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## Physiological workload of hill farm women of Meghalaya, India involved in firewood collection

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### Abstract

Women are not only carriers of human race but civilization and sustainable development rest on them. Their role is quietly appreciated without economic recognition, regard and accountability. The household activities farm women of Meghalaya do are labour intensive, time consuming, arduous, monotonous, repetitive, manual and within economic return resulting in fatigue and drudgery. This study was conducted to determine the perceived physiological exertion, physiological responses and musculoskeletal problem while doing the activity of firewood collection. The subject included forty tribal women of West Garo Hill of Meghalaya within the age group of 20 to 50 years having the average BMI of 21.74, Lean body mass 31.99 kg., fat weight 12.59 kg.,  $VO_2$  max. 25.59 ml/kg/min and grip strength of 28.59 kg. While doing the activity average heart rate, energy expenditure, total cardiac cost of work and physiological cost of work were 129.67 bpm, 11.90 kJ/min, 8529.59 beats and 47.92 ppm, respectively. The cardiovascular stress index was quite high (47.25) in comparison to many workers involved in factory activities. Perceived physical exertion was rated by farm women as “heavy to very heavy”. Incidences of musculoskeletal problem were also very high as farm women reported that they had severe to very severe pain in upper and lower back, neck, head, arm, wrist and fingers.

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## 1. Introduction

Women are the lifeline and backbone of every society and if we analyze the women's contribution in history, it is conspicuous that women are the pioneer of all civilization without any recognition. From the dawn of civilization their role is silently appreciated without economic recognition, regard and accountability. Women comprise 50 percent of the population, contribute 75% work hours receive 10% income and 1% share in property (FAO). Women's work remains unrecognized and in unorganized sector of economy despite the fact that their contribution to family is vital. Man received lion's share of income and recognition for their economic contribution, while most of women's work remains unpaid, unrecognized and undervalued because of faulty concept of labour force participation [1]. Household or domestic work is not considered as economic activity, mainly because of its use value than exchange value [2] which indicates reason behind neglect of women's economic contribution to household in particular and society in general [3]. The most striking characteristics of household labour is that, whether employed or not, women continue to do the majority of housework [4]. Women of Meghalaya are not exceptional. The Meghalaya state of North East India is a tribal dominating area where matrilineal society is prevalent. The women folk of this hilly region feel proud of doing agricultural and allied activities along with household chores. Rural women of Meghalaya make critical contributions to household production and consequently to household and national food security. The majority of rural women take on an increasing share of household labour and their lives are characterized by mounting drudgery. Drudgery of rural women is started at dawn while fetching water from far places in hilly terrain. Their work is labour intensive, monotonous, time consuming, arduous and repetitive which leads to fatigue and drudgery. Drudgery of farm women is an important aspect that has attracted wide attention of researchers. If measured by the extensiveness and intensiveness of their involvement, farm women shoulder much more burden than man [5]. Many of such activities are drudgery prone to varying degree. Even women suffer from different health problems which adversely affect their working efficiency and family welfare. Women have shorter time to rest than men and environmental degradation is increasing women's workload [6]. Considering all the study was envisaged to estimate the physiological workload of hill farm of Meghalaya, India involved in firewood collection as the activity of firewood collection was considered by hilly tribal women as most drudgery prone activity [7].

## 2. 2. Material and methods

Total of 40 subjects of two age groups (20-35yrs and 36-50 yrs) from two villages of West Garo Hills of Meghalaya who were involved in firewood collection were selected purposively for the study. 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 physical characteristics

Body mass index or Quetlets index was calculated as follows [8]. Physical fitness or body types were categorized by following Garrow's Scale[9].

$$BMI = \frac{\text{Body weight (in kg)}}{\text{Height}^2 \text{ (square meter)}} \quad (1)$$

For assessing body composition multiple skin fold anthropometry was used. Measurements of skin fold thickness, the most commonly used technique that determines subcutaneous fat in the body was done at the triceps, biceps, sub scapular and supraclavicular skin folds. These measurements were taken to derive body density, per cent body fat, fat weight and lean body mass. The following formulae used to determine the body density, per cent body fat, fat weight and lean body mass [10].

