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Nutritional status and productivity of female tea pluckers of a tea garden in Dooars, West Bengal

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ABSTRACT

AIMS: This study was proposed to investigate the association, if any, between nutritional status and work productivity in female tea pluckers of tea garden in Dooars, West Bengal. METHODS: All women who had worked as tea pluckers during the immediately preceding month excluding those who were pregnant, were recruited for this study. Socio-demographic variables, health and diet variables were surveyed. Different physiological and anthropometric variables and haemoglobin concentration were measured. RESULTS: Out of 100 female tea pluckers 90 pluckers were found to be anaemic (Hb concentration less than 12g/dL) and 44 pluckers had evidence of BMI (kg/m^2) less than 18.5. A strong correlation in between anaemia and productivity were observed (P<0.001). Female tea pluckers with lower haemoglobin concentration, lower BMI and lower mid upper arm circumference showed less productivity. Much lower haemoglobin concentrations is found in subjects with lower standard of living index. CONCLUSION: Adequate dietary supply is required to the workers engaged in tea plucking. Nutritional status of this population can be ameliorated through creating health awareness, nutritional intervention and overall improvement of socioeconomic conditions of female tea pluckers.

1. Introduction

The tea industry occupies a place of considerable importance in the Indian economy, producing a fourth of the world's annual tea output – among them some gardens producing high quality teas and employing around 1.26 million people at tea plantations directly and 2 million people indirectly.

It is well known that the two crucial cost elements of tea industry are labour wages and estate supplies. In fact, as the most costly and yet measurable operation in the tea industry, plucking has the focus of a productivity – linked approach in respect of wages and incentives. It has been reported that about 60 – 66% of the total work force in a tea garden is engaged in plucking operation and this alone accounts for 70 – 80% of total cost of green leaf production [1]. The tea pluckers are almost exclusively women particularly in India.

It is generally recognized the nutritional status affects work performance and productivity [2]. Despite efforts to improve living condition, many plantation workers still have to contend with poor housing, inadequate sanitary facilities and limited access to safe drinking water. Under nutrition and anaemia remains problem in this population [3]. In a study of anaemia in pregnancy conducted in the plantation sector it was found that 58.3% of the subjects were anaemic [4], mainly due to iron deficiency. Several earlier studies reported that anaemia is known to reduce physical capacity and work productivity [5, 6]. However, other nutritional factors also influence work productivity. One of the strongest and best documented relationship is the negative influence of low haemoglobin level on work productivity. The potential impact of anaemia on working women in the plantation sector is quite high since the take home pay is linked to the weight of the tea leaves

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plucked. Work productivity is also important from a management perspective since tea pluckers with a higher physical capacity would increase the productivity.

Workers in the plantation sector in India, as also elsewhere, are exposed to several occupational health hazards – these not have been adequately studied or documented. The tea planting industry is labour intensive and workers are exposed to the vagaries of terrain and climate. In addition to exposure to chemicals in the form of pesticides and fertilizers, the possibility of safety and health hazards is very high.

As poor socio-economic condition, ignorance due to illiteracy, unhygienic living conditions in the residential colonies make the tea garden population vulnerable to various communicable diseases and malnutrition, the specific objective of this study were to describe the various anthropometric indicators of female tea pluckers and also to investigate the association, if any, between the haemoglobin level and BMI with work productivity in terms of total green leaf yield/day /plucker among female tea pluckers.

2. Materials and Methods

Subjects

This study was conducted in a tea estate in Dooars, West Bengal. The study population consisted of women tea pluckers. All women who had worked as tea pluckers during the immediately preceding month excluding those who were pregnant, were recruited.

Assessment of socio-demographic, health and dietary status of female tea pluckers

Socio-demographic variables, health and diet variables were surveyed according to the questionnaire used by Bentley and Griffiths, 2003 [7].

Calculation of Standard of Living Index (SLI)

The SLI is a composite index calculated by the International Institute of Population Sciences and ORC Macro [8] and is based upon a score constructed from the household ownership of possessions/ consumer variables and land/ livestock. The index was then divided into low, medium and high group based upon scores obtained. The high group contains those with a score of 25 – 66, the medium group scores of 15 – 24 and the low group scores of 0 – 14.

Measurement of height and weight

The height (cm) of each subject was measured by an anthropometric rod [9] by allowing the subject to stand straight on a plane surface. They were instructed to look forward during the measurement. The weight (kg) of each subject was measured by conventional weighing pan [9]. They were instructed to stand upon it and to look forward. Weighing pan was reset to zero before each measurement.

