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Ergonomic Assessment of storage shelves of standing kitchen in rural Haryana

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Abstract:

The present study was conducted to investigate the height of kitchen storage shelves in rural areas. For study 50 kitchens' storage shelves were analyzed with respect to the women's anthropometry that were found to be working in kitchen for more than 2 years and were found to be using kitchen for more than 2 hrs daily. In study most of the kitchen were peninsula/ G type kitchen (78.0 per cent) and on average 10-12 years of old. Findings of study reflect that height of storage shelves (1,2 and 3) were found to be at more height comparative to the dimensions of women's (shoulder height, standing height and standing vertical reach). Average dimensions of women were 130.8±5.7cm (Shoulder height), 160.2±5.3 (standing height), cm, and 188.3±19.8cm (standing vertical reach) other side mean height of the counters were 138.6±15.6cm (storage shelf 1), 183.4±18.6cm (storage shelf 2) and 244.7±21.6 (storage shelf 3). As per findings in majority of the houses (64.0%, 84.0% and 54.0%) height of storage shelf 1,2 and 3 were found to be at more height compared to women' working in kitchen dimensions (standing shoulder height, standing height and vertical reach height). Only 12.0 per cent storage shelf- 2, were found to be correlated with standing height of women, means were comfortable to use by women. P values were found to be less than 0.005 (0.000154, 7.6E-14 and 1.87E-17) which represent that there is significantly different in means of each group reflect that kitchen storage shelves' height were not equal or matched with anthropometry of women.

Keywords: Counter, kitchen, storage shelf and vertical reach

INTRODUCTION

The kitchen works as a family room, store room and dining room thus making it a major centre of all activities and heart of any house. The major portion of homemakers total work time four to five hours is spent on cooking and other activities related to feeding the family which in approximately one-fourth of a life span. The work area specially kitchen should be adequately design and properly arranged to reduce the physical, psychological and temporal cost of the homemakers. The planning of the kitchen area need to be considered as prime importance in order to facilitate in carrying out the activity and reducing the effect of fatigue and accidents. Every kitchen is unique in itself, but there is a scope for enhancing the work environment of the homemakers by incorporating ergonomic concepts to make kitchen more functional. Ergonomic kitchen spaces are another great way to save time and energy and efficient ergonomic kitchen required less stress in looking out for the utensils and ingredients in the kitchen so, the kitchen which is a need of an hour should be well planned and comfortable. The every unit of kitchen should be based on human dimensions of homemakers. The main components of ergonomic are incomplete without anthropometry and posture. Based on ergonomic principles the body measurements and functional reaches along with specification for storage design are essential. Women's vertical reach is of critical significance for the layout of cupboard space and shelves. The problem lays in fixed height countertops and a "one-size-fits-all" approach which is usually seen in modular kitchen now days. **Nickel and Dorsey (1960)** have stressed that importance of easy reaches. While working in the kitchen women face numerous problems related to dimensions of the kitchen storage, faulty design of its kitchen storage furniture and a large walking distance between the centers. The design of the kitchen, storage furniture has impact of the strain, time and effort of the home makers. the homemaker spend lot of money in making her kitchen more functional, comfortable and presentable which are earlier in clutter of food supplies and utensils **(Gupta and Pandya, 2019).**

The present study will try to explore the modern kitchen with all components' from an ergonomic lens and evaluate in terms of compatibility of measurements with design and suggest suitable design solutions which can directly affect the well-being and efficiency of the home makers. The present study was undertaken to carry out an in-depth analysis of the selected modern kitchen through an ergonomic lens and suggest suitable design solutions for the same. The aim of this research was to develop a holistic approach to understanding person-environment fit **(Oswald, 2006)** leading to informed design practice. It is important that women should know their comfortable reach(s) in order to plan her storage shelf(s) in the home especially in the kitchen.

METHODOLOGY

The study was undertaken on 50 women of *Behbalpur* village who were found to be working more than 2 hrs daily in

their respective kitchen. The main motto behind the study was to analyze the height of storage shelves of kitchen in respect to the dimensions of women working in it. Dimensions of kitchen; height of storage shelves (1,2, and 3) were taken during study by using inch tap. Storage shelves were categorized as 1, 2, and 3 based on the height; as lowest storage shelf as 1, middle as 2 and top as 3. Each storage shelf height was studied separately with women dimensions like; storage shelf 1 with standing shoulder height, storage shelf 2 with standing height and storage shelf 3 with standing vertical reach of women. During study different abbreviation were used for different terms were as follow:

Table: 1. Abbreviation and definition of terms used in study

Terms	Abbreviation	Definition
Standing Height	SH	Human height or stature is the distance from the bottom of the feet to the top of the head in a human body, standing erect. It is measured using a stadiometer, usually in centimeters when using the metric system, or feet and inches when using the imperial system
Standing Shoulder Height	SSH	Vertical distance from the floor to the acromion (i.e. the bony tip of the shoulder)
Standing Vertical Reach	SVR	the highest point he/she can reach flat-footed (the height of this point from the ground is referred to as "standing reach"
Counter Height	CH	"Counter Height " is the Vertical distance from the floor to the top of the counter.
Storage Shelf Height (1)	SSH (1)	A flat length of wood or rigid material, attached to a wall or forming part of a piece of furniture, that provides a surface for the storage or display of objects
Storage Shelf Height (2)	SSH (2)	
Storage Shelf Height (3)	SSH (3)	

Difference between anthropometric measurements and dimensions of kitchen were studied in 3 groups

Group 1= Relation between standing shoulder height (cm) and storage shelf (1) height (cm)

Group 2= Relation between standing height (cm) and storage shelf (2) height (cm)

Group 3= Relation between vertical reach height (cm) and storage shelf (3) height (cm)

Analysis of data: For significant means of data, statistical analysis was done including. For socio-economic profile and involvement pattern of women in kitchen, frequency and percentages were used. Anthropometric measurements and dimensions of kitchen were statistically studied by using mean, standard deviation, minimum value, maximum value, 10^{th} percentile, 50^{th} percentile and 95^{th} percentile. ANOVA was used to test the significant relation and difference between two means of groups (1-6). One-way analysis of variance was used to determine the factors of those mean were statistically significant or not.

RESULTS AND DISCUSSION

Involvement of women in kitchen activities:

Results regarding time spend in kitchen on different activities. As findings show that in morning time (breakfast) more than fifty per cent respondents (54.0%) were found to be spending 2:00-2:30 hours in kitchen, followed by 36.0 per cent respondents were found to be involved for 1:30-2:00 hrs and only a few percent (10.0%) were involved for 2:30-3:00 hrs in making breakfast. Regarding noon activity, (lunch) 42.0 per cent were found to be involved in using kitchen for 0:30 mints-1:00 hr. For making dinner, most of the respondents (52.0 per cent) were spending 2:00-2:30 hrs in kitchen, and a few per cent respondents (8.0%) were also found to be involved for long time like; 2:30-3:00 hrs in kitchen for cooking activity. In line similar results was found by **Kishtwaria** et al (2007) in their research that Indian women spend on an average 5-6 hours in kitchen which may amount to approximately one fourth of her life span. So the work area and environment of kitchen plays an important role in affecting the health of the worker.

Table 3. Particulars of kitchen

Variable		Percentage
Kitchen type	One wall	6.0
	U shape	16.0
	Peninsula/G type	78.0
No of storage shelf	1 Storage shelf	100.0
	2 Storage shelf	100.0
	3 Storage shelf	60.0
Person work inside	1 member	50.0
	2 members	36.0
	3 members	14.0
Years of	3-8 years	14.0
	8-13 years	52.0
	13-18 years	34.0
Years of old	5-12 years	52.0
	12-19 years	36.0
	19-25 years	12.0

Findings in Table 3 give a clear picture of involvement pattern of women in kitchen activities. As the table

Table: 2. Time spend in kitchen

Activity	Time	Percentage
Morning (breakfast)	1:30-2:00hrs	36.0
	2:00-2:30hrs	54.0
	2:30-3:00hrs	10.0
	No cooking	14.0
Afternoon (lunch)	Up to 0:30 minutes	44.0
	0:30 mints-1:00hr	42.0
Evening (dinner)	1:30-2:00hrs	40.0
	2:00-2:30hrs	52.0
	2:30-3:00hrs	8.0
Any other	Up to 0:15 minutes	42.0
	0:15-0:30 minutes	58.0

Multiple responses

shows that three types of kitchen were found in village; one wall (6.0 per cent), U shaped (16.0 per cent) and peninsula/ G type kitchen (78.0 per cent). Fifty percent women were found to working alone in kitchen activity and were found to be using same kitchen from last 8-13 years, As per findings 52.0 per cent kitchen were 5-12 years old, followed by 36.0 percent 12-19 years and 12.0 per cent kitchen were 12-19 per cent old. The amount of time spent in the kitchen activity, the type of kitchen, used by homemakers in the kitchen are all very important factors to be considered for the well being of the homemakers (**Sultana and Prakash, 2013).**

