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Research Paper

An evaluation and acceptance of kitchen aid for the standing type of kitchen

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■ **ABSTRACT :** Excessive standing causes the joints in the spine, hips, knees and feet to become temporarily immobilized or locked. Thus, the present study was conceptualized to devise some aid for helping the women who work in the kitchen in a standing posture for longer duration. The study was conducted in Ludhiana city in 2013. Based on the anthropometric measurements of 200 surveyed respondents and their suggestions, a kitchen aid was developed and evaluated using physiological parameters like average heart rate, energy expenditure and physiological cost of work. The result showed significant reduction in average heart rate, energy expenditure and PCW. The respondents also appreciated the idea of sitting aid with steps for reaching out to higher shelves.

■ **KEY WORDS:** Physiological cost of work, Energy expenditure, Average heart rate, Kitchen aid

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Prolonged and frequent standing, without some relief by walking, causes blood to pool in the legs and feet. When standing occurs continually over prolonged periods, it can result in inflammation of the veins. This inflammation may progress over time to chronic and painful varicose veins. Excessive standing also causes the joints in the spine, hips, knees and feet to become temporarily immobilized or locked. This immobility can later lead to rheumatic diseases due to degenerative damage to the tendons and ligaments (the structures that bind muscles to bones) (Canadian Centre of Occupational Health and Safety). The 5-6 hour working in kitchen in a standing posture causes lots of discomfort to women (Vibha and Sangwan, 2007). There is another problem generally reported in various studies is of difficulty in reaching out to too high shelves; which in standing type of kitchens are designed above the head clearance space (Malik, 2005 and Joshi, 2006). The height of shelf forces people to either raise their heels or use *patra*/stool to reach the top shelf (Chaudhary and Vinay, 2005). Organization of work surface or storage space is considered important for decreasing cost of work. With a faulty design of kitchen storage shelves, even the normal person without primary anatomical or physical defects may develop degenerative tissue changes and decreased output with maximum input (Kumari and Dayal, 2009).

Efforts has been made by various researchers to make kitchen work environment conducive for the worker by applying the laws of work *i.e.* ergonomics. However, lack of awareness amongst the users and government effort has hampered its proper implementation as cited by Sultana and Prakash (2013) in their study on 1000 homemakers. The 74 per cent of the ordinary kitchen users had no knowledge about the concepts of ergonomics and its benefits involved in a kitchen design. Ordinary kitchen users had suffered more discomfort, fatigue and musculo-skeletal disorders in using their kitchens. Nearly 79 per cent of the ordinary kitchen users experienced more discomfort, fatigue and musculo-skeletal disorders in comparison with only 31 per cent of the modular kitchen users.

Adequately designed and properly arranged kitchen work area reduces physical, physiological and temporal cost of home makers (Saha, 1990). Nagori and Lodha (2011) analyzed

the homemakers 'storage furniture design of semi-modular (SMK) and non-modular kitchens (NMK) in order to reduce their physiological cost of work. The findings of the study highlighted that SMK respondents had normal BMI, lower perceived exertion due to good layout of kitchen storage furniture design. This causes lower musculo-skeletal disorders, which reduce physiological cost of work. A large number of studies indicate that physiological stress can be relieved by devising some technology which may offer to smoothen out strained musculature. So, there should be a solution that can reduce the prolonged standing time of women in kitchen as according to a study freedom to sit at work is important in preventing pain in the lower limbs (Messing *et al.*, 2006).

So, designing a technology which would assist women in doing kitchen work without any stress on musculature and if such technology can also have 'add on' utility and be used for reaching out the top most shelves will be the ideal solution. Thus, present study was conceptualized.

■ RESEARCH METHODS

The first part of research was conducted in 2013 on 200 kitchens which were selected purposively from two zones of Ludhiana city. Women in the age group of 35 -55 years and actively involved in the kitchen work were selected as respondents. The self-structured interview schedule was prepared to collect the information regarding work, worker, workplace and physiological stress felt by the respondents while doing kitchen work.