Calculation of Body Surface Area [BSA] and Body Mass Index [BMI]

Calculation of body surface area of each individual was measured by height – weight nomogram [10]. Body mass index of each individual was calculated by Quetelet's index [10].

Measurement of heart rate

The heart rate (beats/min) of each subject was measured in seating condition after 15mins of rest by a stop watch from the radial artery [11].

Measurement of systolic blood pressure [SBP] and diastolic blood pressure [DBP]

Systolic and diastolic blood pressure (mm-Hg) of the subjects were measured with the help of sphygmomanometer [11]. Both the pressures were measured by allowing the subject in seating position after 15mins of rest.

Measurement of waist and hip circumference and calculation of waist/hip ratio

Waist circumference (cm) was measured with a flexible tape midway between the inferior angle of the ribs and the supra-iliac crest, whereas hip circumference (cm) was measured at the outermost points of the greater trochanters [12]. From this data waist/ratio was calculated.

Measurement of mid upper arm circumference[MUAC]

Mid upper arm circumference (cm) was measured midway between the tip of the shoulder and the elbow of the left arm with the arm hanging freely by the side using a flexible tape [13].

Estimation of haemoglobin [Hb] concentration

Blood sample was taken from the fingertip with sterile disposable pricking needle and 20 µL transferred onto Whatman's No. 1 blotting paper using a micropipette. The filter papers were dried at room temperature and brought for analysis in the department. Haemoglobin concentration was measured within a week of sample collection. Haemoglobin was extracted into Drabkin's solution (from Randox®), by allowing 30 min for elution. Haemoglobin concentration was estimated using the cyanmethaemoglobin method [14].

We then classified all the female pluckers as mild, moderate and severely anaemic based upon their haemoglobin status and following international reference [15]. A haemoglobin concentration <7 g/dL was used to define severely anaemic, 7 – 9.99g/dL for moderate anaemic and 10 – 11.99g/dL correspond to mild anaemic for non-pregnant women.

Measurement of productivity [Total Yield (TE)]

Productivity of each tea plucker was measured in terms of green leaf yield (kg)/ day[3]. Data on productivity were obtained from records maintained by the estate management. This provides a record of the days on which the tea plucker reported to work and the weight (kg) of tea leaves plucked each day. The total weight of tea leaves plucked over the week immediately before recruitment to our study was used to calculate the mean daily weight of tea leaves plucked/ plucker /day.

Statistics

All the data were represented as Mean ± SD. Student's "t" test were done to find the inter-group significance difference between the different study variables and The Pearson's correlation coefficients were determined to find the correlation, if any, between the selected study variable [16]. P<0.05 was chosen as the level of significance.

3. Results

A total of 100 female tea pluckers were recruited to the study. The mean age (years) of all the subjects was 27.96 years (SD: 2.89, range: 22- 32 years).

Results of socio-demographic factors and of the health and diet variables tested in our study are presented in Table 1, 2 and 3, respectively.

Table 4 depicts results of all the anthropometric and physiological variables included in our study, hemoglobin level, productivity and SLI score of all female tea pluckers participated in our study. Classification of female tea pluckers according to hemoglobin level is presented in Table 5. Results revealed that 90% pluckers were anaemic (Hb concentration below 12g/dL) as per international reference [15]. Using this reference, we found that 36 pluckers were mild anaemic (Hb concentration : 10 – 11.99g/dL) and 54 pluckers were moderate anaemic (Hb concentration: 7 – 9.99g/dL). Mean hemoglobin concentration of both mild and moderate anaemic groups were 10.74g/dL, SD: 0.54 and 8.92g/dL, SD: 0.55; respectively. Thirteen pluckers (36%) out of total 36 pluckers showed a BMI (kg/ m^2) below 18.5 in mild anaemic group and thirty pluckers (56%) showed BMI (kg/ m^2) below 18.5 in moderate anaemic group (Table 6).

Results of body weight (kg) and height (cm) are presented in Table 7. Mild anaemic group had a 8.34% higher body weight and 2.87% higher height as compared to moderate anaemic group which was statistically significant (P<0.05 and P<0.01, respectively).

