

SUMMARY  
AND  
CONCLUSIONS

## CHAPTER V.

### SUMMARY AND CONCLUSIONS

In the occupation of homemaking, women perform varieties of tasks, duties and responsibilities. But the study of homemakers work is almost a neglected area. The research in this aspect calls for a series of purposes viz., use of human resources in accomplishing work, requirement of user in the work place and the ergonomic background to guide the functional design, placement and arrangement of work place. The physical cost of the work of the home is to be thought of in terms of effects on all systems of the body that function during work.

Anthropometry, bio-mechanics and work study are the disciplines which contribute greatly to the field of housing. They help to establish the principles and standards for designing of equipment, functional house plan, work space etc. bringing them into harmony with size, shape, mobility and structure of human body. Reliable anthropometric data based entirely on the human body dimensions provide a very useful tool and guide line to the architects for designing of work surface, storage spaces and other fixtures. However, a review of existing literature on 'ergonomics at home' indicates that Indian architects and product designers rely on conversion of western standards. The architect and client rarely meet face-to-face to identify the client's needs and preferences and also to discuss the design solutions. Since the

individual architect does not have time to undertake a full assessment of the user's needs, he/she makes many apparently common sense assumptions which may or may not fit in with the actual requirement. Therefore, he/she needs a systematic body of knowledge or a list of standards of user's requirements.

Design of the functional work center in the kitchen requires anthropometric data which are appropriate to the population of users for whom the plan is intended. Anthropometric characteristics of any population are dependent upon a large number of biological, social and demographic variables, therefore, location of suitable data is essential. In case of housing the designing of work surface height, depth, storage shelves height and depth require standards based on anthropometric data. But, there is inadequate information regarding this aspect for Indian homemakers of various regions. Thus, the present study was undertaken with the broad objectives of collecting anthropometric data for the selected bodily dimensions of women of Northern Karnataka State and to frame the standards for work surface height, depth and storage height, depth reach. The specific objectives of the study were :

1. To record the various anthropometric measurements of a large cross-section of women residing in Dharwad city of Northern Karnataka State.
2. To study the normal and maximum vertical and horizontal reaches of women in standing position.

3. To investigate the convenient reach of shelf height and depth in standing position with and without obstacle.
4. To traverse the diversity in anthropometric characteristics of the sample due to background variables.
5. To examine the interrelationship of selected anthropometric parameters.
6. To establish the standards for designing of fixing vertical fixtures, work counter and storage shelves in the kitchen.
7. To assess the existing measurements of work surface, shelf height and depth, in the kitchen and storage areas of selected subsample households and to compare them with the standards evolved from the study.
8. To suggest the design of work surface and storage based on standards evolved.

The following specific null hypotheses were framed to assess the relationship between the variables under the study:

1. There is no association between the anthropometric characteristics and the following background variables :
  - a) Age of the respondents
  - b) Marital status of the respondents
  - c) Number of children
  - e) Food habit

2. There exists no significant interrelationship among various standing heights, sitting heights and circumferential measurements while standing.
3. The existing work surface and storage measurements in the kitchen do not differ from the standards evolved.

#### METHODOLOGY

The study was conducted in the Dharwad city in Northern Karnataka.

##### A. Sample selection :

Based on the electoral list of legislative assembly of Karnataka 1988, the purposive sampling technique was adopted to select 526 sample respondents for anthropometric and various reach measurements. Further, out of 526 respondents a subsample of 100 houses were selected based on purposive sampling to study the existing housing condition regarding kitchen and storage layout design.

##### B. Tool construction :

Study was carried out with two research tools viz., an interview schedule and observation and measurements. An interview schedule with a structured questionnaire was constructed keeping in view the objectives of the study. It comprised of Part-1 and 2. Part-1 consisted of questions to elicit background information of the respondents. Part-2, comprised of the close end questions on housing background. It consisted of type of housing, problems related to designing of kitchen, storage, adequacy of kitchen and storage design.

Observation and measurements tool included in Part-3 and Part-4. Part-3, dealt with measurements of anthropometric and reaches. Part-4 included recording of existing kitchen condition i.e., measurements of work surface, storage shelves in the kitchen.

