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Research Paper :

An ergonomic assessment of activities done by female workers at kitchen workstation

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ABSTRACT

Study was undertaken to do ergonomic assessment of kitchen workstation for females engaged in cooking activities, with objective to assess the physiological parameters of female workers engaged in selected cooking activities and to evaluate the design of selected work station in-terms of ergonomic standards. Study was conducted in Ludhiana district for which sixteen respondents having similar physical and physiological parameters were selected. For experimentation, five activities; cutting, grating, kneading, rolling and dish-washing were selected. The per cent increase in heart rate was maximum for grating 38.56 and minimum for rolling 16.20. Reduction in grip and pinch strength of right hand was found more as compared to the left hand. The per cent deviation in thoracic and in lumbar region was maximum during kneading and minimum during rolling.

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Ergonomics contributes to the designing and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of the people. To obtain maximum efficiency in work with least cost to the body, there should be an ideal relationship between work, worker and work place (Steidl and Bratton, 1968). The homemaker is the predominant figure in the home and household work is an indispensible part of the homemaker. She requires a lot of energy and time to complete work inside and outside the home with satisfaction and desired standards. Researchers have proved that any work station 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 (Verghese *et al.*, 1995). So, the kitchen workstation should be adequately designed and properly arranged in order to reduce the physical, physiological and temporal costs of the homemaker. If the body fails to maintain the equilibrium while doing work, it adds to the human energy cost and physiological dynamics such as energy expansion, physiological cost of work, muscular effort etc.

EXPERIMENTAL PROCEDURE

Selection of respondents:

Study was conducted in Ludhiana district For study, sixteen respondents having similar physical and physiological parameters were selected. Selected homemakers had mean age 33.7 years, mean height 156.87, mean weight 61.42 kg and mean heart rate 74.7 (beats/min).

Standardization of activities:

Five activities in which the respondents faced maximum problems were selected. These were cutting, kneading, rolling, grating and dish washing. Each of the activity was performed for fifteen minutes. For cutting and grating activities carrot were taken. Kneading was done of wheat flour weighing 500 g. For dish washing, medium sized utensils including skillet, *patila*, full plates, bowls, glasses, serving bowls, different types of spoons etc. of stainless steel were used.

Collection of data:

A preformed questionnaire was used to record personal data, and readings during the experiment. Prior appointments were fixed with the selected subjects, and then as per the convenience of the subjects, visits were

made and experiments were carried out and readings were taken as the subjects performed the intended tasks. Subjects were encouraged to work in a natural way and not to be influenced by the interviewer's presence.

Before the start of each activity, subjects were rested for 15 minutes. At this point of resting position their heart rate, grip strength, pinch strength and normal spine position were taken. Subjects were explained to perform each activity for 15 minutes using their daily use equipment and tools. Heart rate was noted during work at the interval of 5 minutes each. Later, these readings were averaged to get mean values. Posture adopted during activity was also taken with flexi curve and drawn on the chart paper. Immediately after the termination of each activity, the subject was made to sit in relaxed position and recovery heart rate was recorded for 5 minutes at the interval of 1 minute each (or till the value touched the resting value) with the help of heart rate monitor. Reading of grip strength and pinch strength were also recorded. Rest period of 30 minutes duration was given every time before the start of the next activity.

Assessment of physiological parameters:

Based on the heart rate records, the following parameters were calculated.

– Average heart rate during rest, work and recovery period.

– The energy expenditure per minute was estimated from heart rate using the following formula and the classification of work load was done as per Verghese *et al.* (1989).

Energy expenditure (k j/min) = 0.159 x Average heart rate (beats/min) – 8.72

– Total cardiac cost of work (TCCW) was also estimated for the whole day based on the cardiac cost of work and cardiac cost of recovery.

Cardiac cost of work (CCW) = Increased average heart rate x Duration of work

Increased average heart rate during work= Average working heart rate – Average heart rate during rest

Cardiac cost of recovery (CCR) = Increased average heart rate during recovery x Duration

Increased Average heart rate during recovery= Average recovery heart rate –Average resting heart rate

Statistical analysis of experimental data:

Simple averages, percentages, standard deviation and paired 't' test was used to find out significance of differences between existing and improved working conditions.

OBSERVATIONS AND ANALYSIS

The experimental findings of the study have been discussed in the following sub heads:

Cardiovascular responses during the selected activities:

It may be observed from the Table1 that while performing different activities in the kitchen, average heart rate was found to be maximum during grating (106 beats/min) and minimum during rolling (91beats/min). Increase over base in average heart rate was also maximum for grating (29.5) and minimum for rolling (13.1). It was observed that per cent increase of heart beat was 38.56 for grating, 34.74 for kneading, 30.57 for cutting, 21.29 for dish washing and only 16.2 for rolling of chapatti. So, it can be concluded that among the selected kitchen, activities maximum force was exerted for grating followed by kneading dough. The least force was required for rolling chapattis.

The paired 't' test results were found to be highly significant at 1% level of significance indicating that there was significant difference in the average heart rate at rest and during activity.

Muscular stress of selected subjects:

Muscular stress was assessed by measuring the reduction in larger and smaller muscles of hand by using the grip and pinch dynamometer.

