

DISCUSSION

BACKGROUND INFORMATION

1. Effect of age on anthropometric measurements :

The results of the present study indicate that more number of women under the study were young and in early middle age (i.e., from 35-44 years). Correlation regression analysis revealed a negative relationship between age and majority of the standing heights and positive relationship with circumference measurements. Among vertical heights, stature was found to be more affected by age. This finding is on par with the opinion of Stoudt *et. al.* (1965), Molenbroek (1987) i.e., shrinkage in older people, is mainly due to biological changes that take place as a part of the normal ageing process. Along with the stature, leg height, eye height, elbow height and lower leg height also decreased markedly. Similar finding was reported by Stoudt (1981) that there was a decrease in some of the body dimensions between the ages of 18 and 74 years. While examining the effect of age on all circumferential measurements in this study, it showed a positive relationship (correlation co-efficient value ranged between 0.426 to 0.538). These findings are substantiated by the study of O'Breien (1941), who found that, as women grow older their length measurements decrease while girth increases. From the results of the study it could be concluded that the effect of age is more striking on girth measurements than on the length measurements.

2. Effect of marital status and number of children on anthropometric measurements :

Effect of marital status on anthropometric measurements was studied by ANOVA and effect of number of children on body measurements through correlation regression analysis. F-ratios indicated that the linear measurements the difference was significant (at or beyond 0.05 level) for stature and elbow height for three marital status groups. In case of girth measurements it was highly significant for all measurements. Test of critical difference revealed the variations between the groups viz., married, unmarried and widowed women. No differences were observed among married and widowed for both linear and circumference measurements. This could be due to the reason that both married and widowed women under going similar changes due to pregnancy and child birth. But, unmarried sample differed from these two. This could be due to age and no on-set of physical changes that are associated with marriage and pregnancy.

Effect of number of children on body dimensions, correlation regression analysis depicted a negative relationship with standing height measurements and positive with circumference measurements. The effect of number of children on stature, elbow height, leg height, lower leg height was negative (sig. at or beyond 0.05 level). However, the 'r' value was found to be within -0.20. The correlation was above 0.40 for majority of the girths. The circumference

measurements were more affected than linear measurements. O'Breien (1941) also found that married women with number of children had large girth measurements. With number of children the increase in circumference was higher for upperarm, forearm and bust as compared to hip, waist and abdomen.

3. Effect of food habit on anthropometric measurements :

This was studied by computing Analysis of Variance. The F-ratio was significant for a few of linear measurements viz., stature, elbow height, leg height, lower leg height. Between food habit and circumference measurements (bust, waist, abdomen and hip) the differences were significant. It was also noticed that between vegetarians and non-vegetarians the mean standing measurements were low for vegetarians while, mean circumferential measurements were high. This could be due to the consumption of more starchy food. Thus, it could be stated that food habit i.e., vegetarian and non-vegetarian affected the girth measurements more than the standing height measurements.

ANTHROPOMETRIC AND REACH MEASUREMENTS

1. Anthropometric characteristics :

Anthropometric characteristics of 526 women aged between 18-50 years residing in Dharwad city were studied. Altogether 23 measurements i.e., 12 parameters related to standing heights, four measurements for sitting heights (on stool) and six for circumferential measurements while standing

were recorded. There was variations among the sample for majority of the body dimensions. The variation for circumference measurements was greater than variation for standing height measurements. It was above 9 per cent and within 14 per cent (based on C.V.).

The percentage variation for standing heights measurements and for sitting heights was above 4 per cent and within 9 per cent. Between sitting and standing measurements variation was less for standing measurements (above 4 per cent and within 7 per cent) except forearm length. The mean height of women was found to be 152.33 cm. The height of 5th and 95th percentile groups was 137.54 and 152.85 cm respectively. The range for each anthropometric characteristic revealed a wide variation for the sample population. These results are in congruence with findings reported by Varghese *et. al.* (1989). The results of skewness of distribution of anthropometric characteristics revealed that the sample population was not normally distributed. In many cases it was positively skewed indicating that the majority of anthropometric characteristics were less than mean.

