

Ergonomic assessment of women respondents performing dairy activities

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Abstract: Dairy farming is subsidiary occupation of rural women in Dharwad and Kalghatagi taluks of Dharwad district. The study was conducted to know the physiological workload and change the posture so as to reduce the musculoskeletal problems of the women respondents performing milking activity. A representative sample of 35 women were selected as sample under the study for observation and ergonomic assessment of dairy activities viz., milking by using traditional method and drudgery reducing implements. Selection of subsamples for experiment was based on their age i.e., 25-35 years. There was a significant reduction in energy expenditure, physiological cost of work, total cardiac cost of work, time taken and body angles when the activities were carried out by using Drudgery Reducing Tools i.e., revolving stand and stool for milking activity and Gopal khore spade in cleaning of animal shed activity.

Key words: Dairy activities, Ergonomic assessment, Postural analysis

Introduction

Dairy farming involved backbreaking tasks as all the activities are carried out in arduous posture. The women adopt long static postures for some of the activities, which increase the static muscular effort resulting in physiological cost and low productivity. Researchers proved that any work design or work environment that helps to perform the work with minimum energy and put minimum stress on cardio vascular system and muscular system is the best design of work (Varghese *et al.*, 1994). So working posture becomes an important factor while designing ergonomically sound tools and equipment. Use of improved tools for performing the selected activities reduce the angle of deviation of the back and minimize the muscular efforts to perform the task. Lower muscular efforts lead to lower fatigue. Therefore, improved tools for performing the selected activities are beneficial because they lead to the reduction of drudgery and reduce the muscular stress and help the women to adopt correct posture work and also reduce the angle of deviation. Corlett *et al.* (1983) showed the effect of poor working posture in order to perform task could lead to postural stress, fatigue and pain which may in turn force the operator to stop work until the muscle recovers. As milking activity is performed in squatting posture performed by women in traditional method, without any support to sit and which leads to muscular discomfort hence an attempt has been made to know the physiological workload and change the posture so as to reduce the musculoskeletal problems.

Material and methods

The present investigation entitled “Women in dairy farming-an analysis of human cost at work and from the participant’s perspective” was carried out in the Department of Family Resource Management, College of Rural Home Science, University of Agricultural Sciences, Dharwad during 2012-13. A multistage purposive sampling technique was adopted for the selection of the districts, taluks, villages and farm women respondents. The experiment was conducted in Northern transitional zone of Karnataka. Considering the maximum number

of villages associated with Karnataka Milk Federation (KMF), convenience and distance from the head quarters i.e., Dharwad, the Dharwad and Kalghatagi taluks were selected. A representative sample of 35 women were selected as sample under the study for observation and ergonomic assessment of dairy activities viz., milking and animal shed cleaning by using traditional method and drudgery reducing implements. Selection of subsamples for experiment was based on their age i.e., 25-35 years. The independent variables under the study were Milking activity and animal shed cleaning activity. The dependent variable was Human cost of work index of dairy farming. The intermediate variables were Physiological variables (Energy expenditure and Physiological cost of work), Physical variable (Handgrip strength) and Biomechanical variable (Body angles at work). Under experimental investigation the required data were collected by using the following tools and equipments which included Revolving stand and stool for milking, Gopal Khore spade for cleaning of animal shed developed by AICRP, FRM, MKV, Parbhani, Anthropometer rod, Personal weighing balance, Digital Sphygmomanometer, Polar Heart Rate Monitor and Grip Dynamometer.

Results and discussion

Physiological workload while performing the milking activity with traditional method and by using Drudgery Reducing Tools (DRT) is depicted in Table 1. It is evident from the Table 1 that average working heart rate (107 beats/min), recovery heart rate (81 beats/min) and peak heart rate (122 beats/min) was more in traditional method of milking activity than by using DRT (101, 78 and 118 beats/min, respectively). On an average 5.60 per cent (6 beats/min) of reduction was observed in working heart rate, 3.70 per cent (3 beats/min) of reduction was observed in recovery heart rate and 4 beats per min (3.27%) of reduction was observed in peak heart rate while working by using drudgery reducing tool.