Development and evaluation of kitchen aid :

On the basis of suggestions given by the respondents and anthropometric measurements taken during the survey, a kitchen aid was developed and evaluated in the department laboratory.

Selection of respondents :

20 respondents (10% of the surveyed respondents) who were similar in physiological parameters (age, height, weight, body type) and in close range with minimum variation in health status were taken as respondents.

Selection of activities :

Based on the survey results, two routine activities *i.e.* chapatti making and dish washing were selected as the activities for lab experiment because these were perceived as more time consuming, energy requiring activities and caused discomfort to the user. Experiment was conducted in modular kitchen of the department.

Selection of research tools :

For measurement of cardio-vascular responses, Polar Heart Rate Monitor was used. Energy costs and physiological cost of work was calculated from the values of heart rate only.

Laboratory experiment :

Firstly resting heart rate of respondents was calculated. The respondents were made to rest for five minutes and their resting heart rate was recorded after every one minute. The selected respondents were then asked to do chapatti making and dish washing activities for the time period of 30 minutes each both without and with aid. The heart rate was measured at every 5 minutes in each case. Six such readings were taken and used to calculate average heart rate. Energy expenditure was calculated using the formula :

Average heart rate= Average working heart – Average resting heart rate

Energy expenditure rate (KJ/min) = 0.159 × average working heart rate (beats/min) – 8.72

The physiological cost of work was calculated using the following formula :

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

CCW = (Average recovery heart rate – Average resting heart rate) × duration of work

CCR = (Average recovery heart rate – Average resting heart rate) × duration of recovery

Physiological cost of work (PCW) = Total cardiac cost of work (TCCW) / total time of activity

Two such trials were conducted and the average of heart rate, energy expenditure and PCW was calculated for final readings in each case.

■ RESEARCH FINDINGS AND DISCUSSION

Every kitchen is unique in itself. But there is scope for enhancing the work environment of the homemaker by incorporating ergonomic concepts to make kitchen more functional with good reach levels and more storage zones and counter spaces for working which are an instant welcome and cheer to the homemakers today (Mahoney, 2009). Based on the anthropometric measurement of the respondents taken during the survey and suggestions made by them, a kitchen aid was developed and evaluated. It was high adjustable chair with back support and foot rest. A provision of steps for reaching out to higher shelves was also made.

Reduction in average heart rate while working with the help of kitchen aid is shown in Table 1. Per cent increase in reduction of heart rate was 14.52 in case of chapatti making and 8.20 in case of dish washing as heart rate was reduced when the respondents performed the activities with the use of aid. A statistically significant reduction ($p < 0.01$) was found for average heart rate for both the activities while using kitchen aid where elbow height was adjusted to 3" above the work counter. It was also observed by Iwakiri *et al.* (2004) that standing aid had a desired effect in decreasing discomfort

and muscle load on the low back during dishwashing.

In terms of energy reduction which was calculated by using formula based on average working heart rate (Table 2), it was observed that per cent increase in reduction was 17.17 for chapatti making and 10.98 for dish washing. The difference was calculated to be statistically significant ($p<0.01$). Thus, it can be concluded that improved workplace was highly effective in minimizing the energy expenditure of the subjects. The results are in line with those reported by Kaur *et al.* (2007) who reported that the use of improved bag and plucker were found to be highly satisfying in reduction of drudgery in cotton picking in terms of reduction in heart rate, energy expenditure, total cardiac cost of work and physical cost of work. Shobha *et al.* (2007) also found that modern kitchen tools were more efficient in reducing the energy to a considerable extent in almost all the activities.

Furthermore, reduction in "physiological cost of work" (PCW) while doing chapatti making and dish washing is presented in Table 3. It is evident from the table that reduction was significant in case of dish washing ($p< .10$) but non-significant reduction was observed for chapatti making with the use of aid. Previous research has also shown that improved method of performing cotton picking activity by women reduced heart rate, energy expenditure, total cardiac cost of work and physiological cost of work (Kaur, 2006).

