ORIGINAL ARTICLE e-ISSN: 2349-0659 p-ISSN; 2350-0964

Malnutrition and Anemia: A Health Burden among Tea Garden Workers in West Tripura District, Tripura, India

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Abstract

Introduction: The tea garden workers are an underestimated group of our society and are considered to be the most nutritionally vulnerable community. This study was undertaken to study the nutritional status of the male and female tea garden workers of West Tripura district, Tripura, India. **Methods:** In this cross-sectional study, a total of 409 tea garden workers including both sexes (males: 197; females: 212) of age group 18–60 years were selected. A questionnaire for on-ground data collection was administered along with the assessment of dietary intake and dietary quality, anthropometric data measurements, physiological measurements, hematological and biochemical estimation. **Results:** Most of the workers were vegetarian, and about two-thirds of the participants consumed two meals per day. None of the subjects was in the habit of taking packed lunch in routine, and maximum respondents (males: 84.26%; female: 83.96%) were in the habit of keeping fast. Skipping meals was also common in a vast number of the participants (males: 83.24%; females: 84.90%). A maximum number of participants complained of anorexia, headache, breathlessness on exertion, lethargic feeling, pale conjunctiva, pale skin, and flat nails. A very high prevalence of anemia (males: 94.91%; females: 99.04%) was observed among the workers. The present study also revealed dietary inadequacies, particularly regarding protein, energy, calcium, and all micronutrients (iron, β-carotene, folic acid) except vitamin C. A positive significant ($P < 0.05$) correlation was observed between hemoglobin and various daily dietary intakes of blood-forming nutrients. **Conclusion:** The present study reveals the prevalence of anemia among tea garden workers, especially female workers. Nutritional insufficiency might be one of the important factors in this process. This study suggests that a comprehensive public health policy should be developed so that the tea garden workers' health and nutritional needs can be addressed.

Keywords: Anemia, Diet quality, Nutrient adequacy ratio, Nutrient intake, Tea garden workers

Asian Pac. J. Health Sci., (2022); DOI: 10.21276/apjhs.2022.9.1.40

Introduction

India is the second-largest producer of tea plantations in the world and the biggest consumer of tea. In India, the tea industry occupies a prime position. It holds considerable potential for economic development, as it earns substantial foreign exchange and provides employment to a large number of unskilled laborers in India.[1] The tea sector of India provides a massive scale of employment with production concentrated primarily in West Bengal, north-eastern states, and to a lesser extent in the southern states such as Tamil Nadu and Kerala. Assam, West Bengal, Kerala, and Tamil Nadu produce the most significant production of tea in India.[2] Tripura has a history of tea plantations since back to 1916. Tripura is one of the famous tea-growing states. About 54 tea estates, 21 tea processing factories, and more than 4000 small tea growers are available in Tripura. Approximately, 9 million kg of tea is produced in a year, and Tripura achieved the 5th largest among the 16-tea producing states in India.[3] Tea is additionally a crucial agro-industry of Tripura, which contributes immensely to the state's economy.

It is well known that the health and socioeconomic status of the worker of any industry is one of the crucial factors for its productivity, development, and growth. As per the report, the majority of the tea garden workers belong to tribal communities from different states of India. The workers were brought to the different tea estates as forced labor during the colonial period of India.[2] Due to traditional socio-cultural and low literacy levels, the tribal populations generally have poor nutritional status. Hence, it is expected that the prevalence of malnutrition may be found in the tea garden workers of the North-Eastern states. Several reports support this postulation.[4,5] High magnitude of undernutrition and infectious diseases among the tea garden population of Assam was reported by Medhi *et al.*[6] Nutritional problems like being underweight among children, thinness among adults, and micronutrient deficiency disorders like anemia were widespread. Another report by Deka[7] revealed that tribal populations working in the tea industry are affected by various social, economic, and developmental constraints that expose them to different types of health problems and high rates of malnutrition. Several studies have revealed that tea garden workers are suspected of various diseases such as communicable and non-communicable diseases.[8] Malnutrition in tea garden workers is also common due to unhygienic living conditions, overcrowded residentials, poor socioeconomic conditions, and illiteracy. In a study conducted by Sengupta and Sahoo[9] on male tea garden workers in the year 2014, malnutrition was found in the majority of workers. In 2017,

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How to cite this article: Nath SK, Das AS, Datta S, Wankhar W. Malnutrition and Anemia: A Health Burden among Tea Garden Workers in West Tripura District, Tripura, India. Asian Pac. J. Health Sci., 2022;9(1):255-262.

