Impact of physical, physiological and nutritional factors on the daily productivity of female tea pluckers in Jalpaiguri District, West Bengal

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Abstract:
Aims: The purpose of this study was to see if there was any link between physical and physioolgical parameters, nutritional condition of the female tea pluckers and productivity in terms of plucked tea leaves per day in different tea estates of Jalpaiguri District, West Bengal, India

Results: Results of our study revealed that out of total female pluckers in our study, 92.27% female tea pluckers were anemic (Hb concentration below 12 gm/dL) and 54.07% female tea pluckers BMI (kg/m^2) less than 18.5. Prevalence of moderate anemia was much higher in subjects with lower standard of living index. Female tea pluckers with lower hemoglobin concentration, lower physical and physiological parameters showed less productivity in terms of tea leaves plucked per day.

Methods: In this study total 293 female individuals including Two hundred and thirty three female tea pluckers between 18- 45 years of age and sixty control subjects who voluntarily participated were included. Various physical and physiological, socio demographic, health and diet variables were investigated. A variety of physiological and anthropometric characteristics, as well as hemoglobin concentration and productivity in terms of plucked tea leaves per day were also assessed.
Conclusion: Workers involved in tea plucking required a sufficient quality food in their daily diet. The nutritional level and health status of this community can be improved by raising the health awareness, providing nutritional assistance. Overall health status of these female tea pluckers are directly related to their earning (wages) from tea garden.

Keywords: Female tea pluckers, BMI, hemoglobin, productivity.

Introduction

Production of tea depends upon accurate plucking. The accurate plucking is considered as the plucking of two tea leaves and one centre bud. It is an artistic and skilled job and this activity is overwhelmingly labor intensive, relies completely on manual labor. It has been ascertained that about 60-66% of the total workforce in a tea garden is engaged in plucking operation [1, 2]. In most plantations, women work as helpers to men and are paid lower wages. This is not the case in tea plantations. The tea pluckers are almost exclusively women. In tea plucking activity women workers are much better than male tea pluckers. Because male tea pluckers most of the time manhandled the tea plants especially during the busy plucking session. The tenderness fits; it is said that women workers whose tender hands give less trouble to the plants while twisting 'two leaves and a bud' from the bushes. Female tea pluckers earning completely depend upon how much they plucked tea leaves in a whole day. From the management perspective the productivity in terms of plucking tea leaves per day is very important. Not only is that, it also equally important from female tea pluckers perspective [3]. It is generally recognized the nutritional status affects work performance and productivity in other different sectors [4]. 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 anemia remains problem in this population [3]. Several earlier studies reported that reduction in physical performance and work productivity is linked with severity of anemia in several sectors [5, 6]. We conducted this study on female tea pluckers to portray an assortment of anthropometric parameters and also to scrutinize the relationship, if any, between the hemoglobin concentration and BMI with total tea leaf plucked per day by female tea pluckers.

Materials and Methods

In this study total 293 female individuals voluntarily participated. Two hundred and thirty three female tea pluckers between 18- 45 years of age of two different tea estates in Jalpaiguri district, West Bengal, India were selected following a random sampling technique. On other hand, sixty female control subjects were recruited for our study from the nearby locality of tea garden whose age matched with tea pluckers group. We explained the purpose and procedure of our study to all participants and their informed consent was taken before starting our work.

Inclusion criteria of female tea pluckers

- Female tea pluckers who were working as tea pluckers during the immediately preceding month and apparently looking healthy
- Female tea pluckers who voluntarily participated in the study and sign for consent

Inclusion criteria of control subjects

- Those who mostly involved in household works (non-agricultural work) and apparently looking healthy
- Those who did not have any experience of tea plucking and were not exposed directly to pesticide
- Those who voluntarily participated in the study and sign for consent

Exclusion criteria of both control subjects and female tea pluckers

- Individuals who were unwilling to take part
- Pregnant females and lactating mothers
- Individuals with recent surgical history, deformity, chronic illness
- Individuals who had been exposed to radiation therapy within the last six months of our study

We enrolled 233 female tea pluckers in this study from two tea gardens of Jalpaiguri district, West Bengal. They were then grouped into (a) less than 2 years of plucking experience (n=32), (b) more than 2 years but less than 5 years of plucking experience (n=64) and (c) more than 5 years of plucking experience (n=137).

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

Socio-demographic variables, lifestyle (smoking habit, alcohol consumption) were surveyed according to the questionnaire used by Bentley and Griffiths [7].

Assessment of Standard of Living Index (SLI)

Standard of Living Index (SLI) was calculated based on a score constructed from the household ownership of possessions/ consumer variables and land/ livestock by method described by the International Institute of Population Sciences and ORC Macro [8].

The Standard of Living Index divided into low (0 – 14), medium (15 – 24) and high (25 –66) group based on scores obtained. Studied groups were also surveyed by detailed questionnaire about occupational features.

Age, height and weight measurement

Age in years of the participants was recorded from their aadhar card/voter ID card. The height in cm of each participant was measured by an anthropometer [9]. They were instructed to stand straight with bare footed in a flat surface and look forward during the measurement. The weight in kg of each participant was measured by standard weighing machine with light clothing [9]. They were instructed to stand straight, look forward with bare footed on the instrument during the measurement. Weighing machine was kept in flat surface and reset to zero before each measurement.

