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Original Research Article

Impact study of nutritional education as a controlling measure of iron deficiency anemia

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ABSTRACT

Background: Iron deficiency anaemia is one of the most common nutritional disorders world-wide, especially in India and other developing countries. Young children and women in the reproductive age group are the most vulnerable to iron deficiency anaemia. Part of the reason for this lack of action is the fact that iron deficiency anaemia (IDA) has few overt symptoms. Hence this study have been undertaken to see the impact of nutritional counselling as a controlling measure of IDA.

Methods: Rural women of reproductive age group were first screened for anemia and then for IDA. Two groups were formed one experimental group who were given nutritional counselling and another group designated as control group devoid of any such counselling. Baseline haematological indicators were estimated along with dietary surveys in both the groups. Haematological estimation and dietary survey was carried out again after six months and those women in experimental group still found to be anemic were again counselled, the procedure was repeated again at twelve months and at the end of the study that is eighteen months. Data's were then statistically analysed for finding significant between the groups.

Results: Our study showed statistically significant differences in haematological indicators between the experimental and control group at the end of the study. Intake of nutrition also showed statistically significant differences between the experimental and control group at the end of the study.

Conclusions: Intervention only with iron and folic supplements is not adequate to tackle iron deficiency anemia problem. Therefore, there is a need to use interventions measures like nutritional education approaches for addressing major preventable causes of anemia.

Keywords: Iron deficiency anemia, Nutritional education, Women of reproductive age group

INTRODUCTION

Iron deficiency anaemia (IDA) is a significant public health problem in India. The National Family Health Survey (NFHS –2), India reported that anaemia is a major health problem with over half of every married woman in the age group of 15-45 years having the condition. It was reported that 53.9 percent among women in the age group of 15-49 years living in rural area and 45.7 percent of urban women any form of anemia. In the report of data in NFHS-3 it revealed that among married women between the ages of 15-49 years, the prevalence of anaemia has risen from 51.8 percent in 1998-99 (NFHS-2) to 56.1 percent in 2005-06 (NFHS-3). In Chhattisgarh state as per NFHS-3data the percentage of rural women having any form of anemia is 59.8%. Thus, it is obvious that this problem clearly requires immediate attention and intervention.

Consequence of anemia

Anemia is known to lead to several functional abnormalities with health consequences. Although mild anemia with haemoglobin levels above 10 g/dl is not known to result in any serious impairment of function, moderate to severe anemia is known to have several functional consequences which includes impaired maximal work capacity, decreased immunological competence.[1,2] Although a moderate degree of anemia may not seriously affect day-to-day work, most of which corresponds to sedentary to moderate levels of activity, impaired work capacity that was seen only in those engaged in hard physical labour with moderate to severe anemia.[3] The World Health Organization (WHO) contends that the micronutrients like iron, folic acid, are among the most critical for maternal and child health.[4] However, deficiencies of these same nutrients are the most common among women of reproductive age (WRA) and are associated with poor pregnancy and birth outcomes including premature delivery, low birth weight, and increased perinatal mortality and increased risk of death during delivery and postpartum.[5-10] It is estimated that as many as 20% of maternal deaths are caused by anemia and that anemia may be an associated cause in many as 50% of maternal deaths worldwide and cognitive development of the offspring.[11,12]

Common causes of IDA

The main reasons for IDA have been determined to be inadequate intake of iron, low bioavailability (1–6 percent) of dietary iron from plant foods, due to inhibitory factors, low levels of absorption enhancers in the diet, repeated pregnancies, increased needs during growth and development among children and adolescents, or excessive iron losses due to parasitic infection.[13,14]

Past approaches in controlling IDA

Major approaches in battling IDA previously were medicinal supplementation with iron and folic acid. Although supplementation with iron is considered necessary for groups at high risk as a short-term emergency measure, it fails to address the root causes and cannot provide the overall long-term benefits of economy and sustainability. Evaluation studies of India's nationwide and long-standing supplementation programme showed irregular supplies, non-compliance by the beneficiaries, poor counselling, etc. As such, the supplementation strategy has proved to be inadequate.[15]

Hence this study have been undertaken to study the impact of nutritional counselling as a controlling measure of IDA.

METHODS

This is a longitudinal interventional study done on rural women of reproductive age group of 14–45 years.

Place of study: District Mungeli of state Chhattisgarh.

Period of the study: January 2014 to September 2016.