Data for Part-1 and 2 were collected with the help of a structured questionnaire. In Part-3 and 4 information was recorded by using the following instruments such as anthropometer rod, measuring tape, black rexin rolling board, wooden adjustable shelf and adjustable table surface

All the measurements and responses were recorded in the recording sheet by the researcher.

C. Method of data collection :

Data were gathered personally by the investigator. Women in the age group of 18-50 years participated in anthropometric and reach investigations. Housewives were interviewed to gather required data for housing background, kitchen and storage condition.

D. Analysis of data :

Various statistical analysis viz., frequency, percentage, percentiles, mean, standard deviation, coefficient of variation correlation co-efficients analysis of variance, step-wise regression analysis and 't' test were used for analysing the data.

### MAJOR FINDINGS OF THE STUDY

Highlights of the findings of the present study are reported below.

#### BACKGROUND INFORMATION OF THE RESPONDENTS

Majority (84.02 per cent) of the respondents were young and in their early middle age i.e., from 25 to 44 years. About 73 per cent of them were married. Hindu religion dominated among the respondents (97 per cent) and general caste namely Brahmin, Lingayat etc., took the upper hand. More than 50 per cent of the respondents had 2-4 children and 29 per cent had no children. In 66 per cent of the households, number of female members available in the age group of 18 to 50 years was only one. About 35 per cent of the families belonged to the lower limit of the middle income group namely Rs. 4000/- (monthly income) while 36 per cent were in the income range of Rs. 4000/- to Rs. 7000/-. Majority of the families (88 per cent) consumed vegetarian food. Nuclear family type was more predominant (70 per cent). Women had good educational background. Fifty two per cent of them studied upto pre-university (upto 12th standard) and 40 per cent were graduates. The respondents' husbands or heads of the family were graduates (36 per cent), post-graduates (24 per cent) and technical graduates (19 per cent). Regarding employment status of women, 72 per cent were non-employed. The sample also included girls studying in college (14 per cent) and 8 per cent of girls who had completed their

education. More than 50 per cent of respondents' spouses or heads of the family were engaged in service. Domicile of the respondents revealed that majority (93 per cent) belonged to Karnataka and more than 50 per cent of them were from Northern Karnataka. Rest of the sample were from Maharashtra, Andhra Pradesh, Tamilnadu and other states.

#### ANTHROPOMETRIC AND REACH MEASUREMENTS

##### 1. Anthropometric measurements :

The mean stature of Northern Karnataka women was found to be 152.33 cm (5 ft.). The percentile values were : 5th percentile 137.54 cm, 50th percentile 147.85 cm, and 95th percentile 152.85 cm. Little variation in stature, eye height, arm span, elbow height was observed among the sample (C.V. = 0.40 to 0.45). Sizeable differences among the sample were noticed for other standing heights namely arm length, upperarm length, forearm length, hand length, leg height, lower leg height, functional reaches (C.V. ranged from 0.55 to 0.141). The sample group differed obviously for sitting heights when compared to standing heights. Variation in circumference measurements namely bust, upper and forearm, waist, abdomen and hip among the respondents was high (c.v. = ranged from 0.093 to 0.142). A high variability was found for waist circumference (c.v. = 0.142) when compared to other girth measurements. For many standing and sitting and for circumference measurements the skewness of distribution was found to be positive i.e., to the right indicating that more number of respondents' measurements lie under the area below

the mean. However a negative skewness of distribution was also noticed for a few of linear measurements and waist girth. Thus, it is clear from the data that, the selected sample differed regarding various anthropometric characteristics (except functional reach) from each other.

The results of intercorrelation indicated that standing heights measurements were highly correlated among themselves. However, among them a high correlation of stature with arm span (0.832), elbow height (0.879) and eye height (0.924) was observed. Sitting heights were more correlated with standing heights than girth measurements. Among circumferential measurements bust and hip measurements were highly correlated. The relationship between girth and standing measurements was not obvious.

The results of Analysis of Variance revealed that the effect of marital status on anthropometric characteristics showed that the stature ( $F=4.47$ ), elbow height ( $F=5.10$ ) were affected. However, CD values revealed that there was no difference between married and widow groups, but unmarried differed from these two.

