

METHODOLOGY

CHAPTER III. METHODOLOGY

The chapter on methodology presents the procedure adopted for conducting the present investigation in detail under the following heads.

I. Research design :

1. Type of research
2. Variables
3. Conceptual definitions
4. Operational definitions

II. Data collection :

1. Locale of study
2. Sample selection
3. Research tools
4. Method of data collection

III. Data Analysis :

1. Coding
2. Categorisation
3. Statistical analysis
4. Testing of hypotheses

I. RESEARCH DESIGN

1. Type of Research :

The present study was an attempt to explore the empirical data on user's needs and requirement for a design of functional kitchen and storage. The research design used was descriptive design. A survey was conducted to collect the required data.

Universe of the study : Women residing in Dharwad city formed the universe of the study. Dharwad city in North Karnataka was the research operational area.

2. Variables :

The variables selected for the research are as follows :

A. Independent Variables :

- a. Family Variable : 1. Food habit
- b. Personal variables : 1. Age
2. Marital status and number of children

B. Intervening Variables :

- a. Linear measurements
- b. circumferential measurements

C. Dependent Variables :

- a. Vertical reach measurements
- b. Shelf reach measurements
- c. Horizontal reach measurements

A. Independent variables :

Researchers have agreed (Pheasant, 1982) that along with genetic differences other variables also cause anthropometric variability. These are age, sex, race, culture, socio-economic class and occupation. In the present study food habits is considered as family variables and age, marital status and number of children as personal variables, which were selected as independent variables.

a. Family variable :

1. Food habits : These vary from place to place and with cultural differences of regions and country. To some extent

food habit depends upon the local cropping pattern and food resources. Although growth is genetically determined it is strongly influenced by the dietary habit. Thus, it was considered as an important independent variable.

b. Personal variables :

1. Age : It is an important variable causing the variability in the anthropometric measurements. For height and other body lengths full growth is attained by the age of 17-18 years in females (Damon, Stoudt and McFarland, 1971). Shrinkage in height in older people has also been noted (Molenbrock, 1987). This shrinkage is mainly due to biological changes that take place as a part of the normal ageing process. Data reveal the decrease in the number of body dimensions between the ages of 18 and 74 years (Stoudt, 1981). As women grow older their length measurements decrease while girth increases. Due to these physical changes, physique of elderly women differ from younger women (O'Brien, 1941). Thus, it was thought appropriate to study this variable in the present investigation.

2. Marital status and number of children : Physical changes in women after marriage and pregnancies are noticeable. Unmarried women are thin while married women are stout. Women with no issues are tall and women with children are short and heavy with large girth measurements (O'Brien, 1941). Hence, it was felt necessary to study both these variables.

B. Intervening variables :

Based on the work already carried out in the field of anthropometry and reaches (Farely, 1955; Das and Grady, 1983; Reinhold, 1983), both linear and circumference measurements were considered as intervening variables for the present study. The intervening variables act as dependent variables being directly or indirectly affected by independent variables and they also operate as independent variables affecting dependent variables.

Linear and circumference measurements provide useful information concerning both physical growth and physical development. They also provide basis for many useful indices and these indices may serve in differentiating the performance of the individuals. Either linear or circumference measurements alone may not provide adequate information. Therefore, measurements of these two together will help to determine the relative relationship of both (Waren and Buskirk, 1974). People differ in their linear and circumferential measurements due to genetic difference, age, sex, culture, occupation and ethnic diversity (Oboren, 1987 and Grandjean, 1988).

a. Linear Measurements : Differ from individual to individual and between two sexes. Linear measurements include all vertical measurements both at sitting and standing postures. Commonly the linear measurements include; stature, acromian height, tibial height, elbow or radial height,

sitting height, forearm and upper arm length etc. It also include breadth like chest width, elbow width, knee width etc. Linear measurements can be measured with a number of instruments.

In the present study 12 standing heights viz., stature, arm span, right arm length, elbow height, upper arm length, forearm length, hand length, leg height, lower leg height, eye height, functional reach-1 and functional reach-2 were selected. The selected four sitting heights were elbow height, sitting height, eye height, stool height

b. Circumferential measurements : Are the measurement of girth. Commonly recorded girth measurements are chest, waist, abdomen, thigh, arm, forearm and so on. Under the present study six circumference measurements like bust, upper arm, forearm, waist, abdomen and hip were included. These measurements reflect changes that may occur as a result of growth.

c. Dependent variables : Vertical reach, horizontal reach and shelf reach measurements were the dependent variables of the study. Literature reviewed (Bhavnani, 1965; Reinhold, 1983; Pheasant, 1986 and Varghese *et. al.*, 1989), reveal that reaches of workers should be used as guides for designing of layouts, equipment etc. Therefore, it was considered necessary to know the following reaches of women for the designing of kitchen work area and storage.