With due discussion with program officers of women and child development office of the district and block medical officer, five villages of was chosen for this study where anemia prevalence were suspected to be more common among women, and those place which are not endemic to malaria. With due consent of women who volunteer for the study, screening test was first done to find out the women suffering from anemia and then those found to be anemic were screened for iron deficiency anemia(IDA).

The CDC/WHO expert groups on 7th May 2004 recommended that hemoglobin and serum ferritin are the most valuable indicators of the impact program to control iron deficiency.[16]

Exclusion criteria

Women who have been found to be suffering from chronic inflammatory disease or past history of such after questioning them about such diseases were excluded from the study as inflammatory disease would interfere with the ferritin results.

Also women informing having recent major surgery or hemorrhagic incident were excluded.

Inclusion criteria

Apparently health women of age between 14 -45 years and non-pregnant and non-lactating women were taken for the study.

A total of 2105 women of age group were screened for hemoglobin out of which 76% that is 1600 were found to be anemic. Women who were found to be anemic were then tested for ferritin test out of which 73% that is 1600 women were found to be suffering from IDA.

IDA was considered when hemoglobin values falls below 12.0 gm/dl of blood and ferritin value less than 15.0 ng/ml of blood.[17]

At the baseline 584 IDA women from 305 household were randomly taken in the experimental group and 584 women from 310 household were taken in control group.

In this study, anemia was defined according to the World Health Organization (WHO) definition as a baseline hemoglobin concentration less than 12.0 mg/dl.[18]

Base line study include estimation of hemoglobin,ferritin, Total Iron Binding capacity (TIBC) estimation of women along with food intake survey by continues seven days 24 hours dietary recall method.[19]

Hemoglobin was estimated by cynamethhemoglobin method and ferritin by radioimmuassay (RIA). Total iron binding capacity (TIBC) was estimated by estimated by iron and TIBC kit in semiautoanalyzer, by Ferrozine method.[20,21]

Nutritional education intervention

Our main focus was to give counselling to women in experimental group to include food enrich in iron in their dietary habits and to include necessary enhancer of iron absorption. Counselling includes basic concepts in food and nutrition, to educate them about anemia and iron deficiency as public health problems, food which are good iron sources, food which are good iron absorption enhancers and inhibitors. Inclusion of heam iron food sources in their diet as per their faith and that is acceptable to their palate, and food which are easily available either seasonally or throughout the year, and that are also economical so that the counseling does not become burdensome and unacceptable to them. Interactions with the women were done in local language in very simple communicable way.

Though the experimental group receives counselling the control group was reframed from such counseling from the investigator.

After baseline study the hematological and food survey was again carried out after six months for both groups and those women still found to be anemic in experimental group was re-counselled. The procedure was repeated again at twelve months and finally at the 18th months data of both experimental and control group were statistically analyzed to study the impact of nutritional counselling.

Blood sample collection

Blood samples were taken to perform hemoglobin to determine serum concentrations of ferritin and TIBC. Each sample consisted in 5 ml of blood taken from the antecubital vein of the arm after cleaning of the zone with isopropyl alcohol. From this, 4mL were used to obtain serum and 1 ml was treated with EDTA for hemoglobin. Serum samples were obtained by centrifugation of blood samples, within 4 hours of extraction. Serum was kept at optimum temperature and protected from light until analysis.

Data on 24 hour recalls were converted to nutrient intakes by a computerized dietary analysis system Intake assessment and calculations were done using the software "Dietcal" (version 7.0; Department of Dietetics; AIIMS New Delhi and Profound Tech solutions, India) which is based on the values in the Nutritive Value of Indian foods database.[22]

24 hour recalls were administered on consecutive seven days to each participant at 6 month intervals. Recalls for each subject included all days of the week: The interviewer requested participants to recall all food and drink consumed over the previous 24 hours. Portions were carefully estimated by use of food models, household measures and utensils in conjunction with a detailed description of the food and method of preparation. The average intake was then calculated for one day for every participant in the study.

Necessary ethical approval was taken for this study. Descriptive medians are presented on untransformed nutrients and food group data.

Statistical analyses

The Kolmogorov-Smirnov test was used to assess normality of the data. Since our Kolmogorov-Smirnov test results showed that our data was not normally distributed we opted for non-parametric tests.[23]

Man-Whitney test was conducted to compare the median and mean ranks of hematological indicators viz. heamoglobin (Hb), Ferritin and TIBC, nutrition indicators viz. protien, iron, free folic acid (FFA), total folic acid (TFA) and Vit C and food groups, viz cereals, roots and tubers, other vegetables (OV), green leafy vegetables (GLV) pulses, fishes, meat, and fruits intakes between the experimental and control groups. We used multivariate linear regression models to examine the association between hemoglobin at 18th months and nutrient intakes and food groups at 18th month, adjusting for potential confounding factors. Kuskar Wallis test was used to compare the nutrition intakes between different socioeconomic groups.