Further, total cardiac cost of work and physiological cost of work was estimated by considering the cardiac cost of work,

Table 1. Physiological workload of women respondents while performing milking activity in traditional and using drudgery reducing tool
n=35

Physiological parameters	MA- TM	MA- DRT	Percentage reduction	Z test
Average working heart rate (beats/min)	107.00	101.00	6.00 (5.60)	8.5**
Average recovery heart rate (beats/min)	81.00	78.00	3.00 (3.70)	4.64**
Average peak heart rate (beats/min)	122.00	118.00	4.00 (3.27)	10.29**
Average total cardiac cost of work (beats)	178.00	121.00	57.00 (32.02)	7.3**
Average physiological cost of work (beats/min)	36.00	29.00	7.00 (19.44)	5.84**
Average energy expenditure (kj/min)	8.28	7.00	1.28 (15.45)	8.58**
Average time taken for the activity (min)	5.00	4.00	1.00 (20.00)	6.61**

Figures in parentheses indicate percentage

** Significant at 1 per cent level

MA-TM: Milking activity in traditional method

MA-DRT: Milking activity by using drudgery reducing

cardiac cost of recovery and total cardiac cost of work and it was found highest in case of traditional method. There was 32.02 per cent of reduction in total cardiac cost of work and 19.44 per cent of reduction in physiological cost of work while performing milking activity by using DRT. The estimated energy expenditure in traditional method was 8.28 kj per min and by using DRT it was 7.00 kj per min. Hence, 15.45 per cent of reduction was recorded in average energy expenditure. On an average, the time required to perform the milking activity was 5.00 min in traditional method, whereas 4.00 min was required to complete the work by using DRT. There was significant reduction (20.00%) in time requirement.

Table 2 depicts the physiological workload of women respondents performing Animal Shed Cleaning Activity (ASCA). The traditional method of cleaning animal shed was carried out by using long and short handled brooms of 52 and 32 cm, respectively while in DRT long handles spade was used. It was observed from the table that average working heart rate (115 beats/min), average recovery heart rate (81 beats/min) and average peak heart rate (130 beats/min) was high in traditional method of ASCA than by using drudgery reducing tool (103, 77 and 119 beats/min, respectively). On an average, 10.43 per cent (12 beats/min) of reduction was observed in average working heart rate, whereas 4.93 per cent (4 beats/min) of reduction was observed in average recovery heart rate and 8.46 per cent (11 beats/min) of reduction was observed in peak heart rate. Total cardiac cost of work and physiological cost of work was found highest in case of tradition method. There was 31.93 per cent of reduction in total cardiac cost of work and 32.56 per cent of reduction in physiological cost of work while

performing animal shed cleaning activity by using *Gopal Khore Spade*. The average energy expenditure in traditional method was 9.54 kj per min and in DRT it was 7.58 kj per min. There was a reduction of 20.54 per cent in energy expenditure by using DRT. Swapnali and Krishna (2007) revealed that the physiological workload of rural women in performing the activity of cleaning the animal shed was very high and in order to reduce the workload, the use of improved tools were found very effective and useful. With the use of improved tools ergonomic cost namely the heart rate, energy expenditure, TCCW and PCW were reduced significantly at 1 per cent level of significance.

When photography of angles of body parts of working women while carrying out milking activity was analyzed with the help of Kinovea software, the findings indicated that deviation in the upper part of the body viz., neck, trunk, upper arm and lower arm was less when DRT was adopted. It is clear from the Table 3 that the angle of deviation of neck while milking in traditional method was 28.00° forward flexion while in using drudgery reducing tool was 13°. Thus, reduction in the angle of neck flexion was 53.57 per cent (15.00°). Similarly, the angle of deviation of trunk in traditional method was 29.00° and by using DRT it was 18.00° and the reduction in angle of trunk flexion was 37.93 per cent (11.00°). Further, the angle of deviation of upper arm and lower arm in traditional method was 87.00° and 99.00°, respectively, and by using drudgery reducing tool it was 85.00° and 91.00°, respectively. The reduction in angle of deviation was 2.29 per cent (2.00°) and 8.00 per cent (8.08°) lower arm, respectively. The flexed knee angle in traditional method was 19.00° and extended knee angle while using

