

IRON, ZINC, FOLIC ACID AND VITAMIN B12 CONTENT OF FORTIFIED RICE CONSUMED AND HAEMOGLOBIN STATUS OF SCHOOL GOING ANAEMIC ADOLESCENTS



Food Science

KEYWORDS: Micronutrient, Adolescent, Haemoglobin, Anaemia.

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ABSTRACT

Objective: to assess the effect of extruded rice fortified with haemopoietic micronutrient namely iron, zinc, folate and vitamin B12 on haemoglobin status in adolescents. **Methodology:** The investigation was carried out in a rural higher secondary school of Uthramelur Taluk in Kancheepuram district of Tamilnadu, India. A total of 250 adolescents in the age group of 10 to 18 years residing in the school hostel, studying from standard VI to XII, were screened for the blood haemoglobin levels by cyanmethaemoglobin method, 0.02 micro litre of capillary blood was drawn by finger prick method, incubated for three minutes and immediately analysed using semi autoanalyser for haemoglobin concentration and the results were compared with WHO (2011) cut off value. Out of 250, 220 who were anaemic and willing to participate in the study were included for the study but only 201 adolescents could complete the study due to various reasons. Food weighing survey was conducted in 12 per cent of the adolescents including all the age groups and both genders and the mean dietary deficit of these micronutrients was arrived at for deciding the quantity of nutrients required for supplementation. Based on the deficit, the composition for the rice premix (Extruded rice with haemopoietic micro-nutrients) was evolved and it was manufactured by a PATH (Promoting Appropriate Technology in Health) approved Indian manufacturer. One gram of developed rice premix provided 19.6 mg of iron, 60.2 mcg of folate, 0.1 mcg of vitamin B12 and 4.1 mg of zinc. This rice premix was mixed with the regular rice in the proportion of 0.8:99.2. The micronutrient composition of the rice premix was planned so that consumption of 120 g of fortified rice would fill up the gap of the haemopoietic micronutrients. Deworming was carried out by administering albendazole tablets for all the adolescents. The selected 220 adolescents were randomly assigned to control and experimental groups. All the adolescents in the experimental group were served with the breakfast prepared with the fortified rice (Rice premix with regular rice) while the control group received the breakfast prepared with the unfortified regular rice. The feeding was carried out for 6 days a week and for a total of 250 days. The impact of the intervention was assessed through anthropometric measurements -body weight, height (computed BMI), biochemical parameters namely, blood haemoglobin. All these parameters were evaluated before the start of supplementation and at the end of the supplementation period. **Result:** The BMI of the adolescents revealed that there was no significant difference between control and experimental group of boys and girls. There was a significant increase in the mean haemoglobin level of all the adolescents (both gender and both the groups). However, a rise was 32% (3.04 g/dl) among the adolescents of experimental group whereas in the control group it was only 6% (0.64 g/dl). **Conclusion:** The results reveal that fortification of staple food with haemopoietic micronutrient is an effective strategy to improve haemoglobin status and reduce the prevalence of anaemia.

INTRODUCTION

Adolescence is an interim period from childhood to adulthood with maximum amount of physical, physiological and behavioural changes. WHO defines adolescent group as life span between 10 to 19 years (SEARO, 2014). Nutritional negligence which happens during this period results in anaemia.

Micronutrients are nutrients which are needed in smaller quantities in the body, but play an important role in the production of hormones, enzymes and other substances that help in the functioning of reproductive and immune system and act as co-enzymes and co-factors in the metabolic reactions. The deficiencies not only cause specific diseases, but also act as aggravating factors in infectious and chronic diseases, greatly impacting morbidity, mortality, and quality of life (Tulchinsky, 2010). The mortality data of WHO evidences that 0.8 million deaths are accredited to iron deficiency every year globally. (Kapil, 2014).

Nutrients in haemoglobin synthesis are proteins- all essential amino acids are necessary particularly methionine, vitamins -B12, C, A, B6, B2 and folic acid. Poor intake of these nutrients, chronic low grade inflammation and infections and malaria also contribute significantly to iron malnutrition. The average iron density of an Indian diet is not more than 10 mg/1000 Kcal, with the lowest density of 4.3 and the highest of 15.6 mg/1000 Kcal (NIN, 2011).