Source of support: Nil

Conflicts of interest: None.

Received: 28/10/2021 **Revised:** 19/11/2021 **Accepted:** 03/12/2021

Debnath and Debnath[10] researched the West Tripura district and discovered that the tea garden workers live in poor socioeconomic conditions. During this study period in the West Tripura District, the socioeconomic condition of the tea garden workers was found very despondent.

Iron deficiency anemia is the most common nutritional problem around the world. Anemia is a matter of concern not only with human beings but with social and economic development also. The second leading cause of disability is anemia which leads to 1 million deaths per year. According to the World Health Organization (WHO) rankings, IDA is the third leading cause of Disability Adjusted Life Years lost for females aged 15–44 years.[11] If sufficient iron stores are assured during adolescence, adverse effects of anemia in later life and during pregnancy can be controlled easily.[12] According to the published data on the prevalence of anemia among tea garden workers in India belonging to a low socioeconomic status, this research has made an effort to highlight the current scenario, the root cause of anemia, and dietary habits of the tea gardens of West Tripura district.

Material and Methods

Site Selection and Study Duration

This study was carried out from December 2017 to March 2020 to study the prevalence of anemia among the male and female tea garden workers aged 18–60 years of West Tripura district, Tripura, India.

Ethical Approval

Ethical approval for the study was taken from the Human Ethics Committee of the Assam Down Town University, Guwahati, Assam, India (Memo No. adtu/ethics/Ph.D. Scholar/2017/003 dated: 21/11/2017).

Sampling Technique and Subject Selection

A multistage stratified random sampling technique was adopted to select the subjects of this research work. First of all, we have selected five tea gardens randomly out of the 21 tea gardens of the West Tripura district. After selecting gardens, 442 tea garden workers were selected randomly and asked to provide their age. The information provided by the workers was subsequently verified from official government records such as the Aadhaar card, birth certificate, and electoral roll. Subjects were further screened based on their compliance or noncompliance for all kinds of measurements and tests, consumption of alcohol (country liquor), tobacco (cigarettes, beedi, and hookah) use for a prolonged period, history of chronic disease or chronic medication. In this stage, 21 workers were found not eligible and excluded from this study. After explaining the complete aim, objective, and protocol of the research work in detail, only the voluntarily participating subjects with written consent were included in this study, and 12 workers were excluded as they were not interested in signing a consent letter. Finally, the sample size of both groups of subjects was 409 (Male-197 and Female-212). A pre-designed and pretested proforma was used to collect socio-demographic characteristics such as age, sex, source of income, family size, monthly family income, and dietary patterns.[13]

Assessment of Dietary Intake and Dietary Quality

A 24-h recall method was used for three consecutive days with standardized questionnaires to know the workers' dietary intake and dietary quality.[14] The different varieties of food items include breakfast, lunch, and dinner taken by the workers, were converted into their raw equivalent values and categorized according to their respective food groups. The average daily intake of protein, energy, iron, folic acid, calcium, β-carotene, and vitamin-C was calculated using the standard calculation from the values per 100 g. The calculated result compared with the recommended dietary allowances (RDA)[11] for the corresponding age group. The nutrient adequacy ratio (NAR)[12] was used to know and calculate the diet quality of the garden workers. The nutrient adequacy ratio was calculated for each nutrient by each subject using the following formula.

$$NAR = \frac{Subject's\ nutrition\ intake\ of\ the\ day}{RDA\ of\ the\ respective\ nutrients}$$

Then, the subjects were divided into inadequate (<0.66), fairly adequate (0.66–<1.0), or adequate (>1.0) NARs for various nutrients. Data of energy intake were categorized as a percent of RDA of the respective age group. Subjects consuming 25% above the RDA value for energy (>125% of RDA) considered under excess energy intake. When subjects' energy intake was below 25% of the RDA (<75% of RDA), they considered them as inadequate energy intake.

