Research Article

Impact of Double Fortified Salt (DFS) Supplementation on the Nutritional Profile: Anaemic Adolescent Girls

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Abstract

Iron deficiency Anaemia (IDA) still persists around the world, due to unsuccessful implementation of anaemia control programmes at national and international level. Keeping this aspect, a pilot study was conducted to reduce anaemia at home scale level. For the study, a preliminary survey was performed to detect anaemia (Hb>12g/dL) among adolescent girls (n=80) studying at Government schools of Ludhiana, (Punjab). Then the anaemic subjects, were categorized into control (n=30) and experimental (n=30) group. The experimental group were provided double fortified salt (containing iron 85ppm+iodine 15ppm/100g) along with nutrition counselling while control group received only iodized salt (iodine 15ppm/100g) to use for three months in daily meals for family. Two adult (1 male and 1 female) member of the family (18-35 years) were also selected for haemoglobin estimation to assess iron stores. The findings revealed that there was significant improvement ($p \leq 0.05$, $p \leq 0.01$) observed in the experimental group after supplementation.

Keywords: Double fortified salt; iron status; anaemia; nutritional status; nutritional counselling

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Introduction

Iron deficiency Anemia is a public health problem that affects population in both developed and developing countries. Globally, anemia affects 1.62 billion people that correspond to 24.8 per cent of the population while the prevalence of anemia in India is 74.3 per cent. [1]. Iron deficiency Anaemia continues to be the leading micro-nutrient deficiency around the world, despite of National and international programmes to control and prevent anemia that have not been successful after a period of even three decades due to several factors responsible for it i.e. like use of low fortification level, low consumption of iron fortified food by the population, lack of access and availability of iron fortified foods, poor purchasing power, food taboos, socio-economic factors, and parasitic infections etc. So, keeping this view aspect in mind, Now, Ministry of women and children have now recommended combination of different approaches including dietary diversification, fortification and supplementation for combating iron Deficiency Anemia (IDA) and Iodine Deficiency Disorders (IDD) that are major public health problems often co-existing in many regions in India. For this strategy, salt is one of the food vehicles available for food fortification technique. Salt dual-fortified with iodine and micronized ground ferric pyrophosphate (FePP) is a sound approach to control the micronutrient deficiency along with improving the nutritional status [2-4]. Till now, double fortified salt has not been used successfully due to its scarcity. So the present research work was designed to assess the impact of double fortified salt on the nutritional status of anemic adolescent girls in terms of their anthropometric (BMI), biochemical (Hb, PCV, MCHC and MCV) and nutrition educational profile.

Material and Methods

Selection of subjects and Collection of Data

A baseline survey was preformed to screen the anaemia (Hb>12g/dL) among adolescent girls (n=80) studying (16-18 years) at Government schools of Ludhiana District (Punjab). Then the anaemic subjects (n=60) were categorized into control (n=30) and experimental (n=30) group to assess the impact of nutritional status of subjects for a period of three months conducting pre and post test. For the study, two adult (1 male and 1 female) member of the family (18-35 years) from both (control and experimental) groups were also selected for haemoglobin estimation to assess the impact of nutritional intervention. To accomplish the objectives of the study, an interview schedules was developed to obtain the desired the information on various aspects of data collection. To evaluate the efficacy of supplementation among adolescent girls, both double fortified salt (experimental group- containing iron 85ppm+iodine 15ppm/100g) and iodized salt (control group- iodine 15ppm/100g) were distributed for the use in all meals prepared for the selected family of the subjects for a period of three months.

Anthropometric measurements

Anthropometric measurements viz. Height and weight of the selected subjects were measured by using standards methods [5] and compared with ICMR standard values [6]. To evaluate the nutritional status of adolescent subjects (16-18 years), the data on weights and heights used to classify body mass index [7].

Biochemical Analysis

Blood and Urine samples of the selected subjects were collected in an EDTA vacuum container by trained personnel under aseptic conditions before and after the supplementation of trial period. Blood samples were analyzed for the haemoglobin estimation [8, 9], red blood cells [10], packed cell volume [11] mean corpuscular haemoglobin concentration (MCHC) = Hb/PCV x 100 (%) and also for calculating mean corpuscular volume (MCV) = PCV/ RBC x 100 (%). 24-hr urine samples were collected and analyzed for urinary iodine excretion [12] and urinary creatinine [13].