Table 2. Physiological workload of women respondents while cleaning the animal shed in traditional and using drudgery reducing tool
n=35

Physiological parameters	ASCA - TM	ASCA - DRT	Percentage reduction	Z test
Average working heart rate (beats/min)	115.00	103.00	12 (10.43)	10.56**
Average recovery heart rate (beats/min)	81.00	77.00	4 (4.93)	7.58**
Average peak heart rate (beats/min)	130.00	119.00	11 (8.46)	8.64**
Average total cardiac cost of work (beats)	858.00	584.00	274 (31.93)	9.92**
Average physiological cost of work (beats/min)	43.00	29.00	14 (32.58)	9.92**
Average energy expenditure (kj/min)	9.54	7.58	1.96 (20.54)	10.56**

Figures in parentheses indicate percentage

** Significant at 1 per cent level

ASCA- TM: Animal shed cleaning in traditional method

ASCA- DRT: Animal shed cleaning by using drudgery reducing tool

Table 3. Angle of body parts of women respondents while performing milking activity in traditional method and by using drudgery reducing tool n=35

Body parts	Angle of Body Parts (in degrees)			Percentage Reduction/ Increase in angles	Joint movement
	MA-TM	MA-DRT	Reduction/ Increase in angles		
Neck	28.00	13.00	15.00	53.57	Flexion
Trunk	29.00	18.00	11.00	37.93	Flexion
Upper arm	87.00	85.00	2.00	2.29	Flexion
Lower arm	99.00	91.00	8.00	8.08	Flexion
Knee	19.00	51.00	-32.00	62.74	Extension
Feet	83.00	90.00	-7.00	7.78	Extension

MA-TM: Milking activity in traditional method

MA-DRT: Milking activity by using drudgery reducing tool

drudgery reducing tool was 51.00° and there was an increment of -32.00°. Further, an angle of flexed feet was 83.00 in traditional method and it was extended to 90.00° in case of DRT adoption.

The Table 4 presents angle of body parts of women in cleaning of animal shed in traditional method and by using DRT. The angle of deviation of neck while shed cleaning in traditional method was 31.00° while using drudgery reducing tool was 25.00°. Thus, reduction in the angle of neck flexion when compared was 19.35 per cent (6.00°). Similarly, the angle of deviation of trunk in traditional method was 66.00° and by using drudgery reducing tool it was 33.00° and the reduction in angle of trunk flexion was 50.00 per cent (33.00°). Further, the angles of deviation of upper arm, lower arm, knee and feet in traditional method were 82.00, 117.00, 145.00 and 90.00°, respectively, and by using drudgery reducing tool were 25.00, 89.00, 144.00 and 88.00°, respectively, and the recorded reduction in angle of deviation was 69.51 per cent (57.00°),

23.93 per cent (28.00°), 0.68 per cent (1.0°) and 2.22 per cent (2.00°), respectively.

Based on recorded angle of body parts *viz.*, neck, trunk, lower arm, upper arm, knee and feet while performing dairy activities, the level of risk was assessed by using Rapid Entire Body Assessment (REBA) scale. Table 5 unfolds the risk assessment of the women respondents based on REBA while performing milking and cleaning of animal shed activities in traditional and by using DRT. The REBA was developed by Hignett and McAtamney (2000). It is a tool to assess the effect of working posture on body and to give urgency with action should be taken. The REBA can be used when an ergonomic workplace assessment identifies that further postural analysis is required. From the assessment, it was clear from the table that maximum respondents (82.86%) had high risk in the traditional milking method whereas only 5.74 per cent of the respondents had very high risk in performing the activity in traditional

Table 4. Angle of body parts of women respondents in cleaning of animal shed in traditional method and by using drudgery reducing tool n=35

