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Physical Characteristics and Physical Fitness of Indigenous Garo Tea Plucking women: A Study in Small Tea Plantations of Meghalaya (India)

Tapsri R. Marak[1], Deepak Bhagat[1] and Swapnali Borah[2*]

[1]*Department of Management, North-Eastern Hill University, Tura Campus- 794002, Meghalaya, India*
[2]*Department of Family Resource Management, Central Agricultural University, Tura- 794005, Meghalaya, India*

*Corresponding author

A B S T R A C T

The understanding of physical characteristics and physical fitness are considered as the best measure of an individual capability in doing physical work. A sample of 40 women working in small tea plantations of West Garo Hills district in Meghalaya were selected for the present study with two age groups 20-35 years and 36-50 years who have spent maximum years and highest field experience in tea leaf plucking. Physical characteristics of subjects were assessed by recording age, height, weight, Body Mass Index (BMI), VO_2 max of women workers. The mean age of all the women workers was 35.02 years, mean weight was 48.22kg with 150.92 cm height. The mean of the VO_2 max of the subjects was 25.68, Lean body mass is 35.7kg, fat weight is 13.4kg and the computation of Body Mass Index (BMI) was 21.29 which can be considered in normal category and majority of women workers belonged to ectomorphic group. Physical fitness level of majority of women workers was of high average, the average grip strength of women tea garden workers was 25.28 kg and the average strength of back of women was 53.19 kg.

Introduction

The Indian Tea Industry is about 172 years old and is one of the largest tea producers in the world. India has emerged as world leader in all aspects of tea production, consumption and export mainly because it accounts for 31% of global production (Ministry of Agriculture, GoI, 2015). Tea plantations are mainly located in rural hills and backward areas of North Eastern states and Southern parts of India. Tea production is both land as well as labour intensive activity (Saikia *et al.,* 2014). Though tea cultivation has been introduced lately in the district of West Garo Hills in comparison to other parts of north-east India, it has shown considerable improvement in area and production over the years. The tea area in the district has increased from 287 ha in 2000-01 to 600 ha in 2012- 13.

In terms of area and production, West Garo Hills ranks first in the entire Garo Hills.

According to Hazarika and Borah (2013) small tea plantation provides employment opportunities with the potential of transforming the socio-economic condition of the rural people. Tea plantation is an agro based labour intensive industry providing employment to over one million workers comprising mostly of immigrant workers and their descendants (Labour Bureau, Ministry of Labour and Employment, Government of India, 2009) but indigenous Garo people are engaged in tea cultivation in West Garo Hills district of Meghalaya. Small tea plantations are confined to Rongram block in West Garo Hills along the hilly areas in Meghalaya which is ideal for tea cultivation. An earlier report also had suggested that poor workplace design caused increases in physical stress and postural shifts as well as decreases in performance (Antle *et al.,* 2018; Karwowski *et al.,* 1994). Chaffin and Anderson (1984), Pan and Schleifer (1996) reported that there is an interrelationship between posture, comfort and performance in plucking - based activity. While performing the activities they require maintaining some postures for a long period of time which may cause damage to the health. Women workers generally complaint of body ache, pain in the neck, leg, hand and other parts of the body so their fatigue arise soon which reduce the productivity in tea garden (Biswas *et al.,* 2002). Women are predominantly associated with number of manual, rigorous tasks in small tea plantations. Women perform most of the difficult activity such as plucking and weeding in tea gardens. Female workers are predominantly engaged in tea leaf plucking (Bhadra, 1992; Engels, 1993; Labour Bureau, 2012). On the other hand, too much physical stress may cause injuries or break down over time (Bhattacharya and Mc Glothlin, 2012). The productivity of labour depends on the working conditions. The working conditions of workers in tea garden were exploited where they perform their task has a great bearing on

their health and efficiency which in due course affect production (Bhatt, 1988; Chatterjee, 1990; Brackbill *et al.,* 1994). There should be job demand and physical fitness compatibility to improve physical stress on bodies and improved performance. Therefore, the study intends to know the physical characteristics and physical fitness of women workers involved in small tea plantations.

