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Health Improvement of Iron Deficiency Anemia in Adolescent Girls of Trans Yamuna Region of Prayagraj District

Mansor Mohamed Ali Alholi[1] and Sapna Smith Lal[2*]
[1]Phd Scholar, [2]Assistant Professor
Sam Higginbottom University of Agriculture, Technology and Sciences-
Prayagraj-211007-U.P, India

Abstract
The adolescence is an age group where the not only body faces drastic changes in it but its essential's requirements also increases. It requires proper balance of rich diet, lack of which may lead to condition of anemia. In todays scenario, it is one of the most common condition among adolescents especially girls. This study aims to evaluate the combinatorial effect of folic acid, vitamin E, vitamin C and Zinc with iron when administered in anemic condition by adolescent girls. The results have showed remarkable effects of these combination among subjects before and after supplementation. The iron profile parameters including ferritin, total iron and level of haemoglobin showed a significant percent increase among the subjects. The results revealed trans sat. level increased by 18.550 ± 4.156 (%) in case group while 4.948 ± 1.941(%) in control group. A similar effect was traceable in other parameters too with remarkable increase after supplementation of vitamins deriving the inference that combined effect of iron tablets is much more than its effect alone. Iron was seen percentage increase of 29.883 ± 16.069 (%) (case group-group II) much higher to 15.361 ± 2.020 (%) (control group- group I). The Ferritin level also showed highly significant results with percentage increase in the level by 52.844 ± 36.041(%) (group I) and 7.187± 6.370(%) (group II). Results indicated a significant correlation when before and after vitamin supplementations were compared. Thus, the combination could prove beneficial if administered in anemic condition to the adolescents especially girls.

Keywords: Adolescence, Vitamin E, anemia, antioxidants.

Introduction

Anemia has gradually become one of the stereotypical conditions that is prominent among young children and pregnant women.In recent years, studies have been conducted to assess the incidence of anemic condition among adolescent girls majorly caused due to the nutritional imbalance. India is one of the severely affected countries among other developing countries. WHO has categorized adolescent age group within life span of 10-19 years**(WHO, 1996)**. Some other risk factors which prominently causes anemia in adolescent girls of developing countries

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are poverty, insufficient diet, infections due to poor hygienic conditions and access constraints for appropriate health facilities**(Kaur *et al*., 2006).**Some of the prominent effects that are visible in adolescent girls suffering fromanemiaare slow or improper growth, low immunity, delay in onset of menstruation cycle, inactiveness, poor performance in day-to-day activities especially academic curriculum.

Developing countries exhibit the highest number of anemia cases in adolescent girls accounting for around 5 million out of total effected adolescent population. On the other hand, India itself account for 21% of only adolescent cases out of total anemic population **(Kishore, 2006; Lal and Pankaj, 2007)**.This study was designed in consideration to the devastating consequences of anemia among adolescent girls in our country, the study emphasizes on population of Prayagraj region. The management of this condition is intake of iron tablets, which are known to be the sole source to sort the problem of anemia. But improper iron absorption capacity in few patients render this solution to be inefficient. This study evaluates the increased rate of iron absorption when supplemented with antioxidant vitamins E.

Material and Methodology

Study area and population

The study was conducted in various regions of Prayagraj that included Andalpur, Mahewa, Baswar, Amiliya, Dandi, Dandupur, Jasra. 248Adolescent girls aged between 10 to 19 years were selected for the study, with their consent and assurance of confidentiality of their records. The record comprised of details of the subject like, age, socio-demographic status, menstrual statue and any linked medical history (if any), and other health related details. In this study adolescent girls who were pregnant and severely ill at the time of the study were not included.

Study Design

The study comprised of two groupsGroup-I and Group-II each of 124 subjects. Group-I subjects were supplemented with normal diet + 100mg iron + 1.5mg folic acid daily whereas Group-II 124subjects were administered with normal diet + 100mg iron + 1.5 mg folic acid daily + Vitamin E (400mg once a time daily) + Vitamin C (500mg once a time daily) for three months + Zinc (50 mg once a time daily) for three months + anti-helminthic drug (Albendazole 400 mg) once a single dose.

