

## ORIGINAL ARTICLE

**Anaemia, its determinants and effect of different interventions amongst tea tribe adolescent girls living in Dibrugarh district of Assam**Tulika Goswami Mahanta<sup>1</sup>, Bhupendra Narayan Mahanta<sup>2</sup>, Pronab Gogoi<sup>3</sup>, Puspendra Dixit<sup>4</sup>, Vandana Joshi<sup>5</sup>, Sandeep Ghosh<sup>6</sup>

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**Abstract**

**Background:** Nutritional anaemia, one of the major public health problems in India is associated with lower productivity, higher sickness rate and absenteeism having inter-generational effect. Morbidity during adolescent has implication on future safe motherhood, optimum growth and development of foetus and children. Aims and **Objective:** To assess, prevalence and determinants of anaemia and effect of different interventions amongst tea tribe adolescent girls. **Materials & Methods:** A community based intervention study was conducted covering 16 tea estates of Dibrugarh District, Assam. 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. Interventions given were weekly IFA supplementation, dietary diversification, health promotion by monthly NHED, cooking demonstration, cooking competition and kitchen garden promotion and counselling to improve IFA compliance and remove barriers was done. 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%. History of passage of worms (9.1%), 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. Associated morbidities showed significant reduction following active intervention. **Conclusions:** High anaemia prevalence requires urgent attention to avoid preventable morbidities. Implementation of different intervention in an integrated manner was found effective in reducing the burden of anaemia and associated factor.

**Key Words**

Anaemia; tea tribe; adolescent girls; Iron folic acid supplementation (IFA); Dibrugarh; Assam

**Introduction**

Anaemia, one of the Worlds nineteenth leading risk factor for death and disability adjusted life year (DALY) is an indicator of poor nutrition and health with major consequences for health, social and economic development of a population.(1) Nutritional anaemia, one of the major public health problems in India affecting almost 90% poor children, adolescent girls and women, considered as

“female disease “causing red alert for Indian women.(2) Taller women with greater arm circumference were able to pluck more green leaves, earn higher wages and were absent less often indicating the effect of anaemia and productivity amongst tea tribe population. (3)

Adolescence, the formative period of life is defined by the World Health Organization as the age group of 10-19 years.(4) Adolescence is one of the

important stages of the life cycle in terms of health interventions as more than 33% of the disease burden and almost 60% of premature deaths among adults can be associated with behaviours or conditions that begin or occur during adolescence.(5) An ICMR conducted study showed very high burden of communicable, non-communicable and nutritional disorders amongst tea garden population.(6) As per SRS 2007-09 data, Assam is having the highest maternal mortality (380) of which tea garden community constitute the most.(7) Dibrugarh has the world's largest area covered by tea gardens with distribution of tea plantations and tea factories in the entire District and many tea gardens are more than 100 years old.

### Aims & Objectives

- To assess the prevalence of anaemia and its determinants amongst tea tribe adolescent girls
- To measure the effect of different interventions implemented in an integrated way.

### Material 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 159 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.

**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 computerized 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.(9) 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).(10) Community based intervention was given by weekly iron folic acid supplementation (WIFS), 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.

**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, 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**

- Weekly iron folic Acid supplementation,
- Monthly NHED,
- Quarterly cooking demonstration and
- Yearly cooking competition

#### **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. ([Table 1](#)) 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 + 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 + 6.5 cm and 37.9+ 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 1.37-53.24), 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 from 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, counselling 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](#))

## 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.(7,11) 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 thin with BMI below cut off value.(12) 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.(13) ICMR study reveals similar result with our study indicating that in Assam anaemia amongst adolescent girls is universal. 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.(14) Stool examination findings indicating high prevalence of soil transmitted helminthiasis (84.20%). Other studies; also shows high prevalence of helminthic infestations. (6,15,16) The association between poor housing, water supply and sanitation with occurrence of diarrhoea has already been documented.(17) 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. (18) 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. (18) Correction of nutrition during early years by

1000 days nutrition intervention and continuum of care may prove fruitful in such situation. (19)

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.(20)

Nutritional anaemia is one of the major public health problems in India affecting almost 70% of children and 56% amongst ever married women.(21) 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. (22, 23) 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 Anganwadi centres 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).6 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. (24) 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. 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. (25, 26) 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. (27,28) 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.(29) 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 2017.5 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.

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

Anaemia is a major problem amongst Tea tribe adolescent girls. Different community based Intervention was found effective. There is a need to sustain the effort by different means like community ownership which may be achieved by social and behaviour change communication and Government ownership by advocacy, for long term sustainability of the project.

## Recommendation

Integrated approach with different community based intervention for prevention and correction of anaemia and related symptoms was found effective, useful and operationally feasible.

