DIETARY DIVERSITY AND ITS EFFECT ON ANAEMIA PREVALENCE AMONGST TEA TRIBE ADOLESCENT GIRLS IN DIBRUGARH DISTRICT OF ASSAM, INDIA

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ABSTRACT

OBJECTIVE

Effect of Dietary diversity and other intervention in prevalence and determinants of anaemia amongst tea tribe adolescent girls.

DESIGN

A community based before after intervention study was conducted covering 16 tea estates of Dibrugarh District, Assam.

PROCEDURE

Variables includes socio-demographic, environmental, anthropometry, history of present and past illness, clinical examination and laboratory investigation including haemoglobin, serum ferritin, haemoglobin typing and routine stool examination and dietary survey using 24 hour recall method and food frequency questionnaire. Interventions given were dietary diversification, health promotion by monthly NHED, cooking demonstration, cooking competition and kitchen garden promotion and counselling to improve IFA compliance and remove barriers and directly observed weekly IFA supplementation. SPSS and EpiInfo software, used to calculate of rates, ratios, chi-square test, Fisher Exact test and multiple logistic regression analysis.

RESULTS

Enrolments were 802, with mean age, 14.8 years. Anaemia prevalence was 96.3% with median serum ferritin, 22.9 ng/ml. Prevalence of Sickle cell anaemia was,12% and helminthiasis 84.20%, night blindness (5.6%), weakness (62.1%), loss of appetite (37.5%), gum bleeding (23.6%), loose motion (13%), loss of weight (9.9%), menstrual problem (19.3%) was common. Following intervention mean haemoglobin difference was 1.48 gm/dl with 13.5% difference in prevalence. Significant association found with worm infestation, lower serum ferritin, insanitary water-sanitation facility and extra salt use, indicating infection, infestation and iron deficiency as major cause of anaemia. Dietary diversification found effective.

CONCLUSIONS

High anaemia prevalence requires urgent attention. Implementation of different intervention in an integrated manner was found effective.

KEYWORDS

Dietary diversification, Anaemia, tea tribe, adolescent girls, Iron folic acid supplementation (IFA), Assam.

INTRODUCTION

Nutrition, an input and output of development, recognized internationally as, indicator of National development. [1] Malnutrition restrains growth and lowers resistance. [2] Anaemia, a “female disease” - red alert for Indian women affects productivity as evident that taller women in tea-estates as having greater arm circumference, plucks more green leaves earn higher wages with less absenteeism. [3, 4]Interventions on adolescent have intergenerational effect. [5, 6] Study revealed very high burden of communicable, non-communicable and nutritional disorders amongst tea-tribes. [7] AHS 2012-13, showed Assam is having highest MMR (301/ lakh live birth) of which upper Assam (401/ lakh live birth) constitute most. [8,9] This prompted us to assess effect of different interventions on anaemia.

MATERIALS AND METHODS

SETTING

Assam is the World’s largest tea growing region. More than 51% of India’s tea – accounting for 1/6th of global tea production – is grown in the tea estates, of the country’s north-eastern state of Assam. Most of the workers are descendants of tribal communities brought to Assam from neighbouring States by the British to work on the tea estates in early 20th century, who have retained their unique tribal socio-cultural identity. They live within the estates in designated settlements called ‘labour lines’. Tea community represents approximately 17% of Assam’s

population and 27% of Dibrugarh district. Dibrugarh District is selected as it has I59 registered tea estates contributing to 27 % of Assam production.[8]

ETHICAL STATEMENT

The study protocol was approved by the Institutional Ethics Committee of Assam Medical College, and necessary permissions were obtained in addition from District Health Authority and Assam Branch of Indian Tea Association. After explaining study procedures, a written informed consent was sought from all eligible participants along with assent for inclusion of below 18 years participants, and those consenting were included in the study. In case a participants who could not read or write, verbal information was provided, and consent was recorded as a thumb impression in presence of two impartial witnesses. The surveys were preceded by meetings with community leaders to ensure community wide participation. All study participants found to be having morbidities were treated by Government supplied Medicine through sub centres situated in the tea estates.

SAMPLE SIZE

Considering 68% girls as anaemic, with 5% relative precision and 95% confidence interval the required minimum sample size is 723. Taking 10% non-response rate and rounding up the sample size becomes 800.[9]

STUDY DESIGN

It was a ‘community based before-after intervention study’. Multistage random sampling method was used for selection of study subjects. As the District has seven rural and one urban block having tea estates, therefore 16 tea estates were selected, two from each block using computerised random number. From each tea estates 50 adolescent’s girls aged between 10-19 years were selected using simple random sample from the list of adolescent girls maintained in each tea estates. Data collection was done by house to house survey. Demographic, socio economic, environmental history was taken along with clinical assessment. Reproductive tract infection was assessed by syndromic approach. Anaemia and related morbidities were assessed using predesigned, pretested schedule. Standard case definition for morbidity was used and a recall period of fifteen days was taken for morbidity assessment along with clinical examination. [11] Anthropometric measurements like weight and height measurements were converted into three standard indices i.e., height-for-age (stunting), body mass index BMI -for-age (thinness) and weight-for-age (underweight). Each of the three nutritional status indicators was expressed in standard deviation units (Z-scores) from the median of the reference population (The new WHO growth standard).[12]