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Data Collection and Analysis of disease management

5 ml of blood sample was drawn from the subject and were used to study following parameters:

S.No.	Biochemical analysis	Parameters
1	CBC	Hb/ MCHC/PCV/MCV/MCH/RBC
2	Iron Profile	Trans Sat./ ferritin/ Iron/ TIBC
3	Vitamin C/ Vitamin E/Zinc	

WHO cut off values for assessing anaemia in adolescent girls (WHO, 2011)

- Normal > 12gm/dl
- Mild anaemia 10gm/dl and 12 gm/dl
- Moderate anaemia 7gm/dl and 10gm/dl
- Severe anaemia <7gm/dl

**Hb : Hemoglobin ; MCHC : Mean Corpuscular Hemoglobin Concentration ; PCV: Packed Cell Volume ; MCV : Mean Corpuscular Volume ; MCH : Mean Corpuscular Hemoglobin; RBC : Red Blood Cells; TIBC: Total iron binding capacity*

Total haemoglobin, Mean Corpuscular Volume (MCV) and Mean Corpuscular Haemoglobin (MCH) were estimated by Fully automated bidirectional analyser (6 Part Differential SYSMEX XN-1000). Iron, Ferritin, total iron binding capacity were measured by Fully automated bidirectionally Interfaced chemi Luminescent Immuno Assay, Vitamin E was estimated by following Liquid Chromatography Tandem Mass Spectrometry (LC-MS) and Vitamin C was measured by **Roe *et al.* (1954).** All the parameters were evaluated using the mentioned methods and disease management study was conducted to observe the combined effect of iron with vitamin C and E administered in order to enhance the effects of iron tablets in anaemic condition.

Result & Discussion

The study conducted on 248 adolescent girls suffering from anaemia including subjects of all the three conditions i.e. mild, moderate and severe anaemia. The subjects were tested for their response towards reduction in anaemic condition when given only iron tablet in comparison to diet supplemented with antioxidant vitamin E along with iron tablets. The following sections summarizes (*table 1 and table 2*) the observations recorded during the study.

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Participants'information

The subjects who participated in the study were adolescent females of age ranging from 10 to 19 years. Participants were categorized in two age groups of 10-14 years, 15-19years. Out of 248 girls, 79(31.85%) girls were between 10-14 years, whereas maximum number of participants belonged to the category of 15-19 years age group. 169participants with highest proportion of 68.14% were of this category (shown in table 1).WHO has categorized adolescent age group within life span of 10-19 years **(WHO, 1996).** Therefore all the participants were of adolescent stage and had the anaemia condition of mild, moderate or severe type. The study was designed with 2 groups-Therespondents of Group-I were supplemented with normal diet + 100mg iron + 1.5mg folic acid daily andiron deficient respondentsof group II were administered with normal diet + 100mg iron + 1.5 mg folic acid daily + Vitamin E (400mg once a time daily) + Vitamin C (500mg once a time daily) for three months + Zinc (50 mg once a time daily) for three months + anti-helminthic drug (Albendazole 400 mg) once a single dose.

In socio-economic data the respondents were categorized under 5 classes, Upper, Upper middle, Middle, Lower middle and Lower, showing proportion of 5.24%, 7.66%, 16.93%, 55.24% and 14.92% respectively in each class. In the current study of religion, it showed that the highest percentage 63.30% are Hindus while 34.27% of the participants are Muslims and 2.42% are Christian. The records of dietary habits showed that higher percentage were vegetarian 54.03% than non-vegetarian 40.32% and 5.64% areVegetarian but take egg. The WHO grading scale was used to categorize the subjects as 29.43% normal (12 gm/dl), 47.98%. mild (10-12gm/dl), 16.93% moderate (7-10gm/dl) and 5.64% severe (less than 7gm/dl) (shown in table 1).

