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Assessment of physiological workload of paddy seed selection activity performed by Assamese farm women

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Abstract
Paddy seed selection is a most important post harvest activity of Assam. About 70 – 80 per cent of the farm women participate in seed selection activity of paddy which is a woman exclusive post harvest activity. Seed selection of paddy grain activity is performed to remove immature paddy as well as paddy of other variety. Both left and right hands are used for seed selection, left hand is used for holding the grains and right hand is used for removing immature seeds from the bundle. An attempt was made to assess physical fitness of farm women, to determine physiological workload and pinch grip strength in seed selection activity. Thirty subjects in the age group of 21-45 years were purposively selected. A stepstool technique was adopted for assessing physical fitness of the participants. Heart rate was recorded with polar heart rate monitor (polar sports tester – PE 4000) and pinch hand position or pinch grip was measured with pinch dynamo meter during the operation. About 47 per cent farm women were having 'high average' physical fitness. Average working heart rate values in seed selection activity was 109.20 b.min^{-1} and average energy expenditure was 8.16 kJ/min respectively. Physiological workload of farm women in seed selection of paddy grains was found to be 'Moderately Heavy' activity. Ergonomic interventions through designing of small hand tool will improve work performance and enhance productivity of farm women.

Keywords: Physical fitness, physiological workload, rating of perceived exertion, pinch grip

Introduction
Paddy seed selection is a woman exclusive post harvest activity which is performed manually. In Assam about 70 – 80 per cent of the farm women participate in post harvest activity of paddy grains with traditional tools. Use of pinch hand position is one the major risk factors of farm women in seed selection activity. Work related musculoskeletal disorders (WMSDs) are common health problems among the farm women. Assessment of physiological workload and postural analysis can be an appropriate base for planning and implementing interventional ergonomics programs in the workplace. To improve the efficiency of the farm women their physiological workload and posture needed to be assessed and corrective measures should be suggested to avoid the musculoskeletal disorders. Chaudhary *et.al* (2007) [2] opined that harvesting and post- harvesting operations were reportedly more suited to the physical health of the women. The agricultural operations like reaping of crops, storage of food grains, storage of seed and processing were reported to be mostly done by women. An attempt was made to assess physical fitness of participants, to determine physiological workload and pinch grip strength in seed selection activity of paddy.

Methodology
Selection of subjects
Thirty subjects in the age group of 21-45 years who are normal, non-pregnant, non-lactating and without any major illness were selected for the purpose of the study.

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) [3]. BMI or Quetlet's Index Weight (kg/height^2 (m) was used to classify the body types as Ectomorph (<20), Mesomorph (20-25) and Endomorph (>25).

Determination of physical fitness
Physical fitness of the participants was determined by using step-test method. 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 activity. 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. 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) [4] was used.

Determination of physiological workload
The workload of the subjects was determined by recording the heart rate responses while selecting seed by using polar heart rate monitor (Polar Sports Tester – PE 4000). The heart rate measurements were taken by fitting the monitor to the subject's body to note minute-wise recording for that specified duration *i.e.* 30 minutes. Resting heart rate and recovery heart rates were also recorded. Energy expenditure was estimated from the heart rate responses using the formula by Varghese *et al*. The physiological workload was determined as per the physiological workload index developed by Varghese *et al* 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) [5]. The formula is given below:

Energy Expenditure (kJ.min^{-1}) =0.159 x HR (beats.min^{-1})-8.72.

The Physiological workload was determined as per the workload classification developed by Varghese *et al.* (1994) [5].

Physiological Workload Index

Physiological Workload	Heart rate (beats/min)	Energy expenditure (kJ/min)
1. Very light	Up to 90	Up to 5
2. Light	91-105	5.1-7.5
3. Moderately heavy	106-120	7.6-10.0
4. Heavy	121-135	10.1-12.5
5. Very heavy	136-150	12.6-15.0

Rating of perceived exertion

Subjective perception of exertion is a method for providing reliable information for the assessment of workload. Subjective rating of feeling of tiredness was studied by using the Rating scale of Perceived Exertion (RPE) developed by Varghese *et al.* (1994) [5]. The exertion perceived by the participants before and immediately after completion of seed selection activity was recorded and categorized as very light, light, moderately heavy, heavy and very heavy based on the scores 1,2,3,4 and 5 respectively.

Pinch Grip

Pinch hand position or pinch grip was measured with pinch dynamo meter during the operation. Both left and right hand grip were measured before and after completion of seed selection activity.

