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Physiological Cost of Homemakers While Using Kitchen Storage

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ABSTRACT The present study aims to analyse the homemakers' storage furniture design of semi-modular (SMK) and non-modular kitchens (NMK) in order to reduce their physiological cost of work. For this purpose, sixty households were selected from two posh areas of Udaipur city having semi- modular and non-modular kitchens (30 each). An interview and observation schedule was used to gather the relevant information regarding respondents' anthropometric measurements, Body Mass Index (BMI), Rated Perceived Exertion (RPE) and Musculo-Skeletal Disorders (MSD). 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.

INTRODUCTION

Kitchens are important premises of any home. A kitchen can make anybody's health and at the same time it can destroy anybody's health (Lagomarsino 2004). A woman spends a major part of her time in the kitchen (Varghese 1996), therefore designing the layout of the workspace must be given considerable attention (Charles 1976) along with the organization of the work surface. Designing of a functional storage should be according to the anatomical measurements, age, sex and postural consideration of the users' to serve the purpose (Chakharbarti 2001). Proper space for the storage and performance of routine activities, the correct positioning of equipment save a lot of unnecessary bending and other motions. It not only adds to the convenience and comfort of the homemaker but also enables the task to be performed quickly by the homemaker with least cost (Kistwaria et al. 2007). Organization of the work surface or storage spaces decreases the cost of work (Kumari and Dayal 2009). Poorly designed work surface in terms of counter height, width and depth and kitchen storage space causes permanent body damage besides increasing the work hence it should be given careful attention (Kistwaria et. al 2007). Women's work demands a high degree of physical efforts leading to fatigue and frustration. There is a large amount of energy spent, demands on the body due to the different types of activities and manner in which these activities are performed leads the body segment to be manipulated in the space, and thus results in change in posture leading to increase in physiological cost of work. Wrongly designed posture induces improper postures, leading to operational uneasiness and strain while working (Kumari and Dayal 2009). It may also result in permanent change in spine, in position of the joints, ligaments and muscles and in location of the organs of the body (Grandjean 1988), thus enhancing the physiological cost of work and fatigue (Blum 2009). Hence, the study analyses the homemakers' physiological cost of work while using kitchen storage furniture for cooking. The objectives of the study are as under-

a. To calculate homemakers' physiological cost of work while using kitchen storage furniture for cooking in semi- modular (SMK) and non-modular kitchens (NMK) in terms of-
   i. Work area triangle
   ii. Body Mass Index (BMI)
   iii. Rated Perceived Exertion (RPE)
b. To find out the requirements of kitchen (SMK and NMK) storage design felt by homemakers which minimise their cost of work through-
   i. Different working body postures and
   ii. Musculo Skeleton Disorders (MSD)

MATERIAL AND METHODS

A sample of sixty households having semi-modular and non-modular kitchens were selected from two posh areas of Udaipur city, that is, 30 each for SMK and NMK from October 2008 to March 2009. An interview schedule was

used to gather the relevant information regarding respondents' profile and anthropometric measurements. Anthropometric rod was used to measure body lengths. BMI was calculated using Quetelet's Index given by Garrow (1984). Respondents' rated perceived exertion (RPE) was measured through a scale developed by Varghese et al. (1994). Respondents' musculoskeletal disorders were measured by body map and angle of deviation of spinal cord by flexicurve and numbers of postural changes were recorded while cooking in SMK and NMK. One semi-modular and one non-modular kitchen were selected for cooking purpose where cooking activity was performed thrice by three homemakers. Standardized menu was prepared and respondents physiological cost of work was calculated thrice (before, during and after cooking) and average readings were calculated in terms of body mass index, rated perceived exertion, intensity of pain in body, musculo-skeletal disorder, angle of deviation, frequency of postural change while utilising kitchen storage facilities. These measurements were used in order to calculate the physiological cost of work while using kitchen storage during cooking activity. Frequency, percentage and student't' test were used to analyse the data.