Anthropometric Measurements

The subjects' body weight was measured with a standard weighing scale nearest 0.1 kg with minimum clothing. The standing height of the participants was measured to the nearest 0.1 cm in the standard arm hanging position with a Harpenden type Anthropometer. The same trained person took measurements 2 times. Body mass index (BMI) was calculated using the standard calculation as the weight in kilograms divided by the height in meter square. The nutritional status of the subjects was estimated according to the internationally accepted WHO.[15] According to the WHO, 1995, when the BMI of any person is <18.5, the person is suffering from chronic energy deficiency (CED), and it has three categories (CEDI, II, III). CED III was defined as BMI less than 16.0, CED II as BMI of 16.0–16.9, CED I as BMI of 17.0–18.4, and normal as BMI of 18.5–24.9. We adopted the WHO[15] classification of the public health problem of low BMI (<18.5), based on adult populations around the world. According to this classification, a low prevalence (5–9%) of low BMI is defined as a warning sign requiring monitoring, a medium prevalence (10–19%) as indicating a poor situation, a high prevalence (20–39%) as indicating a serious situation, and a very high prevalence (≥40%) as indicating a critical situation.

Physiological Measurements

Blood pressures were measured with the help of a sphygmomanometer and stethoscope. The subjects had to sit for a 5-min rest period before measurement. Both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured twice, and the average values of the two readings of the SBP and DBP were recorded. The measurements were recorded from the left arm at the heart's height.[16] Pulse rate was measured at the

left radial artery by palpating for 1 min. Resting heart rate (HR) is determined by measuring the pulse rate at the left radial artery by palpating for 1 min.[17]

Collection of Blood Samples

Blood samples were taken from each subject between 8 am and 10 am after the subjects had fasted overnight. A total of 5 mL fasting venous blood was collected. Two millilitres of blood were collected into EDTA-containing sterile tubes to analyze hemoglobin. The remaining 3 mL was collected into an evacuated tube containing no anticoagulant to analyze total protein, serum albumin, and serum globulin.

Hemoglobin Estimation

Hemoglobin, serum protein, albumin, and globulin were assessed to determine the nutritional status of the subjects. Hemoglobin was estimated from whole blood by following the cyanmethemoglobin method[18] using a biochemical kit (Coral Clinical Systems, Tulip Diagnostics(P) Ltd., India). The prevalence of anemia was determined using the cut-off values for mild, moderate, and severe anemia as recommended by the study group of WHO.[19] The severity of anemia was categorized as severe (<7 g/dl), moderate (7–10 g/dl), and mild (10–12 g/dl).

Biochemical Estimation

Total protein, albumin, and globulin were estimated using a biochemical kit (Coral Clinical Systems, Tulip Diagnostics(P) Ltd., India).

Statistical Analysis

All statistical tests were performed using the following standard techniques. Descriptive data presented as mean ± SD. Unpaired t-tests were performed to check for differences between the groups. Pearson correlations analyzes were performed. Statistical analyzes were performed with SPSS, version 17.0. $P < 0.05$ was considered to indicate statistical significance.

Results and Discussion

Mean values for age, physical and physiological characteristics of the two groups are presented in Table 1. Results revealed that there were significant differences in height (cm) and weight (kg) between the male and female workers; these characteristics were found significantly higher for males ($P < 0.001$) compared to females. No significant differences in BMI (kg/m^2), SBP and DBP were observed between male and female workers. Furthermore, there were no significant differences in HR.

Table 1: Age, physical and physiological characteristics of the tea garden workers

Variables	*Male (n=197)*	*Female (n=212)*	*P value* (Male vs. Female)*
Age (Years)	39.45±11.20	36.67±11.50	0.027
Height (cm)	159.13±7.38	152.23±5.97	0.000
Weight (kg)	50.32±9.50	44.54±8.21	0.000
Systolic Blood Pressure (mm of Hg)	119.14±18.69	116.68±20.19	0.127
Diastolic Blood Pressure (mm of Hg)	76.81±11.29	75.45±11.88	0.065
Heart Rate (Beats/min)	84.97±8.30	85.78±09.09	0.393
BMI (kg/m^2)	19.82±3.14	19.21±3.36	0.091

Values are expressed as mean±SD. *Denotes *P*-value based on the unpaired *t*-test.

Table 2 presents gender-wise nutritional status based on BMI of tea garden workers. The prevalence of CED, based on a BMI of <18.5 kg/m^2, was 51.87% in males (CED I: 25.38; CED II 15.20%; and CED III: 11.29%) and 58.72% in females (CED I: 28.23%; CED II 17.15%; and CED III: 13.34%). As far as overweight and obesity of the overall population are concerned, only 4.13% male and 3.19% of female workers were found overweight. There was only 0.60% male, and 0.55% of female workers showed obesity. When the total population was considered, 55.29% of the population was under the CED category.

