ± 2.12	150.20 ± 2.11	1.000 ^{NS}	162 cm
	17	151.10± 2.64	151.10 ± 2.64	-	163 cm
Weight (kgs)					
IFA	16	39.8± 1.09	40.0± 1.14	1.751 ^{NS}	53 kg
	17	44.10± 1.54	45.00± 1.55	2.212*	54 kg
IAP	16	44.30± 1.60	44.35± 1.60	1.451 ^{NS}	53 kg
	17	44.44± 2.08	45.36 ± 1.86	2.063*	54 kg

*Significant at 5%, NS Non significant

Table 6: Body Mass Index of the subjects before and after the study (Mean ± SE) (N = 60).

Parameters	Group (n=30)	Before	After	t value	Reference
BMI (Kg/m^2)	IFA	17.92± 0.41	18.01 ± 0.41	1.602 ^{NS}	18.5-24.99 #
	IAP	19.57± 0.48	19.72 ± 0.47	1.985 ^{NS}	

WHO (2005), ^{NS} Non significant

Table 7: Distribution of the subjects according to BMI index (WHO, 2005) (N = 60).

Categories of Body mass index (kg/m^2)	Risk of co-morbidity	IFA (n = 30)		IAP (n = 30)	
		Frequency		Frequency	
		Before	After	Before	After
Underweight (< 18.5)	Low (but risk of other clinical problems)	19 (63.33)	18 (60)	10 (33.33)	9 (30)
Normal (18.5-24.99)	-	11 (36.66)	12 (40)	20 (66.66)	21 (70)
Overweight (≥ 25.00)	Average	-	-	-	-
Pre obese (25-29.99)	Increased	-	-	-	-
Obese I (30-34.99)	Moderate	-	-	-	-
Obese II (35-39.99)	Severe	-	-	-	-
Obese III (≥40)	Very severe	-	-	-	-

Figures in parentheses represent percentages.

Body Mass Index (BMI)

The average values for BMI of the subjects of groups IFA and IAP are presented in the Table 6. The distribution of the subjects according to BMI index (WHO, 2005) is given in the Table 7. Before the study, the overall mean body mass index of the subjects in various age categories in the group IFA and IAP, was 17.92± 0.41, 19.57± 0.48, kg/m^2 while after the study, it was 18.01 ± 0.41, 19.72 ± 0.47, kg/m^2 in the group IFA and IAP, respectively. Initially, 63.33 % of the subjects in group IFA, 33.33% in group IAP, were underweight. After the study, the percentage of underweight subjects decreased to 60%, 30% in the group IFA and IAP respectively. No significant difference was found in the mean BMI of the subjects after the study in both the groups. Ghosh and Bala (2009) also reported that there was a significantly ($p < 0.05$) greater proportion of females in the lowest BMI group.

Clinical Examination

As the consumption of iron was grossly inadequate in the diets of the subjects, signs and symptoms of anaemia was observed (Table 8). Higher percentage of the subjects was found with symptoms like headache (86.66%) followed by loss of appetite (73.33%) and lethargy (65%), before the study. After the study, reduction in the percentage of subjects with the signs and symptoms of anaemia was observed,

attributing to the increased intake of iron and vitamin C rich foods. Jarrah *et al* (2007) also identified daily symptoms like dizziness, fatigue, depression and headaches in more than 50% of anaemic female students.

Table 8: Clinical symptoms of anaemia among the subjects before and after the counseling (N = 60).

Clinical signs and symptoms	Frequency	
	Before	After
Pale conjunctiva	27 (45)	16 (26.66)
Pale skin	29 (48.33)	25 (41.66)
Flat nails in fingers	-	-
Loss of appetite	44 (73.33)	35 (58.33)
Headache	52 (86.66)	21(35)
Lethargy	39 (65)	21(35)
Breathlessness	20 (33.33)	14 (23.33)

Figures in parentheses represent percentages

Haematological Profile

A statistically significant ($p \leq 0.01$) difference was observed in the mean Hb levels of all the subjects after the study. However, the increase in the haemoglobin levels of the subjects was higher in the group IAP than in the group IFA. The mean values for PCV were lower than the normal range both before and after the study. Before supplementation, the RBC count was lower than the normal range of 3.8-5.8 million/m3, while after supplementation RBC count came in the normal range in both the groups. The MCHC of all the subjects was lower than the normal range of 32 - 36 % both before and after the study. The MCV values were within the normal range 72 - 100 fl both before and after the study (Table 9). According to WHO classification, before the study, all the subjects in both the groups were anaemic, while after the study 53.33 % of the subjects in the group IAP were found non anaemic.

Table 9: Hematological profile of the subjects before and after the study (Mean ± SE) (N = 60).