Nutrition Education

After pre-testing, the subjects were imparted nutrition education (only experimental group) supplemented with printed material on the food groups, balanced diet, function of different nutrients and their requirements, nutritional disorders, their control and prevention, use and store of salt and also on healthy cooking practices. Nutritional counselling of (experimental) selected adolescent subjects was done at an interval of fifteen days for a period of three months. The impact of nutrition intervention was evaluated after comparing the pre and post test scores.

Statistical Analysis

Student's *t* test was used as statistical tools for analysis the efficacy of double fortified salt in terms of improvement in anthropometric profile, haemoglobin level and urinary iodine status before and after supplementation among the selected subjects. Results were expressed as Mean±SD and the level of significance was set at ($p \leq 0.05$; $p \leq 0.01$). Wilcoxon signed rank test to determine the improvement in knowledge scores. All statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 16.0.

Results and Discussion

General information of subjects

The survey on selected adolescent girls revealed that in the control group 56.67 per cent were in the age of 17-18 years old followed by 43.33 per cent in the age of 16-17 years old respectively. While in the experimental group, 80 per cent of the selected adolescent girls were in 16-17 years of age followed by 20 per cent from 17-18 years old. In the control group, the subjects were studying in 11th (53.33%) and 12th (46.67%) class while all the subjects in the experimental group were studying in 11th class (100%) only.

Impact of supplementation on the nutritional status of anaemic adolescent girls

Anthropometric profile

The anthropometric profile of the selected adolescent girls is depicted in **Tables 1-3**.

Height

The results revealed (Table 1) that the initial mean height of subjects was 153.2±5.2cm in control and 154.5±7.5in experimental group. There was a positive increase in height after supplementation in both the groups. After supplementation the mean height was recorded as 153.6±5.2cm in control and 155.1±7.1cm in experimental group.

The data (Table 2) further elucidated that in comparison to ICMR standards, there was increased in height was increased from 95.80 to 96.05 per cent in control and 96.59 to 96.98 per cent in experimental group after supplementation. Another study also evaluated the nutritional status of adolescent girls and findings revealed that the mean height was 157.4cm against the NCHS reference standards of 163.7cm height [14].

Table 1 Impact of nutrition intervention on the anthropometric profile of selected adolescent girls (n=60)

Parameters	Suggested values	Control Group (n=60)		T-test	Experimental Group (n=60)		T-test
		Before	After		Before	After	
Height (cm)	159.95	153.23±5.28 (140-164)	153.63±5.26 (140-165)	2.74***	154.5±7.59 (140-172)	155.1±7.12 (143-172)	2.81***
Weight (kg)	52.1	42.11±4.42 (35-52)	42.35±4.31 (35-51.5)	0.70^{NS}	45.21±7.48 (33.5-65)	45.25±7.48 (35-67)	0.76^{NS}
BMI(kg/m^2)	18.5-24.99	17.94±1.77 (14.5-21.2)	17.96±1.81 (14.3-21.4)	0.98^{NS}	18.94±2.86 (13.5-25.5)	18.79±2.85 (13.5-26.17)	1.55^{NS}

Figure in the parenthesis represents the range
##Nutrition Intervention: Control group (Iodized salt) and Experimental group (double fortified salt+ nutrition counseling); **Level of significance at 0.05%; ***Level of significance at0.01% NS-Non Significant

Table 2 Impact of nutrition intervention on the percentage of height and weight of selected adolescent girls (n=60)

Parameters	ICMR#	Control Group(n=30)		Experimental Group(n=30)	
		Before (%)	After (%)	Before (%)	After (%)
Height (cm)	159.95	95.80	96.05	96.59	96.98
Weight (kg)	52.1	80.38	81.28	86.78	86.85

#ICMR standards (2010), ##Nutrition Intervention: Control group (Iodized salt) and Experimental group (double fortified salt+ nutrition counseling)

Table 3 Impact of nutrition intervention on the body mass index (BMI) of selected adolescent girls (n=60)

Classification	BMI (kg/m^2)	Control Group (n=30)		Experimental Group (n=30)	
		Before	After	Before	After
Underweight	< 18.5	18(60.00)	17(56.67)	13(43.33)	12(40.00)
Severe thinness	< 16	05(16.67)	05(16.67)	04(13.33)	04(13.33)
Moderate thinness	16 – 16.99	05(16.67)	03(10.00)	04(13.33)	04(13.33)
Mild thinness	17 – 18.49	08(26.67)	09(30.00)	05(16.67)	04(13.33)
Normal range	18.5 – 24.99	12(40)	13(43.33)	15(50.00)	17(56.67)
Overweight	≥ 25.0	-	-	-	-
Pre-obese	25.00 - 29.99	0(0)	0(0)	02(6.67)	01(3.33)
Obese	≥30.00	-	-	-	-
Obese class I	30.00 - 34.99	-	-	-	-
Obese class II	35.00 - 39.99	-	-	-	-
Obese class III	≥40.00	-	-	-	-