Community based intervention was given by monthly nutritional health education program (NHED), quarterly healthy cooking demonstration to all selected girls and yearly cooking competition amongst different adolescents girls groups was done to encourage healthy cooking

practices. The topics of NHED were decided based on baseline study and focus group discussion amongst adolescent girls. Non - compliant girls for WIFS were assessed by barrier analysis and common barriers identified were addressed. Creation of community owned kitchen garden and individual household kitchen garden was done with the help of tea garden management and local NGO and girls club to improve availability of different fruits and vegetables. Weekly iron folic acid supplementation (WIFS) as ongoing Government run program was continued, but given in a supervised way in the form of directly observed therapy, where a community volunteer from each tea estates were given the task with compliance monitoring. Dietary survey was done before and after two years of intervention by using food frequency questionnaire and 24 hour recall method.

Laboratory investigation - Haemoglobin estimation using cyan-meth-haemoglobin method for all consenting girls and serum ferritin using mini VIDUS enzymatic method and gel electrophoresis for haemoglobinopathy was conducted in a subgroup of population. Cross checking of 10% samples was done by ICMR laboratory for quality assurance.

All the equipment for measurements of height and weight were similar at all the centres for ensuring uniformity. Height was measured using stadiometer (accuracy 0.1cm) and weight using calibrated spring weighing machines (accuracy 0.1kg). Standard protocols were used to obtain these measurements. Body mass index [BMI] was calculated. Worm prevalence was assessed through stool examination in a subsample population (50%). Blood samples for Serum Ferritin was also done in 50%, first 50% of consecutive samples of those enrolled adolescent girls were examined for serum ferritin level. Haemoglobin cut off of less than 12 gm/dl was taken to label as anaemia. Total study period was from Sept 2011 to Dec 2013.

Statistical analysis was done using rates, ratios, proportion, chi-square test, Fisher Exact test, t-test and multiple regression using SPSS and EpiInfo software.

Study Design Showing Enrolment in Different Steps of Procedure

Baseline study

- Total Block 8 ➢ Total TEs 159 ➢ 2 TE per block (2x8= 16), Participant enrolled – 802
- Study variables – Socio demographic, stool examination, Hb typing, serum ferritin level.
- Methods – Quantitative – pretested format, qualitative – FGDs, IDIs.

Intervention study

- Monthly NHED,
- Quarterly cooking demonstration and
- Yearly cooking competition
- Kitchen garden promotion,
- Barrier analysis and intervention (n=130, 10% of non-compliant).
- Weekly iron folic Acid supplementation by directly observed treatment with compliance monitoring for all adolescent girls (n=**7620)**

End line study

- Total Block 8 ➢ Total TEs 159 ➢ 2 TE per block (2x8= 16), Participant enrolled – 802
- Study variables – Socio demographic, stool examination, sickling test, serum ferritin level.
- Methods – Quantitative – Pretested format.

RESULTS

The mean age of the study participant was 14.8± 2.3 years Majority were Hindu (724, 90.3%) by religion. Literacy status amongst study participants were better (677, 84.4%) compared to their parents [father 442 (55.1%) and mother 170 (21.2)]. Some adolescent girls 140 (17.5%) were working in the tea estate as tea pluckers of which 132 (16.5%) were temporary workers, while 8 (1.0%) were permanent worker. Most of the parents of study population were permanent workers

of the tea estate with an average monthly income of Rs.2634. Average family size was six with a range of 2-18 people. (Table1)

Prevalence of anaemia was 96.3% (772/802) in baseline study. Pallor as physical examination finding was found in 61.3% (492/802). Lower ferritin level (< 20 mg/ml) was found in 39.2% (123/314) participants, while sickle cell anaemia was prevalent in 12% (38/316). Worm infestation by routine stool examination was found in 84.2% (314) participant. Regarding environmental health, only 205 (25.6%) adolescent girls were living in pucca house (solid and permanent structure), while 353(44%) were living in kutcha house (temporary houses) and 244(30.4%) living in kutcha-pucca house (combined variety) during baseline study. Access to own toilet was found in 648 (80.8%), while 9(1.1%) used public toilet and community / shared toilet use was 8(1.0%). Open air defecation was prevalent in 137(17.1%). The source of drinking water was shallow tube well 747(93.1%) in majority, followed by tap water 50(6.2%), kutcha well (temporary well with unsafe drinking water) 3(0.4%) and pucca well 2(0.2%). Boiling of water was done in 301(37.5%) and filtration in 32(4.0%). No purification of drinking water was done in 58.5% (469) before consumption. Kutcha latrine (temporary insanitary toilet) was situated within the cone of filtration in 319(39.80%) houses. Source of drinking water was accessible to domestic animal in 140 (17.50%) cases. Other contamination like dumping areas, stagnant waste water found in 454 (56.6%) houses. The waste water collection in the platform of water source was found in 649(82.2%). Drainage channel from water source was missing, damaged or blocked with debris in 652 (81.50%) houses. Regular bathing, washing of clothes and cooking utensils at the platform or near the water source was found in 755(94.30%) households. Overall mean haemoglobin level during baseline study was 9.71 + 1.61 which was increased to 11.19 $\pm$ 1.03 with a mean difference of 1.48 which was statistically significant (p=0.000). (Figure 1)