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

Body surface area of each participant was measured by height – weight nomogram [10]. Body mass index (kg/m^2) of each participant was calculated by using the formula body weight (kg) / [height (m)] ^{2} [10].

Measurements Cardio-vascular parameters

Before measuring cardio vascular parameters each participant was asked to take rest for 10 minutes. We measured two cardio-vascular parameters -

Measurement of resting Heart rate

We measured the arterial pulse rate as arterial pulse rate is equal to the heart rate except in pulse deficit. Three fingers were placed in same line on the radial artery for 30 seconds (with help of a stop watch) to count the pulse rate and then multiplied with 2 to get the pulse rate in one minute. [11]

Measurement of systolic blood pressure (SBP) and diastolic blood pressure (DBP)

The Systolic and diastolic blood pressure (mm-Hg) of each participant was measured with the help of sphygmomanometer and stethoscope by Auscultatory method [11].

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

In the midway between the inferior angle of the ribs and the supra-iliac crest was measured with a flexible tape to determine waist circumference (cm) of each participant [12]. The hip circumference (cm) of each participant was measured at the outermost points of the greater trochanters also with the help of flexible tape [12]. Waist/ratio was determined from these two data of each subject.

Measurement of mid upper arm circumference [MUAC]

In the midway between the tip of the shoulder and the elbow of the left arm was measured to determine mid upper arm circumference (cm) and the subject was asked to hang the arm freely during the time of measurement [13].

Collection and processing of blood sample

1 ml of venous blood was collected from the antecubital vein of each study participant after an overnight fast by certified medical practitioner and was transferred to anti-coagulated (EDTA) tubes.

Measurement of Hemoglobin (Hb) concentration in blood

Hemoglobin concentration in blood was measured by cyanmethemoglobin method adopted from Van Kampen et al (1965) [14]. In this method, cyanide and ferricyanide present in Drabkin solution convert hemoglobin to the cyanmethemoglobin. Hemoglobin concentration was expressed in gm per dL of blood.

Measurement of productivity

Productivity of each tea plucker was measured in terms of green leaf yield in kilogram per day by using the method described by Selvaratnam et al (2003) [3].

Data quality assurance

The questioner used in our study was translated to Bengali (local language) to make it understandable for study participants of all the groups. Before the actual data collection, after translating the questionnaire into local language, we pre-tested that. We followed the standard procedure during collection, transportation, storage, processing and analyzation of each and every sample. Separate identifying number was allotted to each participant and all the data were precisely recorded according to the allotted number.

Data analysis and interpretation

All quantitative variable data were presented as mean ± standard deviation. Differences between the selected study variable tested by using one way analysis of variance (ANOVA) and after that by Tukey's post-hoc test. P value <0.05 was considered as the level of significance [15]. All the data were processed and analyzed by using Statistical Package for Social Science (SPSS) Version 23.

Ethical consideration

This study was approved by the Human Ethics Committee of Serampore College, West Bengal. The objective of the study and the extent of involvement were explained before the study to each and every female tea pluckers of those gardens and control subjects. And written informed consent was obtained from each participant of this study.

Results

A total number of 60 control subjects and 233 female tea pluckers were recruited in the study after considering all the inclusion and exclusion criteria. Tea pluckers were then grouped into (a) less than 2 years of plucking experience (n=32), (b) more than 2 years but less than 5 years of plucking experience (n=64) and (c) more than 5 years of plucking experience (n=137).

Socio-demographic variables, lifestyle status and Diet variables of study participants

Results of socio-demographic variables, lifestyle status and Diet variables of all three tea pluckers groups and control group are presented in Table 1and 2 respectively.

		Control group		Less than 2 Years of Plucking Experiences		More than 2 Years but Less than 5 Years of Plucking Experiences		More than 5 Years of Plucking Experiences	
		(n= 60)	%	(n= 32)	%	(n= 64)	%	(n= 137)	%
Education of the subjects (IV standard and above)	**Yes**	11	18.33	07	21.88	11	17.19	19	13.87
	No	49	81.67	25	78.13	53	82.81	118	86.13
Watches television at least once in a week	**Yes**	29	48.33	15	46.88	36	56.25	59	43.07
	No	31	51.67	17	53.13	28	43.75	78	56.93
Smoking	**Yes**	07	11.67	04	12.5	07	10.93	19	13.86
	No	53	88.33	28	87.5	57	89.06	118	86.13

Drinking alcohol	**Yes**	06	10	04	12.50	11	17.19	25	18.25
	No	54	90	28	87.50	53	82.81	112	81.75
Chewing tobacco/ paan masala	**Yes**	47	78.33	25	78.13	57	89.06	128	93.43
	No	13	21.67	07	21.88	07	10.94	09	06.57
Diseases in last 2 years	**No diseases**	48	80	28	87.5	46	71.88	94	68.61
	Malaria	04	6.67	03	9.38	08	12.50	17	12.42
	Jaundice	08	13.33	01	03.13	09	14.06	23	16.78
	Tuberculosis	-	-	-	-	01	01.56	03	02.19

Table 1: Socio-demographic variables, lifestyle status and of female tea pluckers and control group subjects