All statistical tests were 2-tailed and differences were considered significant at $p<0.05$. Statistical analysis was done by SSPS version 22.[24]

RESULTS

Demographic profile of women

Mean age of women in experimental group is 25 years ±7.6 and ranging from 14 yrs to 45 yrs and for control group the mean age is 24 yrs±7.8 yrs and ranging from 14 yrs to 45 yrs.

As per religion all women were predominately Hindu. Nearly all the subjects were from families engaged in agriculture or agriculture labour.

Socioeconomic data was taken by Aggarwal method and accordingly the population was classified into poor, lower middle, middle and high income group.[25] In experimental group 70,319,170 and 15 subjects were in poor, lower middle, middle, and high income group respectively, while in control group 87,311,161 and 15 subjects were in poor, lower middle, middle, and high income group respectively.

Table 1: Mann-Whitney test output of hematological indicators after the end of the study (18th months) between experimental and control groups.

	Interventional group			Control group					
Hematological Indicators	Median	±SD	Mean rank	Median	±SD	Mean rank	Mann-Whitney	Z value	P value
Hemoglobin (mg/dl)	12.1	0.83	748.24	11.2	1.27	400.76	65010.5	-17.78	0.00
Ferritin ng/ml	28.0	16.25	772.27	9.5	8.41	376.73	51218.5	-20.21	0.00
TIBC (μg/dl)	446	51.47	364.49	534	43.91	784.51	44192.5	-21.63	0.00

Table 2: Mann-Whitney test output of nutrition after 18th months indicators between experimental and control groups.

	Interventional group			Control group					
Nutrition group	Median	±SD	Mean rank	Median	±SD	Mean rank	Mann-Whitney	Z value	P value
Protein (g/day)	44.4	6.0	814.82	31.8	3.28	334.18	26793.5	-24.63	0.00
Iron (mg/day)	20.1	7.1	817.57	6.6	1.82	331.43	25215.5	-24.9	0.00
FFA (μg/day)	39.0	7.9	710.87	34.28	4.22	438.13	86462.5	-13.9	0.00
TFA (μg/day)	123.5	22.1	752.14	94.9	19.28	396.86	62770.5	-18.21	0.00
Vitamin C (mg/day)	161.9	63.8	771.40	61.9	14.0	377.60	51715.5	-20.18	0.00

FFA=Free folic acid,TFA=Total folic acid

Table 3: Mann-Whitney test output of food groups after 18th months between experimental and control groups.

	Interventional group			Control group					
Food groups	Median	±SD	Mean rank	Median	±SD	Mean rank	Mann-Whitney	Z value	P value
Cereals (g/day)	371.0	66.26	508.97	374.0	21.7	640.03	127122.5	-6.8	0.00
Roots and tubers (g/day)	80.0	33.26	672.28	80.0	7.82	476.32	108385.0	-11.9	0.00
Other vegetables (g/day)	60.0	25.4	819.00	50.0	10.54	330.00	24396.5	-25.7	0.00
Green leafy vegetables (g/day)	52.8	17.98	835.37	17.14	4.72	313.63	14996.5	-26.77	0.00
Pulses (g/day)	29.9	16.38	766.88	12.85	12.36	382.12	54313.5	-19.73	0.00
Fishes (g/day)	4.2	3.8	776.71	00.00	0.16	372.29	48672.0	-24.21	0.00
Meat (g/day)	00.00	7.66	682.00	00.00	0.00	467.00	103033.0	-16.16	0.00
Fruits (g/day)	86.42	18.69	683.73	80.00	17.68	465.27	102039.00	-11.51	0.00

Table 4: Multiple regression test output after 18th months in experimental group hemoglobin as dependent and nutrient and food group as independent variables.

Dependent variable= Hb	R value	R^2 value	Adjusted R^2 value	Std. error	P value	Degree of freedom	F value
Independent variable =nutrition group	0.902	0.814	0.812	0.36	0.00	5 (regression) 568 (residual)	497.40
Independent variable= food group	0.882	0.779	0.775	0.39	0.00	8 (regression) 565 (residual)	248.29

Dietary data indicate that most of the subjects followed a two meal pattern; their diets were vegetarian, cereal based and monotonous.

At the end of the study that is after 18th months 10 women opted out of the study in experimental group and 8 women opted out from the control group. To keep the sample size equal we kept sample size of both group at 574.