Present research findings [Table 3] revealed that out of 409 studied subjects, only 5.07% were male workers, and 0.94% of female workers had normal hemoglobin values. Whereas 94.93% of male workers and 99.06% of female workers were affected with various grades of anemia, that is, in the case of male workers, 10.65% were severely anemic, 68.02% were moderately, and 16.24% were mildly anemic. In the case of female workers, 32.07% were severely anemic, 64.62% were moderately anemic, and 2.35% were mildly anemic.

The WHO suggested the following cut off points to determine the magnitude of IDA among the population[20]

Prevalence	*Public health problem*
<5%	Not a problem
5–14.9%	Low magnitude
15–33.9%	Moderate magnitude
40% and above	High magnitude

The present research findings specified that the problem of anemia among the studied tea garden worker was of high magnitude as the prevalence rate exceeds 40%.

Results of serum protein, albumin, and globulin revealed [Table 4] that compared to females, males are having significantly higher ($P < 0.001$) levels of total protein ($P < 0.01$) and serum albumin ($P < 0.01$). It was found that 58% of the male and 64% of the female tea garden workers had low serum albumin levels [Figure 1] when the result of serum albumin was closely analyzed for the determination of hypoalbuminemia. Moreover, two-third (61%) of the whole studied population showed hypoalbuminemia.

General Profile

Most of them work as tea leaf pluckers and very few work in factories and offices. The majority of the subjects were predominantly Hindus, and all the subjects belonged to the scheduled tribes and other backward classes. The majority of the subjects belong to medium-sized families comprising five to seven members. The maximum number of the family members informed that their family income was less than Rs. 4000/month. The National Family Health Survey[21] also agreed with the same and reported 58% anemia incidence among the women (15–49 years) of low-income status.

Dietary Habits

Most of the tea garden workers were vegetarian. Out of 197 male and 212 female workers, 70.05% male and 74.06%, female workers

Table 2: Nutritional status of tea garden workers based on BMI classification

Anthropometric Variables	*Nutritional status*	*Cut-off value*	*Male (n=197)*	*Female (n=212)*	*Total population*
BMI (kg/m^2)	CED III	<16.00	11.29%	13.34%	12.31%
	CED II	16.00–16.99	15.20%	17.15%	16.17%
	CED I	17.00–18.49	25.38%	28.23%	25.83%
	Total CED	<18.50	51.87%	58.72%	55.29%
	Normal	18.50 – 24.99	43.40%	37.54%	40.47%
	Over Weight I	25.00 – 29.99	4.13%	3.19%	3.66%
	Obese	>= 30.00	0.60%	0.55%	0.57%

BMI: Body mass index, CED: Chronic energy deficiency, RI: Rohrer index

Table 3: Degree of anemia in tea garden workers

Degree of anemia	*Male worker (n=197)*		*Female worker (n=212)*	
	*Hemoglobin (g/dl)**	*Number of subjects*	*Hemoglobin (g/dl)**	*Number of subjects*
Severe	<7	21 (10.65)	<7	68 (32.07)
Moderate	8–11	134 (68.02)	7–10	137 (64.62)
Mild	11–13	32 (16.24)	10–12	5 (2.35)
Normal	>13	10 (5.07)	>12	2 (0.94)

*World Health Organization,[19] Figures in parenthesis indicate percentages.

Table 4: Levels of serum proteins of the male and female tea garden workers

Variables	*Male (n=197)*	*Female (n=212)*	*P value* (Male vs. Female)*
Total protein (gm/dL)	7.26±1.04	6.93±1.02	0.004
Albumin (gm/dL)	3.73±0.52	3.56±0.57	0.004
Globulin (gm/dL)	3.52±0.90	3.37±0.88	0.110

Values are expressed as mean±SD. *Denotes *P*-value based on the unpaired *t*-test.

