



## Physiological workload of ethnic Garo women of Meghalaya involved in tea leaves plucking activity

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### ABSTRACT

Workers in small tea plantations are employed particularly for the task of plucking tea leaves which is perceived to be the most difficult task as maximum time is spent in this activity, involvement in work is continuous and standing for long durations carrying tea leaves in basket which affects the performance of the workers. The present study was undertaken to analyze physiological workload of forty (40) ethnic Garo women in the two age group 20-35 years and 36-50 years engaged in tea plucking activity in West Garo Hills district of Meghalaya. Interview and experiments were conducted to collect the relevant data from the respondents. Results revealed that majority of women in tea plucking activity complained of tiredness which is merely a subjective feeling for the assessment of workload. The average mean score of heart rate and energy expenditure were 121.17 bpm and 10.22 kJ/min, respectively. Further, it was also observed that the average and peak heart rate of age group (36-50) years was higher than women belonging to (20-35) years. While tea plucking activity being rated as moderately heavy the cardiovascular stress index was 34.84 which was quite high compared to the value of other workers of different industries. Therefore, there is a need to assess perceived physiological workload of ethnic Garo Women involved in tea plucking activity in detail so that their health efficiency and productivity can be promoted.

### 1. Introduction

Women play a significant role in domestic and socio-economic life of the society, nutrition security, generating income, and improving overall well-being of the rural people (Gran, 2019). One of the factors highlighting the contribution of small tea plantations in Meghalaya is that the local people earn income from this sector (Halayya, 1969; Viswanathan *et al.* 2003; Hayami and Damodaran, 2004 and Sarkar, 2008). Though tea cultivation has been introduced lately in West Garo Hills, Meghalaya in comparison to other parts of north-east India, it has shown considerable improvement in area and production over the years (Marak, Bhagat and Borah, 2019).

Tea cultivation in Meghalaya has a favourable unique topography with sandy loam and heavy rainfall accompanied by hilly terrain (Anonymous, 2006). As tea industry provides employment to large number of families in this sector, they are involved at every stage of production starting from nursery development of the young tea plants to plucking of tea leaves to carrying of excessive load in *kokcheng* (a native bamboo basket) to the collection centres. Most of the activities involved in maintaining work relating to tea leaf plucking require a high degree of physical effort which impact the health of women workers engaged in tea plucking activity. Women in tea garden perform extremely tedious, time and labour intensive work for eight hours

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resulting in fatigue while performing different activities. They perform in constant motion in shifts from morning to evening without adequate breaks. The activity in tea garden demands working in extreme environment conditions and perform in a traditional way by hand plucking without knowing its impact on the health of tea garden workers. 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 workers (Bindu & Reddy, 2014 and Marak *et al.* 2019). Since the women workers perform manually in sustained awkward postures which lead to irreparable damage to the body. It may create frequent complaints of body aches, pain in neck, arm and lumbar region. Due to this back breaking and drudgery prone work, the output and leisure of the workers decrease and the health is also affected adversely (Bhattacharyya, Baruah & Farhanaali, 2013). The trend of West Garo Hills production has increased substantially from 2001-2002 which was 4,80,000 kg and touched a new height of 17,89,683kg in 2015-2016 (Anonymous, 2015-16). The production for the year 2014-2015 was 27,533kg and 2015-16 is 25,6285kg in Rongram and Tebronggre tea garden covered by 4.25 ha plantation area. The safety and health of workers in tea production is responsible for the fluctuations in productivity. The productivity of labour depends on the favourable conditions of the workplace. The working conditions should be compatible to the workers with health given priority and efficiency which in due course affect production. Tea production needs to show an increasing trend to keep up with the global market demand besides internal consumption. Role of women workers in small tea plantations goes widely unnoticed and undocumented and the understanding of health and welfare of women working in tea garden continue to remain a problem area. Therefore, there is a great need to analyze their workload in terms of physical stress and its effects of physiological workload so that some suitable techniques and measures can be developed to reduce the workload of women workers of tea plantation (Varghese, Saha & Atreya, 1994), thereby improving the health, human comfort and

and safety of the workers (Kathirvel *et al.*, 2000) leading to higher productivity.

## 2. Materials and Methods

As per the report of Tea Board of India, there are at present four hundred and two (402) registered small tea gardens in West Garo Hills of Meghalaya which were first arranged in descending order on the basis of tea area which has more than 4 hectares under each garden (Chowdhury *et al.* 2016). For baseline survey, ten percent (10%) of tea gardens *i.e.* forty (40) tea gardens were selected where at least 3 women workers were involved in tea plucking activity. Total of 40 subjects of two age groups (20-35 yrs and 36-50 yrs) involved in tea plucking activity were selected purposively for the study who have highest field experience in tea leaf plucking because there exist a significant positive correlation between years of involvement and perceived exertion; and years of involvement and musculoskeletal problems (Borah, 2015 and Marak *et al.*, 2019). The subjects who had body temperature not above 99° F, blood pressure 120/80 ± 10, and heart rate 70-90 bpm were selected for the experiments. In order to collect the reliable experimental data, the selected subjects were given enough rest before putting them on selected tasks.