A Mann-Whitney U test was conducted to determine if there were differences in the median of the hematological indicators viz. hemoglobin, ferritin and TIBC scores in between experimental and control groups.

Median Hb scores (12.1) for experimental and Hb scores (11.2) for control group was statistically significant in experimental then in control μ=65010.5, Z=-17.78, p=0.00.

Median ferritin score (28.0), for experimental and ferritin score (9.5) for control group was statistically significant in experimental then in control μ=51218.5, Z=-20.21, p=0.00.

Table 5: Un-standardized co-efficient table.

	B	P value
Nutrition group		
Protein	0.031	0.00
Iron	0.046	0.00
Free folic acid	0.027	0.00
Total folic acid	0.008	0.00
Vitamin C	0.004	0.00
Food groups		
Cereal	0.007	0.00
Roots and tuber	0.002	0.154
Other vegetable	0.013	0.00
Green leafy vegetables	0.017	0.00
Pulses	0.003	0.160
Fishes	0.056	0.00
Meat	0.062	0.00
Fruits	0.002	0.67

Table 6: A Kruskal Wallis test to determine if there was difference in Hb scores between groups that differed in economic condition.

Socioeconomic group	Number of women	Median
Poor	70	11.8
Lower middle	319	11.9
Middle	170	12.4
High	15	12.6

Table 7: Kruskal Wallis post hoc test (Dunn test) between different socioeconomic groups in experimental group.

Sample 1-sample 2	Test statistics	Std. error	Significance	Adjusted significance*
Poor-lower middle	24.54	21.85	0.261	1.00
Poor-middle	-77.77	23.51	0.001	0.006
Poor-high	-156.12	47.12	0.001	0.006
Lower middle-middle	-53.23	15.72	0.001	0.004
Lower middle-high	-131.57	43.75	0.003	0.016
Middle-high	-78.34	44.60	0.079	0.474

*significance values have been adjusted by the Bonferroni correction for multiple tests.

Median TIBC score (446), for experimental and, TIBC score (534) for control group was statistically significant in experimental then in control μ=44192.5, Z=-21.63, p=0.00.

A Mann-Whitney U test was conducted to determine if there were differences in the median score of the nutrition viz. protein, iron, FFA, TFA, Vit C and food groups viz. cereal, roots and tubers, other vegetables, green leafy vegetables, pulses, fishes, meat and fruits in between experimental and control groups.

Median score for protein (44.4), for experimental and protein (31.8) for control group was statistically significant in experimental then in control μ=26793.5, Z=-24.63, p=0.00.

Median score for iron (20.1), for experimental and iron (6.6), for control group was statistically significant in experimental then in control μ=25215.5, Z=-24.9, p=0.00.

Median score for FFA (39.0), in experimental group and FFA (34.28), for control group was statistically significant in experimental then in control μ=86462.5, Z=-13.9, p=0.00.

Median score for TFA (123.5) in experimental group and TFA (94.9) for control group was statistically significant in experimental then in control μ=62770.5, Z=-18.21, p=0.00.

Median score for Vit C (161.9) in experimental group Vit C (61.9) for control group was statistically significant in experimental then in control μ=51715.5, Z=-20.18, p=0.00.

Median score for cereal (371.0), in experimental group Cereal (374.0), for control group was statistically significant in experimental then in control μ=127122.5, Z=-6.8, p=0.00.

Median score for roots and tubers (80.0), in experimental group roots and tubers (80.0), for control group was statistically significant in experimental then in control μ=24396.5, Z=-25.78, p=0.00.

Median score for other vegetables (60.0), in experimental group other vegetables (50.0), for control group was statistically significant in experimental then in control μ=65010.5, Z=-17.78 p=0.00.

Median score for green leafy vegetables (52.8), in experimental group green leafy vegetables (17.14), for control group was statistically significant in experimental then in control μ=14996.5, Z=-26.77, p=0.00.

Median score for pulses (29.9), in experimental group pulses (12.85), for control group was statistically significant in experimental then in control μ=54313.5, Z=-19.73, p=0.00.

Median score for fish (4.2), in experimental group fish (00.0), for control group was statistically significant in experimental then in control μ=48672.0, Z=-24.21, p=0.00.

Median score for meat (00.0), in experimental group meat (00.0), for control group was statistically significant in experimental then in control μ=103033.0, Z=-16.16, p=0.00.

Median score for fruits (86.42), in experimental group fruits (80.0) for control group was statistically significant in experimental then in control μ=102039.00, Z=-11.51, p=0.00.