The relationship between number of children and some of standing measurements viz., stature ( $r=-0.142$ ), elbow height ( $r=-0.146$ ), leg height ( $r=-0.112$ ), eye height ( $r=-0.116$ ) was negative in direction with circumferential measurements. Correlation and regression analysis indicated that as the number of children increased the girth

measurements also increased and significant at or beyond 0.05 level.

The effect of food habit on body measurements was found to be significant for a few. F-ratio was found to be significant for a few of standing measurements viz., stature (4.32), elbow height (5.87), forearm length (12.10), leg height (4.64) and lower leg height (7.37) and for more than 50 per cent of circumference measurements such as bust (4.77), waist (6.13), abdomen (8.09), hip (5.83). So, food habit affected the circumference measurements more than standing heights.

## 2. Measurements of various reaches :

Various reaches namely maximum, normal, vertical and horizontal reaches of an individual are very important to plan comfortable and convenient working area. Carrying out of some activities require standing position at different distances. Maximum two handed reach (forward) was found to be less than one hand (mean=183.12 cm) reach (right hand) standing 15 cm away from wall. However, mean two handed reach, standing close to the wall (186.61 cm) was observed to be greater than one hand mean upward reach, standing 15 cm away from wall. Both upward one hand and two handed reaches were reduced sizeably while standing 30 cm away from wall. The reduction was 2 cm while standing 15 cm away from wall and 8 cm while standing 30 cm away from wall. The mean downward reach of one hand standing 15 cm away from wall was 72 cm. The distance

between normal two handed reach and downward reach was approximately 33 and 32 cm, while standing 15 and 30 cm away from wall respectively. The maximum vertical two handed reach dimensions was found to be for 5th (170.90 cm), 50th (179.93 cm), 95th percentiles (185.16 cm). Downward and normal reaches of above percentiles while standing 15 cm away from wall were found to be 67.27, 71.22, 74.93 cm and 99.92, 103.43 and 105.03 cm respectively.

Similarly, top shelf height reaches varied with and without obstacle between the worker and the shelf. The mean top shelf height reach was reduced by approximately 8 cm (170.90 cm) when obstacle was fixed. The mean lower shelf height reach was 72.72 cm. The top shelf height reach was 164.37 cm in relation to stature (5th percentile) without obstacle, this was followed by 172.46 cm (50th percentile) and 177.25 cm (95th percentile). But in presence of an obstacle it was reduced to 156.08 cm (difference of 8.29 cm), 165.06 cm (7.4 cm) and 170.03 cm (7.22 cm) for three percentile groups. Eye level reach for three percentile categories was found to be 133.21, 140.24, 144.08 cm and for lower shelf height reach 67.28, 71.11, 72.78 cm. Not much variation was observed in shelf depth reach between in the presence of and in the absence of an obstacle. The recorded shelf depth reaches without an obstacle were 15.79 cm (5th percentile), 16.03 cm (50th percentile), 16.49 cm (95th percentile) while, 14.80 cm 15.11 cm and 15.94 cm for shelf depth reaches with an obstacle for three respective percentiles. The range of 14 to 16 cm

depth of shelf in general was found to be appropriate and within the reach limit as there was no much variation.

The horizontal maximum upward reaches namely one hand, two handed and normal two handed, on the surface (standing) were studied at different elbow heights : at elbow height, at 5 cm and at 10 cm below the elbow height. Maximum one hand mean reach was 47.72 cm and two handed mean reach was 44.17 cm at elbow height and these were reduced by 2.89 cm, 2.73 cm when work surface was lowered to 5 cm below elbow height and by 4.91 cm, 4.81 cm respectively when surface was lower to 10 cm below elbow height.

Also graphic representation and calculation of percentage reduction in normal reach revealed that the right angle between upperarm and forearm gets altered to the maximum level when work surface is at 10 cm below elbow height. The angle ranged from  $23.5^{\circ}$  to  $38.5^{\circ}$ . The elbow extension was high ( $38.5^{\circ}$ ) for 5th percentile, this was followed by 50th ( $29^{\circ}$ ) and 95th percentile ( $23.5^{\circ}$ ).

