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Occupational Constraints Analysis of Women Engaged in Wheat Harvesting

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ABSTRACT The study was undertaken to determine the drudgery of women with the objective of assessing biomechanical and physiological stress while performing wheat harvesting. The field experiment was carried out on 20 women falling in two age groups, viz. 25-35 and 35-45 years. Average heart rate of the women of both age groups increased as the activity proceeded towards the evening. Average heart rate of women of lower age group was 115.9 bpm in the morning and 120.8 bpm in the evening. For the older age group, corresponding figures were 127.2 bpm and 132.7 bpm respectively. The classification of workload on the basis of average and peak heart rate, wheat harvesting activity was graded as moderately heavy to heavy period after activity Almost all the women reported severe to moderate discomfort in lower back (mean score 4.7), knees (3.8), buttocks (2.3) upper back (1.8), ankle knees (3.8), feet (1.7) and neck (1.5).

INTRODUCTION

In India, nearly 70% population earns its livelihood from agriculture. Harvesting of crop is a manual operation done mainly by female farmers in Haryana. Even in post- harvest operations like drying, storage and cleaning of grains like wheat, women play a significant role (Amin et al. 2009).

During harvesting season, they spend nearly 8-9 hours daily to perform the activity. Although the use of different types of harvesters are in practice for large land holders, yet a huge majority of small and marginal farmers is still dependent on manual method due to limitations of power supply, availability of human labour and the tools locally available. In Haryana, harvesting of wheat exhibits an eye catching picture of quantum of work being performed by rural women. Despite their importance to agricultural production, women face severe handicaps as all agricultural tools and technologies are either gender neutral or gender biased for men.

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There are several studies revealing active participation of farm women in several wheat cultivation activities but there is hardly any literature that reveals the physiological workload and biomechanical stress of women while performing the activity. During the activity they adopt unnatural body posture due to which their physiological workload increases and also they face many types of musculo-skeletal problems as a result the efficiency of women to work decreases to a greater extent. Therefore, it is important to introduce new training programmes and technologies that can reduce the drudgery of women thereby raising the quality of their life.

In view of the above facts, an attempt was made to study drudgery of women involved in wheat harvesting with the following objectives:

1. To study the physical fitness of women involved in wheat harvesting activity.
2. To assess the physiological stress of women involved in wheat harvesting.
3. To assess the biomechanical stress of women involved in wheat harvesting

METHODOLOGY

The study was carried out on 20-farm women involved in wheat harvesting activity falling in the two age group viz., 25-35 and 35-45 years. The field experiment was conducted in the month

of April-May for wheat harvesting and bundling activity. To maintain uniformity in the experimental data, physically fit women were selected. Physical fitness of the women was studied through step-stool ergometer as given below:

Health Status through Step Stool Test

Procedure for Physical Fitness

Selected subject was given enough of rest and then her resting heart rate was measured with the heart rate monitor. After the complete rest, the subject was asked to perform the stepping activity on the step-test ergometer for maximum of 5 min with a uniform stepping rate of 30 steps/min. During the stepping activity, the heart rate was recorded every minute. After 5 min of stepping activity, the subject was asked to stop the activity, and sit comfortably on resting chair. Then the recovery pulse rate was recorded after every minute for a period of 5 min.

Physical Fitness Index (PFI): It was calculated by using the formula given below and interpretation of scores was done as given by Varghese et al. (1994).

$$PFI = \frac{Duration \text{ of stepping (sec)}}{\text{Sum of 1st, 2nd \& 3rd min Recovery HR}} x100$$

Health Status Through Aerobic Capacity (VO_2 max): VO_2 max was calculated using the following regression equation given by Saha (1978).

VO_2 *(mI/kg x min)* = 0.377 x step stool test (PFI) - 12.767

The subjects falling within the normal range of health status were selected for the experiment.