Table 7 also represents BMI (kg/m^2), BSA(m^2), heart rate (beats/min), systolic and diastolic blood pressure (mm-Hg), waist & hip circumference (cm) and waist/hip ratio. Resting heart rate of mild anaemic group was 10.61% lower as compared to moderate anaemic group which was statistically significant (P<0.001). BSA of mild anaemic group was found to be 5.6% higher (P<0.001) than modrate anaemic group. Similarly mild anaemic group showed a statistically significant (P<0.05) 6.43% higher BMI when compared with moderate anaemic group. Results of our study also indicate that mild anaemic group showed 6.1% and 11.09% lower systolic and diastolic blood pressure, respectively, as compared to moderate anaemic group and both were statistically significant (P<0.01 and P<0.001, respectively). We did not found any significant differences in waist and hip circumference as well as in waist/hip ratio in between these two groups of pluckers. Mid upper arm circumference (MUAC) was significantly higher (20.26%, p<0.001) in mild anaemic group as compared to moderate anaemic group which is presented in Table 7 also. When we consider productivity of tea pluckers, mild anaemic group showed 12.79% higher green leaf yield/ day as compared to moderate anaemic group which was statistically significant (P<0.05). Differences in standard of living index (SLI) in between mild and moderate anaemic group is also presented in Table 7. Mild anaemic group showed 20% higher SLI as compared to moderate anaemic group which was statistically significant (P<0.05). Although both the groups showed SLI of low group scores (0 – 14).

To find correlation, if any, in between different selected variables we performed Pearson's r correlation coefficient (Table 8). Results of correlation study revealed that productivity was significantly and positively correlated with height, BMI, BSA, SBP, haemoglobin and MUAC in both mild and moderate anaemic group of workers. Weight and DBP also correlated with productivity but statistically insignificant.

Table 1: Socio-demographic variables of mild and moderate anaemic female tea pluckers.

Characteristic	Mild anaemic group (Hb≥10g/dL)		Moderate anaemic group (Hb<10g/dL)	
	n=36	%	n=54	%
Education of the subject (IV standard and above)				
Yes	7	19.45	8	14.81
No	29	80.55	46	85.19
Watches television at least once in a week				
Yes	15	41.67	36	66.67
No	21	58.33	18	33.33
Religion				
Hindu	36	100.00	54	100.00
Muslim	-	-	-	-
Others	-	-	-	-
Caste				
Scheduled caste	28	77.77	39	72.22
Scheduled tribe	6	16.67	15	27.78
Other backward classes	-	-	-	-
Other	2	5.56	-	-

Table 2: Health variables of mild and moderate anaemic female tea pluckers.

	Mild anaemic group (Hb≥10g/dL)		Moderate anaemic group (Hb<10g/dL)	
	n=36	%	n=54	%
Smoking				
Yes	-	-	-	-
No	36	100.00	54	100.00
Drinking alcohol				
Yes	4	11.12	6	13.00
No	32	88.88	48	87.00
Chewing tobacco/ paan masala				
Yes	35	97.22	54	100.00
No	1	2.78	-	-
Diseases in last 2 years				
No diseases	13	36.13	30	55.55
Malaria	5	13.88	4	7.41
Jaundice	10	27.77	16	29.63
Tuberculosis	-	-	-	-
Others	8	22.22	4	7.41
Asthma				
Yes	5	13.88	11	20.37
No	31	86.12	43	79.63

Table 3: Diet variables of mild and moderate anaemic female tea pluckers

	Moderate anaemic group (Hb<10g/dL)		Mild anaemic group (Hb≥10g/dL)	
	n=54	%	n=36	%
Frequency of eating milk/ curd				
Daily	-	-	-	-
Weekly	15	27.77	10	28.57
Occasionally	15	28.57	18	50.00
Never	24	42.86	8	21.43
Frequency of eating pulses				
Daily	23	42.86	8	21.43
Weekly	23	42.86	20	55.56
Occasionally	8	14.28	5	14.29
Never		-	3	7.14
Frequency of eating green leafy vegetables				
Daily	39	71.43	26	71.43
Weekly	12	21.43	10	28.57
Occasionally	3	7.14	-	-
Never	-	-	-	-
Frequency of eating other vegetables				
Daily	27	50	23	64.29
Weekly	19	35.71	13	35.71
Occasionally	8	14.29	-	-
Never	-	-	-	-
Frequency of eating fruits				
Daily	4	7.14	-	-
Weekly	12	21.43	8	21.43
Occasionally	30	57.14	23	64.29
Never	8	14.29	5	14.29
Frequency of eating eggs				
Daily	4	7.14	-	-
Weekly	23	42.86	18	50.00
Occasionally	19	35.71	13	35.71
Never	8	14.28	5	14.29
Frequency of eating meat/chicken/ fish				
Daily	-	-	-	-
Weekly	19	35.71	21	57.14
Occasionally	35	64.29	12	33.33
Never	-	-	3	7.14
Respondent still breast feeding at the time of survey				
Yes	-	-	3	7.14
No	54	100	33	92.86