$$\text{Body density} = 1.1599 - (0.0717) \times \log \text{ of sum of 4 skin fold} \quad (2)$$

$$\text{Per cent body fat} = (4.95/D - 4.5) \times 100 \quad (3)$$

$$\text{Fat weight} = \text{Body weight} \times \% \text{fat} / 100 \quad (4)$$

$$\text{Lean body mass (kg)} = \text{Body weight} - \text{Fat weight} \quad (5)$$

## 2.2. Methods of measuring the physiological parameters

Heart rate (beats/min) was measured with the help of polar heart rate monitor and recorded at rest, during the entire period of work and recovery thereafter for a period of 5 minutes. Energy expenditure was estimated from average heart rate during rest and during work by using following formula for Indian housewives [11].

$$\text{Energy Expenditure (kj/min)} = 0.159 \times \text{Average heart rate (beats/min)} - 8.72 \quad (6)$$

Physiological workload was classified on the basis of working heart rate [11]. Total cardiac cost of work (TCCW) and physiological cost of work (PCW) were determined in this study by using average heart rate during rest and work, recovery heart rate and duration of work and recovery through the following formulas:

$$\text{Total cardiac cost of work (TCCW)} = \text{Cardiac cost of work (CCW)} + \text{Cardiac cost of recovery (CCR)} \quad (7)$$

Where, CCW = AHR x Duration of work

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

CCR = (Avg. recovery heart rate – Avg. resting heart rate) x Duration of recovery

$$\text{Physiological Cost of work} = \frac{\text{TotalCardiacCostofWork}}{\text{TotalTimeofWork}} \quad (8)$$

Cardiovascular Stress Index (CSI) was determined by using following formula [12].

$$\text{CSI} = \frac{100(\text{Heart rate during work} - \text{Heart rate during rest})}{\text{Heart rate maximum} - \text{Heart rate at rest}} \quad (9)$$

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

A modified 5-point scale of perceived exertion was used which is 1-Very light, 2- Light, 3- Moderately heavy, 4- Heavy and 5- Very heavy [13].

## 3. Results and discussion

### 3.1. Details of activity

The activity of firewood collection was studied in details and presented in Table 1. The table revealed that hilly farm women covered average distance of 3.06 km per trip of firewood collection which required 4371.43 steps and 6.24 hrs in hilly terrain of Meghalaya.

Farm women carried loads of firewood in their *kokcheng* (a kind of bamboo basket) on an average 30.88 Kg, but some of them carried up to 40 kg also. But according to ILO Report the permissible limits of lifting and carrying load for women in comfortable outdoor climatic condition in winter is 20 kg and in warm outdoor climatic condition in summer is 15 kg [14].

Table 1. Details of Activity during firewood collection.

Parameters	(20 – 35 yrs.) n = 20	(36 – 50 yrs.) n = 20	Total (20 – 50 yrs.) N = 40
Distance covered (kg)	3.10	3.02	3.06
Required Steps	4428.57	4314.29	4371.43
Carrying loads (kg)	29.85	31.9	30.88
Time spent (hrs)	6.65	5.82	6.24
Frequency of doing work	Daily*	Daily*	Daily*

\* *In dry season*

### 3.2. Physical characteristic

Physical characteristics of farm women involved in firewood collection are presented in the Table 2 and it reveals that the mean age of all the farm women was 33.95 years, mean weight is 51.40 kg with 153.80 cm height. The mean of lean body mass was 31.99 kg, fat weight was 12.59 kg along with  $VO_2$  max 25.59 ml/kg x min. Body Mass Index was 21.74 which can be considered as normal category. It was also observed that majority of subject (95%) belong to mesomorphic group. In North East India majority of Tea industry labour and cashew nut labour also had mesomorphic body type [15, 16]. On an average the 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 2. Physical Characteristics of farm women involved in firewood collection.