Determination of Body Composition and Lean Body Mass

Body Composition

Body composition of the selected subjects was measured using Lange's skinfold calliper. Biceps, triceps, sub-scapular and suprailliac muscles were measured to calculate Lean Body Mass (LBM) which has direct relation with heart rate of the person. Formulae given by Durnin and Rahaman (1967) were used to calculate body density, lean body mass and body composition of the selected subjects:

Body Density (D) = 1.1599 – (0.0717 x log of sum of 4 skin folds)

Percent Fat = (4.95/D – 4.5) x 100

Fat Weight = Body weight x percent Fat / 100

Lean Body Mass (kg) = Body weight – Fat weight

Body Mass Index (BMI)

Body Mass Index was derived by measuring weight and height of the woman using Quetelet Index in the following formula and the grading of the respondents has been done as given by Garrow (1981).

$$\text{Q.I.} = \frac{Weight\ (kg)}{Height^2\ (m)}$$

Body type as per BMI according to Quetelet's Index is graded as ectomorph, mesomorph and endomorph.

Time and Activity Profile

Stopwatch was used for recording time and pedometer was used for measuring the distance traveled.

Assessment of Ergonomic Parameters

Ergonomic assessment consisted of time and activity profile, physiological workload and biomechanical stress.

Physiological Workload

It refers to the physical or muscular effort required on the part of the worker to accomplish a task or an activity. The period during which the work continues is known as work period and period during which the physiological functions return to resting level is known as recovery period. Hence, to evaluate total physiological expenditure, physiological reactions both during the work and during the recovery period are considered. Hence, HR was recorded using polar heart rate monitor firstly at rest and then after every minute for 30 minutes during the experiment till the recovery of the subject. HR was also recorded at the end of the activity. From the values of HR, total cardiac cost of work (TCCW) and physiological cost of work (PCW) for wheat harvesting using various sickles were calculated.

TCCW= Cardiac cost of work (CCW) + Cardiac cost of recovery (CCR)

CCW= (Avg. working HR- Avg Resting HR) x Duration of activity

CCR= (Avg. Recovery HR- Avg Resting HR) x Duration of activity.

Physiological cost of work (PCW) = TCCW / Total time of the activity.

Energy Expenditure

Energy expenditure during work was also calculated by AHR by using the regression equation given by Varghese et al. (1994).

Energy expenditure (KJ/min) = 1.59x Avg Working HR (bpm) – 8.72.

Rating of Perceived Exertion

Though HR is widely used parameter to estimate physical workload yet it is difficult to measure it for the short duration tasks. Hence subjective perceptions of exertion of the subjects known as Rating of perceived exertion(RPE) was determined on a 5 point continuum ranging from very light exertion (1) to very heavy exertion (5). Mean was calculated for all the subjects to get an average score.

Assessment of Biomechanical Stress

Biomechanical stress was measured through postural analysis and musculo- skeletal problems perceived by women.

Postural Analysis

Postural analysis of the lumbo-sacral region was measured using flexicurve before and during the activity. The angle of bend was recorded for upper back as well as lower back of the subject. This was compared with normal angle of the subject at the standing position. It was analysed in terms of angle of deviation at both cervical and lumbar region.

Musculo-skeletal Problems

A human body map was used to identify incidences of musculo- skeletal problems in different parts of the body (Corlette and Bishop 1988) on a five point scale ranging from very severe pain (5) to very mild pain (1).