Symptoms related to anaemia and associated morbidities were present amongst 75.8% (608) adolescent girls and 59% (473) had past health related complaints. All signs and symptoms related to anaemia showed improvement after two years of different interventions (Figure 2).

Use of their owned toilet facility, purification of water by boiling showed significant improvement in end line while compared with baseline study. Health complains like loss of appetite and weakness also showing improvement significantly. Present complain of any illness was also found significantly less during endline study. Prevalence of anaemia declined significantly with 13.5% reduction in endline compared to baseline study. Reproductive tract infection and worm infestation also showed significant improvement. Body mass index and height for age is also showing significant improvement. Serum ferritin level is also improving though the change is not statistically significant. The mean height and weight of the study participants was 146.2 $\pm$ 6.5 cm and 37.9$\pm$ 6.5 kg BMI for age using Z score was normal i.e., between (-2SD) to (+ 2 SD) in 661 (82.4%), thinness below (-3 SD) was found in 30 (3.7%) participants, while 110 (13.7%) were between (-3SD) to (-2SD). Only one girl (0.1%) was found overweight. According to height for age classification using Z – score; severe stunting was

documented amongst 243 (30.30%) and mild to moderate stunting was found in 157 (19.60%) participants. Only 50.1% (402) were having normal height for age. Comparison of baseline and end line assessment of body mass index and height for age showed improvement. There is significant improvement in water sanitation facilities in endline result compared to baseline study results. (Table 2)

Multiple logistic regression analysis using < 10gm / dl as cut off (moderate and severe anaemia combined) showed significant association with worm infestation [OR 3.2 (95% CI 1.8-5.71, p=0.000], lower serum ferritin [OR 2.02 (95% CI 13.72-53.24), p=0.000], insanitary water sanitation facility [OR 2.16 (95% CI 1.01- 4.6), p=0.046] and extra salt use [OR 1.85 (95% CI 1.38-2.46, p=0.000]. (Table 3).

Intervention in the form of nutrition health education program was designed based on findings of baseline study and focus group discussion. Key areas of concern emerged in baseline study was lack of knowledge regarding dietary requirement, healthy cooking practice, hand hygiene and menstrual hygiene, need for consuming safe water and basic sanitation, footwear while going to toilet and different food taboos like not taking any citrus and non-vegetarian food during menstruation, restriction of food during pregnancy and different illness, draining excess water while cooking rice- leading to loss of nutrient form rice, too much frying in open pan causing loss of iodine and other micronutrient and not taking fruits, vegetables, meat, fish, egg and milk due to lack of purchasing power. Low cost locally available nutritious diet was not perceived as good food. Based on these finding nutrition health education program was designed and conducted in each month including topics like hand washing demonstration, cooking demonstration, group discussion on infection prevention practices, training on dietary diversification, counseling on weekly iron folic acid consumption and compliance monitoring at a monthly interval, modular training on menstrual hygiene etc. Cooking competition was held to improve the healthy cooking practices amongst adolescent girls and the adolescent girls group in the form of adolescent club - created both community and individual kitchen garden for making vegetables and fruits available to the community. In- depth interview was done for barrier analysis amongst non –compliant adolescent girls. Ignorance about usefulness of iron folic acid tablet, fear of side effect, inconvenient time of IFA supply, distance of facility supplying IFA were found to be the common reasons for non-compliance. (Figure 3).

Following different interventions for dietary diversification like kitchen garden promotion, nutrition health education program, promotion of healthy cooking practices the consumption of fish, egg, all forms and different varieties of vegetable, soyabean and other lentil consumption showed significant improvement. Other healthy food consumption like fruits, diary product also showed improvement though not significant. (Table 4).