Although the present study finds some similarity with the mean measurement of stature, eye height, lower leg height, arm span and a few of circumferential measurements viz., hip and forearm (Table-5) with the findings reported by Varghese *et. al.* (1989), the measurement differs for different percentile groups namely 5th and 95th percentiles. However,

the present findings for these variables differ from the results reported by Nag *et. al.* (1986), Hanspal (1985) and Ray *et. al.* (1983). Thus, it could be concluded that population of different places, regions vary in their anthropometric characteristics. This could be due to ethnic and biological characteristics and food habits. The anthropometric characteristics of any population are dependent upon the large number of biological, social and demographic variables was also pointed out by Pheasant (1982). Also data of present study when compared with other studies (Table-5) indicated that along with the variation in the stature other body dimensions vary for individuals. This is supported by the argument Barkla (1961), Lewin (1969) and Thompson *et. al.* (1973), that, the dimensions of parts of the body are in constant proportion of the stature for different individuals.

The intercorrelation matrix of anthropometric characteristics showed that most of the standing heights and circumference measurements were highly correlated among themselves and had negligible relationship with each other. The findings of the present study are in agreement with the findings of O'Breien (1941), Lewin (1960), Schahnawad and Davies (1987). The sitting heights were more related with standing heights viz., stature, arm span, arm length, elbow height, eye height than with the circumference measurements. It was positive and significant at or beyond 0.05 level.

2. REACHES :

A convenient kitchen makes the task performance pleasant. It depends on the convenient easy reaches and work surface height of the worker. This is essential to reduce energy cost and to prevent fatigue. The right work surface height and comfortable reach of an individual depends upon body measurements.

a. Vertical reaches : The analysis of vertical maximum and normal reach revealed that maximum two handed reach (forward) was found to be less than one handed reach (right hand). This finding is in agreement with Reinhold's (1983) statement i.e., the two handed acceptable forward reaches are somewhat less than reaches for one hand. This is because of restriction of arm movement across the body. The mean difference between these two reaches were found to be 2 cm (while standing 15 cm away from wall) and 8 cm (while standing 30 cm away from wall). However, two handed reach standing close to the wall was observed to be greater than the one hand reach standing 15 cm away from wall. Therefore, it can be stated that maintaining 15 cm distance between the worker and the object is ideal for two handed tasks. If this distance is increased forward vertical reach capability alters. Examination of mean normal vertical two handed reach at 15 cm (105 cm) and 30 cm (104 cm) away from wall and downward one hand reach i.e., 72 cm (right hand) reach (standing 15 cm away from wall) revealed that convenient reach or work area between downward reach and normal vertical two handed reach lies

between 33 to 32 cm height. Based on this, the ideal location for materials and supplies, between normal two handed reach and downward reach can be, within 104 (72+32 cm) to 105 (72+33 cm) from the floor level.

b. Shelf height reaches : The height of the shelf, drawers and cabinets under the work counter needs to be from downward reach (mean reach = 72 cm) to the mean height of work counter at 5 cm below the elbow height i.e., 93.89 cm (at elbow height) and 88.89 cm (5 cm below elbow height). Therefore, the total height of shelf, drawers and cabinets under the work counter should not exceed 22 cm (work counter at elbow height) and 17 cm (work counter at 5 cm below elbow height). The depth of storage under the work counter could be the width of the work counter or half of the depth of the work counter. It can be at the discretion of the user. Since reaches vary from individual to individual which depends partly on a person's shoulder joint range and also, which decreases with the ageing as stated by Molenbroek (1987), it is advisable to follow the vertical reach standards for different percentile groups. The 5th percentile values of the vertical reach height standing at different distances viz., close to the wall, 15 and 30 cm away from wall in the present study were found to be 170, 165, 160 respectively and these were greater than the findings reported by Molenbreck (1987). Bhavnani's (1965) finding on maximum upward vertical reach i.e., 68.2 inches (170.40 cm) which is lower than the present study findings (183.12 cm) of the mean reach height standing

15 cm away from wall. But the author has not mentioned the standing distance from the wall. With regard to the downward vertical reach standing 30 cm away from wall, her result was found to be slightly higher 25.42 inches (72.62 cm) than the findings of the present study i.e., 72 cm at 15 cm away from wall.