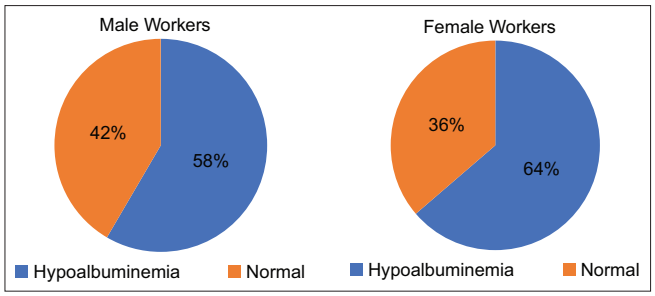

Figure 1: Prevalence of hypoalbuminemia (<35 g/L) among the tea garden workers

were vegetarian respectably. The pattern of meals consumed per day indicated that 71.58% of males and 70.28% of females were consuming only two meals per day. The concept of packed lunch was not common among the subjects. Only 16.24% males and 17.45% females were in the habit of taking packed lunch in routine, whereas approximately 10% used to take lunch sometimes. Out of 409 subjects, 84.26% males and 83.96% females were in the habit of keeping fast, and the purpose of keeping fast was religion-oriented among 59.04% male and 72.47% female of the subjects, respectively. However, 40.96% male and 27.53% female used to keep the fast with no objective, due to lower energy intake, social discernment, socioeconomic status, and pregnancy. Skipping of meals was also common in 83.25% male and 84.91% female workers. The data indicated that 90.24% of males and 89.44% of females were skipping meals regularly;however, only 9.76% of males and 10.56% of females skipped the meal sometimes. Approximately, 53% of the workers used to skip their important meal that is breakfast [Table 5]. The percentage of skipped lunch and dinner of the male workers were 28.66 and 17.68 respectively and for the female workers were 29.44 and 17.22, respectively. They were skipping the meals only to save time according to the 56.10% male and 60.56% female workers whereas 28.66% males and 28.89% females respond as they did not feel hungry and 15.24% males and 10.55% females skipped meals due to angriness. 84.15% of male and 90.56% of female workers reported weakness on skipping meals, and due to this, 22.46% male and 24.54%, female workers ate more in the next meal, whereas 77.54% males and 75.46% females did not bother at all.

Clinical Manifestation of Anemia

The problem of anorexia was experienced, respectively, by 23.86% male and 33.96% female. Headache was experienced by 70.05% males and 73.58% females, respectively [Table 6]. About 67.01% male workers and 69.81% female workers felt breathlessness on exertion. Among them, the majority (81.82% male and 87.84% female) used to experience moderate breathlessness, whereas 18.18% male and 12.16% female workers suffered from severe breathlessness on exertion. Most of the subjects (84.77% males and 87.74% females) had a lethargic feeling. The data as a whole indicated extensive prevalence of pale conjunctiva (male 89.85%; female 91.51%), dryness of eyes on high exposure (male 77.66%; female 74.53%), pale but uncoated tongue (male 34.01%; female 42.45%), pale skin (male 67.51%; females 65.10%), pigmented skin (male 21.32%; females 22.64%), flat (male 56.85%; females 55.66%) and spoon-shaped nails (male 13.71%; female13.21%) among the tea gardens workers.

Nutrient Intake and Diet Quality

Adequate nutrition during adolescence is imperative for supporting the proper physical growth of the body, upkeep of muscles, and preventing future health problems. The mean daily protein consumption of male and female workers was 21.08% and 21.72% [Table 7], respectively of the RDA, and that of protein.

Data of vitamin and mineral consumption indicated that with the exemption of vitamin C, the intake of all other nutrients was not at par with the RDA. β-carotene intake was about 2.55%