Table 2: Diet variables of female tea pluckers and control group subjects

		Control group		**Less than 2 Years of Plucking Experiences**		**More than 2 Years but Less than 5 Years of Plucking Experiences**		**More than 5 Years of Plucking Experiences**	
		(n= 60)	**%**	**(n= 32)**	**%**	**(n= 60)**	**%**	**(n= 32)**	**%**
Frequency of eating milk/ curd	**Daily**	01	01.67	-	-	-	-	-	-
	Weekly	19	31.67	10	31.25	15	23.44	27	19.71
	Occasionally	23	38.33	14	43.75	25	39.06	71	51.82
	Never	17	28.33	08	25	24	37.50	39	28.47
Frequency of eating pulses	**Daily**	21	35	11	34.38	22	34.38	34	24.82
	Weekly	35	58.33	19	59.38	37	57.81	83	60.58
	Occasionally	04	6.67	02	6.25	05	7.81	20	14.6
	Never	-	-	-	-	-	-	-	-

Frequency of eating green leafy vegetables	**Daily**	41	68.33	19	59.38	46	71.88	84	61.31
	Weekly	16	26.67	12	37.50	15	23.44	39	28.47
	Occasionally	03	05	01	03.13	03	4.69	14	10.22
	Never	-	-	-	-	-	-	-	-
Frequency of eating other vegetables	**Daily**	33	55	21	65.63	36	56.25	79	57.66
	Weekly	27	45	10	31.25	28	43.75	47	34.31
	Occasionally	-	-	01	03.13	-	-	11	08.03
	Never	-	-	-	-	-	-	-	-
Frequency of eating fruits	**Daily**	04	06.67	-	-	-	-	-	-
	Weekly	15	25	09	28.13	14	21.88	36	26.28
	Occasionally	32	53.33	22	68.75	43	67.19	89	64.96
	Never	09	15	01	03.13	07	10.94	12	08.76
Frequency of eating eggs	**Daily**	-	-	-	-	-	-	-	-
	Weekly	49	81.67	24	75	43	67.19	98	71.53
	Occasionally	10	16.67	08	25	19	29.69	37	27.01
	Never	01	01.66	-	-	02	03.13	02	01.46
Frequency of eating meat/chicken/ fish	**Daily**	-	-	-	-	-	-	-	-
	Weekly	41	68.33	19	59.38	37	57.81	83	60.58
	Occasionally	18	30	13	40.63	26	40.63	52	37.96
	Never	01	01.67	-	-	01	01.56	02	01.46

Comparison of physical and physiological variable of study participants

Physical and physiological variable of all tea pluckers groups and control group are presented in Table no. 3. The mean age of female tea pluckers of less than 2 years of plucking experience (21.31 ± 1.69 years) was significantly different from control subjects (33.78 ± 6.26 years) and from pluckers having 2 to 5 years of plucking experience (26.38 ± 2.44 years) and from pluckers having more than 5 years of plucking experience (34.78 ± 4.60 years). Pluckers having 2 to 5 years of plucking experience (26.38 ± 2.44

years) was also significantly different from more than 5 years experience (34.78 ± 4.60 years), whereas, mean age of pluckers having more than 5 years experience (34.78 ± 4.60 years) was not significantly different from control subjects.

Mean plucking experience of less than 2 years of plucking experience group was 1.56 ± 0.5 years and of 2 to 5 years of plucking experience was 4.44 ± 0.75 years and of more than 5 years plucking experience group was 14.01 ± 4.84 years. Mean plucking experience of more than 5 years of plucking experience group were significantly different (P<0.001) compared to female tea pluckers group having less than 2 years of plucking experience and 2 to 5 years of plucking experience group. Significant differences were also observed in between 2 to 5 years of plucking experience group and more than 5 years plucking experience group.

Body weight (kg) was significantly different (P<0.001) in female tea pluckers with more than 5 years of plucking experience compared to control subjects, female tea pluckers having less than 2 years of plucking experience and 2 to 5 years of plucking experience. BMI (kg/m^2) and BSA (m^2) were also significantly lower (P<0.001) in female tea pluckers with more than 5 years of plucking experience compared to compared to control subjects, female tea pluckers having less than 2 years of plucking experience and 2 to 5 years of plucking experience.

Female tea pluckers having more than 5 years plucking experience showed significantly lower mid upper arm circumference (cm), estimated lean body mass (kg) (P<0.01), estimated body fat (kg) (P<0.001), waist circumference (cm) (P<0.05) and hip circumference (cm) (P<0.001) compared to control subjects.

Furthermore, resting heart rate (beats/min) was significantly lower in female tea pluckers with more than 5 years of plucking experience significantly lower compared to control subjects, female tea pluckers group having less than 2 years of plucking experience and 2 to 5 years of plucking experience group.

In female tea pluckers with more than 5 years of plucking experience mid upper arm circumference (cm) (P<0.01), estimated body fat (kg) (P<0.01) systolic blood pressure (mm of Hg) (P<0.05) and diastolic blood pressure (mm of Hg) (P<0.05) were also significantly different compared to female tea pluckers having less than 2 years of plucking experience. Systolic blood pressure (mm of Hg) (P<0.05) and diastolic blood pressure (mm of Hg) (P<0.05) in female tea pluckers with more than 5 years of plucking experience were significantly higher compared to 2 to 5 years of plucking experience.