Anaemia is the second leading cause of disability in the world and responsible for nearly one million deaths a year, the majority comes from Africa and South-East Asia. World Bank has ranked iron deficiency anaemia the third leading cause of DALYs lost for females

aged 15-44 years. It accounts for 4.05 per cent loss in Gross Domestic Product (GDP) per annum by causing physical and cognitive losses. In India it corresponds to 1.18 per cent loss in GDP (Pasricha, 2014).

The prevalence of anaemia among adolescent girls in the age group 15-19 years and in the older age group 20-29 years remains almost stagnant at 55.8 per cent and 56.1 per cent respectively. On the other hand, among adolescent boys, prevalence of anaemia in the age group 15-19 years is higher (30.2%) than the post-adolescent age group 20-29 years (19.3%) (Guidelines to control IDA, 2013).

Iron deficiency anaemia not only affects the work capacity of the population but also it brings obstacles to national development. Timely intervention can restore the health as well as increase the national productivity by 20 per cent (<http://www.who.int/nutrition/topics/ida/en/>). The long term measure to combat micronutrient deficiency includes diet diversification and behavior change communication while the short term measures include medical supplementation which is not a sustainable one and food fortification is an important intervention and it is sustainable and cost effective measure (www.iapsmupuk.org). Even though multi channels and strategies are required to address the problem fortification of rice with Rice premix was selected as an adjunct or alternative supplementation strategy in the present study.

Many studies are available on pregnant women and under five, only a few studies are accessible on the nutritional status and iron status of rural adolescents. Therefore, the present study was aimed to study the impact of supplementing iron, zinc, folic acid and vitamin B₁₂ fortified rice on promoting the nutritional status of adolescents in

the age group of 10-18 years.

METHODOLOGY

The school selected for the present study was a rural Higher Secondary School at Kancheepuram District in Tamil Nadu for the reason of permission and cooperation of the school authorities, consent of the parents of adolescents and assent of the participants. The school is run by a charity and provides all facilities towards the education to economically weaker section of the society.

A total of 250 adolescents in the age group of 10-18 years residing in the school hostel and studying in standard VI to XII were screened for blood haemoglobin levels by cyanmethaemoglobin method and the results were compared with WHO (2011) cut off values for classifying anaemia. The haemoglobin status showed that 88 per cent of the adolescents were anaemic. All the XII and X standard students who were not planning to continue their studies in the same school in the following year and those who were non-anaemic were excluded from the study. Out of the total of 250, 220 adolescents who were anaemic and willing to participate in the study were included in the study. Out of 220 anaemic adolescents, ten were from class XII who will not be present for a period of one year. Seven of them showed poor attendance and two of them dropped from the school making finally the total number of participants as 201.

Dietary survey of food weighing method was employed in order to obtain data on the food and nutrient intake of the adolescents for seven consecutive days as the menu in the hostel was seven days cycle menu. The nutrient intake was calculated using the Table (Gopalan *et al.*, 2007). The mean nutrient intake was compared with the RDA (NIN, 2011) to assess the deficit in the diet. The details are presented in Table 1.

The mean RDA of iron, zinc, folic acid and vitamin B₁₂ for Indian adolescents in the age range of 10 to 18 years is 26.8 mg, 10.7 mg, 1.63 mcg and 0.2-1 mcg respectively and the nutrient intake by the food weighing survey was estimated to be 7.9 mg, 6.0 mg, 1.35 mcg, and 0.98 mcg respectively. A gap of 18.9 mg, 4.7 mg, 28 mcg and 0.02 mcg of iron, zinc, folic acid and vitamin B₁₂ was planned to be filled through supplementing fortified rice. As the day scholars would also be participating in the noon meal, the breakfast was selected for feeding with fortified rice. Sample of the regular rice used in the school was sent to the manufacturer of rice premix to avoid differences in appearance of the rice after cooking.

One of the available technologies for fortifying rice is uniform mixing of Rice premix/Ultra rice. Promoting Appropriate Technology in Health (PATH-a catalyst for global health) has used these technologies and developed many different varieties of Ultra rice/Rice premix. The investigator approached PATH organization and got their consent to sponsor Rice premix to carry out the current investigation. The fortificants used were micronized ferric pyrophosphate, folic acid IP, vitamin B₁₂ as 0.1 per cent mannitol base and zinc as zinc oxide IP. One gram of the developed rice premix provided 19.6 mg of iron, 60.2 mcg of folic acid, 0.1 mcg of vitamin B₁₂ and 4.1 mg of zinc, but the net availability of rice premix (after the loss during processing, soaking, and transport) was 19.6 mg of Iron, 4.1 mg of Zinc, 43.3 mcg of folate and 0.048 mcg of Vitamin B₁₂. The required quantity of Rice premix for the conduct of entire study was procured from PATH and stored in the ambient temperature.