RESULTS AND DISCUSSION

Family Background Information

Religion to which the homemaker belongs affects the time use pattern of homemaker in the kitchen. It determines the differences in mode of domestic and social life as well as the type of houses and cultural pattern of people (Gandotra and Jaiswal 2008). The family background information reflected that overwhelming majority of the respondents were Jains (80 per cent) followed by Hindus (18 per cent). Age reflects the experience of a person since age has a direct correlation with the amount of time spent in household tasks (Sandhu 1985). The average age of the respondents was 41 years (Sd = 3.79). Not much variation was found in the average ages of SMK (mean = 42 years, Sd = 3.26) and NMK (mean = 40 years, Sd = 4.00) respondents. Education brings about desirable changes in the attitude of the homemakers, which motivates them to adopt new technologies, leads to awareness and encourage equipment shifts (Gupta and Kohlin 2001). The data explicitly reveals that more than one- third of the respondents were graduates (41.67 per cent), postgraduates (25 per cent) or had passed senior secondary (18.33 per cent). A small percentage of respondents pursued technical degrees (8.33 per cent). Glaring difference was found between the postgraduate SMK and NMK respondents (SMK= 33.33 per cent and NMK = 16.67 per cent). Number of family members in the household determines the workload of the homemaker (Singhal 1989; Lodha 2003). The average size of the respondents' family was 3 members (Sd= 0.82).

Income of the household plays an important role in determining one's economic status (Lodha 2003). The average household income was Rs. 3,05,300.00 (Sd =2,36,489.00) of respondents' husband as well as of the family members on annual basis. A contrast variation was found in the income group between SMK (46.67 per cent) and NMK (63.34 per cent) respondents. As household income increases, household shifts from simple tools, supplies and equipments to complex ones (National Sample Survey 2001)

Kitchen Work Area Triangle

Well-described triangle between storage, preparation and cooking centres which increases work efficiency of the worker without obstruction. The work triangle concept can give you a basis to see how well your space planning will facilitate your work in the kitchen. The kitchen work area triangle was measured on the basis of distance (in feet) between the storage, preparation and cooking centres of the respondent's kitchen. The mean ± SD was taken as a cut-off point for kitchen work area triangle (in feet) to categorize it into average, maximum and minimum. Table 1 illustrates the average work triangle of respondents kitchen was 16.67 feet (Sd==3.18), that more than half of the respondents had maximum work triangle area. However, one- fourth of the respondents have minimum work triangle. Sharp contrast was observed between the respondents SMK and NMKs regarding average (SMK= 33.33 per cent, NMK = 16.67 per cent) and maximum size of work triangle (SMK= 40 per cent, NMK=56.67 per cent).

One- third of the SMK respondents had average kitchen work triangle. Identical results

Table 1: Distribution of respondents according to the kitchen work area triangle (N= 60)

S. No.	Kitchen work area triangle (in feet)	Types of kitchens					
		SMK n=30		NMK n=30		Total N=60	
		F	%	F	%	F	%
1	Minimum (below 16.67)	8	26.67	8	26.67	16	26.67
2	Average (16.67- 19.85)	10	33.33	5	16.67	15	25.00
3	Maximum (above 19.85)	12	40.00	17	56.67	29	48.33
	Mean	16.30		17.03		16.67	
	S. D.	3.31		3.06		3.18	

were reported by Lelland and Gallup (2009) regarding most desirable kitchen triangle size of 15 to 22 feet. Another kitchen planning research (2009) documented that the absolute minimum kitchen triangle should be 12 feet and maximum 26 feet.

Body Mass Index (BMI) of Respondents

In household work, it is important to ensure acceptable adjustment between the physical fitness and work in order to promote health and safety and improve quality of work and performance. Thus, knowledge and limitations of respondents from physical point of view will help to determine their work-demand fitness compatibility. The height and weight of a person is also indicative of one's fitness (Jhajharia 2001). To measure the physiological cost of work, Garrow's scale (1984) of "Body Mass Index" was used to record height and weight of the respondents. On the basis of these measurements BMI of the respondents were calculated and were categorized as energy deficient, normal or obese. Table 2 data exposed that not much of the variation was found between the percentage of SMK and NMK respondents in the BMI class of 17.0-18.5, that is CED grade I (Mild).