Most of the physical and physiological parameters [excluding hip circumference (cm)] in female tea pluckers with less than 2 years of experience were found insignificant as compared to control subjects. In female tea pluckers having 2 to 5 years of plucking experience also most of the physical and physiological parameters [excluding mid upper arm circumference (cm) (P<0.01), body surface area (m^2) (P<0.05), estimated body fat (kg) (P<0.001) and heart rate (beats/min) (P<0.05)] were found insignificant as compared to control subjects.

The results of standard of living index (SLI) of all female tea pluckers groups and control group are also presented in Table no.3. The results of SLI reflect that the entire participants groups were in low score (0 – 14) group and no significant differences were observed between all participants groups.

Total tea leaf plucked (kg) per day in female tea pluckers with having 2 to 5 years of plucking experience was significantly higher than female tea pluckers with less than 2 years of plucking experience [32.03± 3.10 kg vs 29.41 ± 3.45, p<0.001]. Furthermore, total tea leaf plucked (kg) per day in female tea pluckers with more than 5 years of plucking experience was significantly lower than female tea pluckers having 2 to 5 years of plucking experience [28.40 ± 3.22 kg vs 32.03± 3.10, p<0.001] but found insignificant as compared to pluckers having less than 2 years of plucking experience.

Table 3: Physical and physiological variable of female tea pluckers and control group subjects

Variables	Control Group (n= 60)	Less than 2 Years of Plucking Experiences (n= 32)	2 to 5 Years of Plucking Experiences (n= 64)	More than 5 Years of Plucking Experiences (n= 137)	Significance level#
Age (Years)	33.78 ± 6.26	21.31 ± 1.69 ^{a***}	26.38 ± 2.44 $^{a***, b***}$	34.78 ± 4.60 $^{aNS, b***, c***}$	P<0.0001
Tea Plucking Experiences (Years)	NA	1.56 ± 0.5	4.44 ± 0.75 ^{b**}	14.01 ± 4.84 $^{b***, c***}$	P<0.0001
Weight (kg)	46.82 ± 6.38	47.08 ± 5.81 ^{aNS}	45.20 ±7.23 $^{aNS, bNS}$	41.57 ± 4.03 $^{a***, b***, c***}$	P<0.0001
Height (cm)	147.11 ± 4.51	146.85 ± 4.28 ^{aNS}	146.98 ± 5.05 $^{aNS, bNS}$	147.98 ± 4.16 $^{aNS, bNS, cNS}$	NS P<0.312
BMI (kg/m^2)	21.61 ± 2.57	21.90 ± 3.07 ^{aNS}	20.77 ± 2.55 $^{aNS, bNS}$	18.97 ± 1.57 $^{a***, b***, c***}$	P<0.0001

BSA (m^2)	1.43 ± 0.1	1.42 ± 0.07 aNS	1.39 ± 0.09 a*, bNS	1.31 ± 0.07 a***, b***, c***	P<0.0001
Mid upper arm circumference (cm)	25.21 ± 2.70	24.65 ± 2.11 aNS	24.16 ± 2.69 a**, bNS	23.05 ± 2.35 a***, b**, c*	P<0.0001
Estimated Lean Body Mass (kg)	36.21 ± 2.94	36.00 ± 2.25 aNS	35.14 ±2.82 aNS, bNS	34.73 ± 2.72 a**, bNS, cNS	P<0.0024
Estimated Body Fat (kg)	13.73 ± 3.28	13.55 ± 2.81 aNS	12.10 ± 2.57 a**, bNS	11.53 ± 2.58 a***, b**, cNS	P<0.0001
Waist circumference (cm)	29.01 ± 2.0	28.09 ± 2.02 aNS	28.57 ± 2.50 aNS, bNS	27.96 ± 2.27 a*, bNS, cNS	P<0.0173
Hip circumference (cm)	35.23 ± 2.52	33.72 ± 2.24 a*	34.28 ± 2.66 aNS, bNS	33.73 ± 2.18 a***, bNS, cNS	P<0.0006
Waist/ Hip Ratio	0.82 ± 0.04	0.83 ± 0.05 aNS	0.83 ± 0.04 aNS, bNS	0.83 ± 0.05 aNS, bNS, cNS	NS P<0.523
Heart rate (beats/min)	76.88 ± 6.31	79.32 ± 8.10 aNS	81.02 ± 8.35 a*, bNS	86.46 ± 10.05 a***, b***, c***	P<0.0001
Systolic Blood Pressure (mm of Hg)	125.23 ± 11.75	121.72 ± 9.48 aNS	122.25 ± 13.07 aNS, bNS	129.01 ± 13.16 aNS, b*, c**	P<0.00071
Diastolic Blood Pressure (mm of Hg)	82.73 ± 7.60	80.47 ± 6.16 aNS	81.22 ± 9.02 aNS, bNS	85.44 ± 8.87 aNS, b*, c**	P<0.001
Total yield (Plucking Tea Leaf kg/day)	NA	29.41 ± 3.45	32.03± 3.10 b***	28.40 ± 3.22 bNS, c***	P<0.0001
SLI score	12.53 ± 4.01	10.98 ± 3.42 aNS	11.41 ± 3.89 aNS bNS	11.68 ± 4.84 aNS, bNS, cNS	NS P<0.342

Data presented as Mean ± SD. # Significance level based on one way ANOVA, P<0.05. Tukey's post-hoc test was used to find significant difference between selected groups. a: compared to control group, b: compared to less than 2 years of plucking experiences group, c: compared to 2-5 years of plucking experiences group. *P<0.05, **P<0.01, ***P<0.001, NS Not significant.