#Figure in the parenthesis represents the percentage
##Nutrition Intervention: Control group (Iodized salt) and Experimental group (double fortified salt+ nutrition counselling)

Weight

The data (Table 1) showed that before supplementation the average weight of adolescent girls in control and experimental group was 42.11±4.42 kg and 45.21±7.48kg. A non-significant (P>0.05) change was observed in the mean weight of control (42.35±4.31kg) and experimental group (45.25±7.48kg). The data (Table 2) further elucidated that in comparison to ICMR standards, a non-significant increase was observed in weight from 80.38 per cent to 81.28 in control and 86.78 to 86.85 in experimental group after supplementation. In comparison to present study, another study reported that the mean weight of adolescent girls was 55.64kg±6.12kg [15].

Body Mass Index of selected subjects

The data presented in Table 3 showed a non-significant difference in body mass index among adolescent girls of control and experimental group. It was further observed (Table 3) that in control group before supplementation, selected adolescent girls were having mild thinness 26.67% followed by moderate 16.67% and severe thinness 16.67%. However, after supplementation of iodized salt the moderate thinness reduced to 10 percent and mild thinness increased to 30 percent. The percentage of adolescent girls in normal body mass index in control group improved from 40 to 43.33 percent after supplementation. In experimental group, no change was observed in the percentage (43%) of girls having body mass index less than 18.5 kg/m^2 after supplementation. However, the percentage of girls having normal body mass index increased from 50 to 56.7 percent and pre obese category (25-29.9kg/m^2) decreased from 6.67 to 3.33 percent.

Another investigation reported that 68.52 per cent of adolescent girls had BMI of less than 18.5kg/m^2 [16]. One of the study also reported the nutritional status of adolescent girls showing that 53.8 per cent of the subjects were thin and 44 per cent were having normal BMI rest 2.2 per cent were overweight [17].

Biochemical profile

The biochemical profile of the selected subjects and their families is presented in **Tables 4** and **5**.

Table 4 Impact of nutrition intervention on biochemical profile of selected adolescent girls and their family members (n=60)

Parameters	Suggested values	Control Group (n=30)			T-test	Experimental Group (n=30)			T-test
		Before	After	% change		Before	After	% change	
Hemoglobin(g/dL)	12	10.35±0.60	10.33±0.64	-0.19	0.93^{NS}	9.40±0.92	10.48±0.80	11.48	4.50***
RBC(mm^3)	3.9-5.6x10^6	4.14±0.42	4.13±0.43	-0.24	0.78^{NS}	4.11±0.54	4.23±0.74	2.91	3.31***
PCV (%)	36-47	37.08±2.72	37.01±3.25	-0.188	0.82 ^{NS}	36.62±3.20	36.75±2.42	0.35	5.88***
MCHC(fl)	84-95	29.52±1.02	29.52±1.08	0	0.69 ^{NS}	29.47±1.03	30.14±1.29	2.29	5.37***
MCV(pg)	28-32	91.29±6.38	91.29±6.56	0	0.68 ^{NS}	91.33±7.33	91.46±7.52	0.14	1.12^{NS}
Urine iodine (ug/g)	200	104.98±7.56	103.00±5.85	-1.88	1.31^{NS}	113.11±15.29	107.56±5.66	-5.15	1.33 ^{NS}
Hemoglobin(g/dL)									
Adult Female	12-16	11.05±0.65	11.39±0.68	-3.07	1.04^{NS}	10.99±0.75	11.40±0.68	3.59	3.22***
Adult Male	13-18	13.89±0.74	13.91±0.75	0.14	1.16 ^{NS}	13.19±0.75	13.22±0.75	0.22	1.11 ^{NS}

#Figure in the parenthesis represents the percentage
##Nutrition Intervention: Control group (Iodized salt) and Experimental group (double fortified salt+ nutrition counselling)
**Level of significance at 0.05%; ***Level of significance at 0.01% NS-Non Significant

Table 5 Impact of nutrition intervention on the prevalence of anaemia among selected adolescent girls and their family members