The top shelf reach height varied with and without obstacle between the worker and the shelf. The mean top shelf reach height (178.11 cm) was reduced by approximately 8 cm (170.98 cm) when there was an obstacle. The difference between maximum mean upward reach, standing 15 cm away (183.12 cm) and top shelf mean reach height (178.11 cm) was negligible (5.00 cm). Not much difference was noticed between the mean downward vertical reach height (72.00 cm) standing 15 cm away from wall and the mean lower shelf height reach (72.72 cm) without obstacle. The mean depth reach which was approximately 15 cm did not affect in presence of obstacle. Therefore, based on vertical upward reach standing 15 cm away from wall and shelf depth reach (15 cm), was found to be ideal and appropriate measurements.

c. Horizontal reaches : Horizontal reaches on the surface while standing were studied at different elbow heights viz., surface at elbow height, 5 and 10 cm below elbow heights. Mean value of Maximum horizontal one hand reach was higher (47.72 cm) than the mean value maximum horizontal two handed reach (44.17 cm) at elbow height. This is because

right angle between forearm and upperarm is the starting position of greatest strength and efficiency for exerting force with the hands. Therefore, the surface height should be at or slightly lower than the elbow height of the worker. Reduction in both one hand (44.83 cm) and two handed (41.41 cm) mean reaches on the surface 5 cm below the elbow height was less obvious with the marginal difference of 2.73 and 2.89 cm respectively. But reach reduction was sizeable when the surface was lowered to 10 cm below the elbow height i.e., 4.91 cm for one hand and 4.81 cm for two hands. Also, graphic representation (Fig. 19) showed that the right angle between forearm and upperarm gets altered to the maximum level for 5th, 50th and 95th percentiles, when work surface is at 10 cm below elbow height and ^{it} ranged from 23.5° to 38.5°. Elbow extension was high (38.5°) for 5th percentile followed by 50th percentile (29°) and 95th percentile (23.5°). Also the same trend was observed in the percentage reduction of reaches (Fig. 20). It was reported by Reinhold's (1983) that when the arm is abducted to more than 30 cm to the right, it caused rapid reduction in forward reach capability at all heights above the floor. Therefore, work surface 10 cm below elbow height is not advisable. Work surface height could be varied from elbow height to 5 cm below elbow height. The opinion of Kagarian (1983) is in agreement with the present findings. He opined that task involving small or light weight materials can be easily done or handled on a surface at elbow height and 5 cm below elbow height of the workers. At the lowest work

surface height, the wrist bends and arms are extended to the workers sides. In this case the worker has to use the shoulder and back muscles if heavy materials have to be handled.

The mean normal horizontal two handed reach at the elbow height was higher (18.57 cm) than the reaches at 5 cm below the elbow (17.56 cm) and 10 cm below elbow height (16.66 cm). The decrease in mean reach was 1.0 cm in the former elbow height and in the latter, it was approximately 2 cm.

HOUSING DATA

The existing housing data included the study of tenure, type of house and kitchen. Also it dealt with the problems faced by the homemakers related to design of kitchen, storage, adequacy of kitchen and storage shelf dimensions. Although good percentage (59 per cent) of respondents gave specifications for building their kitchen and storage, a sizeable percentage (41 per cent) of housewives did not interfere in it. In such cases builder (contractor) played a key role in deciding kitchen and storage design.

A few (17 per cent) families had independent kitchen while others (83 per cent), had combined kitchen, i.e., with storage shelves or with dining space or with both. Short length of work counter and narrow and cluttered depth of the work counter were the common problems faced by a large percentage of respondents. About more than one-fourth of the sample felt that height of their work counter caused shoulder