Good contrast was observed in the lower normal weight of SMK (6.67 per cent) and NMK (30 per cent) respondents. Significant difference was also observed in the normal BMI of SMK (46.67 per cent) and NMK (26.67 per cent) respondents. Nearly one-third of SMK respondents belonged to the BMI class of 25.0-30.0, that is obesity grade I. A meagre percentage of SMK respondents (3.33 per cent) fall into the BMI obese grade whereas 13.33 per cent of NMK respondents belonged to this class of BMI. Thus, it can be attributed that nearly half of the SMK respondents were falling in the category of normal and hence will have lower physiological cost of work as compared to NMK respondents.

Rated Perceived Exertion (RPE) of Respondents

The psychology of the person plays an important role in designating the work as light or heavy. Usually respondents experience fatigue towards the end of the daily kitchen activity due to a variety of reasons such as duration of work, abnormal posture while cooking and storing etc. On the basis of respondents overall kitchen work experience, the perceived exertion felt by them was assessed on 5-point continuum RPE scale given by Varghese et al. (1955).

Table 2: Distribution of respondents according to their body mass index (N=60)

S. No.	BMI scores	Types of kitchens					
		SMKn=30		NMKn=30		Total N=60	
		F	%	F	%	F	%
1	CED* grade I (Mild, 17.0-18.5)	2	6.67	1	3.33	3	5.00
2	Low weight - Normal (18.5-20.0)	2	6.67	9	30.00	11	18.33
3	Normal (20.0-25.0)	14	46.67	8	26.67	22	36.66
4	Obese grade I (25.0-30.0)	11	36.67	8	26.67	19	31.66
5	Obese grade II (> 30.0)	1	3.33	4	13.33	5	8.33
	Total	30	100.00	30	100.00	60	100.00

*Chronic Energy Deficiency

Table 3 depicts that in SMK, the exertion was perceived very light (23.33 per cent) and light (33.33 per cent) by respondents. This can be related to well organized storage furniture layout of SMKs which can be easily pull or push out having telescopic channel system that requires minimum efforts of respondents in operation.

Table 3: Distribution of respondents according to rated perceived exertion regarding kitchen work (N=60)

RPE score	*Rated perceived exertion*	*Type of kitchens*			
		SMK n=30		*NMK n=30*	
		F	*%*	*F*	*%*
1	Very light	7	23.33	-	-
2	Light	10	33.33	8	26.67
3	Moderately heavy	8	26.67	12	40.00
4	Heavy	3	10.00	6	20.00
5	Very heavy	2	6.67	4	13.33
	Total	30	100.00	30	100.00

Moreover, it reduces bending posture and lowers fatigue while using kitchen storage furniture thus, reducing physiological workload of respondents. Few NMK respondents (26.67 per cent) perceived exertion as light whereas nearly one- third of the SMK (26.67 per cent) and NMK (40 per cent) respondents perceived kitchen work exertion as moderately heavy. This can be reasoned out as NMK respondents had to maintain sitting (on floor/ with aid), squatting or bending postures while using kitchen storage furniture. Glaring difference was also observed between the SMK (10 per cent) and NMK (20 per cent) respondents who perceived kitchen work exertion as heavy. A meagre percentage of SMK (6.67 per cent) and NMK (13.33 per cent) respondents rated kitchen work exertion as very heavy. Significant difference was observed between SMK and NMK respondents' scores regarding kitchen work rated perceived exertion (t= 2.73, sig. level= 0.01). This can be attributed to due to obesity that raises the pain in neck, lower abdomen, lower back, thighs, knees and legs.

Respondents' Musculo-Skeleton Disorders

The major health problems related to abnormal working postures are the "problems of aches" of the musculo-skeletal systems. Incidence of musculo- skeletal disorders of the respondents was identified using the body map that indicates different parts of the body viz. upper extremities and lower extremities.

Data in Table 4 demonstrates that few percentage of SMK respondents felt light pain in the lower extremities of body parts like mid and lower back and thighs since they were young.