Grades of Anemia	Suggested values (g/dl)	Control Group (n=30)		Experimental Group (n=30)	
		Before	After	Before	After
Adolescent girls					
Normal	> 12	-	-	-	03(10.0)
Mild	10-12	28(93.33)	27(90.0)	08(26.67)	19(63.33)
Moderate	7-10	02(6.67)	03(10.0)	22(73.33)	8(26.67)
Severe	< 7	-	-	-	-
Adult Female					
Normal	> 12	08(26.67)	08(26.67)	06(20.0)	09(30.0)
Mild	10-12	12(40.0)	13(43.33)	10(33.3)	12(40.0)
Moderate	7-10	10(33.33)	09(30.00)	14(46.67)	09(30.0)
Severe	< 7	-	-	-	-
Adult Male					

Normal	> 13	20(66.67)	21(70.0)	19(63.33)	23(76.67)
Mild	12-13	09(30.0)	08(26.67)	10(33.33)	07(23.33)
Moderate	9-12	01(1.33)	01(3.33)	1(3.33)	-
Severe	< 9	-	-	-	-

#Figure in the parenthesis represents the percentage
##Nutrition Intervention: Control group (Iodized salt) and Experimental group (double fortified salt+ nutrition counselling)

Haemoglobin level

On the perusal of data (Table 4), it was observed that in control group there was no change in the haemoglobin level of selected adolescent girls after supplementation (10.35±0.6 to 10.33± 0.64 g/dl). The data (Table 5 and **Figure 1**) further showed that in control group before supplementation all the subjects were in mild (93.3) and moderate (6.7) grade of anaemia and after supplementation the corresponding values for having anaemia with mild grade was 90 per cent followed by moderate grade (10%). In experimental group, after supplementation there was significant ($p>0.05$) increase observed in haemoglobin level of selected adolescent girls by 11.49 percent (9.40±0.92 to 10.48±0.80g/dl). The hemoglobin profile of the selected adolescent girls in experimental group showed (Table 5 and Figure 1) that before supplementation majority of the subjects were having moderate (73.3%) and mild (26.7%) grade of anaemia. But after supplementations the majority of the subjects were having mild (63.3%) followed by moderate (26.7%) grade of anaemia. Only 10 per cent of the subjects were found to be non-anaemic (>12g/dl.) whereas in control group, none of the subjects were found to be non-anaemic after supplementation.