Information on food consumption quantity revealed that the mean intake of rice (breakfast) was 120.8 g. Hence in order to meet the existing haemopoietic micronutrients deficit, the rice premix was mixed with the regular rice in the ratio of 0.8: 99.2 so that 100g of fortified rice provide an extra amount of 15.68 mg of iron, 3.28 mg of zinc, 34.6 mcg of folic acid and 0.038 mcg of vitamin B₁₂ (apart from the nutrients present in regular rice).

The study was a randomized control feeding trial among adolescents in the age group of 10 to 18 years. The selected 220 anaemic

adolescents were randomly assigned into control and experimental group by using computer generated random numbers. Out of 220 selected adolescents 201 completed the study with 101 in the experimental group and 100 in the control group. Deworming was carried out by administering albendazole (400mg) tablets for all the adolescents at baseline and at the interval of six months.

All the adolescents in the experimental group were served with recipes prepared using Fortified Rice while the control group received recipes of Unfortified Regular Rice.

The fortified rice and unfortified regular rice were used for preparation of usual hostel recipes such as *pongal*, *tamarind rice*, *lemon rice*, *karakulambu rice*, *tomato rice* and *rice dhal porridge*. Fortified rice recipes were served to the experimental group while unfortified regular rice recipes were served to the control group. One hundred and twenty gram of rice as cooked recipes was served in the breakfast for both the experimental and control groups. The food was served for a total of 250 days, all six days in a week except on Sundays.

Anthropometric measurements of anaemic adolescents namely, height, weight was recorded using staturemeter and digital weighing balance (upto 100 g accuracy) and BMI were determined and blood haemoglobin was estimated at the beginning and end of the study. A prestructured proforma was used to record the data. Anthro Plus Software and SPSS Package Version 16.0 was used for analysis. Approval of the ethical committee (University-HEC.2011-34, School-HEC.01.2011) and informed consent of all the participants were taken before the conduct of the study.

RESULTS AND DISCUSSION

Table 2 presents age wise distribution of the anaemic adolescents selected for the study.

In this study group more number (93) of boys and girls in the age group of 13-15 years were found to be anaemic, also the least (35) was among 16-18 years old adolescents. This is mainly due to the fact that the number of 16-18 years age group adolescents residing in the hostel was less compared to other age groups. The total number of girls (85) staying in the hostel was less compared to that of boys (116).

Mean nutrient intake by the adolescents

The mean nutrient intake by the adolescents is shown in Table 3.

The intake of energy was deficient among all the three age group of adolescents studied, it is because though the intake of cereals was adequate, the intake of pulses, fats/oils, roots and tubers were found to be inadequate in all three age groups. Amirthaveni and Kowsalya (2012) also reported more than 35 per cent shortage of RDA of calories among school going children in Ramanathapuram District of Tamil Nadu.

The intake of protein was found to be inadequate in all the three age groups of boys and girls. The deficit ranged from 4.5 per cent to 26.2 per cent. The lesser deficit of protein than the energy might be due to the reason that every adolescent was given 6 eggs in a week and meat was served on all Sundays apart from their pulse intake.

The intake of micronutrients among the adolescents was found to be less than the RDA in all the age groups except magnesium. The reason behind that is the intake of milk and milk products, green leafy vegetables and fruits were far below from the suggested allowances and the food served is mainly rice based.

The results of the study further indicate that the deficit of iron ranged from 62.9 to 75.9 per cent, The deficit of calcium ranged from 73.8 to 79.6 per cent among all the adolescents studied, this was mainly due to the reason that though the milk was served, none of these adolescents selected for food weighing survey consumed milk and milk products. The deficit of zinc was found to be 34.4 to 51.8 per cent among the three age groups studied. Deficit of folic acid ranged from 1.4 to 32.5 per cent in all the age groups selected. In general all

nutrients in take were found to be inadequate except niacin and magnesium.

