



Technology assessment for grain picking activity

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ABSTRACT

Ergonomic risk factors in conventional grain picking activity were musculoskeletal disorders and unnatural postures. Hence, grain picker with higher capacity and comfortable handle was developed and tested. Physiological cost of grain picking activity was calculated by heart rate method. Developed grain picker is rectangular in shape and light weight tool with comfortable handle, which avoids wrist deviation during grip exertion. Ergonomic assessment of grain picking activity by conventional and improved method performed by female and male workers revealed that physiological cost of work was reduced but statistically results were not significant. Overall body discomfort ratings by male and female respondents in conventional grain picking activity were 7.5 & 7.75 respectively, whereas body part discomfort scores were 78 and 92 for male and female workers respectively. The mean weight of grain picked per lift by female workers was 4.34 and 4.67 kg for the conventional and improved method respectively. Whereas mean weight of grain picked per lift by male workers was 4.90 and 5.22 kg for the conventional and improved method respectively. The rating on time load was found to be 2 using improved method in comparison to the 2.5 and 2.66 time load score in conventional method for female and male respectively. On an average picking efficiency of worker was increased by 6-7 percent and there was highly significant reduction in time load in improved method. Perceived exertion rated by all the selected respondents was reduced significantly at high level when grain picking was performed with the help of developed tool. The developed tool for grain picking activity is recommended as there was improvement in the picking efficiency, production rate and grip strength which resulted in significant reduction of perceived exertion and overall discomfort ratings.

Key words: Physical load, drudgery load, health hazards and postural discomfort.

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INTRODUCTION

A large number of workers perform heavy manual material handling jobs in the unorganized sectors such as brick industry, agriculture, construction, etc. Indian women play an important role in the unorganized sectors. Her work often demands more time and energy resources. She performs the activities in her usual way adapting casual posture without realizing the cost of energy and other muscular efforts which ultimately results in musculoskeletal problems leading to drudgery. [1], [2] Grain picking is one of the activity performed by the women workers as per demand. Grain picking performed by using traditional household tools i.e. Ghamela or Topala and tray. These tools were made up of either iron or plastic material & were without handle. Most of the time, this activity was performed in standing & bending posture. Risk factors in conventional method are musculoskeletal pains and fatigue, postures, involving extreme forward flexion or lateral twisting and bending. The objectives of the experiment were ergonomic assessment of grain picking activity by conventional method & by using developed grain picking tool.

MATERIAL AND METHODS

Ergonomic evaluation of selected grain picking activity

Total 30 healthy farm workers without symptoms of physiological ailment, working in the field for 6 hrs/day having minimum six years experience of grain filling activity were selected for the study.

Mode of data collection

No. of female workers: 20

No. of male workers: 10

Field trials/Replications:	03
No. of activities:	01
No. of methods:	02

Scientific equipments used for the experiment

Polar heart rate monitor, Anthropometer, Sphygmomanometer and grip dynamometer

Measurement of Parameters:

Research Design: Descriptive cum experimental research design

The grain filling tool was evaluated on the following parameters

1. Physiological load: Average working Heart rate ($b.m^{-1}$) by polar heart rate monitor
 - Total Cardiac cost of work=Cardiac cost of work + Cardiac cost of recovery
 - Cardiac cost of work= (Average working heart rate- Average resting heart rate) X Duration
 - Cardiac cost of recovery=(Average recovery heart rate-Average resting heart rate) X Duration
 - Physiological cost of work (PCW): = TCCW / Total time of work [4]
2. Picking efficiency (%) = $(W1-W2)/W1 \times 100$

Where, W1=weight lifted in traditional method and W2= weight lifted in improved method

3. Overall Discomfort Rating: Overall discomfort rating was taken on a ten point psychophysical rating scale (0= no discomfort, 10 = extreme discomfort) and Body Part Discomfort Score to measure the localized discomfort [3]and [5].

Improved method of filling grains in gunny bag.

The newly developed grain filling tool with handle was used for performing filling of grains in gunny bag.

Features:

- Handle of the tool comfortably fits in to the palm of the respondent.
- Rectangular shape and swinging motion provided through design avoids wrist deviation, allowing the hand and fore arm to remain in alignment during forceful grip exertion.
- The weight of tool is not much heavy thus it is easy to use and the center of gravity is in alignment with the center of gripping hand.
- The grip surface is not slippery with rounded edges to prevent cuts.
- Adequate clearance around the handle for avoiding finger damage.

RESULT AND DISCUSSION

Physical characteristics of the respondents involved in filling of grains in gunny bag.

The mean age of the subjects involved in the activity filling of grains in gunny bag was 44 yrs. Average height and weight of male subject was 166.83 cm and 59 kg, and that of the female was 151.83cm and 48.77kg respectively. All the respondents were having more than 6 years work experience and average working period per day was between 7 to 8 hrs.