Parameter (Average)	(20 – 35 yrs.) n = 20	(36 – 50 yrs.) n = 20	Total (20 – 50 yrs.) N = 40
Age (yrs)	27.15	40.75	33.95
Weight (kg)	50.95	51.85	51.40
Height (cm)	154.30	153.30	153.80
Lean Body Mass (kg)	32.05	31.92	31.99
Fat Weight (kg)	12.45	12.72	12.59
$VO_2$ Max(ml/kg x min)	25.39	25.79	25.59
BMI	21.41	22.06	21.74
Body type	Mesomorphic	Mesomorphic	Mesomorphic
Grip Strength (kg)	29.55	27.62	28.59

### 3.3. Physiological responses

Physiological responses such as heart rate and peak heart rate, energy and peak energy expenditure, total cardiac cost of work, physiological cost of work, cardiovascular stress index and workload were measured while cutting and bringing firewood from far away forest and presented in Table 3. It was observed that the total average heart and peak heart rate of farm women while collecting firewood found 129.67 bpm and 139.00 bpm respectively. Further it was also observed that the average and peak heart rate of farm women of older age group (36 – 50 years) was higher than women of younger age group (20 – 35 years). On the basis of previous studies it was found that during sub-maximal work the heart rate is usually higher in older than younger people at a given level of physical effort. It is very true for unskilled or semi-skilled jobs where physical effort is required [14]. The average and peak energy expenditure was estimated at 11.90 kJ/min and 13.38 kJ/min respectively. This activity was graded as “heavy” on the basis of working heart rate and energy expenditure. It was also noticed that on an average energy expenditure of farm women of Haryana involved in fodder collection activity were 11.7 kJ/min with a load of 43.8 kg on their head and

this work was graded as moderately heavy [17]. In Maharashtra women carried a load of 22 kg while cutting and bringing fodder and peak heart rate (117 bpm) was high while doing this activity [18]. TCCW and PCW were also quite high while collecting firewood (8529.59 beats and 47.92 bpm respectively). Cardiovascular stress index (CSI) was computed and compared with other workers (Table 4) and found that CSI of rural hill women was 47.25 which was quite higher than cashew nut worker [19], steel workers [20] and car assembly workers [21]. Such variation of Cardiovascular Stress Index among group of workers might be due to difference in the degree of severity of job and environmental conditions and also duration of activity [22]. The Cardiovascular Stress index may be higher in case of women involved in firewood collection as they carried a load of firewood on their back in hilly terrain of Meghalaya. We found that transportation tasks including larger isometric muscular actions elicited the strongest increase of blood pressure. It is known that physical (isometric) workload can be associated with an increased risk of elevated blood pressure, which in turn is a risk factor for coronary heart disease [23].

Table 3. Physiological responses of farm women during firewood collection.

Parameter (Average)	Firewood Collection (20 – 35 yrs) n=20	Firewood Collection (36 – 50 yrs.) n=20	Total (20 – 50 yrs.) N=40
Heart Rate (bpm)	126.88	132.45	129.67
Peak Heart Rate (bpm)	135.90	142.10	139.00
Energy Expenditure (kj/min)	11.45	12.34	11.90
Peak Energy Expenditure (kj/min)	12.89	9.83	9.96
Total Cardiac Cost of Work (beats)	8408.10	8651.08	8529.59
Physiological Cost of Work (bpm)	46.61	49.23	47.92
Cardiovascular Stress Index	42.43	52.08	47.25
Workload	Heavy	Heavy	Heavy

Table 4. Comparison of Cardiovascular Stress Index (CSI) between collecting and bringing firewood and other works.

Work category	Firewood Collection (Rural hill women)	Cashew nut workers	Steel workers	Car assembly workers
CSI	47.25 ± 5.70	23.82 ± 2.05	25.0 ± 14.0	20.0 ± 7.0

### 3.4. Perceived exertion

While performing an activity, individuals complain of tiredness or fatigue which is merely a subjective feeling provides reliable information for the assessment of workload [24, 25]. The rural women reported that the activity was heavy to very heavy in backward journey from forest with a heavy load of firewood on their back as well as in complete cycle of firewood cutting and bringing activity. But the job of onward journey to forest the rural women reported that the workload was very light to light and in case of cutting firewood the workload was reported as “moderately heavy to heavy”.

Table 5. Rated Perceived Exertion during Firewood Collection.