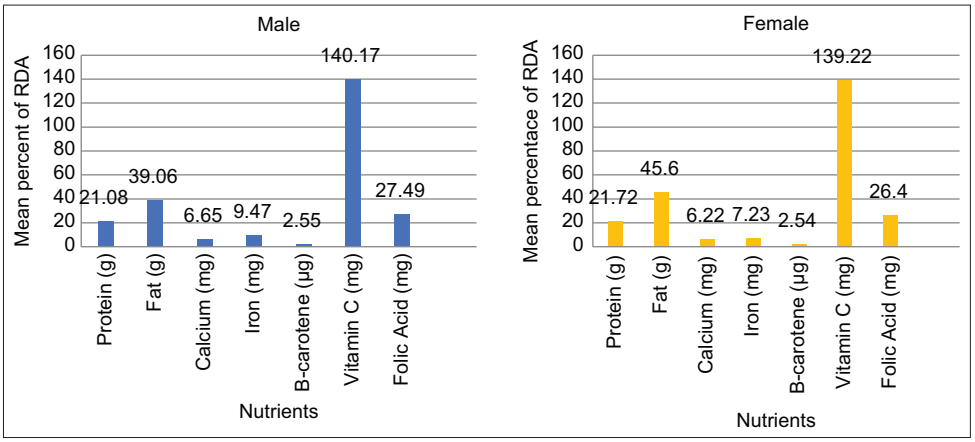

Figure 2: Mean per cent intake of nutrients by tea garden workers

Table 5: Dietary habits of the tea garden workers

Variables	*Number of male workers (n=197)*	*Number of female workers (n=212)*
Food habits		
Vegetarian	138 (70.05)	157 (74.06)
Non-vegetarian	42 (21.32)	35 (16.51)
Eggetarian	17 (8.63)	20 (9.43)
Frequency of meal (per day)		
2 times	141 (71.58)	149 (70.28)
3 times	42 (21.32)	44 (20.75)
4 times	14 (7.10)	19 (8.96)
Packed lunch		
Yes	32 (16.24)	37 (17.45)
No	144 (73.10)	153 (72.17)
Sometimes	21 (10.66)	22 (10.38)
Fast keeping		
Yes	166 (84.26)	178 (83.96)
No	31 (15.74)	34 (16.04)
Purpose of fast keeping	*n*=166	*n*=178
Religion	98 (59.04)	129 (72.47)
General	68 (40.96)	49 (27.53)
Skipping of meals		
Yes	164 (83.25)	180 (84.91)
No	33 (16.75)	32 (15.09)
If yes, which one	*n*=164	*n*=180
Breakfast	88 (53.66)	96 (53.33)
Lunch	47 (28.66)	53 (29.44)
Dinner	29 (17.68)	31 (17.22)
Frequency of skipping meal	*n*=164	*n*=180
Usually	148 (90.24)	161 (89.44)
Sometimes	16 (9.76)	19 (10.56)
Purpose of skipping meals	*n*=164	*n*=180
Not feeling hungry	47 (28.66)	52 (28.89)
To save time	92 (56.10)	109 (60.56)
Due to anger	25 (15.24)	19 (10.55)
Weakness due to skipping of meals	*n*=164	*n*=180
Yes	138 (84.15)	163 (90.56)
No	26 (15.85)	17 (9.44)
If yes, what will you adopt	*n*=138	*n*=163
Eat more	31 (22.46)	40 (24.54)
Do not bother	107 (77.54)	123 (75.46)

Table 6: Clinical manifestations of anemia in the subjects

Variables	*Number of male workers (n=197)*	*Number of female workers (n=212)*
Feeling of anorexia		
Yes	47 (23.86)	72 (33.96)
No	150 (76.14)	140 (66.04)
Incidence of headache		
Yes	138 (70.05)	156 (73.58)
No	59 (29.95)	56 (26.42)
If yes, frequency of headache	*n*=138	*n*=156
Daily	86 (62.32)	96 (61.54)
Alternate days	26 (18.84)	34 (21.79)
Weekly	22 (15.94)	18 (11.54)
Fortnightly	4 (2.90)	8 (5.13)
Breathless on exertion		
Yes	132 (67.01)	148 (69.81)
No	65 (32.99)	64 (30.19)
If yes,	*n*=132	*n*=148
Moderate breathlessness	108 (81.82)	130 (87.84)
Severe breathlessness	24 (18.18)	18 (12.16)
Feeling of lethargy		
Yes	167 (84.77)	186 (87.74)
No	30 (15.23)	26 (12.26)
Eyes		
Pale conjunctiva	177 (89.85)	194 (91.51)
Dry on high exposure	153 (77.66)	158 (74.53)
Tongue color		
Normal	130 (65.99)	122 (57.55)
Pale but not coated	67 (34.01)	90 (42.45)
Skin		
Pale	133 (67.51)	138 (65.10)
Slight pigmentation	42 (21.32)	48 (22.64)
Nothing	22 (11.17)	26 (12.26)
Nails		
Flat	112 (56.85)	118 (55.66)
Spoon shaped	27 (13.71)	28 (13.21)
Brittle, ridged nails	37 (18.78)	46 (21.70)
Normal	21 (10.66)	20 (9.43)

Figures in parenthesis indicate percentages.