### 2.1 Methods of measuring the ergonomic parameters during tea plucking activity

Following methods were used for measuring the selected ergonomic parameters during rest and during tea plucking:

#### 2.1.1 Cardiovascular stress

Heart rate (beats/min) was measured with the help of polar heart rate monitor, which consisted of one transmitter and one receiver to transmit and receive the ECG signals. Transmitter was tied on the chest of the subject receiver was tied on the wrist and ECG signals were recorded at rest, during the entire period of work and recovery thereafter for a period of 5 minutes. Recording of heart rate with this method is very simple and less time consuming. At the same time is equally reliable method to measure

physiological workload. It has got some additional advantages that it takes into account environmental heat and posture at work. The use of this method has been advocated by many researchers in the field of work physiology (Lundgren 1946, Berggren and Christensen 1950, Malhotra *et al.*, 1963, Ganguli and Dutta 1975, Saha and Banerjee, 1976) and is now widely used in world over, as a measure of physiological workload in industries and other field situations.

### 2.1.2 Energy Expenditure

This method has been in extensive use in work physiology since long (Christensen 1953, Durnin and Passmore 1967, Saha and Banerjee, 1976). Though the estimation of energy expenditure through oxygen consumption during work is accurate and reliable, it has certain disadvantages particularly while using in field situation, because of involvement of complicated and time consuming procedures and requirements of elaborate laboratory facilities. Hence, this method was not used in the present study. Here energy expenditure was estimated from average heart rate during rest and during work by using following formula proposed by Varghese *et al.*, 1994 for Indian housewives:

$$\text{Energy Expenditure (kJ/min)} = 0.159 \times \text{Average heart rate (beats/min)} - 8.72$$

### Classification of physiological workload

Physiological workload was classified on the basis of heart rate and presented in the Table below (Varghese *et al.*, 1994):

Physiological workload	Physiological variable (Heart rate)
Very light	Up to 90
Light	91-105
Moderately heavy	106-120
Heavy	121-135
Very heavy	136-150
Extremely heavy	Above 150

### 2.1.3 Total cardiac cost of work (TCCW) and physiological cost of work (PCW)

Physiological workload was classified on the basis of working heart rate [5]. Total cardiac cost of work (TCCW) and physiological cost of work (PCW) were determined by using average heart rate during rest and work, recovery

heart rate and duration of work and recovery through the following formulas:

$$\text{Total cardiac cost of work} = \text{Cardiac cost of work} + \text{Cardiac cost of recovery} \quad (\text{TCCW}) \quad (\text{CCW}) \quad (\text{CCR})$$

Where, CCW = AHR × Duration of work

AHR = (Average working heart rate – Average resting heart rate)

CCR = (Average Recovery heart rate – Average resting heart rate) × Duration of recovery

$$\text{Physiological Cost of work} = \frac{\text{Total Cardiac Cost of Work}}{\text{Total Time of Work}}$$

### 2.1.4 Cardio Vascular Stress Index

Cardiovascular Stress Index (CSI) was determined by using following formula given by Trites *et al.*, 1993.

$$\text{CSI} = \frac{100 (\text{Heart rate during work} - \text{Heart rate during rest})}{\text{Heart rate maximum} - \text{Heart rate at rest}}$$

Where, Heart rate maximum = 220 – Age (years)

## 3. Results and Discussion

### 3.1 Details of tea plucking activity

Women working in tea plucking need to start their journey from home to tea garden in the morning carrying *kokcheng* (a native bamboo basket). They normally fill 4 baskets with tea leaves in a day. These filled baskets have an average load of 13.32 kg which they then empty into a big plastic bag placed near the tea garden. The nature of activity involved in small tea plantation consisted of women labour force working in awkward standing posture in sloping tea gardens in extremes of temperature from morning to evening for seven to eight hours per day regularly for six days in a week. The ethnic women in hills covered on an average distance of 1.065 km per day from four workstations *i.e.* home to tea garden, inside the tea garden, tea garden to collection centre, collection to home which required 1696.65 steps and 7.52 hrs of hills climbing.