The responses of all the 20 respondents regarding acceptance and satisfaction of kitchen aid are given in Table 4. Although the respondents were not familiar with working in the kitchen using a sitting aid and found it somewhat difficult but they appreciated the idea of sitting aid with steps for reaching out to higher shelves (mean score 2.00). According to them the aid can be helpful for longer duration work (mean score 1.75) especially to those women who were suffering from backache, joint pain and discomfort of lower extremities. They found the aid helpful in relieving pain in different body parts (mean score 1.30).

In previous research, Oberoi *et al.* (2004) also reported that kitchen designs based on the anthropometric and reach measurements of the women were very effective in reducing the ergonomic cost of kitchen work. The ergonomic cost of work in the ergonomically sound kitchen was reduced up to 47-50 per cent and with the organized layout of the kitchen the ergonomic cost of work further reduced up to 7-22 per cent.

Limitation :

– The aid can be made of some lighter material which requires help from an expert of the field.

Table 1 : Change in average heart rate of selected subjects while using kitchen aid for performing selected activities

Activities performed	Average heart rate (beats/min.)								Per cent increase in reduction	t value
	Existing working condition				Improved working condition					
	At rest	During activity	Increase over base	Per cent increase	At rest	During activity	Increase over base	Per cent increase		
Chapatti making	77.2	95.97	18.77	24.31	78.45	94.75	16.3	20.78	14.52	3.96***
SE	±0.46	±0.65			±0.35	±0.73				
Dish washing	78.4	96.95	18.55	23.66	79.65	96.95	17.3	21.72	8.20	
SE	±0.34	±0.51			±0.32	±0.47				2.96***

*** indicate significance of value at P=0.01

Table 2 : Change in energy expenditure of selected subjects while using kitchen aid for performing selected activities

Activities performed	Average energy expenditure (Kj/min)								Per cent increase in reduction	t value
	Existing working condition				Improved working condition					
	At rest	During activity	Increase over base	Per cent increase	At rest	During activity	Increase over base	Per cent increase		
Chapatti making	3.56	6.54	2.98	83.7	3.75	6.35	2.6	69.33	17.17	3.96***
	±0.07	±0.11			±0.06	±0.12				
Dish washing	3.75	6.69	2.94	78.4	3.94	6.69	2.75	69.79	10.98	2.96***
	±0.05	±0.08			±0.05	±0.08				

*** indicate significance of value at P=0.01

Table 3 : Difference in physiological cost of work while using kitchen aid **(n=20)**

		Mean	SE	t value
Chapatti making	Without aid	20.34	±0.14	1.708
	With aid	18.91	±0.89	
Dish washing	Without aid	21.53	±0.23	1.95*
	With aid	20.78	±0.44	

* indicate significance of value at P=0.1

- The field experiments were conducted on a sample of 20 only.
- Present study was limited to urban areas only.
- Human behaviour is very complex and always in a state of constant flux of change. No objective tool can be applied to judge it correctly and for all the times.

Table 4 : Satisfaction and acceptance of kitchen aid

	Mean score
Good idea to have provision of steps	2.00
Adjustable steps increases body reach on shelves	2.00
Adjustable seat is good option	2.00
Working on chair was comfortable experience	1.75
Helpful in longer duration work	1.75
Being two in one: its cost effective	1.75
Acceptable in daily routine	1.75
Increases output	1.60
Didn't feel any kind of fatigue	1.51
Cost will be affordable	1.45
Improves body posture	1.40
Helpful in relieving pain in different body parts	1.30
Elbow rest eases out shoulder stress	1.25

2- Extremely satisfied and acceptable, 1- Satisfied and acceptable, 0-Not satisfied and not acceptable

Conclusion :

The standing type of kitchen causes discomfort for longer duration work especially to those women with certain kind of musculo-skeletal pain and other age related problems. The intensity of pain increases if they work for longer duration in a standing position. So, the kitchen aid was developed based on their anthropometric measurements and suggestions given by respondents. The aid evaluated thus proved to be effective in reducing the physiological stress among the selected subjects. However, there is a need to conduct more trials on larger sample and on more activities, to recommend the AID.

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