of the RDA [Figure 2]. Calcium intake among the workers was approximately 6% of the RDA. Iron is a vital nutrient to everyone for growth and development, especially for females, as they need extra iron for menstruation and growth and development. Apart from this, anemia in female tea garden workers leads to high prenatal mortality, increased incidence of low-birth-weight babies, and a high maternal mortality rate later in life.[22]

Results revealed that [Table 8] maximum of the tea garden workers had inadequate NAR with respect to protein (male 86.29%; female 77.36%), fat (male 71.57%; female 73.11%), calcium (male 78.68%; female 83.02%), iron (male 94.42%; female 93.40%), β-carotene (male 85.28%; female 75.47%) and folic acid (male 96.95%; female 91.98%). In case of vitamin C (male 82.23%;

Table 7: Mean nutrient intake and diet quality of the tea garden worker

Nutrient	*Male worker (n=197)*			*Female worker (n=212)*		
	RDA	*Mean±SD*	*% Adequacy*	*RDA*	*Mean±SD*	*% Adequacy*
Protein (g)	60	12.65±1.88	21.08	55	11.95±0.96	21.72
Fat (g)	30	11.72±1.39	39.06	25	11.40±0.95	45.60
Calcium (mg)	600	39.95±9.76	6.65	600	37.36±7.77	6.22
Iron (mg)	17	1.61±0.26	9.47	21	1.52±0.14	7.23
β -carotene (μg)	4800	122.54±1.81	2.55	4800	122.13±1.29	2.54
Vitamin C (mg)	40	56.07±3.69	140.17	40	55.69±3.70	139.22
Folic Acid (mg)	200	54.99±8.08	27.49	200	52.81±6.20	26.40

RDA: Recommended dietary allowances, SD: Standard deviation

Table 8: Nutrient adequacy ratio of the tea garden workers

Nutrient	*Male tea garden workers (n=197)*			*Female tea garden workers (n=212)*		
	Inadequate (<0.66)	*Fairly adequate (0.66–<1.0)*	*Adequate (>1.0)*	*Inadequate (<0.66)*	*Fairly adequate (0.66–<1.0)*	*Adequate (>1.0)*
Protein	170 (86.29)	21 (10.66)	6 (3.05)	164 (77.36)	44 (20.75)	4 (1.89)
Fat	141 (71.57)	49 (24.87)	7 (3.55)	155 (73.11)	48 (22.64)	9 (4.25)
Calcium	155 (78.68)	37 (18.78)	5 (2.54)	176 (83.02)	31 (14.62)	5 (2.36)
Iron	186 (94.42)	8 (4.06)	3 (1.52)	198 (93.40)	13 (6.13)	1 (0.47)
β-carotene	168 (85.28)	22 (11.17)	7 (3.55)	160 (75.47)	37 (17.45)	15 (7.08)
Vitamin C	35 (17.77)	44 (22.34)	118 (59.89)	21 (9.91)	32 (15.09)	159 (75.00)
Folic Acid	191 (96.95)	4 (2.03)	2 (1.02)	195 (91.98)	12 (5.66)	5 (2.36)

Figures in parenthesis indicate percentages

Table 9: Correlation coefficient (r) showing the association between hemoglobin status and various daily dietary intake of blood-forming nutrients of the tea garden worker

Nutrient	*Correlation (Male)*	*Correlation (Female)*
Protein (g)	0.506**	0.468**
Fat (g)	0.299**	0.281**
Carbohydrate (g)	0.759**	0.654**
Calcium (mg)	0.267**	0.117
Iron (mg)	0.441**	0.370**
β-carotene (ug)	0.301**	0.271**
Vitamin C (mg)	0.671**	0.657**
Folic Acid (mg)	0.276**	0.161*

*Correlation is significant at the 0.01 (two-tailed)

female 90.09%), the workers had fairly adequate (0.66-<1.0) and adequate (>1.0) NAR.

The present study [Table 9] revealed the association of poor dietary intake of several hematinic nutrients with hemoglobin status. The daily nutrient intake of blood-forming nutrients by tea garden workers further revealed a highly significant ($P < 0.01$) and positive correlation coefficient between hemoglobin status and vitamin C intake (male r = 0.671; female r = 657 female). Highly significant ($P < 0.01$) and positive correlation were also observed respectively, for iron and folic acid versus hemoglobin (r = 0.441; 0.276) in male and (r = 370; 0.161) in females. The data further revealed a positive and significant ($P < 0.01$) correlation coefficient between hemoglobin versus protein and beta carotene in males (r = 0.506; 0.301) and in females (r = 0.468; 0.271).