Body parts	Angle of Body Parts (in degrees)			Percentage Reduction	Joint Movement
	ASCA - TM	ASCA - DRT	Reduction/ Increase in angles		
Neck	31.00	25.00	6.00	19.35	Flexion
Trunk	66.00	33.00	33.00	50.00	Flexion
Upper arm	82.00	25.00	57.00	69.51	Flexion
Lower arm	117.00	89.00	28.00	23.93	Flexion
Knee	145.00	144.00	1.00	0.68	Flexion
Feet	90.00	88.00	2.00	2.22	Flexion

ASCA- TM: Animal shed cleaning in traditional method

ASCA- DRT: Animal shed cleaning by using drudgery reducing tool

Table 5. Risk assessment of the women respondents based on REBA while performing milking and cleaning of animal shed activities in traditional method and by using drudgery reducing tool n=35

Level of Risk with scores	Milking activity		Cleaning of animal shed		Inference based on REBA scores
	Traditional method	Using drudgery reducing tool	Traditional method	Using drudgery reducing tool	
Negligible risk (1)	-	-	-	-	No change
Low risk (2-3)	-	23 (65.72)	-	17 (48.57)	Change may be needed in the tool design
Medium risk (4-7)	-	12 (34.28)	-	18 (51.43)	Further investigation change soon
High risk (8-10)	29 (82.86)	-	13 (37.15)	-	Investigate and implement change
Very high risk (11+)	06 (17.14)	-	22 (62.85)	-	Implement change

Figures in parentheses indicate percentage

method. Further, it was observed that by using drudgery reducing tool of milking, the higher percentage (65.72%) had low risk which was followed by medium risk (34.28%). Further, it was clear from the table that majority of the respondents (62.85%) had very high risk in performing traditional method of ASCA whereas only 37.15 per cent had high risk in performing the activity. Further, by using drudgery reducing tool higher percentage (51.43%) had medium risk in cleaning whereas, 48.57 per cent had low risk in shed cleaning.

The data on perceived exertion was recorded for milking activity on 5 point scale *i.e.*, very light, light, moderately light, heavy and very heavy (Varghese *et al.*, 1994). It was clear from the Table 6, that higher percentage of the respondents (57.14%) rated milking activity in traditional method as heavy followed by very heavy (31.42%), light (5.72%) and moderately light (5.72%). Further, by using drudgery reducing tool for milking, majority of the respondents (62.85%) rated milking activity as light activity followed by moderately light (22.86%) and very light (14.28%). Similarly, in traditional method of cleaning of animal shed, higher percentage (71.43%) of the respondents rated ASCA as very heavy activity and remaining percentage of women (28.57%) rated as heavy activity. Further, using DRT for animal shed cleaning, the maximum respondents (77.15%) considered it as light activity which was followed by moderately light (14.28%) and very light (8.57%).

Table 6. Opinion on perceived exertion of the selected samples while carrying out milking and shed cleaning activity n=35

Perceived Exertion Scores	Milking activity		Cleaning of animal shed	
	Traditional method	Using drudgery reducing tool	Traditional method	Using drudgery reducing tool
Very light (1)	-	05 (14.28)	-	03 (8.57)
Light (2)	02 (5.72)	22 (62.86)	-	27 (77.15)
Moderately light (3)	02 (5.72)	08 (22.86)	-	05 (14.28)
Heavy (4)	20 (57.14)	-	10 (28.57)	-
Very high (5)	11 (31.42)	-	25 (71.43)	-

Figures in parentheses indicate percentage

The selected variables such as physiological, physical and biomechanical with reference to energy expenditure, physiological cost of work, grip strength (both left and right hand) and body angles at work respectively, has revealed that the use of DRT in carrying out milking and cleaning of animal shed activity was found to be effective as the total scores on these components was recorded low when compared to traditional method of performing the above mentioned activities. It could be concluded that by using DRT *viz.*, Revolving milking stand and stool to milking and *Gopal Khore* spade for cleaning of animal shed has reduced the human cost of work. Thus, it could be recommended to use drudgery reducing tool.

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