Time and work study of the activity filling of grains in gunny bag

The mean weight of grain picked per lift by female workers was 4.34 and 4.67 kg for the conventional and improved method respectively (Table 2). Whereas mean weight of grain picked per lift by male workers was 4.90 and 5.22 kg for the conventional and improved method respectively (Table 3). On an average one to two numbers of lifts were reduced per minute in case of improved method and average grain picking was increased by 6.53 to 7.6 percent per lift. This resulted in increase in production per hour. The rating on time load was found to be 2 using improved method in comparison to the 2.5 and 2.66 time load score in conventional method for female and male respectively. There was highly significant reduction in time load in case of improved method. Picking efficiency of all the workers was increased by 6 to 7 percent in improved method.

Ergonomic evaluation of the activity filling of grains in gunny bag.

Ergonomic assessment of grain picking activity by conventional and improved method performed by female and male workers is shown in table 4 & 5 respectively. Working heart rate of female workers was 114 & 113 beats per minute in conventional and improved method respectively. Physiological cost of work (PCW) of grain picking was reduced by three percent in improved method. The other corresponding parameters such as energy expenditure and cardiac cost of work were reduced when work was performed by improved method. Statistically results were non-significant.

Similarly all the physiological parameters measured for ergonomic assessment of grain picking activity performed by male respondents were reduced in improved method. The working heart rate and physiological cost of work was reduced by 5 and 34 percent respectively but statistically results were non-significant. Perceived exertion rated by all the selected respondents was found to be significantly reduced at high level in case of improved method.

Grip strength of selected workers

Grip strength of the selected workers before and after the work of grain picking was measured for right and left hand. The values of grip strength were higher before the work for both the hands. The percentage change i.e. reduction in grip strength was less in case of improved method. It indicated that improved method was less tiring for the hand muscles.

Assessment of postural discomfort in grain picking activity

Overall body discomfort ratings by male and female respondents in conventional grain picking activity were 7.5 & 7.75 respectively, whereas body part discomfort scores were 78 and 92 for male and female workers respectively. Statistically there was highly significant reduction in all the scores for discomfort ratings by male and female respondents when grain picking was performed by improved method.

Table 1. Physical characteristics of the respondents involved in grain picking Activity

Parameters	Female(n=20) (Mean ± SD)	Male(n=10) (Mean ± SD)
Age (yrs)	43.55 ± 12.65	44 ± 14.57
Height (cm)	151.83 ± 4.62	166.83 ± 4.44
Weight (kg)	48.77 ± 6.71	59.08 ± 6.91
BMI		
Under weight (18.5 or less)	5	2
Normal weight (18.5 to 24.99)	15	8
Over weight (25 to 29.99)	--	-
Obesity (class 1) (30 to 34.99)	--	-
Obesity (class 2) (35 to 39.99)	--	-
40 or greater (Morbid obesity)	--	-

Table 2. Time and work study (Female) n=20

Parameters	Conventional Method (Mean ± SD)	Improved Method (Mean ± SD)	't' Values
Weight of grain picked (kg/ lift)	4.34±1.37	4.67 ± 1.29	NS
Number of lifts / min	16±4.55	14±4.78	NS
Picking efficiency (%)	7 %		
Production (q / h)	38.98 ± 13.56	40.62 ± 13.92	NS
Rating on time load	2.5 ± 0.51	2.0 ± 0.61	2.94 **

** Significant at 1%

Rating on time load: Very slow-5, Slow - 4, Moderate - 3, Fast- 2, Very fast - 1

Table 3. Time and work study (Male) n=10

Parameters	Conventional Method (Mean ± SD)	Improved Method (Mean ± SD)	't' Values
Weight of grain picked(kg / lift)	4.90 ±1.83	5.22 ± 1.18	NS
Number of lifts / min	14 ± 2.62	15 ± 4.19	NS
Picking efficiency (%)	6.13 %		
Production (q/h)	43.86 ± 22.29	48.19 ±18.78	NS
Rating on time load	2.66 ± 0.51	2.0± 0.54	2.86*

* Significant at 5%

Rating on time load: Very slow-5, Slow - 4, Moderate - 3, Fast- 2, Very fast - 1

Table 4. Ergonomic evaluation of grain picking activity performed by female workers n=20

Physiological parameters	Conventional Method (Mean ± SD)	Improved Method (Mean ± SD)	Significant reduction in Improved over conventional	't' values
<i>Heart rate</i>				
WHR (b.m ⁻¹)	114 ±13.86	113 ±13.46	1(1)	NS
PHR (b.m ⁻¹)	127 ±18.36	124 ± 16.03	3(2)	NS
<i>Energy expenditure</i>				