A multiple regression test between Hb as dependent variable and nutrient group as independent variable shows R^2 for the overall model was (81.4%), with an adjusted R^2 of (81.2%), a large size effect according to Cohen's classification. Protein, iron, FFA, TFA and Vit C statistically predicted Hb with F (5, 568)=(497.40), p<0.005.

There is an increase in Hb value for one unit rise in the independent values.

A multiple regression test between Hb as dependent variable and food group as independent variable shows R^2 for the overall model was (77.9%),with an adjusted R^2 of (77.5%), a large size effect according to Cohen's classification.[26]

Cereal, roots and tubers, other vegetables, green leafy vegetables, pulses, fishes, meat fruits, statistically predicted the depended Hb value, F (8,565)=(248.29), p<0.005.

There is an increase in Hb value for one unit rise in the independent values.

A Kruskal Wallis test was conducted to determine if there were difference in Hb scores between group that differed in economic condition: the poor (n=70), lower middle (n=319) middle (n=170) and high income group (n=15). Median Hb scores were statistically significantly different between the different levels of the economic groups. $X^2(3)$=23,069, p=0.00. Subsequently pair wise comparisons were performed using Dunn's procedure with Bonferroni correction for multiple compressions. Adjusted p value was presented.[27,28] This post hoc test reveled statistically significant difference in the median Hb scores between poor (11.8) and middle income group (12.4) p=0.006, poor (11.8) and high group (12.6) p=0.006 and lower middle group (11.9)- middle group (12.4) but not between the poor group (11.8)- lower middle (11.9) group or any other combination.

DISCUSSION

Although the most effective strategies to combat nutritional IDA are food fortification and supplementation programs, it is generally recognized that nutritional education should always accompany those initiatives and also that education is the most fundamental and permanent strategy to achieve changes in food habits and to obtain a balanced nutrition that includes all the required nutrients during the different life stages.

Our results shows that there is a statistically significant difference in the hematological parameters like Hb, ferritin and TIBC between the experimental and the control group after the end of the study. The median score of Hb of the experimental group after the end of the

Study was (12.1) while that of control group was (11.2). The median score of ferritin of the experimental group after the end of the study was (28.0) while that of control group was (9.5). The median score of TIBC of the experimental group after the end of the study was (446) while that of control group was (534). The nutrition intake after the end of the study between the experimental and the control group also showed statistically significant differences. The median score of protein (44.4), iron

(20.1), FFA (39.0), TFA (123.5) and Vit C (161.9) shows marked increased in the experimental group as compared to the control group where the median score are as follows protein (31.8), iron (6.6), FFA (34.28), TFA (94.9), Vit C (61.9).

The median score of consumption of other vegetables (60.0), GLV (52.8), pulses (29.9), fishes (4.2) and fruits (86.42) also shows remarkable increase in experimental group than in control group where the median score are as follows other vegetables (50.0), GLV (17.14), pulses (12.85), fishes (00.0) and fruits (80.0).

The regression co-efficient shows that there is a positive correlation between the Hb values and nutrients and food intake.

The median Hb scores were statistically significantly different between the different levels of the economic groups. The post HOC test though revealed that there is no significant difference between the poor group (11.8)-lower middle (11.9) group.

The etiology of iron deficiency anemia has not changed over the decades. Apart from early marriage, repeated pregnancies, poor dietary habits, poverty and illiteracy are all factors which affect its incidence and severity. Dr Subramanian, Professor of Population Health and Geography, Harvard University, and one of the lead researcher expressed that 'India continues to have severe anemia burden'.[29] This emphasis highlights that social patterning of anemia by socio-economic status and education in several low-income and middle-income countries, including India. However, too little progress has been made toward the global elimination of iron deficiency. Part of the reason for this lack of action is the fact that iron deficiency anaemia (IDA) has few overt symptoms.[30]

CONCLUSION

Anemia remains to be a problem with multifactorial causes. Hence, intervention only with iron and folic supplements is not adequate to tackle this problem. Therefore, there is a need to use multiple interventions, comprehensive the best result approaches for addressing major preventable causes of anemia. Researchers have to concentrate on interventional studies to improve the hemoglobin of women of childbearing age which may include preventive supplementation, food-based approaches and nutrition education to improve dietary intake. Every Government has to take step to improve quality of services to the education and socioeconomic status of women, improving the number of health care providers and intensifying public education to promote the use of health services and healthy behaviors moreover adherence to the prescribed program in order to achieve the goal.

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