RESULTS AND DISCUSSION

Physical Characteristics

Mean age of the respondents engaged in wheat harvesting operation was 32 years measuring body height of 158.6 cm and body weight as 47.7 kg (Table 1). Fat percentage of women was 43.9%. Aerobic capacity (Vo_2max) was found to be 1.7 l/min. On physical fitness index, majority of the respondents were having high average PFI (60%) followed by good (20%) below average (15%) and good PFI (5%). More than half of the women (70%) were having ectomorph body type followed by mesomorphs (20%) and endomorphs (10%)

Time and Activity Profile

Table 2 depicts that on an average women spent at least 8 hours in wheat harvesting activity and 2 hours in bundling activity per day during which they tie an average of 50 bundles. Respondents were agricultural labourers so time spent was equal for both the age groups. On an average, women from both the age groups travel 2.2 km per day while doing wheat harvesting activity and 1.6 km per day while performing

Table 1: Physical characteristics of selected respondents

Variable	*25-35 years (n=10)*	*25-35 years (n=10)*	*Total*
	Mean ±SD	*Mean ± SD*	
Age (years)	27.7 ± 2.4	40.2 ± 3.0	32.0
Height (cm)	158.8 ± 2.0	159.2 ± 3.9	158.6
Weight (kg)	48.2 ± 8.6	47.4 ± 7.0	47.7
Lean body mass (kg)	25.5 ± 2.4	25.1 ± 2.1	25.3
Fat (%)	41.0 ± 6.0	46.8 ± 7.0	43.9
Body mass index (kg/m^2)	19.4 ± 4.2	18.9 ± 3.3	19.1
Vo_2max (l/min)	1.9 ± 0.19	1.5 ± 0.13	1.7

Table 2: Time and activity profile of selected respondents for wheat harvesting and bundling activity for one day

	Activity	*Age group*		*Total*
		25-35	*35-45*	
(A)	*Wheat Harvesting Activity*			
	1 Type of implement used for performing the activity	Local sickle	Local sickle	Local sickle
	2 Average time spent for whole day (hrs.)	8	8	8
	3 Average distance traveled on whole day (km)	2.3	2.1	2.2
(B)	*Bundling Activity*			
	1 Average distance traveled on whole day (km)	1.5	1.7	1.6
	2 Average time spent for bundling activity/day (hrs.)	2	2	2
	3 Average number of bundles tied per day	50	50	50

bundling activity. Khan et al. (2012) reported that a woman during pre-harvest activities spent 38.72 hours on wheat production per acre in one season while post harvest activities accounted for 121.55 woman hours per acre for this crop.

On an average a women spent 20 days in wheat harvesting and bundling activity per year. In one year they spent an average of 25 man days in wheat harvesting and 5 man days in bundling activity during which they tie an average of 1000 bundles and travel an approximate distance of 44 km during wheat harvesting and 32 km during bundling activity.

Physiological Stress

Physiological stress of the wheat harvesters was determined on the basis of various parameters like average and peak heart rate, energy expenditure, physiological cost of work and rating of perceived exertion (RPE) while performing the activity.

Table 3 shows that in the morning average working heart rate of the woman of lower age group was 115.9 bpm which increased in the evening and reached up to 120.8 bpm. Similar increase was also observed for the respondents of higher age group and their heart rate values were 127.1 bpm (morning) and 132.7 bpm (evening). This may be due to fact that respondents get tired after day long activity. Also slight increase in peak heart rate was reported during evening in both younger and older group. Similar kind of trend was also observed for energy expenditure. Average energy expenditure for younger age group during morning and evening hours was 9.7 kJ/min and 10.4 kJ/min respectively. Correspondingly, values of older age group were 11.4 kJ/min and 12.0 kJ/min respectively.

For bundling activity, average and peak heart rate was found to be more in older group than in younger group. The classification of workload on basis of average and peak heart rate and energy indicated that the activity of wheat harvesting was graded between moderately heavy and heavy while bundling activity was graded between heavy and very heavy.

Table 4 reveals the similar kind of trend for both TCCW and physiological cost of work as observed for heart rate and energy expenditure for both wheat harvesting and bundling activity. For RPE it was observed that bundling activity was more stressful than wheat harvesting. RPE for wheat harvesting activity was 3.4 whereas for bundling activity it was 3.6 depicting heavy exertion.