Results in Table 4 and fig. 1,2 and 3 unveiled the mismatch between women dimensions (standing shoulder height, standing height and vertical reach) and storage shelves heights. Cent percent of the kitchen were having two types of storage shelves and storage shelf 1 and 2 and only 60.0 per cent kitchen were having 3rd type of storage shelf. Each storage shelf was studied separately with women' dimension; as storage shelf 1 was studied with standing shoulder height and same like this storage shelves 2 and 3 were studied with standing height and standing vertical reach, respectively. The mean height of storage shelf 1, 2, and 3 were 138±15.6 cm, 183.4±18.6cm and 244.7±21.6cm which were found to be high than women standing shoulder height (130.8±5.7cm), standing height (160.2±5.31cm) and standing vertical reach (188.3±19.8cm), respectively. Finding in line were unveiled by **Charu,** (2014) that mean height of top shelf of above counter and built in cupboard above counter was found to be 211 cm and 234 cm respectively which was more than the recommended (167cm). Regarding depth of work counters which were observed to more than the recommended depth i.e.55 cm (calculated on the basis of mean horizontal reach + 10 cm). Findings in table reflect that storage shelf 1, height was found to be more than standing shoulder height of women in 64.0 per cent kitchen, followed by 24.0 percent storage shelf (1) height was found to be correlated with dimension and in only 12.0 per cent kitchen storage shelf (1) was observed to be at low height compared to standing shoulder height. Data in table further reflect that majority (84.0% and 54.0 %) of the kitchen storage shelves (2 and 3) were found to be at more height compared to women' working in kitchen dimensions (standing height and vertical reach height) followed by a few per cent (4.0% and 2.0%) kitchen' storage shelf were having low height than standing and vertical reach height of women. Only 12.0 per cent storage shelf (2) were found to be correlated with standing height of women, means were comfortable to use by women. It can be concluded that height of storage shelves was not adequate and was too high in most of the kitchens (as the mean vertical reach of the respondents was found out to be x=94.27). These findings can be substantiated with the findings of **Vinay and Chaudhary (2005)** who also found that height of the top shelf was not within the maximum reach of the users. Approximately 27.33 per cent women were have to raise their heels to reach the top shelf and sometimes have to use *patra* or stool to store items. Tip toeing to reach out top most shelves also increases human costs. **Kaur (1993)** also revealed in her study that dimensions of kitchen storage shelves were not in accordance with the recommended dimensions. Difficulty in reaching out to too high shelves; which in standing type of kitchens are designed above the head clearance space is generally reported as a problem by women **(Malik, 2005 and Joshi, 2006)**. Adequate design and dimensions of workplace improves the work efficiency of the worker. In the present study majority of the dimensions of work counters and storage shelves were not according to anthropometric measurement of the respondents which can cause musculoskeletal pain in various body parts.

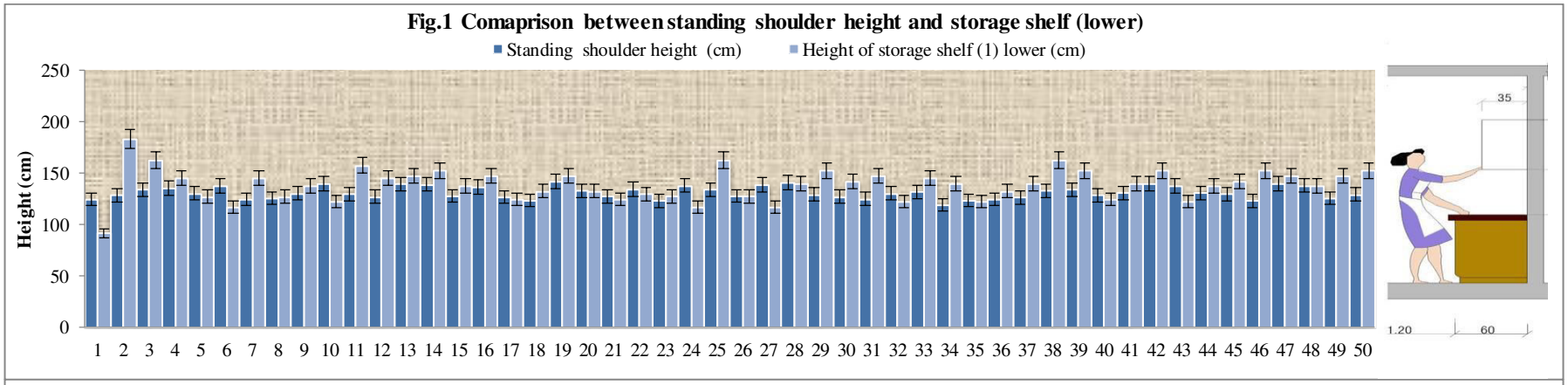

Fig.1 Comaprison between standing shoulder height and storage shelf (lower)