Comparison of hemoglobin concentrations of study participants

The hemoglobin concentrations (gm/dL) of control subjects and all female tea pluckers groups [less than 2 years, 2 to 5 years and more than 5 years of plucking experience group] are shown in figure 1. Compared to control subjects hemoglobin concentrations were significantly low in all female tea pluckers groups [less than 2 years of experience: 10.26 ± 1.07 vs 11.36 ± 1.16, p<0.001, 2 to 5 years of experience: 10.42 ± 1.06 vs 11.36 ± 1.16, p<0.001 and in more than 5 years experience: 9.81±1.17 vs 11.36±1.16, p<0.001]. Hemoglobin concentrations (gm/dL) of female tea pluckers with less than 2 years of plucking experience was found insignificant as compared to female tea pluckers having 2 to 5 years of plucking experience and more than 5 years plucking experience. But, female tea pluckers having more than 5 years plucking experience showed significantly lower hemoglobin concentrations compared to pluckers of 2 to 5 years of plucking experience [9.81±1.17 vs 10.42 ± 1.06, p<0.01].

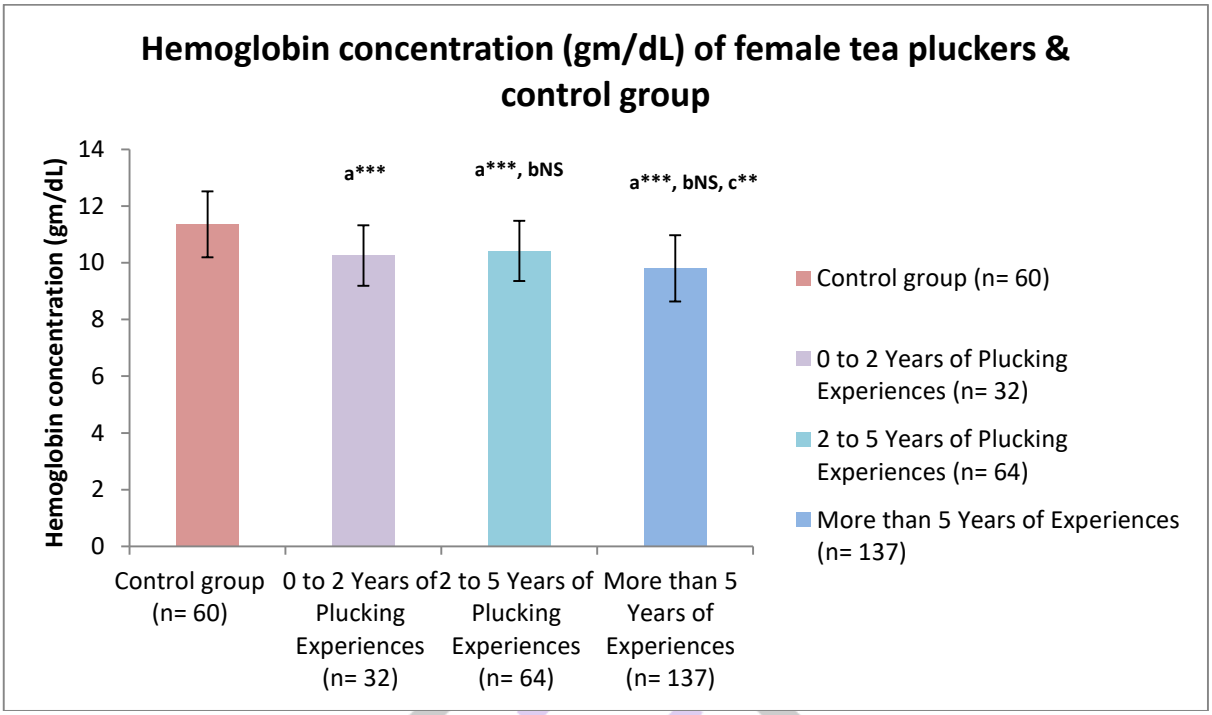

Figure 1: Hemoglobin concentration of female tea pluckers [less than 2 years of plucking experience, n= 32; 2 to 5 years of plucking experience, n= 64 and more than 5 years of plucking experience, n= 137] and control group [n=60] subjects. Data presented as Mean ± SD. ### Significance level based on one way ANOVA, P<0.001. Tukey's post-hoc test was used to find significant difference between selected groups. a: compared to control group, b: compared to less than 2 years of plucking experience group, c: compared to 2 to 5 years of plucking experience group, **P<0.01, ***P<0.001, NS Not significant.