Table 4: Distribution of respondents according to the intensity of body pain while using kitchen storage (N=60)

S. No.	*Intensity of body pain**	*SMK n=30*					*NMK n=30*				
		Very light	*Light*	*Mode-rate*	*Severe*	*Very severe*	*Very light*	*Light*	*Mode-rate*	*Severe*	*Very severe*
1	Neck	23.33	-	3.33	3.33	3.33	3.33	26.67	3.33	26.67	-
2	Right shoulders	26.67	16.67	3.33	-	-	3.33	10.00	16.67	-	36.67
3	Left shoulders	30.00	10.00	-	-	-	3.33	16.67	16.67	16.67	-
4	Rightwrist	30.00	6.67	6.67	3.33	-	-	6.67	36.67	-	
5	Leftwrist	23.33	6.67	3.33	-	-	3.33	13.33	23.33	-	-
6	Right arm	33.33	13.33	6.67	-	-	3.33	16.67	23.33	-	-
7	Left arm	16.67	6.67	6.67	-	-	3.33	20.00	13.33	-	-
8	Right elbow	40.00	10.00	3.33	6.67	-	3.33	-	-	40.00	-
9	Left elbow	36.67	6.67	3.33	-	-	-	-	-	13.33	-
10	Right forearm	30.00	13.33	6.67	6.67	-	-	33.33	10.00	33.33	
11	Left forearm	23.33	13.33	-	-	-	-	10.00	6.67	16.67	-
12	Mid back	23.33	33.33	-	-	-	-	6.67	53.33	-	3.33
13	Lower back	10.00	26.67	23.33	6.67	3.33	3.33	13.33	23.33	33.33	33.33
14	Right thighs	46.67	-	-	3.33	-	-	-	33.33	-	-
15	Left thighs	36.67	10.00	-	3.33	-	-	-	43.33		
16	Right knee	36.67	-	3.33	3.33		-	3.33	16.67	-	-
17	Left knee	36.67	6.67	3.33	-	-	-	-	10.00	6.67	-
18	Right legs	-	13.33	-	-	-		33.33	13.33	3.33	-
19	Left legs	10.00	-13.33	6.67	3.33	-	-	-	6.67	6.67	-
20	Feet	3.33		16.67	13.33	16.67		26.67	20.00	16.67	23.33

* Multiple responses *

Very light pain was felt by SMKs respondents in neck, shoulders, wrist, arms and forearms, mid and lower back and legs due to bending of neck to fetch items from pullout units. A meagre percentage of the NMK respondents felt light pain in shoulders and legs. Near about one-fourth of the SMK respondents reported moderate pain in lower back (16.67 per cent) and foot (26.33 per cent). On the contrary, NMK respondents observed moderate pain in wrists, mid and lower back, thighs and feet. A meagre percentage of the SMK respondents felt severe pain in feet (13.33 per cent) as compared with the NMK (16.67 per cent) respondents. Due to obesity few SMK and NMK reported pain in lower back to feet. Near about one- third of the NMK respondents reported very severe pain in shoulders and mid back. Significant difference was also observed between the musculo skeletal disorders of SMK and NMK respondents (t=2.41, sig. lev-el= 0.05). This was due to more bending in the NMKs to retrieve or store items from the deep cabinets which require stretching of hand, neck muscles as well as mid and lower back pain. Apart from that sitting on floor in squatting postures causes pain in thigh, leg and foot muscles.

Table 5: Student 't' test showing difference between body disorder and type of kitchen (N=60)

S. No.	*Particulars*	*SMK n=30*		*NMK n=30*		*'t' value*	*df*
		Mean	*S.D.*	*Mean*	*S.D.*		
1	MSD	14.36	3.59	19.93	6.16	2.41*	58
2	RPE	2.43	1.16	3.20	0.99	2.73**	58

* Significant at 0.05 level of probability
** Significant at 0.01 level of probability

CONCLUSION

Thus, it can be concluded that the physiological cost of work was less among SMKs respondents as compared to NMK respondents. This can be related to ergonomically designed SMK storage furniture with zonal organizational options, which increases work efficiency of the worker. Hence, awareness regarding SMK should be made among the homemakers to reduce their cost of work and minimise health problems.

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