Parameter	Group (n=30)	Before	After	t-value	Reference
Hb (g/dl)	IFA	9.9 ± 0.12	10.32 ± 0.09	4.713**	≥ 12 g/dl @
	IAP	10.1 ± 0.13	11.70 ± 0.09	16.603**	
PCV (%)	IFA	32.57 ± 0.55	34.37 ± 0.40	4.213**	37 – 48 % #
	IAP	32.77 ± 0.45	36.70 ± 0.38	7.745**	
RBC (million/m^3)	IFA	3.62 ± 0.08	3.90 ± 0.07	4.214**	3.8 - 5.8 million/m^3 #
	IAP	3.69 ± 0.11	4.25 ± 0.10	5.333**	
MCHC (%)	IFA	30.37 ± 0.57	30.12 ± 0.40	0.482 ^{NS}	32 - 36 % #
	IAP	31.01± 0.56	31.71± 0.39	1.046 ^{NS}	
MCV(fl)	IFA	91.13 ± 2.38	88.92 ± 1.66	0.994 ^{NS}	76 - 100 fl #
	IAP	90.61 ± 2.54	88.34 ± 2.86	0.776 ^{NS}	

@ WHO (1972), ** Significant at 1%, # Chugh (2007) , ^{NS} Non significant

Table 10: Distribution of subjects according to their Haemoglobin level (NIN, 1986) (N = 60).

Categories of anaemia with haemoglobin level (g/dl)	Frequency	
	Before	After
Severe (≤ 7 g/dl)	-	-
Moderate (8.0 – 9.9 g/dl)	20 (33.33)	10 (16.66)
Mild (10.0 – 10.9 g/dl)	30 (50)	16 (26.66)
Marginal (11.0 – 11.9 g/dl)	10 (16.66)	18(30)
Non-anaemic (≥ 12 g/dl)	-	16 (26.66)

Figures in parentheses represent percentages

Distribution of the subjects according to NIN (1986) classification is presented in the Table 10. Subjects were screened for their anaemic status and it was found that before the counseling and supplementation, majority of the subject were in the category of mild anaemia (50%), followed by moderately anaemic subjects (33.33%) and 16.66% of the subjects were marginally anaemic. None of the subjects suffered from severe anaemia. After the counseling, percentage of moderately and mildly anaemic subjects reduced to 16.66 and 26.66%, respectively. Majority of the subjects came in the category of marginal anaemia (30%) after the counseling. Approximately, 26% of the subjects became non anaemic after the counseling. Improvement in the haematological profile of the subjects is attributed to the increased intake of iron and vitamin C rich foods.

Nutrition Knowledge

Distribution of KAP (Knowledge, attitude and practices) scores obtained by the subjects is given in the Table 11. The mean score before nutrition education was ≤ 10, in the range of 11-16 and 17-22 in 16.66, 70 and 13.33% of the subjects respectively. It was observed that after nutrition education, none of the subjects scored less than 16. The post test scores were in the range of 17-22, 23-28 and 29-34

in 18.33, 53.33 and 28.33% of the subjects respectively. Gain in score by the subjects after nutrition counseling was 9.9 and quantum of improvement was 1.60 times.

Table 11: Distribution of KAP scores obtained by the subjects (N = 60).

KAP Scores	Frequency	
	Pre test	Post test
≤ 10	10 (16.66)	-
11 - 16	42 (70)	-
17 - 22	8 (13.33)	11 (18.33)
23 - 28	-	32 (53.33)
29 - 34	-	17 (28.33)

KAP - Knowledge, attitude and practices, Figure in parentheses represent percentages.

CONCLUSION

The results of the present study indicates that there was inadequate consumption of cereals, pulses, green leafy vegetables, milk and milk products, roots and tubers, fruits and non-veg. food (meat, egg and fish) in the diets of the subjects. Correspondingly, the intake of energy, protein, iron, niacin, vitamin C and vitamin B_{12} was below RDAs which was reflected from their low weights. As a result, the blood haemoglobin levels, RBC and PCV of the subjects were lower than the normal range. Although after the study, there was significant improvement in the haematological profile of the subjects.

Nutrition counseling had a significant impact on the nutritional status of the adolescent girls, which was evident from their dietary intake. As a result, there was improvement in the dietary intake of the subjects. Consequently, there was increased intake of energy, protein, folic acid, iron and vitamin C attributing to the improved haematological profile of the subjects. Significant improvement in the haematological profile of the subjects was observed in the group IAP than in the group IFA.

A positive understanding of how to improve the nutritional practices was observed. The subjects started supplementing their diets with vitamin C rich foods like Amla powder and lemon water, which led to reduction in the signs and symptoms of anaemia among the subjects. A gain in KAP scores by one and a half time was observed after the nutrition counseling. Therefore, providing vitamin C supplements had additional advantage as more significant improvement was observed in the haematological profile of the subjects receiving iron supplements along with vitamin C than in the group receiving iron supplement alone.

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