## Limitation of the study

As it is an action research by community based intervention study with multiple intervention combined, effect of each intervention cannot be measured individually and cannot be compared.

## Relevance of the study

This study documents the high prevalence of nutritional anaemia and effectiveness of feasible interventions implemented in an integrated manner.

## Authors Contribution

TGM, PD, VJ designing of the study, TGM, BNM, PG study tool development and methodology and manuscript writing , TGM, PG data analysis, PD, VJ, SG helping in carrying out community based interventions. TGM data ownership as PI of the project.

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**Tables**

**TABLE 1 SOCIO-DEMOGRAPHIC INFORMATION OF THE STUDY PARTICIPANTS**

Variables	Number	Percentage
<b>Age</b>		
10-12	149	18.6
13-15	343	42.8
16-19	310	38.7
<b>Religion</b>		
Hindu	724	90.3
Christian	68	8.5
Muslim	10	1.2
<b>Caste</b>		

<b>General</b>	9	1.1
<b>OBC</b>	793	98.9
<b>Education status</b>		
Illiterate	125	15.6
Primary school	128	16.0
Middle school	280	34.9
High school	262	32.7
Above	7	0.9
<b>Father education</b>		
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
<b>Mother education</b>		
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

**TABLE 2 COMPARISON OF DIFFERENT DETERMINANT OF ANAEMIA DURING BASELINE AND ENDLINE STUDY**

Variable		Baseline	Endline	Change in % (Increase/ decreases)	p-value
<b>Toilet facility</b>	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
<b>Purified Water</b>	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
<b>Health complaints</b>	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
	Gum bleeding	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
<b>Present complaint at the time of visit</b>	Yes	75.8%	59.9%	-15.9%	<0.0001
<b>Anaemic prevalence</b>	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
<b>Prevalence of anaemia</b>	Anaemic	96.3%	82.8%	-13.5%	0.000
<b>RTI infection</b>	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
<b>Worms Infestation</b>	Present	84.2%	57.0%	-27.2%	<0.0001
<b>Serum ferritin level</b>	<30	59.2%	46.8%	-12.4%	0.0693



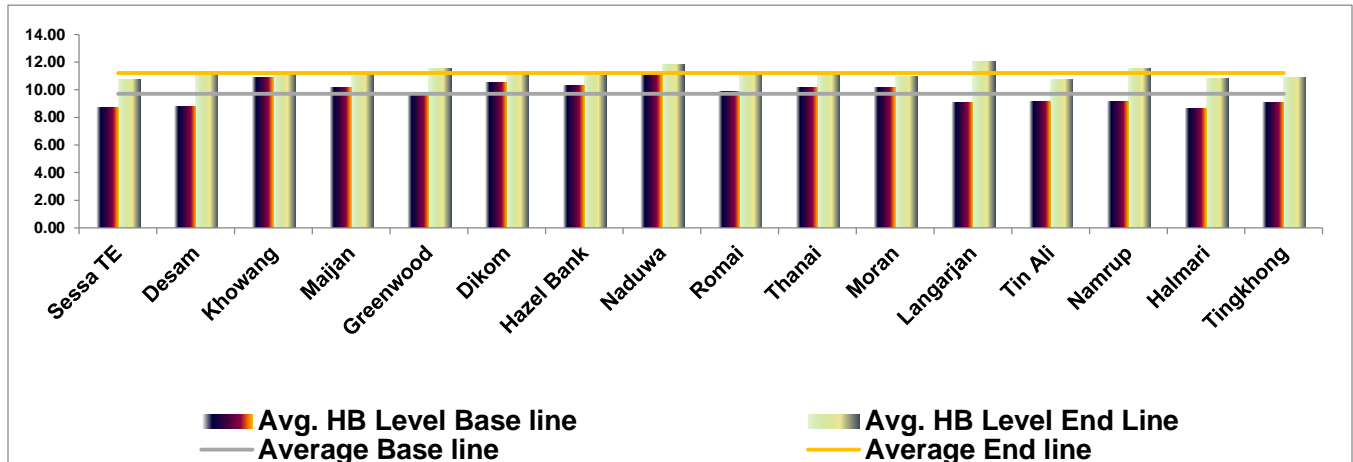
	>=30	40.8%	53.2%	12.4%	0.0763
<b>BMI</b>	Normal	82.5%	88.4%	5.9%	0.0019
	Thin	13.7%	10.0%	-3.7%	0.4407
	Severe	3.7%	1.6%	-2.1%	0.7137
<b>Height for age</b>	Normal	49.4%	57.7%	8.3%	0.015
	Thin	19.7%	27.2%	7.5%	0.093
	Severe	30.9%	15.1%	-15.8%	0.0011
<b>Water sanitation facilities</b>	latrine within 10 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 m radius	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 SEVER ANAEMIA**