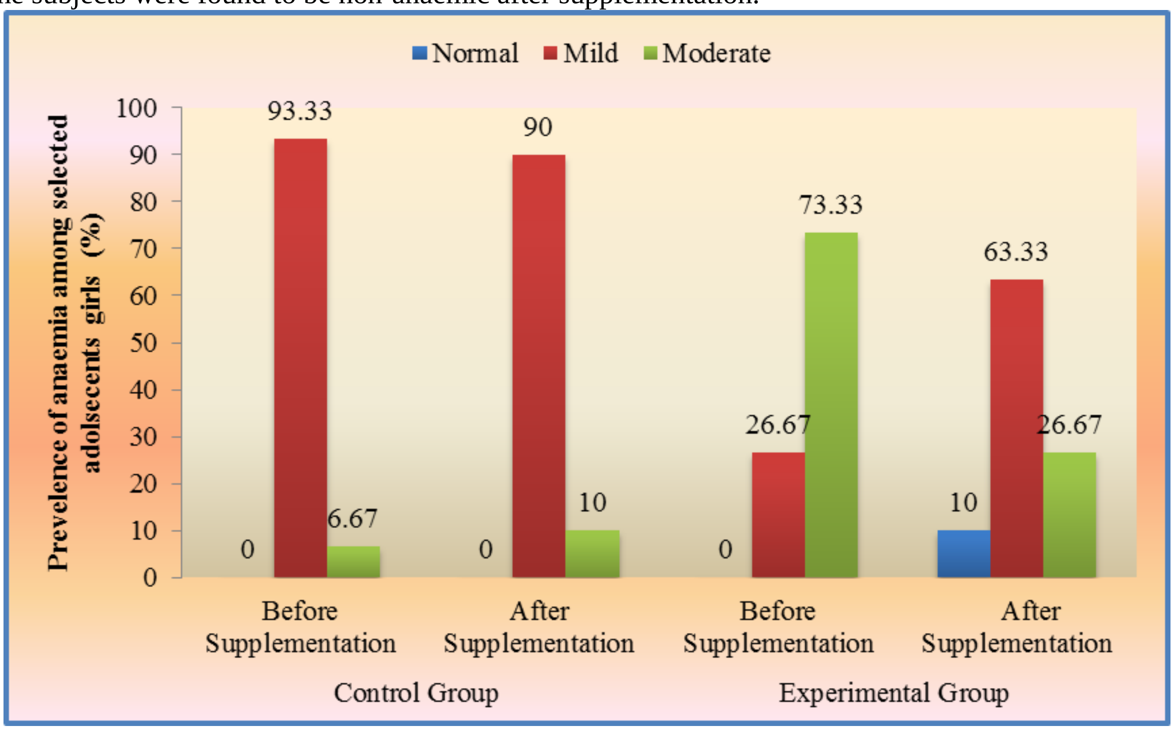

Figure1 Impact of nutrition intervention on the prevalence of anaemia among selected adolescent girls

The data (Table 5) on the haemoglobin level of the adult family member showed that in experimental group, the haemoglobin level among the female adult member of the family increased by 3.54 percent (10.99±0.75g/dl 11.49±0.68g/dl) as compared to control group ((11.05±0.65g/dl 11.39±0.68g/dl) with significant difference at $p>0.05$. In terms of grade of anaemia, the data (Table 5 and **Figure 2**) further revealed that majority of the subjects were having mild followed by moderate and normal grade of anaemia before (40, 33.3, 26.7%) and after (43.3, 30, 26.7%) supplementation. In the experimental group, a significant improvement was observed in terms of grades of anaemia after supplementation for moderate (46.7 to 30%), mild (33.3 to 40%) and normal (20 to 30%) in the selected adult female member of family due to consumption of double fortified salt in all the meal preparations at home.

On the perusal of data (Table 4), it was found that in control group the initial mean haemoglobin level of the selected adult male member of the family was 13.89±0.74g/dl which increased in few points after supplementation (13.91±0.75g/dl). Majority of the selected adult male of control group were in normal grade followed by mild and moderate before (66.7, 30, 3.3%) and after supplementation (70, 26.7, 3.3%). In the experimental group, the mean haemoglobin level of selected adult male subjects before supplementation was 13.19±0.75g/dl which increased after supplementation (13.22±0.75g/dl) due to the consumption of double fortified salt. The data further showed that after supplementation percentage of non-anaemic adult males in the family increased from 63.3 to 76.7% and anaemic in the grade of mild and moderate to 33.3-23.3% and 3.33 to 0%. However, there was non-significant change observed in the haemoglobin status of adult male subjects in both groups (control and experimental).