The maximum upward one hand reach was found to be 40.50 cm, 47.50 cm and 56.50 cm at elbow height and 37.00 cm, 44.00 cm and 53.83 cm for two handed reach for above mentioned three percentile groups. Mean normal two handed reach on work surface at elbow height was found to be 18.57 cm, 17.56 cm at 5 cm and 16.66 cm at 10 cm below elbow height.

Based on the findings of stepwise regression analysis, stature was the first significant predictor

variable. It explained the variance in both vertical maximum reach standing close to the wall (71.22 per cent) and shelf height reach without obstacle (42.18 per cent). In case of horizontal reaches at different levels, elbow heights of an individual played an obvious role. It was found to be the first and significant predictor variable in stepwise regression analysis. About 13 to 24 per cent of variation (overall) in the maximum horizontal two handed reach was explained by variation in the elbow heights of an individual.

#### HOUSING, KITCHEN AND STORAGE CONDITIONS

Sixty eight per cent of respondents lived in their own houses. Those who lived in rented houses (40.63 per cent), paid mean rent of Rs. 810.42. Slightly more than 50 per cent of respondents dwelling in their own house reported that they gave suggestions and specifications while constructing kitchen and storage, at the same time sizeable percentage (41 per cent) did not. In such cases builder played a key role in deciding kitchen and storage design. L-shaped kitchen was dominant among the sample houses (64 per cent). Majority (98 per cent) had medium size kitchen (3.09 sq. mt. to 16.0 sq. mt.). The existing kitchen area was found to be 9.58 sq.mt (mean size = 11 ft. x 9.6 ft. or 3.32 mt. x 2.88 mt.). It was adequate in the opinion of 77 per cent of housewives.

In majority of the houses (84 per cent) kitchen light switch was located in a safe place. Polished black

stone (Kadapa stone) was used in most (83 per cent) of the houses for work counter surface. Medium size work counter was common among 65 per cent of the families. Its length ranged from 223.66 cm to 475.76 cm (2.24 mt to 4.76 mt.). The mean length was 349.71 cm. The length was short according to more than 50 per cent of the sample. More than 75 per cent of the families had medium depth of the counter ranging from 53.44 cm to 64.24 cm. The mean depth was 58.84 cm. However, in their opinion depth was narrow and cluttered (44 per cent). Regarding height of the counter, medium height of counter level was observed in 70 per cent of the sample households and height ranged from 74.68 cm to 86.38 cm. The mean height of the counter was found to be 80.53 (2.68 or 0.81 mt.). According to 25 per cent of women the counter height was found to be either high or low, causing shoulder and back pain respectively. In the opinion of 46 per cent of the sample the height of the work counter was not suitable.

Built-in open shelves were common among the selected houses (85 per cent). Higher percentage (85 per cent) had storage shelves on one side or away from work counter. Along with these, shelves under the work counter were also noticed in 56 per cent of the families. The mean height and depth of the shelf under the counter were found to be 48.20 cm and 55.63 cm respectively. In many households it was not within the reach even with bending of the body (64 per cent) and not within the normal reach (62 per cent). Suggestions for reducing its depth were recorded.

In case of built-in shelves the mean total shelf height was found to be 200.96 cm. The height ranged from 201 cm to 250 cm in 61 per cent of houses and top shelf height ranged from 151 to 200 cm (85 per cent). Almost 50 per cent of homemakers found the height of top shelf 'within' maximum reach and 34 per cent found 'beyond' maximum reach and reported that it required raising of heels (34 per cent) or a stepping stool (24 per cent) to reach the stored items. Regarding the availability of number of shelves, 2nd middle shelf was present in 85 houses (cent per cent) and 3rd shelf was observed in 70 houses (82 per cent). The mean height of 2nd and 3rd middle shelves were found to be 123.36 and 91.71 cm from the floor level respectively. Lower shelf was present in 74 per cent of the households and the mean height was 60.28 cm. Further, 62 per cent of users reported that it was not within the normal reach. In general the mean depth of the shelves was 33.50 cm.

Overall, design of the storage shelf was not satisfactory (56 per cent). Day light in place of storage was adequate according to more than 50 per cent of the sample. About 51 per cent of the respondents accepted that they were satisfied with overall kitchen design, adequacy of day light and ventilation. The kitchen sink height was suitable to more than 50 per cent of the sample. However, it was either low (31 per cent) or high for 10 per cent of housewives.