BMI of the anaemic adolescents during the study period

Mean BMI of the anaemic adolescents is compared with BMI for age z score (BAZ) of WHO (2007) and presented in Table 4

After the intervention the increment of BMI was higher (0.8) in boys of experimental group than the control group (0.27) similarly girls of experimental group recorded slightly higher increment of 1.02 as compared to that of control group 0.84. However the result revealed that there was no significant difference between control and experimental group of boys and girls, but there was a significant difference after the intervention both in control and experimental groups (p<0.01). This might be due to the reason of growth spurt during adolescent age. In general girls recorded higher increment of BMI than the boys, however all values recorded at baseline as well as end of the study were found to be lesser than BMI for age Z score (BAZ WHO,2007) growth standards. A study by Goyle (2012) on the effect of supplementation of biscuits with and without micronutrients on the weight and height of 107 adolescent girls in the age group of 10 to 16 years and found a statistically significant improvement in the mean BMI.

Haemoglobin level of the anaemic adolescents during the study period

The mean haemoglobin level of all the anaemic adolescents at the beginning, midterm and after intervention is presented in Table 5.

The above Table shows that the mean haemoglobin level increased throughout the study period among the boys and girls of both experimental and control groups. After six months of supplementation the haemoglobin level among the boys of experimental group increased from 10.36 ±0.85 to 11.69 ±0.92g/dl and in the girls a rise from 9.35 ±0.90 to 10.74 ±0.92g/dl which was slightly greater than that of the boys. In the case of control group also a mild increase had been recorded ie boys (from 10.57 ±1.17 to 11.05 ±1.27 g/dl) whereas in girls it was from 9.91±1.14 to 10.23±1.33g/dl.

Anand *et al* (2007) also found that fortified (iron, folic acid, vitamin C, vitamin A) candies were effective in improving the haemoglobin level and decreasing the anaemia among 410 children in the age of 3- 6 years for a period of 3 months.

The pooled data also showed a significant increase of mean haemoglobin among experimental 3.04 g/dl group after intervention.

At the end of the study, there was a significant increase in the mean haemoglobin level of all the adolescents (both gender and both the groups). However, a rise of 2.76 g/dl among the boys and 2.45g/dl among the girls of experimental group was noted and increment was higher than the increment in boys 0.79 g/dl and girls 0.44 g/dl of control group proving the impact of intervention. It is gratifying to note that all boys in experimental group attained the normal haemoglobin level of >13g/dl but girls reached only the very closer value (11.80g/dl) to normal level.

Conclusion

In this study the BMI of the girls was better compared to boys, however all the values recorded at baseline as well as at the end of the study were found to be lesser than the WHO (2007) growth standards. The result showed a significant increase of mean haemoglobin only among experimental group after intervention. Hence fortification of staple food with multimicronutrient is an effective strategy to alleviate anaemia.

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TABLE 1 MEAN MICRONUTRIENT INTAKE BY THE ANAEMIC ADOLESCENTS

(N=24)

Age in Year s	Gen der	Iron (mg)			Zinc (mg)			Folic acid (mcg)			Vitamin B12 (mcg)		
		RDA *	AI	Defi cit	RDA *	AI	Defi cit	RDA *	AI	Defi cit	RDA *	AI	Defi cit/ Exce ss
10-12	Boys (4)	21	7.8	13.2	9	5.9	3.1	140	138	2	0.2-1.0 [†]	0.93	-0.07
	Girls (4)	27	6.5	20.5	9	4.9	4.1	140	126	14	0.2-1.0	0.88	-0.12
13-15	Boys (4)	32	8.5	23.5	11	6.4	4.6	150	140	10	0.2-1.0	1.12	+0.12
	Girls (4)	27	7.1	19.9	11	5.3	5.7	150	128	22	0.2-1.0	0.93	-0.07
16-18	Boys (4)	28	9.0	19.0	12	7.0	5.0	200	146	54	0.2-1.0	1.03	+0.03
	Girls (4)	26	8.5	17.5	12	6.5	5.5	200	135	65	0.2-1.0	0.96	-0.04
Mean		26.8	7.90 (30 %)	18.9 (70 %)	10.7	6.0 (56 %)	4.7 (44 %)	163	135 (83 %)	28 (17 %)	0.2-1.0	0.98 (98 %)	0.02 (2%)

*Recommended Dietary Allowance (ICMR, 2010), AI -Actual intake. †-Upper limit of RDA was considered as cut off for calculation of vitamin B12 deficit.