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Table 1: Proportions observed on data collection of respondent and their various information

Respondents Performa			
S.No.	**Parameter**	**Conditions**	**Population (%)**
1	Age Group	10 to <15years	31.85%
		15 to 19 years	68.14%
2	Socio-economic class	Upper	5.24%
		Upper middle	7.66%
		Middle	16.93%
		Lower middle	55.24%
		Lower	14.92%
2	Religion	Hindu	63.30%
		Muslim	34.27%
		Christian	2.42%
3	Dietary habit	Vegetarian	54.03%
		Non-vegetarian	40.32%
		Vegetarian but take egg	5.64%
4	Grading of anaemia	Normal	29.43%
		Mild	47.98%
		Moderate	16.93%
		Severe	5.64%

**Group I: 120 respondents (control group) and Group II: 120 respondents (iron deficit group); Group I administered normal diet and group II administered iron tablets supplemented with antioxidant vitamin E*

The CBC data, biochemical parameters results and estimation of vitamin level collectively defined the elevation in positive effect of antioxidant supplementation along with iron tablets to the iron deficient subjects. Biochemical parameter analysis was done before supplementation and after supplementation to the 2 groups (group I and II) administered with normal diet + 100mg iron + 1.5mg folic acid daily and normal diet + 100mg iron + 1.5 mg folic acid daily + Vitamin E (400mg once a time daily) + Vitamin C (500mg once a time daily) for three months + Zinc (50 mg one time daily) for three months + anti-helminthic drug (Albendazole 400 mg) once a single dose (table 1). The tabulated results shows that BMI was close to normal range in both the groups whereas haemoglobin was seen to have strikingly lower value in group II as compared to group I which showed near normal range recording. Thus after supplementation with vitamins group I showed slight increase in hb from 12.057±1.014 to 12.289±0.979 unlike group II which showed visibly higher increase from 8.773 ±1.382 to 10.308 ±1.513.

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Table 2: Iron status recorded among subjects administered with only iron and iron supplemented with vitamin E tablets			
Biochemical parameters	**Condition**	**Group I (n=120)**	**Group II (n=120)**
		Mean±S.D	**Mean±S.D**
hb	**Biochemical analysis**		
	Before the supplementation	12.057±1.014	8.773 ±1.382
	After supplementation	12.289±0.979	10.308 ±1.513
	Change	0.232± 0.035	1.535 ± 0.131
	Percentage(%)	1.924± 3.451	17.496 ± 9.479
	t-test (p-value)	**1.834 (0.068) NS**	**8.341 (0.000)**
MCHC (g/dl)	Before the supplementation	30.388 ± 1.074	28.073 ± 1.739
	After supplementation	30.713 ± 1.011	29.557 ± 1.894
	Change	0.325 ± 0.063	1.484 ± 0.155
	Percentage(%)	1.069 ± 5.865	5.286 ± 8.913
	t-test (p-value)	**2.453 (0.014) NS**	**6.427 (0.000)**
PCV (%)	Before the supplementation	40.546 ± 3.767	34.331 ± 4.261
	Post	41.589 ± 3.851	37.843 ± 4.395
	Change	1.043 ± 0.084	3.512 ± 0.134
	Percentage(%)	2.572 ± 2.229	10.229 ± 3.144
	t-test (p-value)	**2.156 (0.032)**	**6.388 (0.000)**
MCV (fl)	Before the supplementation	94.784 ± 7.415	85.634 ± 8.851
	After supplementation	96.589 ± 7.288	90.048 ± 8.546
	Change	1.805 ± 0.127	4.414 ± 0.305
	Percentage(%)	1.904 ± 1.712	5.154 ± 3.445
	t-test (p-value)	**1.933 (0.054) NS**	**3.987 (0.000)**
MCH (pg)	Before the supplementation	28.538 ± 2.950	25.623 ± 3.722
	After supplementation	29.089 ± 3.106	27.557 ± 3.519
	Change	0.551 ± 0.156	1.934 ± 0.203
	Percentage(%)	1.930 ± 5.288	7.547 ± 5.454
	t-test (p-value)	**1.432 (0.153) NS**	**4.204 (0.000)**
RBC (x 10^6µL)	Before the supplementation	4.122 ± 0.507	3.738 ± 0.514
	After supplementation	4.205 ± 0.513	3.969 ± 0.483
	Change	0.083 ± 0.006	0.231 ± 0.031
	Percentage(%)	1.970 ± 1.183	8.643 ± 6.031
	t-test (p-value)	**1.281 (0.201) NS**	**3.647 (0.000)**
Trans Sat (%)	**Iron profile**		
	Before the supplementation	17.076 ± 8.034	14.028 ± 8.253
	After supplementation	17.921 ± 8.190	16.629 ± 8.596
	Change	0.845 ± 0.156	2.601 ± 0.343
	Percentage(%)	4.948 ± 1.941	18.550 ± 4.156
	t-test (p-value)	**0.820 (0.413) NS**	**2.430 (0.015)**
S. Iron (µg/dl)	Before the supplementation	71.269 ± 26.381	47.451 ± 21.245
	After supplementation	82.219 ± 26.914	61.673 ± 24.659
	Change	10.948 ± 0.533	14.188 ± 3.414
	Percentage(%)	15.361 ± 2.020	29.883 ± 16.069
	t-test (p-value)	**3.235 (0.001)**	**4.865 (0.000)**