pain (in case of high work counter) and back pain (low work counter). Height of the top shelf was beyond maximum reach of the user 34 per cent and it required raising of heels and a step stool to reach the supplies in case of 24 per cent. This result shows similarity with the findings of Bhavanani (1965) and Varghese *et. al.* (1989). Shelves under the work counter in the present study were also not within the normal reach, it required bending of the body and squatting on the floor. Kitchen size was small for 44 per cent of respondents. About 31 per cent of homemakers felt that the sink height was low in their kitchen. Not much variation was observed in the opinion of respondents regarding the adequacy of the work counter dimensions. Overall, the housewives were not satisfied with the storage shelf design. In their opinion the height and depth of the shelves were not suitable and not easy to reach. This finding is supported by Swamy's (1989) observation. Overall kitchen design was satisfactory in the opinion of the selected respondents. Separate store room adjacent to kitchen, reduction in the depth of the storage shelves, serving window in the kitchen were some of the suggestions given by the respondents.

EXISTING KITCHEN AND STORAGE CONDITION

Measurements of work counter, storage shelves, heating appliance, kitchen and window size were recorded by the investigator. 'L' shaped kitchen was dominant among the sample group. In majority (83 per cent) of the houses polished kadappa stone was used for counter surface. The

reason may be, low cost and availability of the material. Built-in-shelves (open) were common among the selected households. Swamy (1966) also reported similar findings with regard to storage facility in the kitchen. The storage shelves under the work counter and beside or away from the work counter were reported by majority of the families. In general shelves under the work counter were partitioned with one shelf only. The mean height and depth of shelves were found to be 48.20 cm and 55.63 cm respectively. In more than one half of the sample households (64 per cent) the shelves under the work counter were not within the reach while bending the body. However, good number of housewives expressed the feeling by casually reporting to the investigator that, because of the existing unsuitable dimensions of the shelves under the work counter, they were not used much. Because they were very deep, mostly used as a place for storage of unwanted supplies and also it was a place for cockroaches. They found it difficult to maintain the cleanliness of such shelves. Swamy (1966) also reported similar kinds of remarks and dissatisfaction of 55 per cent of homemakers with regard to cleaning of the shelves.

In majority of the houses (above 80 per cent) location of the kitchen light switch was in a safe place and at a convenient height (mean height = 159.33 cm) and this was found to be within the limit of one hand reach in the present study (Mean = 183.12 cm). More than 50 per cent of the families possessed gas stove with stand and its height ranged

from 15.59 cm to 19.57 cm. The total length of medium size work counter in the selected households ranged from 223.66 cm to 475.76 cm (2.24 mt. to 4.76 mt). In the opinion of more than 50 per cent of the sample, the work counter length was not sufficient. Thus, it stresses the need for increasing the length of work counter. Seventy per cent houses had height of work counter ranging from 74.68 cm to 86.38 cm or 0.74 mt to 0.86 mt or 2.49 ft. to 2.87 ft. For more than 40 per cent of the sample the work counter height was not suitable. The findings of the present study are more or less on par with the findings of Varghese *et. al.* (1989). According to their findings, the prevailing work counter height i.e., 70 to 75 cm was not found to be convenient to the majority of the users and they were not satisfied with it. While collecting data the investigator gathered a few comments made by the respondents with regard to the height of the work counter. In reality, although the housewives wanted to raise the height of the work counter they felt it would be inconvenient considering the height of the heating appliance (gas stove) and the height of the vessel or pressure cooker which causes additional height of work counter. Because of this reason they preferred to have low work counter. This stressed the need for modification in the work counter design.

In most of the houses the depth of the counter was observed to be medium size namely 53.44 cm to 64.24 cm. The existing mean kitchen area was found to be 9.58 sq. mt. (95808.96 sq. cm.) which is more than the minimum area

specified by the National Building Code (for kitchen cum store, the minimum area = 5.55 sq. mt. with a minimum width of kitchen = 1.8 m). A sizeable sample (77 per cent) felt that kitchen area was adequate and the mean kitchen size was 11 ft. x 9.6 ft. or 3.32 mt x 2.88 meter.

Thus, the existing housing data on kitchen and storage design call for immediate attention of the builders and designers to give more importance and consideration for the reach capabilities of the users in designing the ergonomically sound kitchen layout. Further, the feedback information from the users emphasising certain disadvantages of the prevailing kitchen and storage design which is not serving its purpose fully, will serve to fill the gap of communication between the user and designer.