Activities	20 – 35 yrs n = 20	SD	36 – 50 yrs n = 20	SD	20 – 50 yrs N = 40	SD
<i>Phase I</i>						
Onward Journey	2.0	0.649	2.3	0.657	2.15	0.653
Collection	3.5	0.950	3.6	0.945	3.55	0.948
Backward Journey	4.6	0.503	4.7	0.470	4.65	0.487
<i>Phase II</i>						
Complete cycle	4.7	0.470	4.8	0.410	4.75	0.440

Rating: 5 - Very Heavy, 4 - Heavy, 3 - Moderately Heavy, 2 - Light, 1 - Very Light

### 3.5. Perceived health hazards

Health hazards expressed by rural women were recorded, causative factors were analyzed and types of hazards were noticed (Table 6). Rural women had lots of physical hazards including upper and lower back pain, cervical pain, wrist and finger pain, pain in shoulder joints etc. due to frequent bending posture while cutting firewood in repetitive motion, carrying heavy loads, forceful exertion etc. Majority of the subjects involved in repetitive nature of work had shoulder and wrist pain which may lead to Cumulative Trauma Disorder (CTD) in long run [26, 27]. Pain in the lower back can restrict mobility and interfere with normal functioning. Low back pain is the most significant health problems. A big reason of pain in the back is the continuous bending of lumbar spine. The women repeat this posture many times while doing household and allied activities. Pain is unlikely to arise from the intervertebral disks themselves since they do not contain nerve ending in adult. The lower part of the back bears the weight of the upper body along with any weight that is carried and it also twists and bends more than the upper back. The repetitive or prolong exertion causes pain in the muscles, as a result causes weakness or spasm in the muscles. Long hours of work, continuous attention, precision, variety in work, extreme postures, poor nutrition and health apparently indicate that the farm women whether tribal or nontribal are under serious physical stress. Some of the factors which influence an individual's capacity and have a bearing on musculoskeletal problems are age, strength and fitness [28]. Physical stress combined with psychosocial stress produces a level of musculoskeletal strain, since the perception of pain or fatigue is modified by other psychological factors [29]. Insect bites were very common problem and at the same time snake bite was also not rare as reported by rural hilly women. Skin irritation was also very common problem among farm housewives as they come into contact with dried leaves, barks, pollens and allergens.

Table 6. Perceived health hazards of farm women involved in firewood collection activity.

Health Hazard	Causative factor	Types of hazards
a) Upper and lower back pain	Bending posture while cutting and bringing firewood, carrying heavy load in hilly terrain	Physical
b) Cervical pain	Carrying heavy load	Physical
c) Wounds in finger	Cutting firewood with "rua" (axe) and "atte" (native knife)	Mechanical
d) Pain in fingers and wrist	Cutting firewood in repetitive motion	Physical
e) Pain in shoulder joint	Repetitive and forceful exertion in cutting firewood	Physical
f) Insect and snake bite, wounds at foot	Susceptible as bare foot	Zoonotic
g) Skin irritation	Contact with dried leaves, bark and allergen	Environmental

### 4. Conclusion

Studies by different professional groups revealed that women are exploited without any consideration of workload demand, physical fitness, nutritional status and their biological status as they perform a dual role. As a result, the aggregate workload plays on them is so high that it becomes incompatible with their physical fitness leading to fatigue and drudgery and thereby lowering efficiency and impairing health in the long run [30]. Firewood collection is one of the most drudgery prone activities for women as Cardiovascular Stress Index was higher than many of industrial worker. The "kokcheng" can be improved or modified to lessen the drudgery while carrying firewood. But the activity of firewood collection should not be encouraged as it is one of the reasons of environmental degradation. Moreover, millions of women and girls around the world are in risk being raped, beaten and even killed while searching for firewood they need to cook food for their families. In addition burning wood creates indoor air pollution due to release of toxic smoke and suspended particulate which leads to respiratory problem and eye irritation and as a result more cases of children and women morbidity and mortality. The literature indicates that rural women faced higher risks of morbidity and mortality because of strenuous physical work [31]. Therefore related organizations need to look at the matter and have to form some policies for supplying of

alternative fuel energy to poor rural households. Installation of smokeless and improved *chulha* (traditional cook stove) may be one alternative as it has required less firewood and keeps the indoor environment clean.

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