Classification of study participants according to hemoglobin level

Classification of female tea pluckers and control subjects according to hemoglobin level is presented in Figure 2. Results of our study revealed that 92.27% female tea pluckers in our study participants were anemic (Hb concentration below 12 gm/dL) as per international reference [16]. We also found that in control subjects 32 subjects were mild anemic (11.18 ± 0.53) and 10 subjects were moderately anemic (9.54 ± 0.43) and their hemoglobin concentration were significantly lower (P<0.001) than control subjects having normal hemoglobin concentration (12.68 ± 0.48**)**. Among, female tea pluckers with less than 2 years of plucking experience 18 subjects were found mild anemic (10.58 ± 0.45) and 11 subjects were moderately anemic (9.18 ± 0.65) and their hemoglobin concentration were found significantly lower (P<0.001) than pluckers with less than 2 years of plucking experience having normal hemoglobin concentration (12.36 ± 0.18**)**. In female tea pluckers having 2 to 5 years of plucking experience 38 subjects were found mild anemic (10.62 ± 0.53) and 19 subjects were moderately anemic (9.26 ± 0.53) and their hemoglobin concentration were found significantly lower (P<0.001) than pluckers with 2 to 5 years of plucking experience having normal hemoglobin concentration (12.43 ± 0.17). Among, female tea pluckers with more than 5 years of plucking experience 52 subjects were found mild anemic (10.61 ± 0.45) and 77 subjects were moderately anemic (8.99 ± 0.67) and their hemoglobin concentration were found significantly lower (P<0.001) than pluckers with more than 5 years of plucking experience having normal hemoglobin concentration (12.45 ± 0.25).

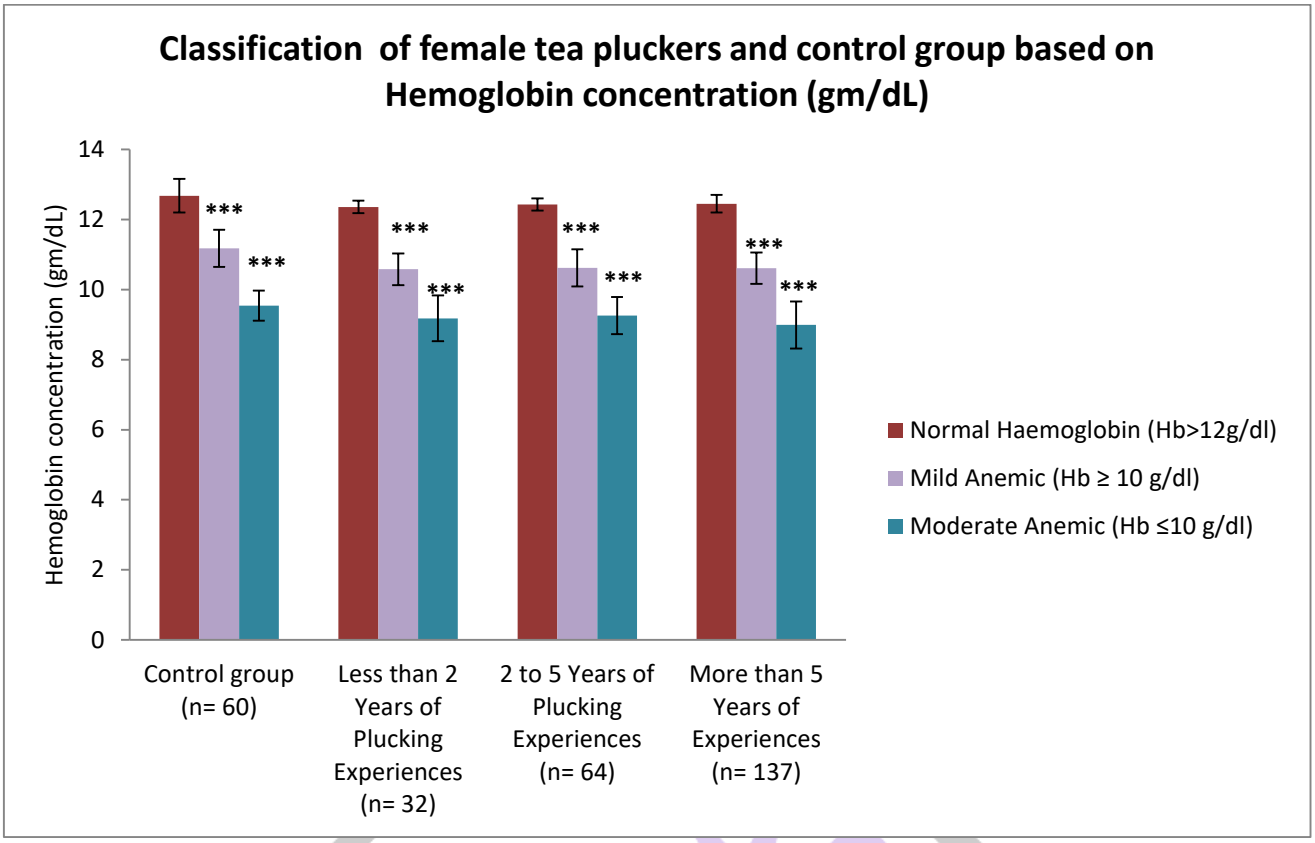

Figure 2: Classification of female tea pluckers [less than 2 years of plucking experience, n= 32; 2 to 5 years of plucking experience, n= 64 and more than 5 years of plucking experience, n= 137] and control group [n=60] subjects based on hemoglobin level. Data presented as Mean ± SD. ### Significance based on two tail Students t test, compared to female tea pluckers and control group having normal hemoglobin concentration. ***P<0.001