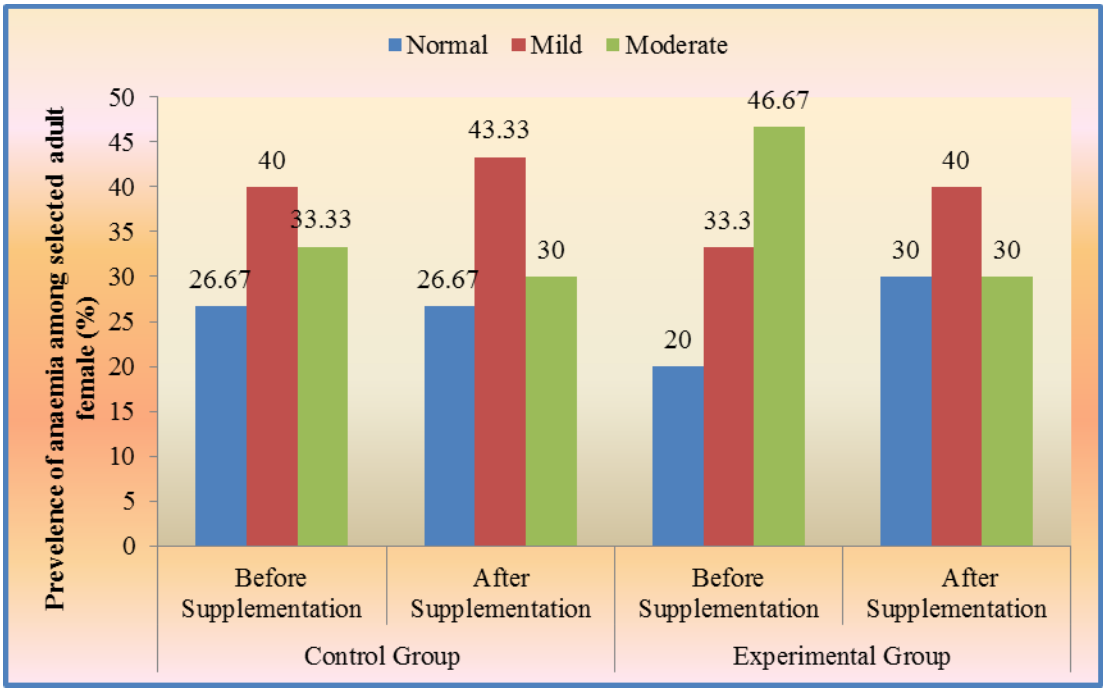

Figure 2 Impact of nutrition intervention on the prevalence of anaemia among the selected adult female member of the family

Red Blood Count (RBC)

The data on red blood count of the selected adolescent girls revealed that in control group there was non-significant change even after supplementation (4.14±0.42 to 4.13±4.13mm^3) where as in experimental group the red blood count cell increased significantly after supplementation from 4.11±0.54 to 4.23±0.74mm^3.

Packed Cell Volume (PCV)

The packed cell volume of the selected adolescent girls in control group was found statistically non-significant before (37.08±2.72%) and after supplementation (37.01±3.25%) whereas in experimental group, a significant ($p>0.05$) increase was found after supplementation (36.62±3.20 to 36.75±2.42%). The statistical analysis revealed a significant ($p<0.01$) increase in PCV value after the supplementation in the experimental as compared to control group.

Mean Corpuscles Haemoglobin Cell (MCHC)

The data showed that in control group there was no change in MCHC value after supplementation (29.52±1.02 fl to 29.52±1.08 fl) but value increased significantly after supplementation in experimental group from 29.47±1.03 to 30.14±1.29fl.

Mean Corpuscles Volume (MCV)

The data on MCV showed non-significant change after supplementation in the control (91.29±6.38 to 91.29±6.56pg) and experimental (91.33±7.33 to 91.46±7.52 pg) group. Another study reported that the mean MCV value in adolescent was 76.24±7.95 pg in South Arabia [18].

Urinary Iodine Excretion (ug/g)

The data (Table 4) on mean urinary iodine excretion showed that in control group, the initial mean urinary iodine value was 104.98±7.56ug/g creatinine and after supplementation the corresponding values was 103.00±5.85ug/g whereas in experimental group, the decrease was observed in the mean urinary iodine excretion value after supplementation (113.11±15.29 to 107.56±5.66ug/g creatinine). However, the mean urinary iodine excretion remained statistically non-significant. All the subjects had normal urinary iodine value when compared with the reference value [19].

Improvement in nutritional knowledge level of selected adolescent girls

The effect of nutrition counseling on the selected subjects is presented in **Table 6**. The nutrition counselling of experimental group was done after every fifteen days for a period of three months. The pre and post test scores of both groups (control and experimental) were estimated. The effect of nutrition counseling on the nutritional knowledge level of selected adolescent girls revealed that in control group the test score increased from 14.75 to 28.50 percent whereas in the experimental group the test score was 13.12 percent and increased significantly ($p>0.05$) after nutrition counseling that was 74.06, thereby indicating an improvement in nutritional knowledge scores of adolescent girls in experimental group.

Table 6 Effect of nutrition counselling on the knowledge level of selected adolescent girls

Group	Number of Items	Pre test scores	Post test scores	Z value
Control	16	2.36(14.75)	4.56 (28.50)	3.605
Experimental	16	2.10(13.12)	11.85 (74.06)	4.782

*Wilcoxon Signed-Ranks Test Significant at 5% level
Figure in the parenthesis represents the percentage

Conclusion and Recommendations

Daily consumption of DFS is necessary to result in any significant reduction in iron deficiency anaemia. During the experimental period none of the beneficiaries complained of any side effects on the consumption of DFS over a period of 90 days. After supplementation of double fortified salt in all meals prepared in the families, the iron status of the adolescent girls also improved with increase in haemoglobin level by 11.49 percent, PCV by 0.35 percent and MCHC by 2.21 percent. The haemoglobin level of the adult female family member also found to be improved by 3.59 percent. The present pilot work recommends that as double fortified salt is a feasible and cost-effective intervention for improving the iron and iodine status of vulnerable group. So, public awareness about double fortified salt should be channelized through mass media i.e. double fortified salt should be made one of the essential commodities in Public Distribution System to eradicate the dual problem of Iron Deficiency Anaemia and Iodine Deficiency Disorders.

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