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Ferritin (ng/ml)	Before the supplementation	55.246 ± 52.243	23.604 ± 18.884
	After supplementation	59.217 ± 48.915	36.079 ±25.692
	Change	3.971 ± 3.328	12.475 ± 6.806
	Percentage(%)	7.187± 6.370	52.844 ± 36.041
	t-test (p-value)	**0.617 (0.573)NS**	**4.356 (0.000)**
TIBC (µg/dl)	Before the supplementation	373.270 ± 53.575	421.238 ± 80.739
	After supplementation	364.841 ± 51.839	388.730 ± 73.681
	Change	-8.429 ± 1.736	-32.508 ± 7.058
	Percentage(%)	-2.258 ± 3.240	-7.717 ± 8.741
	t-test (p-value)	**-1.259(0.209)NS**	**-3.312(0.001)**
Vitamin C	Before the supplementation	2.367 ± 0.214	2.592 ± 0.205
	After supplementation	2.352 ± 0.191	3.417 ± 0.249
	Change	-0.015 ± 0.023	0.825 ± 0.044
	Percentage(%)	-0.584 ± 10.747	31.820 ± 21.163
	t-test (p-value)	**-0.582 (0.561) NS**	**28.484 (0.000)**
Serum Zinc (µg/dl)	Before the supplementation	124.925 ± 32.517	145.151 ± 22.627
	After supplementation	126.475 ± 34.053	200.679 ± 29.185
	Change	1.550 ± 1.536	55.528 ±6.558
	Percentage(%)	1.058 ±4.723	38.255 ± 28.983
	t-test (p-value)	**0.376 (0.714) NS**	**16.744 (0.000)**
Vitamin E (ng/mL)	Before the supplementation	6984.528 ± 1728.314	7562.255 ± 1958.356
	After supplementation	7031.378 ± 1765.728	10549.337 ± 2139.264
	Change	46.85 ± 37.414	2984.082±180.908
	Percentage(%)	0.670 ± 2.164	39.460 ±9.237
	t-test (p-value)	**0.211 (0.832) NS**	**10.496(0.000)**

**Data are presented as ± S.D. Hb : Hemoglobin ; MCHC : Mean Corpuscular Hemoglobin Concentration ; PCV: Packed Cell Volume ; MCV : Mean Corpuscular Volume ; MCH : Mean Corpuscular Hemoglobin; RBC : Red Blood Cells; TIBC: Total iron binding capacity*