Discussion: The response to this study was very good as all consented participated in the study. Prevalence of anaemia was almost universal (96.3% vs 82.8%) in baseline and end line study. According to National family health survey -3 reports, anaemia prevalence amongst adolescent

boys and girls aged 15 – 19 years is 30%. Compared to NFHS 3 report; our study finding reveals very high prevalence of anaemia which warrant urgent action to avoid preventable morbidities and mortalities. The District is having highest maternal mortality in Assam (430/lakh) and according to finding of maternal death review most of the death was occurring amongst tea garden population and anaemia and pregnancy induced hypertension was found as the leading cause of death amongst this group.[8] An earlier study has indicated that almost 96% of pregnant mothers and 100% of adolescent girls are anaemic (mild to severe); similarly 55% of mothers and 46% of girls are below BMI.[13]Dibrugarh, one of the 16 Districts surveyed by ICMR reports anaemia prevalence as 93.3% with 35.5% mildly anaemic, 49.9% moderately anaemic and 8.8% severely anaemic.[14] ICMR study revels similar result with our study indicating that in Assam almost all adolescent girls are anaemic. Lower serum ferritin level indicates iron deficiency as the main cause of anaemia. Sickle cell anaemia is common amongst 12% of anaemic individuals. There is wide variation in expected range of values amongst normal female population varying from 9.3ng/ml to 159 ng/ml with a mean value 58 ng/ml. Mean value of serum ferritin in our study population was lower (27.9 vs 58 ng/ml) than the findings of reference population. A study done in urban slum also shows, family size, menstrual lost and bioavailable iron are influencing factor of low iron states.[15] Stool examination findings indicating high prevalence of soil transmitted helminthiasis (84.20%). Other studies; also shows high prevalence of helminthic infestations.[7,16,17] The association between poor housing, water supply and sanitation with occurrence of diarrhoea has already been documented.[18] The high prevalence of anaemia may be because of frequent occurrence of diarrhoea and high worm infestation related to poor housing condition and environmental sanitation. Another study done in adolescent girls living in slums of Ahmedabad shows significant association between fathers occupation, habit of tea consumption with food, habit of green leafy vegetable consumption and body mass index.[19] There is evidence of significant improvement in anaemia and associated factors like worm infestation, symptoms of reproductive tract infection, several symptoms of anaemia and other micronutrient malnutrition and environmental influencer following active intervention by giving nutrition health education program, different health promotional activities, kitchen garden promotion, cooking demonstration and holding of cooking competition amongst adolescent girls.

Mild to moderate stunting was prevalent in 19.3% and 30.6% (229) were having severe stunting. Higher prevalence of stunting amongst adolescent may be influenced by genetic as well as nutritional deficiencies indicating chronic malnutrition. District level household survey done in 2007- 08 reported 20.8 % girls getting married before 18 years of age.[19]Correction of nutrition during early years by 1000 days nutrition intervention and continuum of care may prove fruitful in such situation.[20]

Reproductive tract infection was found to be very common. White discharge, lower abdominal pain and ulcer were found as symptoms of RTI. Improvement of menstrual hygiene may reduce the prevalence of RTI. Higher prevalence of night blindness (5.7%) indicates the necessity of

screening of adolescent girls for vitamin A deficiency disorder and promotion of practice of dietary diversification. Goitre was found in 1.87% which indicates presence of iodine deficiency disorder and it was observed that some of them are still not using iodized salt and the salt preservation technique to prevent iodine evaporation was also found defective in few households.[21]

Nutritional anaemia is one of the major public health problems in India affecting almost 70% of children and 56% amongst ever married women.[22] There is convincing evidence that iron deficiency and anaemia causes impaired growth, developmental delay, decreased physical activity, behavioural abnormalities and impairs cognitive function (poorer attention span, memory, concentration and concept acquisition) leading to poor school performance.[23,24] Nutrition awareness and education are particularly giving importance for children and adolescents' to improve knowledge of anaemia, diet and health generally and of iron-rich foods specifically through different health and ICDS Schemes like celebration of village health and nutrition day, supplementary nutrition program i.e., supply of take home ration (THR) for adolescent girls and hot cooked food for children through Anganwadicentres and SABLA scheme for adolescent girls. Therefore, parents as well as children need to learn about nutrition in order to give appropriate information or advice to improve the diets of their children. The ICMR study also revealed high magnitude of under nutrition and infectious diseases among tea garden population of Assam. Their finding shows nutritional problems like underweight among children (59.9%), thinness among adults (69.8%) and micronutrient deficiency disorders like anaemia (72%) were widespread. Common infectious diseases were worm infestation (65.4%), respiratory problems (6.7%), diarrhoea (1.7%), skin infections, filariasis (0.6%) and pulmonary tuberculosis (11.7/'000).[7] Poor nutrition among them also probably makes them vulnerable to infectious diseases and vice versa. Presence of household toilet was found to reduce orofecally-transmitted diseases, as also reported earlier.[25] However, high prevalence even among toilet holders may be because of contaminations of surroundings due to open field defecation by large numbers of other community members and poor maintenance of toilets facilities.

