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Research Paper

Physiological cost of parboiling of rice - A food processing activity performed by farm women

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ABSTRACT : Parboiling of rice is a common food processing activity performed predominantly by women in the villages of Assam. Parboiling is done mainly for preparation of indigenous food items such as parboiled rice, puffed rice, flaked rice etc. with conventional tools and is highly time consuming and laborious activity. An attempt was made to assess the physical fitness of respondents, physiological workload, muscular and postural stress involved in the process of parboiling of rice. Rating of perceived exertion (RPE) was calculated using Borg's 5 point rating scale. Body map was used to identify pains in different parts of the body. Twenty rural women without any health problem in the age group of 21-45 years were selected for this experimental study. Physical characteristics of the respondents involved in parboiling of rice revealed that the average height and weight were 150.30cm and 47.70 kg, respectively. Lean Body Mass (LBM) of the respondents was 29.6 kg. Aerobic capacity (VO_2) and fat percentage of the women were found to be 29.80 (ml. kg^{-1}. min^{-1}) and 19.61. Results indicate that working heart rate and energy expenditure of the respondents with conventional tool were 104 $b.min^{-1}$ and 7.70 kJ/min, respectively. On the basis of average and peak heart rate and energy expenditure, the physiological workload of parboiling of rice was categorized as 'moderately heavy'. Average rating of perceived exertion (RPE) was 3.2 in 5 point scale. The angle of deviation of respondents was 7^0. The incidences of musculo-skeletal problems were observed to be 'severe' to 'moderate' in different parts of the body. Majority of the respondents (83 %) experienced pain in shoulder joint, lower back, upper arm, lower arm, hand and wrist. Use of conventional tool as well as poor work station compelled the farm women to adopt awkward postures while performing parboiling activity. Ergonomic interventions are required to enhance work efficiency and comfort level thereby reducing health hazards of farm women.

KEY WORDS : Physiological workload, RPE, Parboiling

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Parboiling of rice is a common food processing activity performed predominantly by rural women of Assam throughout the year. Parboiling is done mainly for the preparation of parboiled rice and also for indigenous food items like puffed rice, flaked rice, etc. The nutritive value of parboiled rice is more than unprocessed rice. It is usually done in open space on three stoned chulah on a big iron *kadhai*. After parboiling, the parboiled rice is drained with the help of a bamboo basket which is not designed ergonomically. Thereby increases various health hazards and physiological workload of farm women. The farm women engaged in parboiling often complaints of pains and burning sensation due to heat in different parts of the body. The smoke filled work environment and the use of poorly designed conventional tools during parboiling process undoubtedly results in stress and fatigue of the workers.

Knowledge on physiological cost of work in terms of heart rate and energy expenditure of rural women will be of great use in providing necessary changes required in the work environment, work place and methods of performing the task. Therefore, in this paper, an attempt was made to assess the physical fitness of farm women, physiological workload,

muscular and postural stress involved in the process of parboiling of rice.

■ RESEARCH METHODS

Subjects:

A sample of 20 rural women without any health problem in the age of 21-45 years was selected for this experimental study from Jorhat district of Assam. The farm women who were actively involved in the activity of parboiling of rice were selected.

Body composition:

Body composition was assessed on the basis of Lean Body Mass (LBM). The estimation of LBM was determined from the skin fold thickness at four sites *i.e.*, biceps, triceps, sub scapular and suprarilliac with the help of skin fold calipers. BMI or Quetlet's Index (weight in kg/ height in m^2) was used to classify the body types as ectomorph(<20), mesomorph (20-25) and endomorph (>25).

Determination of physical fitness:

Physical fitness of the respondents was determined by using step-test method. The test was administered according to the designed protocol; resting, working and recovery heart rate were monitored continuously by using Heart Rate Monitor (Polar Sports Tester PE 400) during all the three phase. Physical Fitness Index (PFI) was determined on the basis of scores obtained during stepping exercise as given by Saha (1996).

Classification of workload:

The physiological workload of the subjects was determined on the basis of heart rate reading using the formula of Varghese *et al.* (1994).

The heart rates of the subjects were recorded at rest, during work and after the completion of work (recovery).The Total Cardiac Cost of Work (TCCW) and the Physiological Cost of Work (PCW) were also worked out. The Total Cardiac Cost of Work (TCCW) is the sum of Cardiac Cost of Recovery (CCR) and Cardiac Cost of Work (CCW).