Materials and Methods

At present there are 402 registered tea gardens in West Garo Hills district of Meghalaya, out of which ten percent (10%) of tea gardens i.e. forty (40) tea gardens are sorted out on the basis of area which is more than 4 acre where at least 3 women workers involved in tea plucking activity was selected from each garden. Thus, 120 workers form baseline information. Again Forty (40) women workers were selected with two age groups 20-35 years and 36-50 years who have spent maximum years and highest field experience in tea leaf plucking because there is an existing significant positive correlation between years of involvement and perceived exertion; and years of involvement and musculoskeletal problems (Borah, 2015). The subjects was free from muscular and vascular abnormalities and who have body temperature not above 99º F, blood pressure 120/80 ± 10, and heart rate 70-90 bpm was selected for the experiment.

Methods of measuring physical characteristics

Physical characteristics was assessed by taking measurement of height, weight, body composition, body mass index (BMI) etc. by using anthropometric kit along with Harpenden skinfold caliper and physical fitness was interpreted by physical fitness index (Harvard step-test score) and by

assessing VO_2 max. Hand grip strength was assessed by using hand grip dynamometer and back strength was assessed by using back dynamometer.

Body Mass Index (BMI)

The Body Mass Index or Quetlets index was used to find out the physical fitness of the workers and indicate the energy adequacy. It can be calculated by the formula given by Deurenberg *et al.,* (1991).

$$BMI = \frac{Body\ weight\ (kg)}{Height\ m^2}$$

Body type

For assessing body composition multiple skin fold anthropometry was used for the measurement of skin fold thickness for determining the body density, per cent body fat, fat weight and lean body mass. The formulae given by Durwin and Rehman, (1967) were used in determining the body density, percent body fat, fat weight and lean body mass.

Physical fitness

Physical fitness is defined as the capacity of the person to meet the physical demands to carry out daily activities energetically and vigilantly in a specified time without any undue stress and fatigue with a number of components such as cardio respiratory endurance, muscle strength, muscle endurance, flexibility and body composition, cardio respiratory endurance – measure of the circulatory and respiratory systems ability to deliver required oxygen and nutrients in order to fuel muscles during physical activity.

Physical fitness of the subjects was recorded with the help of two methods

Wooden stool ergometer: Wooden stool ergometer was used which has dimension of

LxBxH: 45x30x24 cm. The subjects were given rest and then her heart rate was measured. During the stepping activity, heart rate of the subject was recorded for the entire stepping period for 5 minutes with an interval of one minute each. After 5minutes of stepping activity, the subject was given rest and their recovery pulse for 5 minutes was recorded at an interval of 1 minute in the same manner as that of stepping activity.

Physical fitness Index =
$$\frac{Duration\ of\ stepping\ (sec)}{Sum\ of\ I,II\ and\ III\ min\ recovery\ pulse\ count} \times 100$$

Scores of step stool were interpreted as below:

Up to 80:   Poor physical fitness
81-100:   Low average
101-115:   High average
116-135:   Good
136-150:   Very good
Beyond 150:   Excellent

Physical fitness on the basis of VO_2 max: VO_2 max of the selected subjects was calculated from the following linear equation (Chauhan and Saha, 1999):

VO_2 max (ml/kg $\times$ min) = 0.377 $\times$ Step stool score (PFI) – 12.767

The VO_2 Max was calculated to evaluate the physical condition of the individual workers. The physical fitness of selected sample was studied through this method as per classification by Varghese *et al.,* (1994). The formula is based on the relationship between age and body weight as they have great influence on VO_2 max. The use of step test scores as a measure of physical fitness was strongly supported by many scientists in view of strong positive correlation being observed between physical fitness index (Harvard step-test score) and VO_2 max (Astrand and