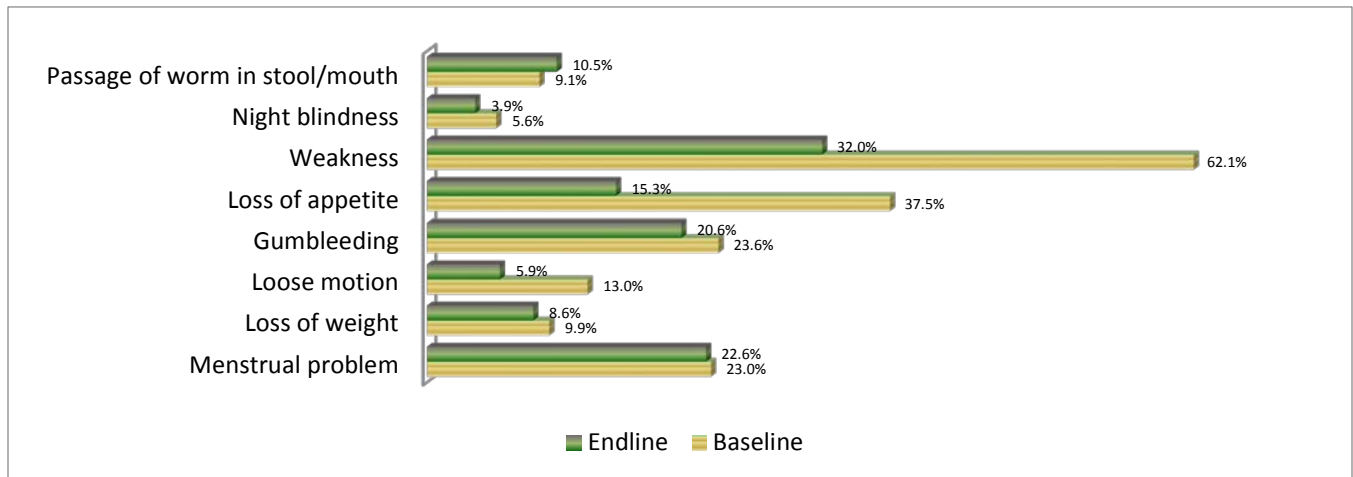
Variable		N (%)	PR (%)	OR (95% CI)	P-value
<b>Father Education Status</b>	High/above	147 (18.3)	73 (49.7)	Ref.	
	Middle	115 (14.3)	54 (47.0)	0.89 (0.55 - 1.46)	0.664
	Primary	180 (22.4)	103 (57.2)	1.35 (0.87 - 2.10)	0.173
	Illiterate	360 (44.9)	210 (58.3)	1.41 (0.96 - 2.08)	0.075
<b>Mother Education Status</b>	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
<b>Toilet facility</b>	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
<b>Purified Water</b>	Filtration/Boiling	333 (41.5)	172 (51.7)	Ref.	
	None	469 (58.5)	268 (57.1)	1.24 (0.94 - 1.65)	0.124
<b>Present complaint at the time of visit</b>	No	194 (24.4)	115 (59.3)	Ref.	
	Yes	608 (75.8)	325 (53.5)	0.78 (0.56 - 1.09)	0.156
<b>RTI infection</b>	No	368 (45.9)	203 (55.2)	Ref.	
	Yes	434 (54.1)	237 (54.6)	0.97 (0.74 - 1.29)	0.875
<b>Worms Infestation (n=373)</b>	Absent	59 (15.8)	22 (37.3)	Ref.	
	Present	314 (84.2)	206 (65.6)	3.20 (1.80 - 5.71)	0.000
<b>Serum ferritin level (n=314)</b>	<30	186 (59.2)	137 (73.7)	Ref.	
	>=30	128 (40.8)	12 (9.4)	2.02 (13.72 - 53.24)	0.000
<b>BMI</b>	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
<b>Height for age</b>	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
<b>Water sanitation facilities</b>	Sanitary	30 (3.7)	11 (36.7)	Ref.	
	Insanitary	772 (96.3)	429 (55.6)	2.16 (1.01 - 4.60)	0.046
<b>Extra Salt User</b>	No	469 (58.5)	228 (48.6)	Ref.	
	Yes	333 (41.5)	212 (63.7)	1.85 (1.38 - 2.46)	0.000

**Figures**

**FIGURE 1 COMPARISON OF MEAN HAEMOGLOBIN LEVEL IN STUDIED TEA ESTATES BEFORE AND AFTER INTERVENTION**



**FIGURE 2 BEFORE AND AFTER (BASELINE – END LINE) COMPARISON OF HEALTH COMPLAINTS**



**FIGURE 3 BARRIER ANALYSIS- REASONS FOR IRREGULAR INTAKE OF IFA**