Postural stress:

Postural analysis was done during parboiling with the help of flexi curve. The angles of postural bends were taken the during parboiling operation. The angle of deviation at the lumbar region was analyzed against the normal erect sitting position.

Musculo-skeletal problems:

The incidence of musculo-skeletal problems in different body parts were identified by using five point scale ranging from very severe (5) to very mild (1).

Cardiac strain index:

The cardiac strain index was calculated with the following formula :

$$\text{Cardiac Strain Index} = \frac{\text{Working heart rate} - \text{Resting heart rate}}{\text{Heart rate maximum} - \text{Resting heart rate}} \times 100$$

Statistical analysis:

Mean, standard deviation and percentage were worked out for different parameters and data were interpreted accordingly.

■ RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation have been discussed under following heads:

Physical characteristics:

Data on physical characteristics of the respondents (Table 1) involved in parboiling of rice show that the mean age of the respondents was 42 years, mean height was 150.30 cms and mean body weight was found to be 47.70 kg. The Lean Body Mass (LBM) and fat percentage of the respondents were found to be 29.60 kg and 19.61 per cent, respectively. Aerobic capacity (VO_2 max) was found to be 29.80 $ml.kg^{-1} min^{-1}$. The value of mean body mass index (BMI) was calculated to be 18.75 kg. m^{-2} and it was observed that majority of the respondents (55%) fell in the category of 'Ectomorphic' body type followed by 'Mesomorphic' (40%) and 'Endomorphic' (5%) body types.

Table 1 : Physical characteristics of the rrespondents

Physical characteristics	Mean ± SD
Age (years)	42 ± 4.16
Height (cm)	150.30 ± 3.62
Body weight (kg)	47.70 ± 3.84
LBM (kg)	29.6 ± 4.10
VO_2 max ($ml.kg^{-1}min^{-1}$)	29.80 ± 3.30
Fat percentage (%)	19.61 ± 1.69

Physical fitness of the respondents:

Regarding physical fitness index, Fig. 1 indicates that fifty per cent of the respondents had 'high average' physical fitness followed by 'below average' (30%) and 'good' (15%) physical fitness. A few per cent (5%) of the respondents had 'very good' physical fitness and none of the respondents fell under excellent category.

Physiological workload of parboiling of rice:

The physiological workload of parboiling of rice was analyzed from the heart rate and energy expenditure values as classified by Varghese *et al.* (1994 and 1989).

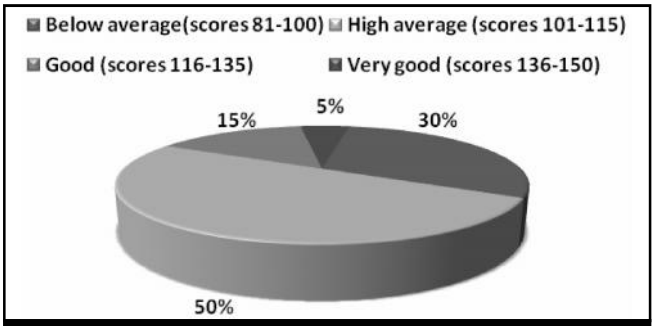

Fig. 1 : Physical fitness index (PFI) of the respondents

From Table 2, it was observed that the average and peak working heart rate values were 104 b. min^{-1} and 107 b. min^{-1}, respectively during parboiling of rice in conventional method. The average resting heart rate value of rural women was 76.22 b. min^{-1} (Fig 2). Likewise, the average and peak energy expenditure values were 7.70 kJ. min^{-1} and 8.3 kJ. $min^{-1,}$ respectively. Hence, on the basis of working heart rate and energy expenditure, the physiological workload of parboiling of rice was categorized as 'moderately heavy' (Fig. 3). Singh and Sarmah (2004) concluded that fetching fuel, fetching of fodder and storing grains were heavy activities (125-150 beats min-1), delivering milk was light activity (75-100 beats min-1) and milling of grains is light to moderately heavy activity (75-125 beats min-1) depending upon the distance travelled, time spent, amount of load, posture adopted and mode of carrying load while performing the particular load carrying activity.

