Physiological Workload of Farm Women in Paddy Storage Activity of Assam

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Abstract: Storage of paddy grains is one of the most drudgery prone post harvest activity of Assam, which is predominantly performed by rural women. In developing countries like India the workers suffer from assorted health problems due to awkward postures and carrying heavy loads (Mukhopadhyay, 2008; Sett and Sahu, 2008). An attempt was made to assess physical fitness, physiological workload, muscular and postural stress involved in storage of paddy grains. Heart rate was recorded with heart rate monitor and postural stress in different region was measured with inclinometer. For postural analysis Ovaku Work Posture Analysis System (OWAS) method was used. The physiological workload of farm women in storing paddy was categorized as 'heavy' activity. It was found that work postures have a distinctly harmful effect on musculoskeletal system of the farm women. The angles of average flexion was highest in upper arm (90.620) and extension was in thoracic and it was observed to be 115.300 indicating deviation of body parts. Ergonomic Interventions is essential for reducing physiological cost and improving productivity and comfort to the farm women.

1. Introduction

Storage of paddy grains is one of the most drudgery prone post harvest activity of Assam, which is predominantly performed by rural women. In Assam, more than 70 per cent of farm women are involved in post harvest activities such as threshing, sun-drying, sieving, winnowing, cleaning and storage of paddy grains. In developing countries like India the farm workers suffer from assorted health problems due to awkward postures and carrying heavy loads (Mukhopadhyay, 2008; Sett and Sahu, 2008). The work related musculoskeletal disorders (WMSDs) resulted from frequent trunk bending, twisting and repetitive handling of load at a time. Poor work posture constitute one of the main risk factor for work related musculoskeletal disorders (WMSDs), ranging from minor back problems to severe handicapping. Poor posture increases the physiological cost of work and energy expenditure. Knowledge on physiological cost of work in terms of heart rate & energy expenditure of farm women is of great use in providing necessary changes required in the work environment, work place and method of performing the tasks. Keeping this in mind the study was carried out to assess the physical fitness, physiological workload, postural stress and ranges of motions of farm women in storing paddy grains by conventional method.

2. Methodology

2.1. Selection of subjects

Thirty subjects in the age group of 25-35 years who are normal, non-pregnant, non-

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lactating and without any major illness were selected for the purpose of the study.

2.2 Physical characteristics and body composition

Estimation of lean body mass (LBM) was determined from the skin fold thickness at four sites, i.e. biceps, triceps, subscapular and superilliac muscles with the help of skin fold calipers by using the methods prepared by Durnin and Rahman (1967). BMI or Quetlet's Index weight (kg)/height2 (m) was used to classify the body types as Ectomorph (<20), Mesomorph (20-25) and Endomorph (>25).

2.3 Determination of physical fitness

Physical fitness of the participants was determined by using electronic tread mill. The test was administered according to the designed protocol; working and recovery heart rate was monitored continuously by using Heart Rate Monitor (Polar Sports Tester – PE 4000) during the test. The stepping exercise (30 steps/min.) was continued for a maximum of 5 minutes. The recovery pulse rate was recorded while the subject was sitting on a chair. Physical fitness index (PFI) was measured with the following formula:

PFI = Duration of stepping in sec / Sum of 1st, 2nd& 3rd min. recovery pulse count X 100

The scores thus obtained were interpreted using the physical fitness index (PFI) and categorized as poor, low average, high average, good, very good and excellent the scale proposed by Saha (1996) was used.

2.4 Determination of physiological workload

The workload of the subjects was determined by recording the heart rate responses while storing paddy grains by using Polar Heart Rate Monitor (Polar Sports Tester – PE 4000). The physiological workload was determined as per the physiological workload index developed by Varghese et al. (1994) on the basis of heart rate and energy expenditure values of the participants.

The energy expenditure was estimated from the heart rate responses by using the formula of Varghese et al. (1994). The formula is given below:

Energy Expenditure (kJ.min-1) =0.159xHR (beats.min-1)-8.72.

TCCW=CCW+CCR

Cardiac Cost of Work (CCW) = (Avg. Working HR - Avg. Resting HE) x Duration

Cardiac Cost of Rest (CCR) = (Avg. Recovery HR - Avg. Resting HE) x Duration

Physiological Cost of Work (PCW) = TCCW/ Total Time of Activity

2.5 Postural analysis

Postural analysis was conducted during the performance of paddy storage activity with Dual Inclinometer (Dualer IQTM). The spinal curvature of the subjects in erect standing position at the cervical, thoracic, lumbro sacral and upper extremities (flexion and extension) was observed. The ranges of motion (ROM) in cervical, thoracic, lumbro sacral and upper extremities were recorded for each subject during the paddy storage activity. Ovaku Work

posture Analysis system (OWAS) was used to assess specific body postures of the farm women and recommend the changes to be made in the body postures while storing of paddy grains.