TABLE 2 AGE DISTRIBUTION OF THE ANAEMIC ADOLESCENTS

(N=201)

Age (year s)	Boys						Girls						Grand total	
	Experim ental Group		Control Group		Total		Experim ental Group		Control Group		Total			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
10-12	24	40.0	20	35.7	44	37.9	16	39.0	13	29.5	29	34.1	73	36.3
13-15	26	43.3	25	44.7	51	44.0	20	48.8	22	50.0	42	49.4	93	46.3
16-18	10	16.7	11	19.6	21	18.1	5	12.2	9	20.5	14	16.5	35	17.4
Total	60	100	56	100	116	100	41	100	44	100	85	100	201	100

TABLE 3 MEAN NUTRIENT INTAKE OF THE ANAEMIC ADOLESCENTS

(N=24)

Nutrients	%excess/deficit of RDA (2010)					
	Age in years					
	10-12		13-15		16-18	
	Boys	Girls	Boys	Girls	Boys	Girls
Energy (kcal)	-26.1	-35.9	-33.4	-35.8	-36.4	-25.4
Protein (g)	-4.5	-15.3	-15.7	-26.2	-22.8	-19.0
Fat (g)	-34.3	-45.7	-42.2	-47.5	-46.0	-28.6
Calcium(mg)	-77.0	-79.6	-75.9	-79.4	-73.8	-75.8
Iron (mg)	-62.9	-75.9	-73.4	-73.7	-67.9	-67.3
Vitamin A (mcg)	-50.5	-54.9	-48.3	-52.8	-54.3	-55.7
Thiamine(mg)	-9.1	-19.0	-21.4	-25.0	-20.0	+10.0
Riboflavin(mg)	-61.5	-60.8	-62.5	-64.8	-66.7	-54.2
Niacin(mg)	0	-9.2	+12.5	0	+5.8	+24.3
Vitamin C (mg)	-42.5	-48.0	-40.0	-47.5	-32.5	-35.0
Folic Acid (mcg)	-1.4	-9.9	-8.0	-16.0	-27.0	-32.5
Magnesium (mg)	+51.6	+54.8	+8.4	+34.3	+88.2	+47.3
Zinc (mg)	-34.4	-45.0	-41.8	-51.8	-41.7	-45.8
Vitamin B ₁₂ (mcg)	-7.0	-12.0	+12.0	-7.0	+3.0	-4.0

TABLE 4 MEAN BMI OF THE ANAEMIC ADOLESCENTS DURING THE STUDY PERIOD

(N=201)

Details	Boys(116)			Girls (85)		
	E (n=60) M SD	C (n=56) M SD	P Value E vs C	E (n=41) M SD	C (n=44) M SD	P Value E vs C
BAZ of WHO(2007)	19.05±1.62	19.05±1.62		19.31±1.48	19.31±1.48	
BI	15.42±1.82	16.02±0.82	0.080 ns	16.93±2.62	17.27±2.60	0.543 ns
AI	16.22±1.78	16.29±1.75	0.834 ns	17.95±2.50	18.11±2.48	0.764 ns
Diff BI-AI	0.80	0.27		1.02	0.84	
P value BI vs AI	0.01**	0.01**		0.01**	0.01**	

E- Experimental group, C-Control group, BI-Before Intervention, AI-After Intervention, Diff-Difference: **significant at 1%level.ns-not significant.

TABLE 5 MEAN BLOOD HAEMOGLOBIN (g/dl) LEVEL OF ANAEMIC ADOLESCENTS

(N=201)

Gender	Group	N	BI	AI	Diff BI - A	P Value BI Vs. AI	P Value E Vs C
Boys	E	60	10.36±0.8	13.12±1.1	+2.76	0.01**	0.01**
	C	56	10.57±1.1	11.36±1.3	+0.79	0.01**	
Girls	E	41	9.35±0.9	11.80±0.9	2.45	0.01**	0.01**
	C	44	9.91±1.14	10.35±1.5	+0.44	0.01**	
Pooled data	E	101	9.55± 1.0	12.59 ±1.2	+ 3.04	0.01**	0.01**
	C	100	10.28±1.2	10.92±1.5	+0.64	0.004**	

E-Experimental group, C-Control group. **significant at 1% level, BI-Before Intervention, AI-After Intervention

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