Cent per cent of the sample possessed gas stove, among them 60 per cent had it mounted on a stand, its height

ranged from 15.59 to 19.57 cm (medium size). Ninety five per cent of households had only one window and thirty per cent of houses had two windows. The size of the window in 95 per cent of households was 1.05 mt. x 1.23 mt.

Thus, it can be concluded that the existing dimensions of work counter and storage shelve found to be inadequate and unsuitable to the sizeable percentage of the housewives. Further, it was also observed that the existing dimensions were differed from the standards evolved in general.

### CONCLUSIONS

On the basis of findings of this investigation the following conclusions are drawn.

Women of Northern Karnataka had an average height of 152.37 cm (5 ft.). With the variation in the stature, other body dimensions also vary from individual to individual. This is attributed to genetic factor, age, marital status and food habit.

Standing heights and circumference measurements are highly correlated among themselves, sitting heights are more correlated with standing height measurements than girth measurements. Relationship between standing height and circumference measurements is negligible.

Age had a negative significant relationship with most of the standing heights and positive significant relationship with circumference measurements.

The effect of marital status is more obvious on circumference than on standing height measurements. As the number of children increases the girth measurements also increase but with the standing height measurements the relationship become negative.

Food habit has a more significant effect on circumference measurements than on standing heights.

For vertical and shelf height reaches stature is the most appropriate reference point. Upward one hand reach is greater than two handed reach.

Standing 30 cm away from wall causes a greater decrease in vertical reaches when compared with standing 15 cm away from wall. Hence, it is advisable to use the reaches at 15 cm away from wall for storage designs.

Elbow level obstacle between the worker and shelf, reduces the reach capability of the worker to the extent of approximately 8 to 10 cm.

Horizontal reach, both one hand and two handed decrease markedly when the work counter surface is lowered to 10 cm below elbow height and it also extend the angle between upperarm and forearm. Therefore, the adjustability in the work surface height should be between elbow height to 5 cm below elbow height.

Depth of the counter should not be more than 56 cm (based on 95th percentile one hand maximum reach) and not less than 40 cm (5th percentile one hand maximum reach). Beyond these values the worker has to bend forward to reach the items stored closer to the wall.

In the prevailing kitchen the height of the shelves and depth of the shelves under the work counter needs to be modified. The height of shelves should be within downward one hand reach or lower shelf height reach. Pullout drawers are

more suitable and appropriate for storage under the work counter.

While constructing the work counter surface, height of the . . . cooking appliances should be taken in to consideration.

### IMPLICATIONS OF THE STUDY

The findings of the investigation brought out a number of implications for concerned users, equipment designers and architects and builders.

1. The standards of vertical reaches for both upward one hand and two handed reach serve as a convenient reach limit for various height groups. This can be considered for fitting of control switches. Also two handed vertical reach, downward vertical reach and shelf height reach serve as a guide to decide top most shelf height, lower shelf height and pull out drawers height under the work counter.
2. Elbow heights serve as a reference point to decide suitable work counter height to the users.
3. Horizontal maximum reach for one hand with reference to elbow height serve as a guide to decide work counter depth within convenient reach limit.
4. Since the standards are made available for different percentile groups in relation to anthropometric characteristics, an individual can plan kitchen layout and general purpose storage to the requirements.
5. The available sitting height measurements for various percentiles will be useful as a guideline for designing of furniture for sitting purpose.

#### SUGGESTIONS FOR FUTURE RESEARCH

In the light of little research having been conducted on ergonomics of housing under Indian condition with special reference to the designing of work counter and storage according to the convenient reach of the users, the most thrust areas have to be identified for future research. The identified thrust areas are :

1. Seeking the opinions of housewives on practical implication of the standards evolved from the present study for designing of work counter and storage shelves by carrying out experiments on cooking activities.
2. Development of standards based on body measurements for designing of furniture for various purposes such as dining, reading and entertaining.
3. Documentation of postures of housewives while carrying out kitchen activities such as cooking, dishwashing etc and its effect on health.
4. Designing of household equipment for kitchen related activities based on ergonomic principles.