Classification of study participants according to BMI value

Classification of female tea pluckers and control subjects according to BMI value is presented in Figure 3. In our study, 76.67% (n= 54) control subjects BMI (kg/ m^2) were above 18.5 (22.62 ± 2.03) and 23.33% (n= 14) subjects BMI (kg/ m^2) were below 18.5 (18.27 ± 0.17) and significant difference (P<0.001) also present in between their mean± SD BMI values. Among, female tea pluckers with less than 2 years of plucking experience 75% (n= 24) subjects were above 18.5 BMI (kg/ m^2) (23.13 ± 2.52) and 25% (n= 08) subjects BMI (kg/ m^2) were below 18.5 (18.20 ± 0.25) were found significantly lower (P<0.001). Female tea pluckers having 2 to 5 years of plucking experience showed significantly lower (P<0.001) BMI (kg/ m^2) values in 34.38% (n= 22) subjects (22.15 ± 2.06) compared to 65.63% (n= 42) subjects (18.14 ± 0.19). Furthermore, among female tea pluckers with more than 5 years of plucking experience 29.93% (n= 41) subjects were above 18.5 BMI (kg/ m^2) (20.92 ± 1.55) and 70.07% (n= 96) subjects BMI (kg/ m^2) were below 18.5 (18.07 ± 0.45) and also showed significant difference (P<0.001).

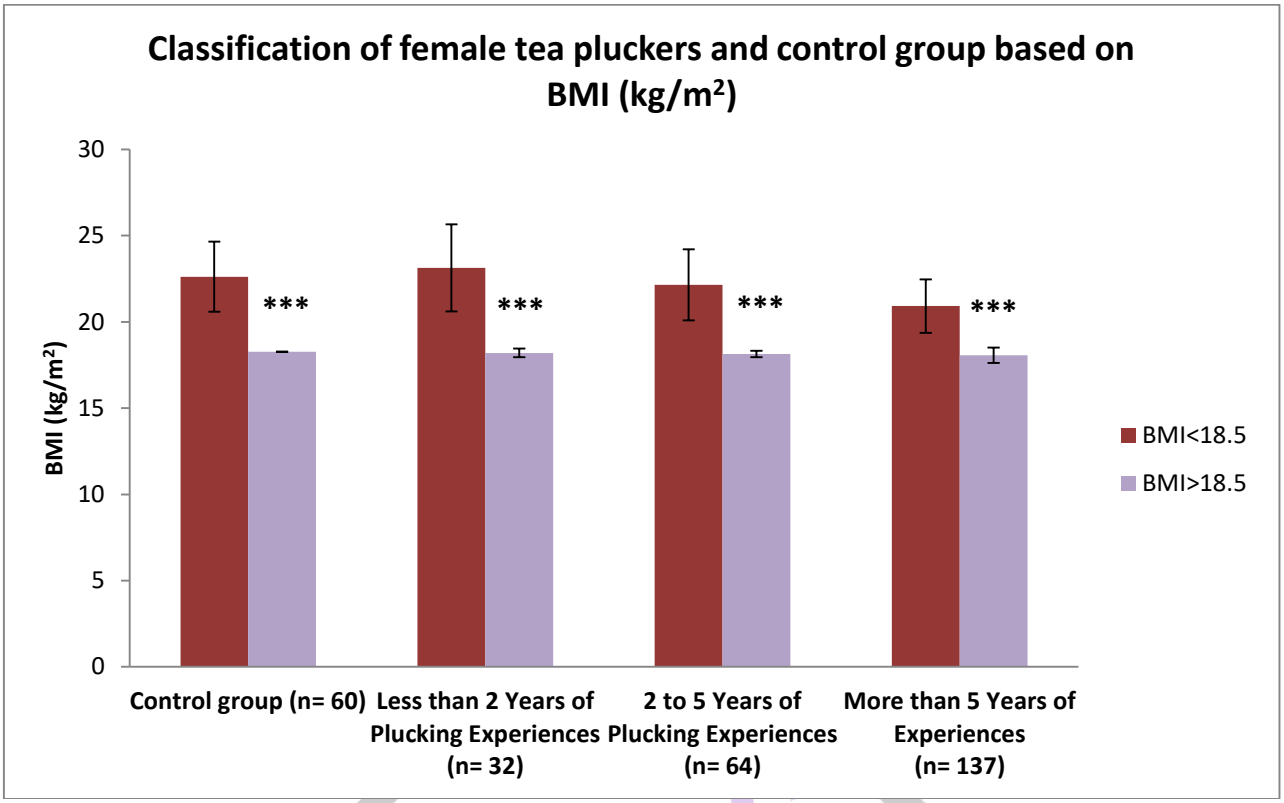

Figure 3: Classification of female tea pluckers [less than 2 years of plucking experience, n= 32; 2 to 5 years of plucking experience, n= 64 and more than 5 years of plucking experience, n= 137] and control group [n=60] subjects based on BMI (kg/m^2). Data presented as Mean ± SD. ### Significance based on two tail Students t test, compared to BMI<18 and BMI>18.5 ***P<0.001

Correlation of in between different selected variables

To find correlation, if any, in between different selected variables we performed Pearson's r correlation coefficient and presented in Table 8. Results of correlation study revealed that productivity or Total yield in terms of plucking Tea Leaf kg/day was significantly and positively correlated with hemoglobin, BMI, height and weight.