Rhyming 1954, Astrand and Rodahl 1970, Saha and Banerjee 1970). Based on VO_2 max, the level of physical fitness of the subjects was classified as follows:

Upto 15.0:   Poor
16.0-25.0:   Low average
26.0-30.0:   High average
31.0-40.0:   Good
41.0-45.0:   Very good
Beyond 45.0:   Excellent

Back strength

In some studies prolonged static muscle contraction appears to be related to head, neck and shoulder pain. The degree of forward bending of the head also appears to be related to the incidence of neck complaints. Schuldt *et al.,* (1986) reported increased level of muscular tension in the cervical region when the neck is bent and Hagberg (1984) suggested that static muscular tension is a factor that possibly favours the appearance of pain. Back Dynamometer was used to measure the strength of the back. It was measured by making the subject stand on the platform with their feet about 15 cm part from each other. Then they were made to hold the handles with both hands and adjust the length of chain so that their straightened back tilts at a forward angle of 30 degrees. The handle is then made to pull by gradually raising their upper body taking care that their legs were not bent at the knee. The results were compared to "Standard Values of Physical Strength of the Japanese 2000" by the Standard Physical Strength Survey Team, Tokyo Metropolitan University.

Hand grip strength

Handgrip strength is a strong indicator of health status to determine total muscular strength of fingers, hands and wrist and endurance. Muscle strength is the ability of a muscle to generate force for a short period, and muscle endurance is the ability of a muscle to generate force over several repetitions or to continue maintaining that force over a period of time. Hand grip strength reflects the maximum strength from combined contraction of extrinsic and intrinsic hand muscles which leads to flexion of hand joints. Age and gender are the determinants of hand grip strength in healthy people.

Results and Discussion

Physical characteristics of women workers in tea plucking activity

The physical characteristic is considered as one of the best measure of an individual capability in doing physical work. Table 1 indicates the physical characteristics of the women workers engaged in tea plucking activity which revealed that the mean age, weight and height of the women workers was 35.02 years, 48.22kg and 150.92 cms respectively.

The mean of the Lean body mass of tea garden women workers was 35.7kg, fat weight was 13.4kg, VO_2 max of the respondents was 25.68 and the computation of Body Mass Index (BMI) revealed that the average BMI was 21.29. The mean blood pressure was 118/72 and pulse rate (74.96 beats/min) and the body temperature (98.6° F) which were in the normal range. Bharara *et al.,* (2012) and Nauriyal (2006) also revealed in their studies that BMI of women workers were 18.54 and 18.30 respectively. Bhasin and Jain 2007 highlighted an increase in the mean values of BMI in both males and females with advancing age. Borah and Baruah (2016) also found BMI of rural women of Assam involved in the activity of sun drying of grain to be 19.8 which was also in normal category.

Body Mass Index (BMI)

BMI is a person's weight in kilograms divided by the square of height in meters. A high BMI can be an indicator of high body fatness and can be used to screen for weight categories that may lead to health problems but it is not diagnostic of the body fatness or health of an individual. Further analysis of BMI in table 2 showed that the BMI of 5% of women workers involved in tea plucking activity belong to CED Grade III, 5% to Grade II, 7.5% to Grade I, 10% to Obese Grade I and majority i.e. 67.5% belong to the normal weight category. Body mass index is an important anthropometric index and has emerged as an important indicator of health and nutritional status among human subjects at different age levels (Kaur and Singh, 2005; Biswas *et al.,* 2002).

