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Anthropometry application: For ease and efficiency in designing of workplaces

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■ **ABSTRACT :** Anthropometry is a science which involves the systematic measurement of the physical properties of human body, primarily dimensional descriptors of body size and shape. Anthropologists have been measuring humans for hundreds of years, but for only the last fifty years or so have the dimensions been used in an organized fashion to improve the design and sizing of the things we use in everyday life. Anthropometric data are a necessary and basic tool for improving human – machine interface to achieve a healthier, safer and more efficient workforce. The data are used in ergonomics to specify the physical dimensions of workplaces, equipment, furniture and clothing so as to "fit the task to the man" and to ensure that physical mismatches between the dimensions of equipment and products whereas the corresponding user dimensions are avoided. Various researches showed that improper dimensions of workplace demands a high degree of physical effort which can lead to musculo – skeletal problems and ultimately decrease the working capacity of workers. Keeping this concept in mind, the present study was undertaken to find out the postural problems faced by the women workers at their workplace *i.e.* kitchens and suggest ergonomically based guidelines for redesigning of their workplace to reduce postural difficulties. For this purpose, related anthropometric data of women respondents were collected. This anthropometric data were further used to calculate the appropriate dimensions of workplaces and some guidelines were also framed on the basis of ergonomic principles to reduce the postural discomfort of respondents.

■ **KEY WORDS:** Anthropometry, Workplaces, Efficiency

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Anthropometry involves the systematic measurement of the physical properties of the human body, primarily dimensional descriptors of body size and shape. Anthropologists have been measuring human for hundreds of years, but for only the last 50 years or so have the dimensions been used in organized fashion to improve the design and sizing the things we use in everyday life. Researches have proved that any workstation design or work environment that helps to perform the work with minimum energy and put minimum stress on cardio - vascular and muscular system is the best design of work (Varghese *et al.*, 1995).

Applied anthropometry – that is, the use of anthropometric data in the design and construction of wide variety of items. Today, industry has embraced the concept so eagerly that the word ergonomics, which derives from the Greek word *ergon* (work)and *nomos* (natural laws of), has become popularly used in advertisements. There appears to be two major divisions of ergonomics. The first deals with the worker, the machine the worker uses, and the environment in which the worker operates.

The objective of this branch of ergonomics is to create the best possible situation on the job relative to the welfare of the worker's physical and mental health, the efficiency of production, and the quality of the product produced. Second, there are characteristics of the manufactured products that interact with the human user. In performing anthropometric measurements, some knowledge of human anatomy is

essential, because almost all measurements are defined in terms of some body part or some specific location on a specified part. Anthropometry deals with measurements of the external dimensions and human body parts, their strengthen speed and their range of motion. There are two types of anthropometric measurements: static and dynamic. As per design application, the static anthropometry assists to concept generation, and dynamic anthropometric consideration are necessary, to accommodate the movement and activity to give final shape to the design. When designing workplaces, adjustments need to be allowed for, so that wide range of individuals can use the product and workplace comfortably and safely (Dul and Weerdmeester, 2001).

Objectives:

–To collect anthropometry measurements of respondents.
–To formulate guidelines for redesigning of their workplaces.

■ RESEARCH METHODS

The present study was conducted in Ludhiana district. Simple random sampling technique was used to select eighty respondents. For selection of respondents, Block-1 and Block -2 of Ludhiana district were randomly selected. For collecting the relevant data as per the objectives of the study, a pre-structured interview schedule was used to know the existing storage facilities and practices followed by both home makers and to assess the postural discomfort experienced by respondents while performing kitchen storage activities. The equipment and techniques were used for taking the anthropometric measurements of respondents and dimensions of various storage units available in the existing kitchens.The guidelines were formulated for redesigning of kitchen storage space to reduce the postural discomfort of the home makers. The guidelines were formulated on the following basis:

–Anthropometric measurements of respondents.
–Recommendations on the basis of available literature.

■ RESEARCH FINDINGS AND DISCUSSION

The anthropometric measurements of 80 respondents of Ludhiana district of Punjab, were taken (Table 1) and discussed accordingly in Table.

For doing the postural analysis of selected subjects, a meal preparation activity which requires the use of all storage units was standardized. The subjects were asked to perform the standard activity in their existing kitchens. The whole activity was recorded by using a video camera for doing the postural analysis of subjects by using low cost tools mentioned in techniques used for postural analysis of subjects. The average total time to perform the selected

Table 1 : Anthropometric measurements of the respondents

Anthropometric measurements (cm)		Min	Max	Mean	S.D.	5^{th} percentile	95^{th} percentile
Body height	Standing	148	171	158	4.92	151.9	166.2
	Sitting	71	98	87	5.25	80	92.2
	Squatting	72	110	93	8.32	81.9	110
Eye	Standing	122	160	146	8.26	122	153.1
height	Sitting	67	87	77	5.75	67	85.1
Shoulder height	Standing	111	150	133	8.16	111	142.2
	Sitting	54	84	64	7.80	55	78
	Squatting	31	95	72	11.29	53.9	92.2
Elbow height	Standing	90	112	101	6.35	90	110.1
	Sitting	23	76	33	10.46	26.8	46.5
Knuckle height	Standing	45	65	54	4.86	48.9	62.1
Elbow to elbow width		45	65	54	4.86	48.9	62.1
Normal arm reach		176	210	188	6.76	182.9	201.4
Maximum reach		183	220	197	6.64	190	209.2
Hip breadth		35	60	46	5.85	38	56.1
Knee height	Standing	40	65	49	6.22	40	62.2
	Sitting	46	60	52	3.64	46.9	60
Buttock – Knee length		45	70	60	4.34	54	67.1
Buttock – Popliteal length		49	63	54	3.24	49	62.1
Horizontal reach		37	50	45	3.25	38	48
Fore arm hand reach		35	46	41	2.49	35	45.1

activity varied between1 hour 30 minutes and 2 hours.