Fig 1: Seed selection of paddy grains

Results and discussion

Details of study

Seed selection of paddy grains is a post harvest activity performs by more than seventy per cent of Assamese rural women. On an average they spent two to three hours in a day just after harvesting the paddy grains. In seed selection activity farm women spent ten to twelve days in the month of December and January. The posture assumed by the farm women in seed selection activity is sitting and forward bending position. Both left and right hands are used for seed selection, left hand is used for holding the grains and right hand is used for removing immature seeds from the bundle.

Physical characteristics and body composition

The mean age of the respondents was 35.20 years (±2.60). The mean height was 152.80 cm (±5.00) and mean weight was 47.24 kg (±4.90). Mean lean body mass (LBM) of an average Assamese woman was 29.10 kg (Table 1). The fat percentage of the respondent farm women was 19.10. Data on body type shows that majority of the respondents belonged to 'Ectomorphic' (62%) group with slender body type followed by 'Mesomorphic' (26%) and 'Endomorphic' (12%).

Table 1: Physical characteristics of the respondents

Physical characteristics	Mean ± SD
Age (years)	35.20 ± 2.60
Height (cm)	152.80 ± 5.00
Body weight (kg)	47.24 ± 4.90
LBM (kg)	29.10 ± 3.15
VO_2 max (ml.kg^{-1}.min^{-1})	29.10 ± 4.92
Fat percentage (%)	19.10 ± 1.70

Determination of Physical Fitness Index (PFI)

Physical fitness index (PFI) of the respondents assessed by using step stool ergo-meter revealed that most of the respondents were (47%) were having 'high average' physical fitness followed by 33% in 'below average' category. Only 15% women were having 'good' physical fitness and minimum percentage (5%) had 'very good' fitness.

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

The physiological workload of paddy seed election was assessed on the basis of heart rates (beats/min) and energy expenditures (kJ/min) values as classified by Varghese *et al.* (1994) [5]. The average resting heart rate values of participants was 85.20 b.min^{-1}. Average working heart rate values in seed selection activity was 109.20 b.min^{-1} and average energy expenditure was 8.16 kJ/min respectively.

The corresponding peak heart rate and energy expenditures values of farm women in seed selection activity were 113.24 b.min^{-1} and 10.00 kJ.min^{-1} (Table 2). Physiological workload of farm women in seed selection of paddy grains on the basis of heart rate and energy expenditures was found to be 'Moderately Heavy'.

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

Parameters		Mean ± SD
Resting heart rate (beats.min^{-1})	Average	85.20 ± 4.20
Working heart rate (beats.min^{-1})	Average	109.20 ± 2.46
	Peak	113.24
Energy expenditure (kJ.min^{-1})	Average	8.16 ± 2.06
	Peak	10.00
Classification of workload	Average	Moderately Heavy
	Peak	Moderately Heavy
Rating of Perceived Extension (RPE)	Average	3.1

Rating of perceived exertion

Perceived exertion of respondents was assessed by using 5 point modified RPE scale. Data revealed that average rating of perceived exertion were as 3.1 in 5 point scales indicating that the exertion perceived by women was moderate throughout the activity (Table 2).

Pinch Grip

Both forward bending and sitting postures were adopted in the activity. Pinch hand position is one of the identified risk factor in seed selection activity. There was a decrease of pinch grip strength during the activity. The percentage change of pinch grip strength was found to be 30 per cent in right hand and 20 per cent in left hand respectively. The percentage reduction of pinch grip strength was found to be less in left hand.

For mitigating the risk in pinch hand position of farm women, an ergonomic intervention in seed selection, a paddy stripper made of bamboo was designed. The use of paddy stripper improves work performance and enhances comfort and efficiency of farm women in paddy seed selection. Fig - 2)

Paddy stripper for paddy seed selection

Uses of paddy stripper for paddy seed selection activity

Fig 2

Use of paddy stripper by farm women in paddy seed selection activity brings some significant benefits to farm women. These are as follows:

- Reduces health hazards of farm women i.e. cuts and wounds.
- Minimizes grip fatigue during the paddy seed selection activity.
- Reduces discomfort in upper arm, lower arm and wrist of both hands.
- The paddy stripper is made of indigenously grown *Bamboo* plant and hence affordable

Conclusions

Ergonomic evaluation of seed selection activity of paddy grains shows that it is a 'moderately heavy' activity indicating that seed selection is a drudgery prone post harvest activity. An ergonomic intervention through designing of small hand tool (paddy stripper) improves work performance, reduces occupational health hazards and enhances productivity of farm women.

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