Body type

BMI is a measurement of leanness based on height and weight of a person, and is intended to quantify tissue mass. It is widely used as a general indicator of whether a person has a healthy body weight for their height. Specifically, the value obtained from the calculation of BMI is used to categorize whether a person is underweight, normal weight, overweight, or obese depending on what range the value falls between. It is observed in Table 3 that the majority of the respondents showed Ectomorphic group (55%) with high metabolism and easily maintain a low fat physique but does not add muscle or body weight. About 35% possess the typical traits of a mesomorph body type with large bone structure, large muscles and a naturally athletic physique. Only 10% of the respondents fit into Endomorphic type who is usually of a shorter build with thick arms and legs and stronger muscles especially the upper legs. Bhattacharyya (2012) conducted a study in Assam and Sengupta and Sahoo (2012)

also studied tea garden labourers in West Bengal and they expressed that majority of the female workers belong to ectomorphic group and most of them had mild Chronic Energy Deficiency.

Physical fitness

After assessing the physical fitness of the women worker involved in tea plucking it can be said that the physical fitness level of women workers was of high average. It was observed in Table 4 that physical fitness level of majority women workers was high average depicted through both step test score and VO_2 max. The younger age group (20-35 yrs) were more physically fit where 65%, 30% and 5% indicated high average, good and very good step test score and VO_2 max respectively compared to the older women (36-50 yrs) which reflected poor (5%), low average (70%) and high average (25%) step test score and VO_2 max. Medhi *et al.,* (2006) reported prevalence of stunting and thinness among different age groups of tea garden workers. Level of physical fitness of women tea garden workers was of high average indicating improvement in work capability and efficiency. In this context, aerobic capacity (VO_2 max) has been considered to be a reliable and valid measure of physical fitness Sengupta and Sahoo (2011) and endurance; as VO_2 max increases, this indicates greater respiratory capacity and thus better cardio respiratory fitness.

Hand grip strength

Hand grip strength is an indication of overall muscle strength which is quantified by measuring the amount of static force generated by one's forearm muscles. Hand grip strength of women worker was assessed and presented in Table 5 which shows that the average grip strength of women tea garden workers was 25.28 kg. The result was

compared with "Standard Values of Physical Strength of the Japanese 2000" by the Standard Physical Strength Survey Team (SPSST), Tokyo Metropolitan University and found that 5.45 kg less than Japanese women. Arvandi *et al.,* (2016) indicated that low hand grip strength is associated with older age group but it is also important to recognize its relation with anthropometric variables indicative of age and significant factors such as nutritional status and level of physical activity and chronic diseases. Borah (2015) reported that the average hand grip strength of farm women was 28.59 kg and further analysis showed that the grip strength is little higher (29.55 kg) among young age group in comparison to older age group (27.62 kg).

Table.1 Physical characteristics of women workers in tea garden

Parameter (Average)	(20 – 35 yrs.) n = 20 (SD)	(36 – 50 yrs.) n = 20 (SD)	Total (20 – 50 yrs.) N = 40
Age (yrs)	25.30 (4.50)	44.70 (5.18)	35.02
Weight (kg)	46.20 (5.47)	50.25 (6.50)	48.22
Height (cm)	151.25 (7.40)	150.60 (4.39)	150.92
Lean Body Mass (kg)	34.70 (4.51)	37.18 (4.30)	35.7
Fat Weight (kg)	11.92 (2.71)	13.06 (2.89)	13.4
VO$_2$ Max (m1/kg x min)	29.69 (3.85)	22.55 (3.33)	25.68
BMI	20.44(3.26)	22.13(2.47)	21.29

Table.2 Body Mass Index (BMI) of the women workers involved in tea plucking activity

BMI class	Presumptive diagnosis	Age group		
		20-35 yrs n=20	36-50 yrs n=20	Total (20-50 yrs) N=40
16.0	* CED Gr. III (Severe)	10	-	5
16.0 – 17.0	* CED Gr. II (Moderate)	10	-	5
17.0 – 18.5	* CED Gr. I (Mild)	10	5	7.5
18.5 – 25.0	Weight normal	60	75	67.5
25.0 – 30.0	Obese (Grade I)	5	15	10
Above 30.0	Obese (Grade II)	-	-	-