Multiple logistic regression analysis showed significant association of moderate and severe anaemia with worm infestation, lower serum ferritin, insanitary water-sanitation facility and extra salt use, indicating infection, infestation and iron deficiency as major cause of anaemia. Consumption of salty tea during work hours may be another cause of anaemia as tannic acid in tea is a known inhibitor of iron absorption. Anaemia is recognized to be public health problem and both nutritional (such as iron and other mineral and vitamin deficiencies) and non-nutritional (such as infection, infestation and haemoglobinopathies) factors contribute to the onset of anaemia and iron deficiencies.[26,27] Among variant haemoglobins, Haemoglobin E (Hb E) and sickle cell anaemia is widely prevalent in this part of the country. In South east Asia and the Indian Subcontinent, Hb E considered as common disorders of blood posing a major genetic and public health problem. [28,29]Haemoglobinopathy, particularly HbE and sickle cell haemoglobin (HbS) and thalassemia are considered to be the other contributing factor in occurrence of

anaemia in Assam and Hb S was reported to be mostly restricted to the tea garden community of Assam. The tribal population is vulnerable population, in terms of social development, isolating dwelling places in difficult terrain, rigid customs and beliefs, illiteracy and separation from non-tribal population exposes them to many health and social issues. In India, 8.19% population distributed in different states have tribal population.[30] Coverage target of key strategic Approach to Reproductive, Maternal, New-born, Child and Adolescent Health (RMNCH+A) in India needs to be holistically implemented where 6% decline in anaemia per year is proposed with weekly iron folic acid supplementation program (WIFS) and newer iron + initiatives so that from 53% (NFHS-3) to 30% prevalence could be achieved by 2017.[6] As prevalence amongst tea tribe adolescent girls was found higher than the national average more focus attention and better coverage is essential. Although evidence from robust randomized controlled trials is scarce, a range of interventions in the adolescent period affecting maternal, new-born, and child health and nutrition outcomes is available through different programs. Inequities in undernutrition also exist between the different demographic, socio-economic and geographic groups of India as evidenced from NFHS I, II & III data. More investment and better management of programs are needed to reduce malnutrition. Inadequate dietary intake and diseases are the most significant immediate causes of malnutrition which results from the unequal distribution of resources, food insecurity and inaccessibility of basic health services and healthy environment along with lack of nutritional knowledge.

Dietary diversification through different interventions like nutrition health education program, kitchen garden promotion to improve accessibility, cooking demonstration and competition to inculcate healthy cooking practices was found effective for the adolescent girls.

Applied and action research in the field of adolescent health is another area where lot remains to be done. Different intervention models, multi-sectoral and integrated approach with creation of good evidence base by proper documentation of successes have the potential to change the health and nutritional scenario of adolescent living in tea estates of Assam.

CONCLUSION

Dietary diversification in an integrated approach by community based intervention for prevention and correction of anaemia and related symptoms was found useful and operationally feasible. There is a need to sustain the effort by different means like community ownership which can be achieved by social and behaviour change communication and Government ownership by advocacy, for long term sustainability of the project.

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Table 1: Socio-demographic information of the study participants

Variables	Number	Percentage
Age		
10-12	149	18.6
13-15	343	42.8
16-19	310	38.7
Religion		
Hindu	724	90.3
Christian	68	8.5
Muslim	10	1.2
Caste		
General	9	1.1
OBC	793	98.9
Education status		
Illiterate	125	15.6
Primary school	128	16.0
Middle school	280	34.9
High school	262	32.7
Above	7	0.9
Father education		
Illiterate	360	44.9
Primary school	180	22.4
Middle school	115	14.3
High school	120	15.0
Above	17	2.1

Others	10	1.2
Mother education		
Illiterate	632	78.8
Primary school	83	10.3
Middle school	43	5.4
High school	27	3.4
Above	4	0.5
Other	13	1.6