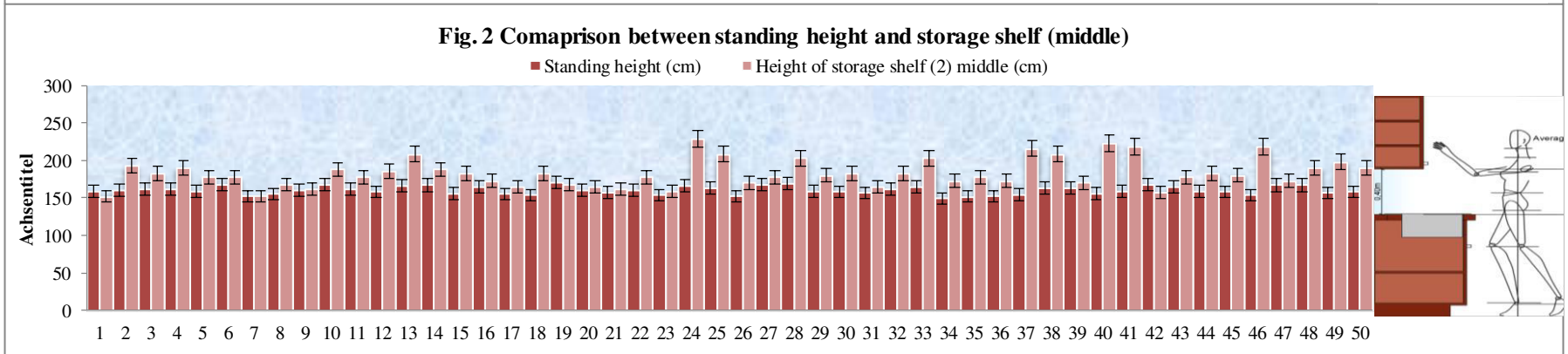

Fig. 2 Comaprison between standing height and storage shelf (middle)

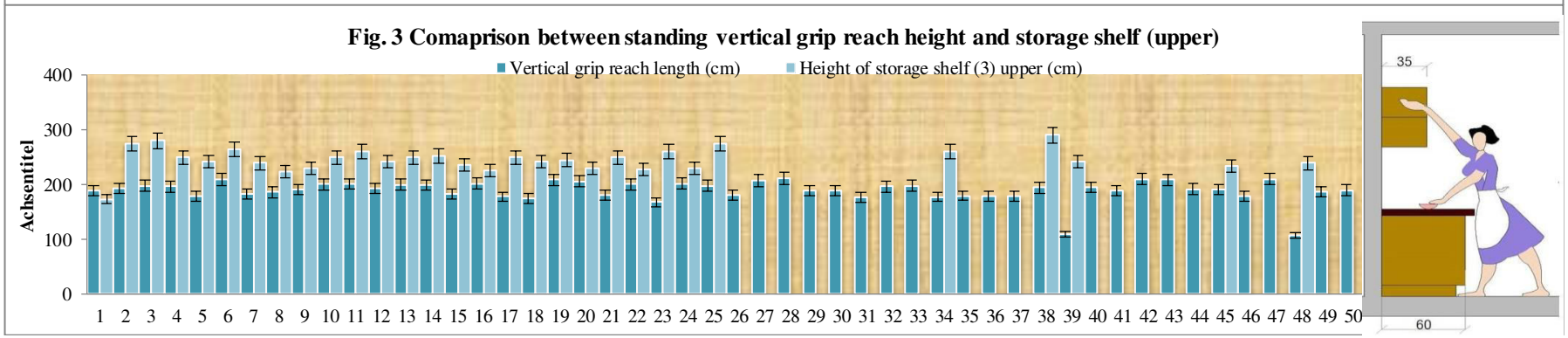

Fig. 3 Comaprison between standing vertical grip reach height and storage shelf (upper)

Table 4. Dimensions mismatch between height of storage shelves and women anthropometry