(*CED stands for chronic energy deficiency)

Table.3 Body Type of the tea garden women workers

Age Group	Score	Body Type	Percentage (%)
20-35 yrs n= 20	<21.50	Ectomorphic	70
	21.5-25.0	Mesomorphic	25
	>25.0	Endomorphic	5
36-50 yrs n= 20	<21.50	Ectomorphic	40
	21.5-25.0	Mesomorphic	45
	>25.0	Endomorphic	15
Total (20-50 yrs) N=40	<21.50	Ectomorphic	55
	21.5-25.0	Mesomorphic	35
	>25.0	Endomorphic	10

Table.4 Physical fitness of women workers in tea garden

PFI- Step Test	Age Group		
	20-35 yrs (n=20)	36-50 yrs (n=20)	Total (20-50)yrs (N=40)
Poor	-	5%	2.5%
Low average	-	70%	35%
High average	65%	25%	45%
Good	30%	-	15%
Very Good	5%	-	2.5%
Excellent	-	-	-
PFI-$VO2$ max			
Poor	-	5%	2.5%
Low average	-	70%	35%
High average	65%	25%	45%
Good	30%	-	15%
Very Good	5%	-	2.5%
Excellent	-	-	-

Table.5 Hand grip strength

Age group	Average hand grip strength (kg)	SD	Average standard value by SPSST* (kg)	Difference
20-35 yrs n=20	26.44	2.67	31.66	-5.22
36-50 yrs n=20	24.11	2.50	29.80	-5.69
Total 20-50 yrs N=40	25.28	2.82	30.73	-5.45

*SPSST denotes Standard Physical Strength Survey Team (SPSST), Tokyo Metropolitan University

Table.6 Average strength of back of women workers in tea plucking activity

Age group	Average Strength of back (kg)	Average Std value by SPSST*(kg)	Difference
20-35 yrs	50.44	86.08	-35.64
36-50 yrs	55.94	83.69	-27.75
Total (20-50 yrs)	53.19	84.88	-31.69

*SPSST= Standard Physical Strength Survey Team (SPSST), Tokyo Metropolitan University

Back strength

Muscular stresses in terms of frequency of postural charge, intensity of body pain especially in low back, due to deviation of spinal curvature during tea plucking activity which was found to be higher for women in the 30-50 year age group and a leading cause of disability among adults. When awkward posture is for long duration chances of back disorders is at high risk. This forward bend of the head and trunk put stress on the lower

spine and neck muscles making them fatigued. Table 6 indicated the average back strength of women which was 53.19 kg and compared with the Japanese women given by Standard Physical Strength Survey Team (SPSST), Tokyo Metropolitan University. The result showed that women workers involved in tea plucking activity had 31.69 kg lesser strength than Japanese women. Similar study by Borah and Baruah (2016) revealed that average strength of back (kg) of women involved in cashew nut factory was 39.95 kg which is 45.41kg less than the standard strength of back of women of that age group.

In conclusion, many studies revealed that women were exploited without any consideration of workload demands, physical fitness and nutritional status as they performed dual role of bread earner and home maker. After assessing the physical anthropometric parameters i.e. it was found that the physical fitness of women workers in small tea plantations was found to be within normal range indicating majority of women showed ectomorphic group with high metabolism and easily maintain a low fat physique but does not add muscle or body weight indicating that women working in tea gardens are habituated to perform heavy muscular work regularly. The findings of the study revealed that strength and endurance needs to be developed as muscle mass develops very slowly. The activities performed by the workers in tea cultivation are repetitive and monotonous and the workload is considered as the most important factor affecting the health problems in small tea growing sectors (Bindu and Reddy, 2016; Rasaily, 2016). Therefore, primary concern should be for promotion of health related physical fitness. Thus, it may be inferred that workload as well as nutritional status has influence over the ergonomic and physical fitness status of tea garden women workers.

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