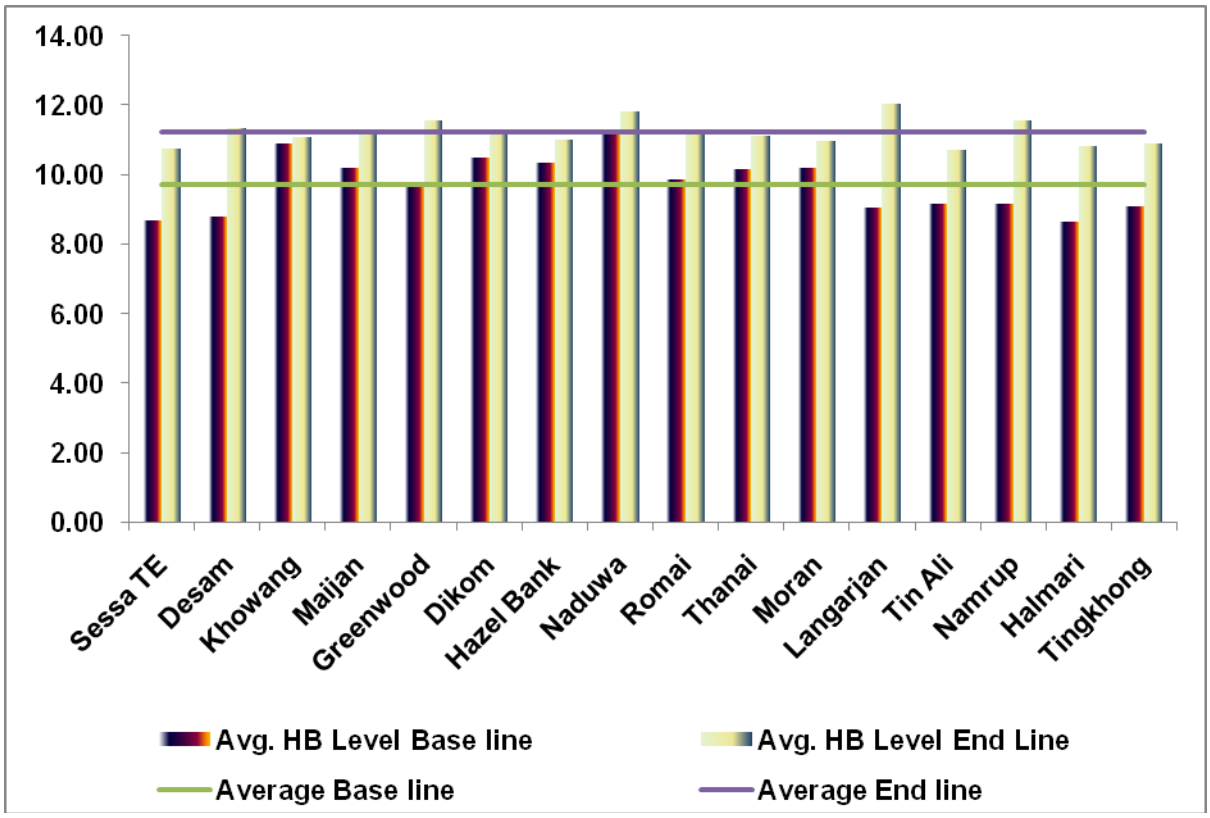

Figure 1: Comparison of meanhaemoglobin level in studied tea estates before and after intervention

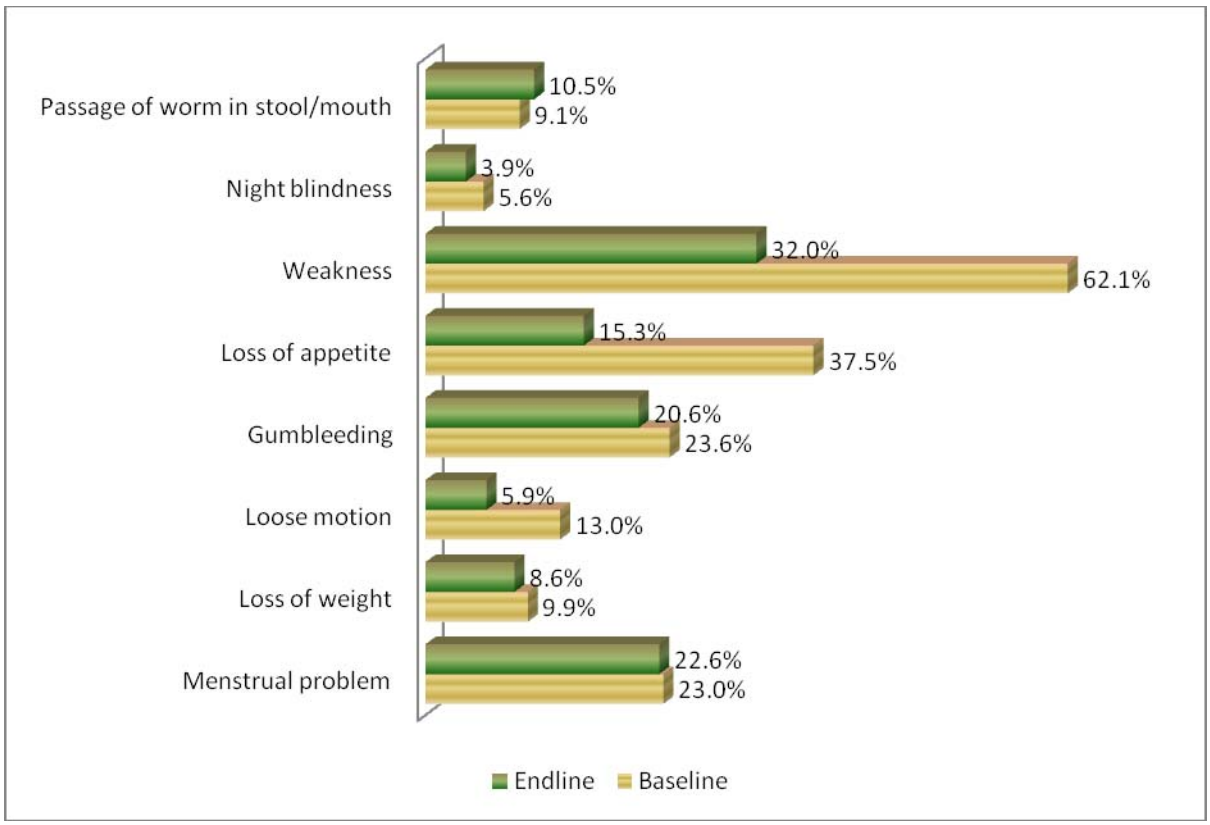

Figure 2: Before and after (baseline – end line) comparison of health complaints

Table 2: Comparison of different determinant of anaemia during baseline and endline study