Table 3: Physiological cost of work during wheat harvesting activity

Activity	*Working heart rate beats/min*				*Energy expenditure kJ/min*				*Classification of workload*			
	Average		*Peak*		*Average*		*Peak*		*Average*		*Peak*	
	I	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*
Wheat Harvesting Activity												
Morning	115.9	127.1	130.0	139.9	9.7	11.4	11.9	12.9	MH	H	H	VH
Evening	120.8	132.7	139.7	14.4	10.4	12.0	12.7	13.6	H	H	VH	VH
Bundling Activity												
Evening	132.0	136.2	142.3	144.9	12.2	12.9	13.9	14.3	H	VH	VH	VH

I- 25-35 years II- 35-45 years

Table 4: Energy expenditure, circulatory stress, physiological cost of work, RPE while performing wheat harvesting and bundling activity

ACTIVITY	*Average heart rate*		*Energy expenditure*		*Average TCCW*		*Physiological cost of work*		*Average RPE*	
	I	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*
Wheat Harvesting Activity										
Morning	115.9	127.1	9.7	11.4	830.9	984.8	41.5	49.2	2.7	2.9
Evening	120.8	132.7	10.4	12.0	960.1	1092.8	48.0	54.5	3.1	3.4
Bundling Activity										
Evening	132.0	136.2	12.2	12.9	135.8	151.5	54.6	58.6	3.4	3.6

Table 5: Average spinal angles at cervical and lumbar region of women wheat harvesting or bundling

Age group (Years)	*Cervical*			*Lumbar*		
	Normal	*Bending*	*Angle of deviation*	*Normal*	*Bending*	*Angle of deviation*
25 - 35	204.2	192.4	11.8	202.2	189.5	12.7
35 - 45	210.1	196.9	13.6	203.3	189.0	14.3

Postural Analysis

The results regarding the angle of deviation of both cervical and lumbar region are presented in Table 5. For cervical region angle of deviation was found to be 11.8^0 and 13.6^o for younger and older age group respectively whereas for lumbar region it was found to be 12.7^o and 14.3^o respectively.

Musculo-skeletal Problems

It is a well known fact that working in a particular posture for longer duration of time causes fatigue and maintaining same posture beyond certain limit of time for years causes musculoskeletal disorders in the body. As a result the working efficiency of the workers is greatly reduced. Working in squatting posture for longer period might be the reason that almost all the women reported severe to moderate discomfort in lower back (mean score 4.7), knees (3.8), buttocks (2.3) upper back (1.8), ankle knees (3.8), feet (1.7 and neck (1.5) . While performing wheat harvesting activity cent per cent of respondents used tradition sickle for cutting wheat. This might be the reason that most of the respondents felt severe discomfort in palm (mean score 3.7), fingers (3.4) and moderate to mild discomfort in wrist/hand (2.7) and lower arm (1.3) (Table 6).

Table 6: Musculo-skelatal discomfort of women during wheat harvesting or bundling

Body parts	*Mean score*
Neck	1.5
Shoulder	3.1
Upper back	1.8
Upper arm	3.8
Low back	4.7
Buttocks	2.3
Wrists	2.7
Fingers	3.4
Knees	3.8
Calf	2.1
Feet	1.5

CONCLUSION

Women perform wheat harvesting activity during morning hours and perform bundling of harvested wheat during evening hours. All the respondents used traditional sickle for cutting the wheat. Average working heart rate was high for both the age group while wheat harvesting and bundling process. On the basis of heart rate, wheat harvesting and bundling activity was graded between moderately heavy to heavy activity. Regarding musculo-skeletal discomfort, they reported very high discomfort in upper arm, low back, knees and fingers.

RECOMMENDATIONS

During wheat harvesting from morning till evening women usually adapt squatting posture and they continue to work in this posture for long duration without adapting any other posture due to which they reported severe pain in lower back and knees. Hence periodic train-

ing programmes should be organised to emphasize on educating workers regarding recognition of musculo-skeletal disorders and importance of rest pauses and maintaining proper posture while performing agricultural activities.

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