2.6 Environmental parameters

Observations on the climatic conditions were important parameters. Measure-ments on ambient temperature, humidity and illuminance level were taken using digital hygrometer and lux meter at the place of work.

3. Results

3.1 Details of study

Storage of paddy grains is performed by more than 70 per cent of the rural As-samese women. After proper sun drying, paddy is stored in storage structures such as bhoral, mer, duly, gunny bags etc for consumption or for commercial purposes. 'Bamboo basket' is a conventional tool used for carrying the grains from yard to the place of storage structures. The storage activity comprises of three sub activities which are performed in sequence (Fig. 1). This includes loading grains, carrying grains to the structures and unloading the grains in the storage structures. Mode of carrying the grains is along the waist side or it is a two handed asymmetrical manual handling task. Standing and bending postures were adopted by farm women in the paddy storage activity. Bending posture was adopted for collecting the grains to the basket and standing posture was adopted for carrying and unloading the grains. The farm woman usually carried more than 16 kg of grains at a time which is above the permissible limits (ILO).

3.2 Physical characteristics and body composition

The mean age of the respondents was 32 years (±5.50). The mean height was 151.42 cm (±4.12) and mean weight was 45 kg (± 4.85). Mean lean body mass (LBM) of an average Assamese woman was 32.35 kg (± 4.21). The aerobic capacity of the respondents is considered to be the best measure for an individual's capacity for doing task and VO2 max (ml kg-1 min-1) was found to be 26.73 (ml.kg-1 min-1) respectively indicating high average level of physical fitness of the respondents farm women. The fat percentage of the respondent farm women was 26.73 (±5.17). Data on body type shows that majority of the respondents belonged to 'Ectomorphic' (47%) group with slender body type followed by 'Mesomorphic' (22%) and 'Endomorphic' (13%).

3.3 Determination of physical fitness index (PFI)

Data on physical fitness index (PFI) revealed that 33 per cent of farm women had 'very good' `physical fitness followed by 30 per cent belonged to 'good' and 27 per cent belonged to 'high average' physical fitness. Only 10 per cent farm women had 'low average' group and none of the respondents were found to be 'poor' physical fitness.

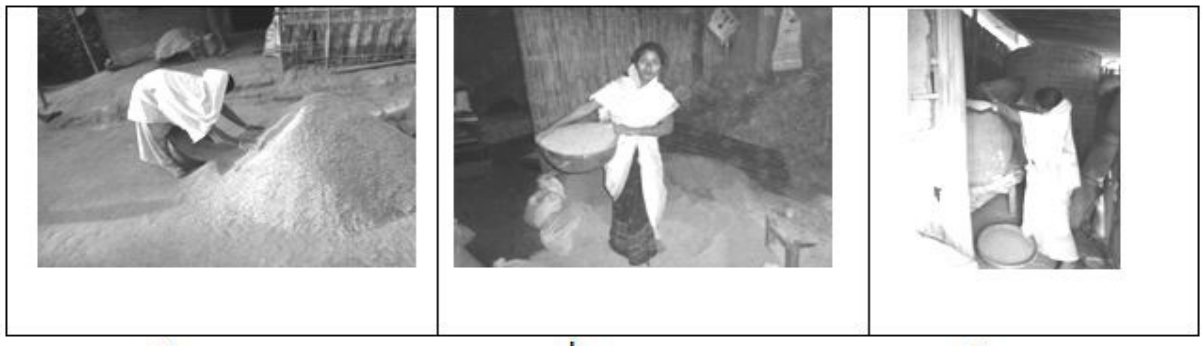

Fig. 1 Different sub-activities of paddy storage activity. a- loading paddy gains, b - carrying paddy grains, c - unloading paddy grains to the storage place

3.4. Classification of physiological workload based on average and peak heart rate.

Classification of the physiological workload of storage of paddy grains was assessed on the basis of heart rates (beats/min) and energy expenditures (kJ/min) values as classified by Varghese et al. (1994). The average and peak heart rate values while storing paddy grains were found to be 127.09 b.min-1 and 132.66 b.min-1 respectively (Table 1 and Fig. 2). The resting heart rate values of farm women were found to be 77.85 b min-1. The average and peak energy expenditures in storing paddy grains were found to be 11.48 kJ/min and 12.37 kJ/min respectively (Table 1 and Fig. 3).

The physiological workload of storing paddy grains on the basis of average and peak heart rates (beats/min) and energy expenditures (kJ/min) were categorized as 'heavy' activity indicating that design modification of conventional basket is required for storing paddy grains. The average total cardiac cost of work (TCCW) and physiological cost of work (PCW) were found to be 2337.54 (beats) and 61.51 (beats/min) respectively while storing paddy grains.