EE (kj.m ⁻¹)	9.35 ± 2.20	9.32 ± 2.14	0.03(0.32)	NS
PEE (kj.m ⁻¹)	11.48 ± 2.91	10.97 ± 2.54	0.51(4)	NS
Cardiac cost				
CCW(beats)	52 ± 36.22	46 ± 37.29	6 (12)	NS
CCR (beats)	40 ± 22.82	31 ± 14.92	9 (23)	NS
TCCW (beats)	92 ± 51.69	77 ± 42.13	15 (16)	NS
PCW (beats)	69 ± 31.79	67 ± 29.31	2 (3)	NS
Rated perceived exertion	4.74 ± 0.46	3.5±0.51	1.24 (26)	8.1**

WHR -Working Heart Rate, **PHR**- Peak heart rate, **EE**- Energy expenditure, **PEE**- Peak energy expenditure, **CCW**- Cardiac cost of work, **CCR**-Cardiac cost of Recovery, **TCCW**- Total cardiac cost of work , **PCW**-Physiological cost of work

Table 5. Ergonomic evaluation of grain picking activity performed by male Workers n=10

Physiological parameters	Conventional Method (Mean ± SD)	Improved Method (Mean ± SD)	Significant reduction in Improved over conventional	't' Values
Heart rate				
WHR (b.m ⁻¹)	96± 8.01	91 ± 6.34	5 (5)	NS
PHR (b.m ⁻¹)	109 ± 10.5	102 ± 12.52	7 (6)	NS
Energy expenditure				
EE (kj.m ⁻¹)	6.5 ± 1.27	5.7 ± 1.00	0.8 (12)	NS
PEE (kj.m ⁻¹)	8.57 ± 1.66	7.53± 1.99	1.04 (12)	NS
Cardiac cost				
CCW(beats)	21 ± 10.6	15 ±10.22	6 (29)	NS
CCR (beats)	15 ± 8.27	8± 6.17	7(47)	NS
TCCW (beats)	36 ± 17.48	24± 15.88	12 (33)	NS
PCW (beats)	44 ± 22.49	29 ± 9.43	15 (34)	NS
Rated perceived exertion	4.66 ± 0.51	3.33 ± 0.51	1.33	5.83**

WHR -Working Heart Rate, **PHR**- Peak heart rate, **EE**- Energy expenditure, **PEE**- Peak energy expenditure, **CCW**- Cardiac cost of work, **CCR**-Cardiac cost of Recovery, **TCCW**- Total cardiac cost of work , **PCW**-Physiological cost of work

Table 6. Grip strength of selected workers

Particulars	Conventional Method (Mean+SD)		Improved Method (Mean+SD)	
	Right Hand	Left Hand	Right Hand	Left Hand
Female (n=20)				
Before Work	6.36 ± 3.18	5.72 ± 2.39	6.30 ± 3.11	5.55 ± 2.38
After Work	5.97 ± 3.60	5.50 ± 2.79	6.41 ± 3.37	5.86 ± 2.62
Percentage change in grip strength (%)	8.28 ± 28.27	6.00 ± 26.96	3.25 ± 33.04	5.84 ± 28.84
Male (n=10)				
Before Work	16.33 ± 3.93	16.5 ± 216	17.16 ± 3.43	16.5 ± 1.76
After Work	16.66 ± 3.44	16.33 ± 1.36	18 ± 3.03	16.16 ± 1.47
Percentage change in grip strength (%)	3.51 ± 12.51	0.30 ± 8.39	5.59 ± 7.87	1.87 ± 2.93

Table 7. Assessment of postural discomfort in grain picking activity

Subject	Female (n=20)				Male (n=10)			
	ODR		BPDS		ODR		BPDS	
	C	I	C	I	C	I	C	I
Group -I	8	7	94	88	7	6	79	61
Group - II	8	6	99	93	8	7	77	62
Group - III	7	6	84	77	--	----	---	-----
Group - IV	8	7	91	83	-----	----	----	-----
Mean+ SD	7.75 ± 2.5	6.5 ± 0.57	92 ± 6.27	85.25 ± 6.84	7.5±0.7	6.5±0.7	78 ± 1.41	61.5 ± 0.7
't' values	2.19*		3.26**		3.19**		33.19**	

C- Conventional, I- Improved, **- Significant at 1% level, *- Significant at 5% level

ODR: Overall discomfort rating: 0 = no discomfort – 10= extreme discomfort

BPDS: Body part discomfort score



Improved method of Grain picking



Grain picking tool

CONCLUSION

Developed grain filling tool is rectangular in shape and light weight tool with comfortable handle, which avoids wrist deviation during grip exertion. Ergonomic assessment of grain picking activity by conventional and improved method revealed that on an average picking efficiency of worker was increased by 6-7 percent and there was highly significant reduction in time load in improved method. Perceived exertion rated by all the selected respondents was reduced significantly at high level when grain picking was performed with the help of developed tool.

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