Table 4: Correlation matrix within different variables of female tea pluckers grouped according to their experiences and control group

	Less than 2 Years of Plucking Experiences		2 to 5 Years of Plucking Experiences		More than 5 Years of Experiences	
	r*	p value**	r*	p value**	r*	p value**
Hb vs TE	0.410	P<0.001	0.487	P<0.001	0.679	P<0.001
BMI vs TE	0.323	P<0.001	0.315	P<0.001	0.458	P<0.001
Height vs TE	0.397	P<0.001	0.801	P<0.001	0.470	P<0.001

Weight vs TE	0.564	P<0.001	0.200	P<0.001	0.663	P<0.001
Mid upper arm circumference (cm) vs TE	0.517	P<0.001	0.621	P<0.001	0.726	P<0.001

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

Discussion

In India the high prevalence of anemia among women is a trouble for them and also for their families. Not only that it also sluggish the economic growth and productivity of the country (Bently and Griffiths, 2003). Results of our study revealed that out of total female pluckers in our study, 92.27% female tea pluckers were anemic (Hb concentration below 12 gm/dL) and 54.07% female tea pluckers BMI (kg/m2) less than 18.5. The results of standard of living index (SLI) reflect the effect of poverty on women's nutritional and anemic status. Prevalence of moderate anemia (Hb concentration less than 12g/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 effect of their own and family members income, literacy standard and inadequate food intake impacted a lot in their health status. Productivity in terms of tea leaves reduced because of their poor health status which eventually affects their income from tea garden. Anthropometry is a low cost but powerful tool compared to clinical and laboratory test for the assessment of nutritional status in the on field study [17]. In addition, BMI is considered to be the most appropriate anthropometric indicator of nutritional status of the adult. BMI is derived from weight and height of individuals. BMI is highly correlated with body weight (or stored energy within the body) and is relatively independent of the height of the adult.

While a BMI <18.5 are considered the cutoff for the diagnosis of chronic undernutrition in adults, a series of cut-offs is provided to delineate the degrees of severity of undernutrition [18]. Mean BMI of all the groups of study participants were within normal range, but BMI (kg/m2) of female tea pluckers with more than 5 years of plucking experience were significantly lower (P<0.001) compared to control subjects, female tea pluckers having less than 2 years of plucking experience and 2 to 5 years of plucking experience. Not only that, BMI (kg/ m2) of most of the female tea pluckers having more than 5 years of plucking experience [70.07% (n= 96)] were below 18.5 (18.07 ± 0.45). And total yield in terms of plucking tea (kg) per day were also significantly lower in female tea pluckers more than 5 years of plucking experience. Lower BMI showed less productivity and this can be correlated with the earlier report of Gilgen et al., 2001 [19]. Results of our study also revealed that weight(kg) and body area (m2) was found to be significantly lower (P<0.001) in female tea pluckers having more than 5 years of plucking experience compared to control subjects, female tea pluckers having less than 2 years of plucking experience and 2 to 5 years of plucking experience. Also, female tea pluckers having more than 5 years plucking experience showed significantly lower estimated lean body mass (kg) (P<0.01), estimated body fat (kg) (P<0.001), waist circumference (cm) (P<0.05) and hip circumference (cm) (P<0.001) compared to control subjects. So these results are also indicative of comparatively inferior nutritional status of female tea pluckers as compared to control subjects. And these changes were found to be related to duration of plucking experience of female tea pluckers. Results of our study also revealed that female tea pluckers having more than 5 years plucking experience showed significantly lower mid upper arm circumference (cm) (MUAC), compared to control subjects, female tea pluckers having less than 2 years of plucking experience and 2 to 5 years of plucking experience. And total yield in terms of plucking tea (kg) per day were also significantly lower in female tea pluckers with more than 5 years of plucking experience compared to female tea pluckers having 2 to 5 years of plucking experience. So, in our study we observed tea leaf plucking (kg) per day (productivity) reduced in the female tea pluckers with reduction in MUAC which is well corroborated with the earlier finding that small MUAC was associated with the lower productivity in workers [20].

Results of our study also revealed that out of total female pluckers in our study, 92.27% female tea pluckers were anemic (Hb concentration below 12 gm/dL). Mean hemoglobin concentration of female tea pluckers with more than 5 years of plucking experience were significantly lower (P<0.001) compared to control subjects and female tea pluckers having 2 to 5 years of plucking experience. Among, female tea pluckers with more than 5 years of plucking experience 56.20% subjects were moderately anemic and 37.96% subjects were found mild anemic. We observed significant correlation in between work productivity in terms of tea leaf plucking (kg) per day in each pluckers and hemoglobin concentration of all three female tea pluckers groups.

We also observed similar significant correlation in between productivity and weight, BMI, BSA and MUAC in all three female tea pluckers groups. All the results from this study collectively point in the same direction that prevalence of anemia and lower weight, BMI, BSA and MUAC had a negative impact on work productivity in terms of tea leaf plucking (kg) per day in female tea pluckers. Low productivity of female tea pluckers in turn result in less earning and inability to procure quality food items which eventually worsen the prevalence of anemia and also reduces other physiological variables like weight, BMI, BSA and MUAC in these population. These contribute to a cycle that maintains low standard of living index in these female tea pluckers.

Conclusion

So in conclusion, adequate dietary supply is essential to the female tea pluckers which demands continuous physical activity for tea plucking. In a community where women is the most important earning member of family, high occurrence of low BMI and anemia and other nutritional level based on physiological variables may have adverse impact on productivity which eventually impact the

family income. Because earning (wages) of female tea pluckers in the tea garden is directly related to the tea leaves plucked per day.

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