Mismatch between storage shelves height and women dimension	Standing shoulder height (shelf 1)	Standing height (shelf 2)	Vertical reach (shelf 3)
Storage shelf height less than	**12.0**	**4.0**	**2.0**
Storage shelf height correlated with	**24.0**	**12.0**	**-**
Storage shelf height more than	**64.0**	**84.0**	**58.0**

Results in table 5 define the relation between anthropometric measurements of women with counters dimensions of kitchen. Report of result on one-way ANOVA give a clear picture of findings as means, Minimum value, Maximum value, 10th percentile, 50th percentile, 95 percentile, F crit, F value and P value. As per ANOVA (analysis of variance) if F value is less than F crit, than the means of both groups are same or significantly correlated, otherwise the means are significantly difference with p value. In all the groups p values were found to be less than 0.005 (0.000154, 7.6E-14 and 1.87E-17) which represent that there is significantly different in means of each group (reflect that kitchen storage shelves'' dimensions were not equal or matched with measurements of women). Same findings are reflected by F crti and F value that in all combinations (groups) F values were found to be high (15.52, 76.36 and 178.71) than F crit (3.94) which reflected that were are significantly difference in means of each group.

Table 5 Relation between anthropometric measurements of women and dimensions of kitchen

	Group 1		Group 2		Group 3	
	SSH	SSH(1)	SH	SSH (2)	VRH	SSH (3)
Mean	130.8±5.7	138.6±15.6	160.2±5.3	183.4±18.6	188.3±19.8	244.7±21.6
Minimum value	119.4	91.4	149.3	121.9	106.5	172.7
Maximum value	141.3	182.8	170.6	228.6	210	289.5
10th percentile	124.1	121.9	152.6	162.8	176.3	225.9
50th percentile	129.9	139.7	159.5	181.6	190.8	242.5
95 percentile	139.6	162.5	167.6	220.7	208.4	277.1
Fcrit		3.94		3.94		4.05
F value		15.52		76.36		178.71
P value		0.000154		7.6E-14		1.87E-17

Group 1= Relation between standing shoulder height (cm) and storage shelf (1) height (cm)
Group 2= Relation between standing height (cm) and storage shelf (2) height (cm)
Group 3= Relation between vertical reach height (cm) and storage shelf (3) height (cm)
Significant at p value of 0.05
Degree of freedom = 96

SUMMARY

Now day standing/modern kitchen designs are used in every home and same was found in rural areas also. Standing style kitchen was found in almost every home in village, but there was no ergonomics rules were followed during construction and designing of same. In present study the availability of storage shelves in kitchen were found to sufficient but not satisfactory in use as counter/shelves were not at appropriate height as per women working in kitchen. The mean height of storage shelf 1, 2, and 3 were 138±15.6 cm, 183.4±18.6cm and 244.7±21.6cm which were found to be higher than women standing shoulder height (130.8±5.7cm), standing height (160.2±5.31cm) and standing vertical reach (188.3±19.8cm), respectively. Women were found to be taking help of someone to bring the material from upper shelf as well as also found to be using stool or *patra* to reach and grasp the material, which sometime also causes injuries and fall. No one kitchen was found appropriate/fit to users' (women) working 5-6 hrs daily inside the kitchen. Similar findings were mentioned by **Sandhu et al (2008)** in their study that users from all height felt 'stress in shoulder and in arms' while using highest dish stacking and kitchen storage shelf. **Joshi (2006)** in their researches recommended the storage space heights for top shelf and built in cupboard above counter should not be more than 165 cm. The process of kitchen work and the activities contained within the kitchen, reflect the requirements that need to be considered in order to design smart kitchens with components suitable for that particular house such as storage, preparation/cooking, dining and accessibility of the cabinets being the most important requirements. Storage compartments such as upper and lower cabinets and their design efficiencies in the kitchen are usually the most important requirements **(Ko, 2007).** Major causes of poor work practices was unconsciousness, unawareness and poor infrastructure of storage and work counter. **(Laddha and Shraddha, 2007).** As per the study findings, it seems that rural kitchens were not ergonomically sound. This suggests that there is a need to create awareness among kitchen users regarding functional requirement of kitchen **(Debata, 2011)**. The workplace, if not designed according to ergonomic principles can lead to various difficulties and work related musculoskeletal pain. Poor management of workplace health can lead to work-related ill health and to high levels of absence due to sickness **(Anonymous, 2006).** Findings of research revealed that kitchen design should be designed by considering anthropometry women performing kitchen activities in standing as well as sitting posture.

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