Variable		Baseline	Endline	Change in % (Increase/decreases)	p-value
Toilet facility	Owned	80.8%	90.3%	9.5%	<0.0001
	Open air defecation	17.1%	8.6%	-8.5%	0.1035
	Public/community	2.1%	1.1%	-1.0%	0.860
Purified Water	None	58.5%	30.9%	-27.6%	<0.0001
	Filtration	4.0%	8.6%	4.6%	0.4036

	Boiling	37.5%	60.5%	23.0%	<0.0001
Health complaints	Menstrual problem	23.0%	22.6%	-0.4%	0.931
	Loss of weight	9.9%	8.6%	-1.3%	0.7858
	Loose motion	13.0%	5.9%	-7.1%	0.1929
	Gumbleeding	23.6%	20.6%	-3.0%	0.4981
	Loss of appetite	37.5%	15.3%	-22.2%	<0.0001
	Weakness	62.1%	32.0%	-30.1%	<0.0001
	Night blindness	5.6%	3.9%	-1.7%	0.736
	Passage of worm in stool/mouth	9.1%	10.5%	1.4%	0.769
Present complaint at the time of visit	Yes	75.8%	59.9%	-15.9%	<0.0001
Anaemicprevalence	Normal	3.7%	17.2%	13.5%	0.0153
	Mild Anaemic	41.4%	74.4%	33.0%	0.000
	Moderate Anaemic	49.4%	7.5%	-41.9%	<0.0001
	Severe Anaemic	5.5%	0.9%	-4.6%	0.5994
Prevalence of anaemia	Anaemic	96.3%	82.8%	-13.5%	0.000
RTI infection	Vaginal discharge	42.4%	14.6%	-27.8%	<0.0001
	Lower abdominal pain	50.4%	29.0%	-21.4%	<0.0001
	Any ulcer in perennial region	4.1%	1.7%	-2.4%	0.6995

Worms Infestation	Present	84.2%	57.0%	-27.2%	<0.0001
Serum ferritin level	<30	59.2%	46.8%	-12.4%	0.0693
	>=30	40.8%	53.2%	12.4%	0.0763
BMI	Normal	82.5%	88.4%	5.9%	0.0019
	Thin	13.7%	10.0%	-3.7%	0.4407
	Severe	3.7%	1.6%	-2.1%	0.7137
Height for age	Normal	49.4%	57.7%	8.3%	0.015
	Thin	19.7%	27.2%	7.5%	0.093
	Severe	30.9%	15.1%	-15.8%	0.0011
Water sanitation facilities	latrine within 10 m of the water source	39.8%	38.9%	-0.9%	0.8194
	water is accessible to domestic animals	17.5%	32.6%	15.1%	0.0013
	Other contamination like dumping areas, drainage etc within 10 mradius	56.6%	31.2%	-25.4%	<0.0001
	Waste water collection on the platform of water source.	82.2%	46.8%	-35.4%	0.0000
	Drainage channel was missing, damaged or blocked with debris of households	81.5%	41.3%	-40.2%	0.0000

	Regular bathing, washing of clothes and cooking utensils at the platform or near the water sources in of cases.	94.3%	84.7%	-9.6%	<0.0001

Table 3. Multiple logistic regression analysis of different determinants for moderate and severeanaemia

Variable		N (%)	PR (%)	OR (95% CI)	P-value
Father Education Status	High/above	147 (18.3)	73 (49.7)	Ref.	
	Middle	115 (14.3)	54 (47.0)	0.89 (0.55 - 1.46)	0.664
	Primary	180 (22.4)	103 (57.2)	1.35 (0.87 - 2.10)	0.173
	Illiterate	360 (44.9)	210 (58.3)	1.41 (0.96 - 2.08)	0.075
Mother Education Status	High/above	44 (5.5)	19 (43.2)	Ref.	
	Middle	43 (5.4)	20 (46.5)	1.14 (0.49 - 2.66)	0.755
	Primary	83 (10.3)	42 (50.6)	1.34 (0.64 - 2.81)	0.426
	Illiterate	632 (78.8)	359 (56.8)	1.73 (0.93 - 3.20)	0.082
Toilet facility	Owned/community	665 (82.9)	372 (55.9)	Ref.	
	Open air defecation	137 (17.1)	68 (49.6)	0.77 (0.53 - 1.12)	0.178
Purified Water	Filtration/Boiling	333 (41.5)	172 (51.7)	Ref.	
	None	469 (58.5)	268 (57.1)	1.24 (0.94 - 1.65)	0.124
Present complaint at the time of visit	No	194 (24.4)	115 (59.3)	Ref.	
	Yes	608 (75.8)	325 (53.5)	0.78 (0.56 - 1.09)	0.156
RTI infection	No	368 (45.9)	203 (55.2)	Ref.	