Table 4: Anthropometric physical and physiological variable of female tea pluckers (n=100)

Variables	Mean ± SD
Haemoglobin (gm/dL)	9.99 ± 1.45
Weight (kg)	42.76 ± 6.52
Height (cm)	146.30 ± 10.62
BMI (kg/m^2)	20.06 ±2.69
BSA (m^2)	1.31 ± 0.13
Heart rate (beats/min)	82.70 ± 11.35
SBP (mm of Hg)	120.37 ± 14.12
DBP (mm of Hg)	76.48 ± 9.78
Waist circumference (cm)	28.66 ± 3.02
Hip circumference (cm)	34.63 ± 3.42
W/H Ratio	0.85 ± 0.08
Mid upper arm circumference (cm)	20.86 ± 4.32
Total yield (kg/day)	30.99 ± 6.70
SLI score	11.0±3.74

Table 5: Classification of female tea pluckers based on haemoglobin level

	No. of pluckers	Haemoglobin concentration (gm/dL)	Significance level
Normal(Hb>12g/dl)	10	13.50±0.62	-
Moderate anaemic (Hb <10 g/dl)	54	8.92 ± 0.55	P < 0.001
Mild anaemic (Hb ≥10 g/dl)	36	10.74 ± 0.54	

*** Significance based on Student's 't' test.**

Table 6: Work productivity of mild and moderate anaemic female tea pluckers with BMI<18.5 kg/m^2 and BMI>18.5 kg/m^2

	Mild anaemic group (Hb≥10g/dL)			Moderate anaemic group (Hb<10g/dL)		
	Number of pluckers	Total yield (kg/day) (Mean ± SD)	Significance level*	Number of pluckers	Total yield (kg/day) (Mean ± SD)	Significance level*
BMI>18.5	23	29.86 ± 5.76	NS	24	27.06 ± 3.27	P<0.01
BMI<18.5	13	33.23 ± 6.87		30	30.19 ± 4.63	

*** Significance based on Student's 't' test. NS: Not significant.**

Table 7: Anthropometric physical and physiological variable of mild (n=36) and moderate (n=54) anaemic group of female tea pluckers

Variables	Moderate (Hb <10gm/dL)	Mild (Hb≥ 10gm/dL)	Significance level *
Weight (kg)	42.82 ± 3.62	46.39 ± 6.52	P<0.05
Height (cm)	141.75 ± 5.64	145.82 ± 5.75	P<0.01
BMI	19.76 ± 2.13	21.03 ± 3.12	P<0.05
BSA	1.25 ± 0.05	1.32 ± 0.09	P<0.001
Heart rate (beats/min)	84.82 ± 8.95	75.82 ± 10.09	P<0.001
SBP (mm of Hg)	120.98 ± 14.33	113.66 ± 8.03	P<0.01
DBP (mm of Hg)	78.98 ± 9.80	70.22 ± 6.46	P<0.001
Waist circumference (cm)	27.97 ± 2.45	28.12 ± 2.26	NS
Hip circumference (cm)	33.45 ± 1.69	34.19 ± 2.36	NS
W/H ratio	0.84 ± 0.08	0.82 ± 0.04	NS
Mid upper arm circumference (cm)	18.41 ± 2.12	22.14 ± 3.34	P<0.001
Total yield (kg/day)	28.39 ± 1.17	32.02 ± 2.62	P<0.001
SLI score	10.0±3.94	12.0±3.59	P<0.05

*** Significance based on Student's 't' test. NS: Not significant**

Table 8: Correlation matrix within different variables of mild (n=36) and moderate (n=54) anaemic group of female tea pluckers.