**Table 1.** Details of tea plucking activity

Tea plucking activity	20-35 yrs	36-50 yrs	Total
Distance covered	1.04	1.09	1.065
Required steps	1653.25	1740.05	1696.65
Carrying load (kg/basket)	13.2	13.45	13.32
Time spent (per day)	7.45	7.6	7.52
Frequency of doing work	Daily	Daily	Daily

### 3.2 Classification of workload of tea plucking women workers

The average heart rate and peak heart rate, average energy expenditure and peak energy expenditure and the classification of workload were determined in Table 2. It was observed that the total average heart rate and peak heart rate were 118.2 and 121.18 bpm, respectively. Further it was also observed that the average and peak

heart rate of older age group (36-50 yrs) was higher than women of younger age group. The average and peak energy expenditure were 10.22 kJ/min and 10.97 kJ/min, respectively. It was also found to be higher for older age group. On the basis of average heart rate and peak heart rate, tea plucking activity was classified into five categories, viz. very heavy, heavy, moderately heavy, light and very light. When the classification of workload was made on the basis of average heart rate, the activity of tea plucking was rated as "moderately heavy". Tea-leaf plucking has been classified as a "light" job in terms of energy expenditure and "moderately heavy" in terms of heart rate. Varghese *et al.* (2000) also reported that the acceptable limits of physiological workload among women workers as determined from energy expenditure and heart rate were found to be 10kJ/min and 110bpm, respectively for eight hours continuous work. Borah (2009) revealed that the perceived workload of the activity by the female workers was heavy to very heavy and they felt severe to very severe pain in both upper and lower extremities and most of the joints of the body.

**Table 2.** Heart rate, Peak heart rate, Energy expenditure, Peak Energy Expenditure and Classification of workload of tea plucking women workers

Age group	Average heart rate (bpm)	Average Peak heart Rate (bpm)	Energy expenditure (kJ/min)	Peak energy expenditure(kJ/min)	Classification
20-35yrs	117.9	117.9	9.74	11.15	Moderately heavy
36-50 yrs	118.5	124.45	10.69	10.79	Heavy
Total (20-50yrs)	118.2	121.18	10.22	10.97	Moderately heavy

### 3.3 Total Cardiac Cost of Work and Physiological Cost of Work

It was observed that average total cardiac cost of work (TCCW) and physiological cost of work (PCW) of tea plucking women workers were 21985 beats and 40.71 bpm, respectively (Table. 3). It was also noticed that TCCW and PCW were higher in case of older women in comparison to younger women. Work with high metabolic demand can lead to physical and mental fatigue increase in work injuries and decrease in work performance, higher risk for cardiovascular diseases (Karpansalo *et al.*, 2002:

Krause *et al.*, 2007; Wigaeus Tornquist *et al.*, 2011; Wulch *et al.*, 2012; Krause *et al.*, 2014).

**Table 3.** Total Cardiac Cost of Work (TCCW) and Physiological Cost of Work (PCW) of the subjects while performing tea plucking activity" is part of Table 3 title. The Table 3 title should be "Total Cardiac Cost of Work (TCCW) and Physiological Cost of Work (PCW) of the subjects while performing tea plucking activity

Age Group	Parameters	
	TCCW (beats)	PCW (bpm)
20-35 yrs	21878	40.51
36-50 yrs	22746	42.12
Total (20-50)yrs	21985	40.71

### 3.4 Cardiovascular Stress Index of tea plucking women

Table 4 shows cardiovascular stress index of women workers engaged in tea plucking activity was 34.84. It was observed that the value of the cardiovascular stress was high compared to other workers of steel industry and car assembly workers (Table 5). Sen *et al.* (1983) conducted a study to evaluate the workload of Indian female tea-leaf pluckers and to grade work in terms of job heaviness. They found the operation of walking with loaded baskets to be the most strenuous job.

**Table 4.** Cardiovascular Stress Index (CSI) of subjects involved in tea leaves plucking of women workers

Age group	CSI
20-35 yrs n=20	31.48
36-50 yrs n=20	38.21
Total (20-50 yrs) N=40	34.84

**Table 5.** Comparison of Cardiovascular Stress Index between present work and other works

Work Category	Tea leaf pluckers	Steel workers	Car assembly workers
CSI	34.84 ± 8.09	25.0 ± 14.0	20.0 ± 7.0

### 4. Conclusion

Workload demands for women workers in small tea plantations was considered extremely tedious, time consuming and labour intensive due to their performing dual role, physical fitness and nutritional status and their biological functions (Shramshakti, 1988). The literature on physiological workload indicates age-related imbalance between physical workload and physical work capacity is suggested to result in a chronic overload, increasing the risk of long-term health effects such as musculoskeletal complaints and disorders. For many aging workers in physically demanding occupation, extreme physical workloads, increasing the risk of disease or disablement, are still reported. In terms of heart rate, the average and peak heart rate of older age group (36-50 yrs) was higher than women of younger age group. As a result, the aggregate workload placed on them tends to be so high that at times it becomes incompatible with their physical fitness leading to fatigue thereby lowering in efficiency and impairment of

health in the long run. It is reported that when Individual gets fatigued there is a gradual decrement in the capacity for work as well as in the agility and alertness, thereby leading to accident potentialities and lower productivity (Caplan & Lindsay, 1946; Mackworth, 1950). Therefore, there is a need to promote awareness, knowledge and training programmes for improving the working condition and body posture and ergonomic interventions are required for reduction of drudgery of work of women which would contribute to higher productivity.

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