3.5 Postural stress and range of motion (ROM)

From the analysis of working posture by OWAS method it was further evident that out of the three different types of postures adopted in storage activity the posture adopted in unloading paddy grains need 'corrective measures' as soon as possible while the postures adopted in loading grains requires 'no immediate action' but changes are needed in near future. In carrying paddy grains, the adopted posture need not require any change. Thus, it was clear that by remaining in awkward postures repeatedly during those activities, farm women suffered from discomfort affecting different body parts.

Table 1. Physiological parameters of storage of paddy by conventional basket

Physiological parameters	Conventional basket	Mean ± SD
Average resting heart rate (b.min^{-1})	77.85	77.85 ± 4.79
Average working heart rate (b.min^{-1})	127.09	127.09 ± 2.60
Average peak heart rate (b.min^{-1})	132.66	
Average energy expenditure (kJ. min^{-1})	11.48	11.48 ± 0.41
Peak energy expenditure (kJ. min^{-1})	12.37	
Total cardiac cost of work(TCCW) (beats)	2337.54	2337.54 ± 357.10
Physiological cost of work (PCW) (b. min^{-1})	61.51	61.51 ± 9.39
Average RPE	4.22	4.22 ± 0.32
Physiological workload		
Average	Heavy	
Peak	Heavy	
Total time taken for the experiment (min)	30 min	
Environmental parameters		
Mean temperature (°C)	22	
Mean relative humidity (%)	49	
Illuminance level (lx) i. Loading grains	95	
ii. Carrying grains	83	
iii. Un-loading grains	21	

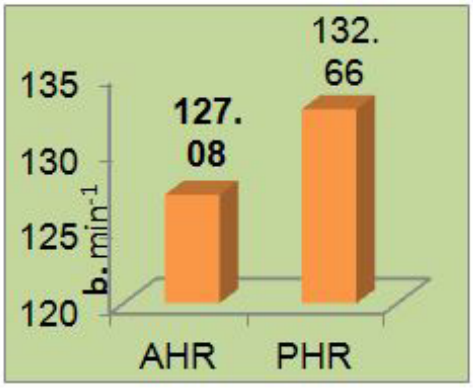

Fig. 2 Average and peak heart rates

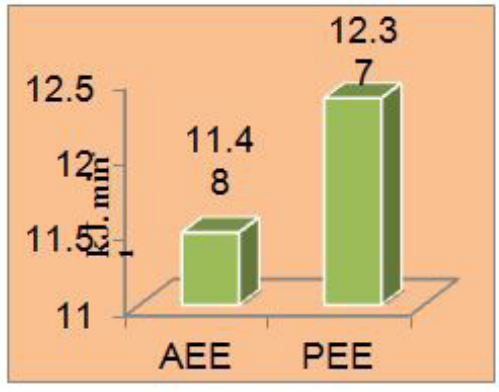

Fig. 3 Average and peak energy expenditures

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The ranges of motions (ROM) were recorded with the help of dual inclinometer. Both static and dynamic movements were adopted during storage activity. The postures assumed by the farm women in paddy storage were standing in forward bending position. The range of motion (ROM) in cervical, thoracic and lumbro scaral showed that the angle of average flexion was 30.60° and average extension was 38.000 in cervical, while it was observed to be 62.50° and 115.30° for thoracic and in lumbro scaral region average flexion was 32.33° and extension was 28.83°. The angles of average flexion were 90.62°, 35.09°, 57.80° and average extensions were 77.12°, 68.20°, 48.58° in upper extremities indicating deviation in the different body parts.

4.3.5 Environmental stress

The mean temperature was found to be 22°c and mean relative humidity (RH) was observed to be 49 per cent. Farm women performed storage activity within the acceptable limit or comfort zone limit of temperature and humidity is due to fact that the experiment was conducted in winter season. An assessment of visual comfort of the subjects regarding the lighting condition revealed that the illuminance level were 95 lx in loading grains, 83 lx in carrying and 21 lx in unloading grains to the storage structure. The work place was found to be non-conducive to worker which is below the recommended standards for general work area especially in unloading grains (150 lx). This is due to the fact that there was no provision of windows for natural lighting in the storage structures.

5. Conclusion

Ergonomic evaluation of storage of paddy grains shows that the physiological workload of while storing paddy grains was categorized as 'heavy' activity indicating that design modification of conventional bamboo basket is necessary for farm women. From the analysis of postural load it was found that work postures have a distinctly harmful effect on musculoskeletal system of the farm women. The working methods should be changed as soon as possible. For most efficient functioning of muscles, range of motion of body parts should be minimized. Ergonomic interventions are essential for reducing physiological cost, health hazards, improving productivity, comfort and workable life of the farm women during storage of paddy grains.

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