The iron profiles of the subjects were analysed based on parameters Trans S. Iron (µg/dl), Ferritin (ng/ml), TIBC (µg/dl). The results showed that in case of trans sat. also supplementation of vitamins had positive effect showing increase from 17.076 ± 8.034(%) to 17.921 ± 8.190(%) in group I while from 14.028 ± 8.253(%) to 16.629 ± 8.596(%) in group II. Therefore the percentage increase was much significant for group II with 18.550 ± 4.156 (%) than in group I 4.948 ± 1.941(%). A similar effect was traceable in other parameters too with remarkable increase after supplementation of vitamins deriving the inference that combined effect of iron tablets is much more than its effect alone. In case of iron it was seen that percentage increase in iron level was 29.883 ± 16.069(%) in group II much higher to 15.361 ± 2.020(%) of group I. The Ferritin level also showed highly significant results with percentage increase in the level by 52.844 ± 36.041(%) (group I) and 7.187± 6.370(%) (group II). Serum Zinc level and vitamin E level showed a slight variable pattern with almost insignificant percentage increase for group I with 1.058

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±4.723(%) and 0.670 ± 2.164(%) respectively. But for group II increase was highly significant with 38.255 ± 28.983(%) in serum zinc whereas 39.460 ±9.237(%) in serum.

The independent *t*-test was also carried out to evaluate the significance between cases and controls that showed a highly significant with (P<0.005) in most of the parameters of iron profiles and vitamin status. Therefore the recorded results showed that combination of iron with these vitamins could prove more beneficial than their solo effect which indicated by the significant correlation when before and after vitamin supplementations were compared.

Antioxidants are known to play integral role in developing as well as maintaining proper immune responses. Oral intake of vitamin E is one common practice which could help better immune response , it also works in prevention of atherosclerosis and increases osmotic resistance of RBC. It also nullifies the harmful effect of highly reactive species. Uptake of 400 IU/day of vitamin E for 2 months helps better absorption of vitamin by the body**(Fialkow*et al.*, 2007; Behe and Segal, 2007; Malle*et al.*, 2007).**

Several studies have been conducted on adolescent girls suffering from anaemia consistent to our study. **Sharda Sidhu *et al.*(2008)** in her study on anaemic adolescent girls of Hassan district presented that one (1.2%) girl was 12 years of age, 28 girls were 13 years of age, 51 (60.7%) girls were 14 years of age and four (4.8%) were 15 years of age. In the study it was revealed that anaemia increased with progression towards adolescence, being highest in case of girls aged 14 years. Being a global problem, nutritional anaemia is still a bigger problem for a developing country like India. Several issues are responsible, inadequate dietary habit being the major one. A number of studies have been conducted to identify its prevalence in rural areas revealing its rate from 46% to 98% **(Kanani, 1994; Pathak, 2004; Sampath, 1997).**

In consideration to the problem, several iron supplementation program has been developed in past. But most of them have either failed or not implement efficiently, the reason being that they did not reach to the people who are effected most, health workers are not very well equipped with the complete information on these supplementation programs and ineffective distribution of the supplements among the needy ones. Also, the side effects are less or not at all known. The need of the hour is that people must be made aware of these supplements and their benefits. So that they could efficiently help the young growing girls

who are facing the issue and are unable to tackle it due to unavailability of the right facilities and knowledge.

Conclusion

Our study majorly focuses on the problem of anemia among one of the most vulnerable age groups i.e., adolescent especially in girls. Adolescent girls are majorly effected by the problem in view to problems like inappropriate dietary habits, inadequate nutritional intake, acute and chronic inflammation, sudden growth spurt, greater need of iron, more loss of iron from the body during the menstruation, other inherited or acquired disorders of related to haemoglobin. This may also include other environmental and financial factors which worsens the situation. Therefore, much attention is required to deal with problem as only iron tablets may not fulfill the growing needs of adolescents. In this study, a combination of iron, folic acid daily, vitamin E, vitamin C, Zinc is used with an aim to prove helpful tool to improve adolescent girls iron status.

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Conflicts of interest

There are no conflicts of interest

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