It is evident from Table 1 that the minimum body height while standing was 148 cm and maximum was 171 cm, followed with minimum body height while sitting was 71 cm and maximum body height was 98 cm and in squatting position it was 72 cm minimum and 110 cm maximum, while the minimum shoulder height while standing was 54 cm and maximum was 84 cm, followed with minimum shoulder height while sitting was 71 cm and maximum shoulder height was 98 cm and in squatting position it is 31 cm minimum and 95 cm maximum. The mean of eye height while standing was 146 cm and sitting was 77 cm, while the mean elbow height while standing was 101 cm and mean sitting elbow height was 33 cm. The minimum knuckle height (standing) was 45 cm and maximum was 65 cm followed with mean height 54 cm while the minimum normal arm reach was 176 cm and maximum was 210 cm followed with mean height 188 cm. while the maximum reach was 183 cm and maximum was 220 cm followed with

Table 2: Guidelines to redesigning kitchen storage space to minimize postural discomfort

Storage units	Dimension	Anthropometric measurement used		Formula used	Formulated / recommended dimensions	Sources
Top shelf (above counter) Built-in cupboard (above counter) Top open shelf without counter Overhead storage	Height	Shoulder height	125	Shoulder height (125cm)+ 12.5 cm	137.5 cm or should not be more than 165 cm or ≤ 167 cm	Kaur (1991) Malik (2005) Joshi (2006)
Lowest shelf (above counter)	Height	-	-	-	Should not be > 37.5 cm(from counter) 132 cm	Kaur (1991) Verma (2001)
Counter	Height	Elbow height	101	Elbow height (101 cm)-7.5 cm	94 cm	Malik (2005), Steidl and Bratton (1968)
Top shelf below counter	Height	-	-	-	60 cm or ≤ 60 cm	Verma (2001), Joshi (2006)
Lowest shelf below counter, Knob of lowest drawers below counter. Lowest shelf without counter	Height	Knuckle height	52	Knuckle height	52 cm 60 cm	Malik (2005), Pellegrin (2008)
Hooks	Height	-	-	-	≤ 165.16 cm	Joshi (2006)
Top shelf above counter, Lowest shelf above counter, Built- in cupboard above counter, Overhead storage, Top open shelf without counter	Depth	Horizontal forward reach	45	Should not be more than horizontal forward reach (45 cm) + 10 cm	Should not be more than 55 cm	Kaur (1991)
Counter	Depth	Horizontal forward reach	45	Should not be more than horizontal forward reach (45 cm) + 10 cm	Should not be more than 55 cm or 55 – 60 cm	Kaur (1991) Sumangala (1995)
Built- in cupboard below counter, Top shelf below counter, Lowest shelf below counter, Lowest drawers, Lowest shelf without counter	Depth	Horizontal forward reach	45	Should not be more than horizontal forward reach (45 cm) + 10 cm	Should not be more than 55 cm or 46 cm or < 46 cm	Verma (2001) Malik (2005) Joshi (2006)
Wire mesh ventilated cupboard	Depth	Horizontal forward reach	45	Should not be more than horizontal forward reach (45 cm) + 10 cm	Should not be more than 55 cm or ≤46 cm	Malik (2005) Joshi (2006)
Work triangle	-	-	-	-	7 to 8 m Should not exceed 7 meters	Grandjean, (1973) Education planning group (1992)
Toe kick	-	-	-	-	7.5 cm	Kaur (1991)

mean height 197 cm. The minimum hip breadth was 35 cm while maximum 60 cm followed with mean value as 46 cm. The knee height while standing was 40 cm and maximum was 65 cm, followed with minimum knee height while sitting was 46 cm and maximum body height was 60 cm. The mean height of buttock – knee was 60 cm and buttock – popliteal was 54 cm followed with the mean of horizontal reach was 45 and fore arm hand reach was 41 cm.

The guidelines were formulated for redesigning of kitchen storage space to minimize the postural discomfort (Table 2). These guidelines were formulated based on the anthropometric measurements of 80 home makers and literature based recommendations. In addition, the data related to various dimensions of existing storage provisions were collected which served as a base for formulation of these guidelines which have been presented in Table 2.

For calculating the height of top shelf (above counter), built-in cupboard (above counter), overhead storage and top open shelf without counter the formula used is shoulder height (125cm)+ 12.5 cm. The knuckle height is used for calculating the height of lowest shelf below counter, knob of lowest drawers below counter and lowest shelf without counter. Whereas, to calculate the height of counter, the used formula is Elbow height (101 cm)-7.5. For calculating the depth of storage spaces, it is suggested that depth should not be more than horizontal forward reach (45 cm) + 10 cm.

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