	Yes	434 (54.1)	237 (54.6)	0.97 (0.74 - 1.29)	0.875
Worms Infestation (n=373)	Absent	59 (15.8)	22 (37.3)	Ref.	
	Present	314 (84.2)	206 (65.6)	3.20 (1.80 - 5.71)	0.000
Serum ferritin level (n=314)	<30	186 (59.2)	137 (73.7)	Ref.	
	>=30	128 (40.8)	12 (9.4)	2.02 (13.72 - 53.24)	0.000
BMI	Normal	662 (82.5)	369 (55.7)	Ref.	
	Thin	110 (13.7)	52 (47.3)	1.37 (0.64 - 2.92)	0.414
	Severe	30 (3.7)	19 (63.3)	0.71 (0.47 - 1.06)	0.100
Height for age	Normal	396 (49.4)	228 (57.6)	Ref.	
	Thin	158 (19.7)	87 (55.1)	0.74 (0.54 - 1.03)	0.075
	Severe	248 (30.9)	125 (50.4)	0.90 (0.62 - 1.30)	0.590
Water sanitation facilities	Sanitary	30 (3.7)	11 (36.7)	Ref.	
	Insanitary	772 (96.3)	429 (55.6)	2.16 (1.01 - 4.60)	0.046
Extra Salt User	No	469 (58.5)	228 (48.6)	Ref.	
	Yes	333 (41.5)	212 (63.7)	1.85 (1.38 - 2.46)	0.000

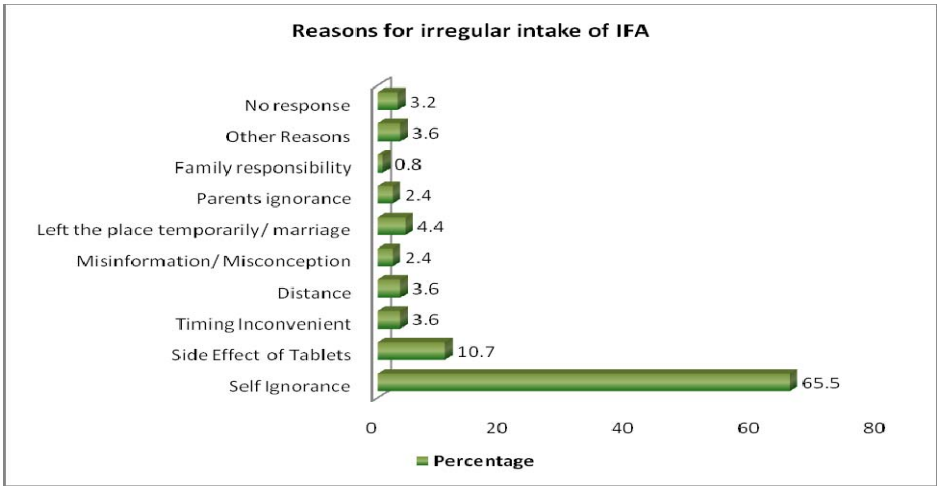

Figure 3: Barrier analysis- reasons for irregular intake of IFA supplementation

Table 4: Comparison of food consumption pattern during baseline and endline study.

Variables	Baseline (Average)	Endline (Average)	Mean difference (gm)	Std. Deviation	95% CI	t-value	p-value
Meat (monthly in gm)	847.61	848.47	0.86	367.31	29.49 – 31.21	0.056	0.956
Fish (monthly in gm)	562.42	604.78	42.36	353.39	8.39 – 76.34	2.451	0.015
Egg (monthly in gm)	267.22	301.73	34.51	281.68	2.45 – 66.57	2.119	0.035
Rice (Daily in gm)	545.66	583.31	37.65	20.94	1.81 – 77.12	1.874	0.061
Refined milled grain (monthly in gm)	2483.81	2591.01	107.19	2134.68	152.49–366.88	0.813	0.417
Dairy product (monthly in gm)	423.33	454.21	30.88	715.86	109.72–171.49	0.0436	0.664
Deep fried food (monthly in gm)	471.93	504.77	32.83	363.65	30.51 – 96.19	1.026	0.307
Pickled veg. (monthly in gm)	118.86	178.38	59.51	317.46	23.19 – 95.82	3.225	0.001
Dessert/sweet (monthly in	210.30	223.48	13.18	304.54	26.21 – 52.57	0.659	0.510

gm)							
Soyabean (monthly in gm)	196.61	221.18	24.57	237.59	1.95 – 47.20	2.135	0.033
Legumes (monthly in gm)	415.63	503.18	87.54	409.95	46.83 – 128.25	4.228	0.000
Fruit (monthly in gm)	499.45	518.52	19.07	337.83	23.18 – 61.32	0.889	0.375
Leafy green vegetable (monthly in gm)	632.56	910.12	277.55	761.48	208.46– 346.65	7.894	0.000
Other vegetable cooked (monthly in gm)	1324.92	2383.38	1058.45	2452.46	822.66– 1294.2	8.824	0.000