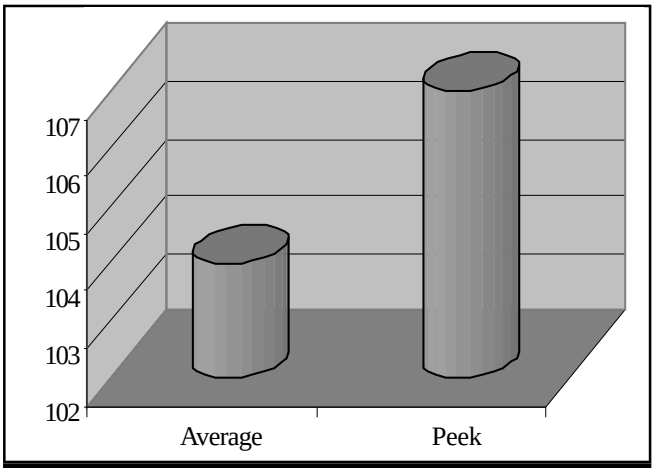

Fig. 2 : Average and peak working heart rate in parboiling of rice

Further perusal of Table 2 reveals that the cardiac strain index of the farm women was 25.24. The average total cardiac cost of work (TCCW) and physiological cost of work (PCW) were observed to be 1482 (beats) and 39.58 (beats/min), respectively during parboiling activity with conventional tool. The average rating of perceived exertion (RPE) was 3.2 in 5 point modified RPE scale.

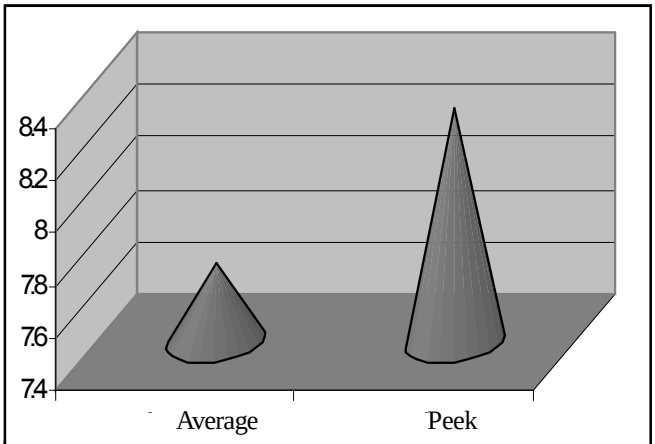

Fig. 3 : Average and peak energy expenditure in parboiling of rice

Postural analysis:

The postures adopted by the workers while parboiling of rice is usually standing with forward bending at back (Fig. 4). Analysis of data on postures showed that angle of normal curve of the respondents was 185° and the angle of deviation while parboiling with conventional tool was found to be 7° from the normal curve. The farm women has to assume forward bending posture for taking out the parboiled rice from the *kadhai* which leads to postural discomfort and various musculo-skeletal problems.

Fig. 4 : Farm woman using bamboo basket for parboiling of rice

Musculo-skeletal problems:

The incidences of musculo-skeletal problems in different body parts were investigated by using body map. During parboiling process, the farm women has to stoop forward in

Table 2 : Average and peak heart rate, energy expenditure and classification of physiological worlload

Physiological parameters		Mean ± SD
Working heart rate (beats.min^{-1})	Average	104 ± 2.55
	Peak	107
Energy expenditure (kJ.min^{-1})	Average	7.70 ± 2.10
	Peak	8.3
Classification of workload	Average	Moderately heavy
	Peak	Moderately heavy
Cardiac strain index		25.24
Rating of perceived extension (RPE)		3.2 ± 0.30
TCCW (beats)	Average	1482 ± 234.70
PCW (b.min^{-1})	Average	39.58 ± 8.25
Environmental parameters		
Humidity (%)	Average	58.42
Temperature (°C)	Average	30.01

standing posture for stirring and removing the parboiled rice with the help of conventional bamboo basket. As a result, in the present study, it was found that about 83 per cent of the farm women experienced pain in shoulder joint (4.3), lower back (4.2), upper arm (4.0), hand (3.1), lower arm (3.0), and wrist (3.0) which was expressed in a 5 point scale ranging from 'very severe' to 'very mild'. Moreover, the poor work station was also responsible for drudgery of the farm women during parboiling of rice.

Environmental parameter:

The environmental condition of the workplace such as temperature and humidity plays an important role in the parboiling activity. The temperature and humidity were recorded thrice in every 15 minutes during the activity. The mean temperature was found to be 30.02°C and mean relative humidity (RH) was observed to be 58.42 per cent during the month of August -September.

Conclusion:

The foregoing study highlights that the physiological cost of parboiling of rice was a 'moderately heavy' activity based on average heart rate and energy expenditure values. Ergonomically designed hand tool along with improved work station may enhance the work efficiency and comfort of the farm women. Further, it may reduce the occurrences of musculo-skeletal problems and postural stress of farm women.

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