Discussion and Conclusion

The present investigation was conducted on 409 tea garden workers (18–60) years) selected randomly from tea gardens of West Tripura district, Tripura state, India. The study results revealed that 96.97% of the tea garden workers studied suffer from anemia, and the females (99.04%) are the worst affected. This result supports the earlier studies with the tea garden workers of Assam.[6,23] Nutritional anemia is the most common type and cause of anemia. Severe undernutrition might be one of the essential factors for the development of anemia. This study suggests that anemia is higher among the tea garden workers of the West Tripura district. The present research also revealed a dietary deficiency of the workers predominantly regarding protein and all micronutrients except vitamin C intake.

Levels of serum total protein, transferrin, albumin, and prealbumin are all commonly used for nutrition assessment of visceral protein stores. Among all these proteins, albumin is most often used to assess visceral stores of protein. Serum albumin has a long half-life (18–20 days) and is often considered a late marker of malnutrition.[24] Individuals with malnutrition, chronic inflammation, enteropathy, or liver disease can have reduced serum albumin concentrations.[25] However, low serum albumin levels are often accompanied by abnormal levels of other indices that reflect malnutrition (e.g., anthropometrics, total lymphocyte count, ferritin) and usually indicate a state of poor nutrition. Although some non-nutritional factors may also mediate the low level of serum proteins, we included the total serum protein, serum albumin, and globulin in our study. The result of serum albumin in this study revealed that tea garden workers are suffering from hypoalbuminemia (Male: 58.44% and Female: 63.69%). As serum albumin concentration can be considered an indicator of overall health, and studies have shown that hypoalbuminemia is a strong predictor of mortality for various acute and chronic illnesses,[26] the result of serum albumin, along with BMI revealed that tea garden workers of West Tripura district are suffering from severe nutritional deficiency. To further analyze the nutritional deficiency, we included dietary intake and dietary quality analysis of these workers. Results of the dietary analysis revealed that most of the tea garden workers are vegetarian and are in the habit of keeping fast and skipping meals. These might affect their nutritional status. Analysis of nutritional intake with diet quality revealed that except vitamin C, intake of all other nutrients is not at par the RDA value of nutrients such as protein, fat, calcium, iron, β-carotene, and folic acid.

Results of dietary analysis further revealed that the maximum number of tea garden workers are having inadequate nutrient intake. To further analyze, a correlation study was performed to analyse the association with dietary intake of nutrients with hemoglobin status of these workers. Pearson correlation study revealed a strong positive correlation with the hemoglobin and protein along with other micronutrients. These findings will corroborate with the earlier studies, where anemia has been described as a nutritional problem.[19,27]

The observation of the present study revealed that anemia prevalence could be pretty high, especially among the tea garden workers. Correlation study further claims strong evidence for the association of nutritional deficiency with prevalence of anemia in the studied population.

Although the present study was a cross-sectional study, it has inherent limitations. It may not depict the actual scenario of all the tea garden workers of Tripura as a whole. However, this kind of study is the first initiative to find the prevalence of anemia and nutritional status of tea garden workers of West Tripura district. In addition, an inevitable limitation is that all information depends on the respondents' memory. To avoid this, average intake for the past 3 days were needed and performed by a skilled and well-trained interviewer. The present study implies the importance of including both sexes of workers, especially female workers in the risk group as controlling anemia among tea garden workers (vulnerable group) could considerably decrease infant and maternal morbidity. There is a prerequisite for effective publicity for recognizing the problems associated with anemia among workers and planning intervention programs through prophylaxis treatment, dietary modification/supplementation of hematinic nutrients, and nutrition education that would improve the hemoglobin levels among the tea garden workers. Moreover, this study suggests that a comprehensive public health policy should be developed to undertake preventive, promotive, and curative measures so that the health and nutritional needs of the tea garden workers can be addressed. This study also emphasizes the need for more research on the tea garden workers of other districts of Tripura, India.

Acknowledgment

We are grateful to Assam downtown University (ADTU) and Tripura Institute of Paramedical Sciences (TIPS) for all the support provided during the research. All the workers, those who participated in this study and managers and other administrative staff members of all the tea gardens are hereby gratefully acknowledged.

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