	Mild anaemic group (Hb≥10g/dL)		Moderate anaemic group (Hb<10g/dL)	
	r*	p value**	r*	p value**
Haemoglobin vs Total yield	0.78	0.001	0.70	0.001
Weight vs Total yield	0.19	NS	0.21	NS
Height vs Total yield	0.43	0.01	0.42	0.01
BMI vs TE	0.56	0.001	0.57	0.001
BSA vs TE	0.50	0.001	0.38	0.01
SBP vs TE	0.44	0.001	0.26	NS
DBP vs TE	0.47	0.001	0.48	0.05
MUAC vs TE	0.46	0.001	0.59	0.001

***Pearson's correlation coefficient**
**** Significance based on two tail Student's 't' test**

4. Discussion

The high prevalence of anaemia among women in India is a burden for them, for their families and for the economic development and productivity of the country [7]. Result of this study revealed that 90% of the subjects of our study population were anaemic (Hb concentration less than 12g/dL) and 44% of the study population had evidence of BMI (kg/m^2) less than 18.5. Anthropometry is a powerful tool for the assessment of nutritional status particularly in the field conditions where it is difficult to conduct clinical and laboratory test [17]. In addition, BMI is considered to be the most suitable, objective anthropometric indicator of nutritional status of the adult. It was chosen because this anthropometric indicator, derived from measures of weight and height of individuals of both sexes, is consistently and highly correlated with body weight (or energy stores within the body) and is relatively independent of the height of the adult. While a BMI <18.5 is considered as the cutoff for the diagnosis of chronic undernutrition in adults, a series of cut- offs are provided to delineate the degrees of severity of undernutrition [18]. Results of our study revealed that height (cm), weight(kg), and body surface area (m^2) were found to be higher in mild anaemic group compared to moderate anaemic group (P<0.05, P<0.01 and P<0.001, respectively). Whereas, heart rate(beats/min), systolic and diastolic blood pressure were found to be lower in mild anaemic group compared to moderate anaemic group (P<0.001, P<0.01 and P<0.001, respectively). So these results may be indicative of comparatively better nutritional status of mild anaemic female tea pluckers as compared to their moderate anaemic counterpart.

We observed a significant difference in BMI [(kg/m^2](($p<0.05$) and BSA [m^2] ($p<0.001$) in between moderate and mild anaemic group. Mean BMI of both the groups were within normal range, but the 36% pluckers in mild anaemic group had BMI<18.5 whereas 56%pluckers in moderate anaemic group had BMI<18.5. Results of this study revealed that subjects with BMI<18.5 plucked 10.37% and 10.14% less than the subjects with BMI>18.5 in moderate anaemic group and mild anaemic group, respectively. Thus it may be hypothesized from our findings that female tea pluckers with lower Hb concentration and lower BMI showed less productivity and this is well in line with the earlier report of Gilgen et al [19].

Results of our study also revealed that there was a significant difference in mid upper arm circumference (MUAC) between moderate anaemic group and mild anaemic group. Mild anaemic group showed a MUAC of 22.14cm, SD: 3.34 and their average green leaf yield (productivity) was 32.02 kg/day, SD: 6.06; whereas moderate anaemic group with MUAC of 18.41cm, SD: 2.12 plucked 28.39kg/day, SD:1.17. So, productivity of the female tea pluckers were also linked with MUAC in our study which is well corroborated with the earlier finding that small MUAC was associated with the lower productivity in workers [13].

The results of standard of living index (SLI) reflect the effect of poverty on women's nutritional and anaemic status. Prevalence of moderate anaemia (Hb concentration less than 10g/dL) was much higher in subjects with lower SLI which revealed a great diversity in the extent and depth of poverty in the pluckers of the tea garden. The direct effect of poverty that resulting in low income, limited education and insufficient diet have all been associated with poor health outcomes for the pluckers which ultimately trafficked to lower productivity.

Productivity of the mild anaemic group was significantly 12.79% higher as compared to moderate anaemic group ($p<0.05$). Work productivity in terms of green leaf yield (kg/day /plucker) was significantly correlated with Hb concentration in both mild ($r=0.70$, $p<0.05$) and moderate($r=0.78$, $p<0.05$) anaemic group. We also observed similar significant correlation in between productivity and height, SBP, BMI, BSA and MUAC in both mild and moderate anaemic group of female tea pluckers. All results from this study seem to point in the same direction that prevalence of anaemia and lower height, BMI, BSA and MUAC had a negative effect on labour productivity. It seems likely that anaemia results in low productivity which in turn result in low take home pay and inability to purchase food which ultimately aggravate the prevalence of anaemia in these population and thus contributes to a viscious cycle that maintains poverty.

5. Conclusion

So in conclusion, adequate dietary supply is required to the workers engaged in occupation like tea leaves plucking, which demands continuous physical labour. In a community where women is the most important bread earner for the family, high prevalence of thinness and anaemia may have adverse impact on family income as in the tea garden wage is directly related to the work output.

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