Table 1: Increase in cardiovascular responses of the selected respondents while performing the different activities

Activity	At rest (beats\min)	During activity (beats\min)	Increase over base	Percentage increase	't' value
Cutting	76.20 ± 0.84	99.5 ±2.75	23.3	30.57 ± 3.7	47.65*
Grating	76.50 ± 0.97	106 ±5.0	29.5	38.56 ±2.5	44.18*
Kneading	77.70 ± 0.83	104.7 ±4.40	27	34.74 ±4.6	60.37*
Rolling	77.90 ± 1.87	91 ±2.56	13.1	16.2 ±5.2	20.03*
Dish washing	77.50 ± 0.93	94 ±3.22	16.5	21.29 ±3.5	26.32*

* indicates significance of value at P=0.01

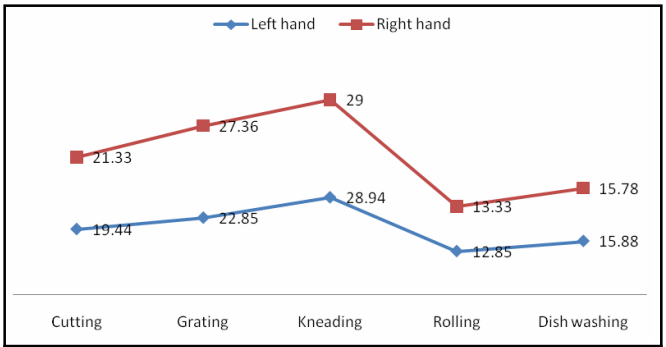

Fig. 1: Percentage reduction in the grip strength of left and right hands after performing the selected activities

Reduction in muscular grip strength (kg) of subjects in doing selected activities:

The mean values of percentage decrease of the muscular strength for both the hands independently (right hand and left hand) are presented in Fig.1. It indicates that the maximum percentage reduction in both the hands occurred while kneading (28.89% and 29% for left and right hand, respectively) and minimum was observed after the activity of rolling (12.85% and13.33% for left and right hand, respectively).

Further, the data also indicate that the per cent decrease in grip strength of right hand was more as compared to left hand. The paired 't' test values were found to be comparatively more significant for right hand (1 % level of significance). It has been suggested that dominant hand (right hand) is about 10% stronger than non-dominant hand (left hand).This may be due to more habitual use of right hand for doing activities by all the subjects as compared to left hand.

Reduction in muscular pinch strength (kg) of subjects in doing selected activities:

Data pertaining to the reduction in pinch strength after performing such activities where hands specifically fingers were involved is presented in Table 2. The values of the Table indicate that the maximum percentage reduction in pinch strength of both the hands occurred while grating (44.15% and 47.00%) for left and right hand respectively and minimum was after the performance of activity of rolling (12.50% and15.38%) for left and right hand, respectively. Kneading dough was another activity which could be considered as strenuous from this particular parameter point of view as data revealed that about 42.85% in left hand and 45.13 % in right hand percentage reduction was observed.

Further, the data also indicate that the per cent decrease in pinch strength of right hand was more as compared to left hand. The paired t test values were found

to be comparatively more significant for all the activities for right hand (1 % level of significance). It has been found that there were significant differences between pinch strength of left hand and right hand as well as between male and female subjects.

Postural stress of selected subjects while doing selected activities:

It can be seen from the Fig. 2. that a change of 5.5^0 to 21^0 in thoracic region was observed while doing the various selected activities. The per cent deviation in thoracic region was maximum during kneading (10.71 per cent) followed by grating (7.2 per cent) and minimum during rolling of chapatti (2.8 per cent). In the lumbar region, a change of 5 to 23^0 was seen during various activities. Per cent deviation was maximum again during kneading (11.61 per cent) and minimum during rolling (2.5 per cent). It can be concluded that percentage deviation is directly related to the activities where more exertion or force has to be applied by the worker.

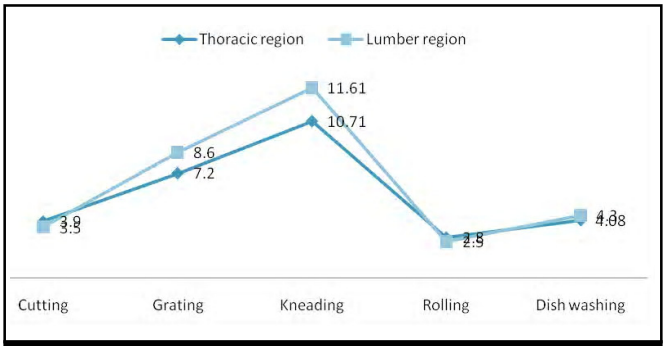

Fig 2: Percentage deviation of thoracic and lumbar during various selected activities

Further, it can be noticed that percentage deviation was more in thoracic region as compared to lumbar region for rolling and cutting whereas deviation was found more in lumbar region as compared to thoracic region for kneading, grating and dish washing. Differences in the degree of resting and working posture for both thoracic and lumbar regions were found to be significant at 1 % level of significance.

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