1. Vertical reach measurements : In the present study 9 vertical reach measurements were considered (Table-6).
2. Shelf reach measurements : Seven shelf height and depth reach measurements were included (Table-6).
3. Horizontal reach measurements : Nine horizontal reaches were studied (Table-6).

3. Conceptual definitions :

Conceptual definitions of certain terms used in the present study are described below.

Work place : It refers to the arrangement of different work spaces.

Work space : It is the immediate area in front of the operator. It deals with the arrangement of display, control, tools etc.

Work surface : It is the three dimensional envelope of a work space. It deals with the horizontal (Workbenches, desks, tables and counters) and vertical (angles etc.) work surfaces.

Work surface height (Standing) : It is the distance from floor to finger tips and lies slightly below the elbow height while standing. It is determined on the basis of work height for speed performance.

Maximum working area : It is the area that can be reached by extending the arm from the shoulder.

Normal working area : Is the area that can be conveniently reached with a sweep of the forearm and keeping the upper arm hanging in a natural position at the side.

Vertical reach : It is the radius of the action of the upper limb with the hand able to grasp objects.

Horizontal reach : It is the operational field of each arm which extends from the lowered elbow to thumb. Horizontal reach must be determined by the height of the working surface, which generally lies between 3 to 10 cm below the elbow.

Posture : It is the attitude taken by the body in different situations like standing and sitting.

Landmarks : These are the definite points located on the human skeleton. Landmarks used in the present study are defined below (Fig: 1, Source: Singh, I.P. and Bhasin, M.K. (1968): Anthropometry, pp. 17).

1. Vertex : It is the highest point on the head when the head is in eye-ear plane. This is not an anatomically determined point and is dependent on the orientation of the skull.

2. Acromion : It is the most lateral point on the lateral margin of the acromial process (near shoulder joint) when the subject stands in normal position with his/her arms hanging by the sides. It is easier to locate on lightly built individuals.

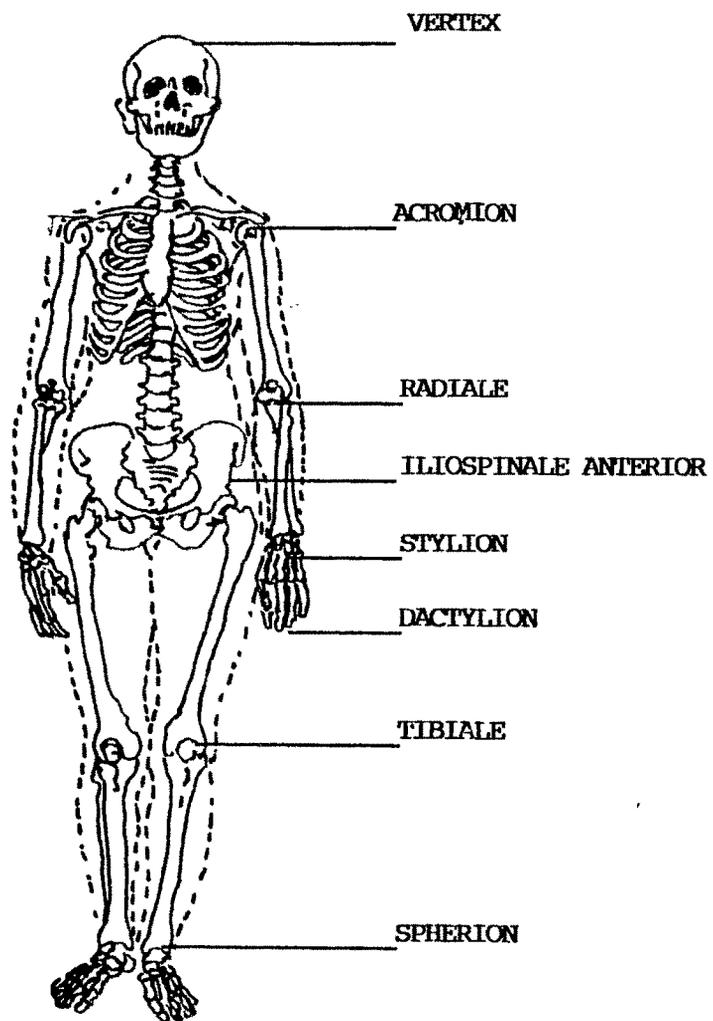


FIG.1. LANDMARKS ON HUMAN BODY FOR MEASUREMENTS

3. Radiale : It is the highest point on the upper margin of the radiale capitulum when the arm is hanging downwards.

4. Iliospinale anterior : It is the highest point on superior anterior iliac spine. It can be located with the fingers by placing on the hip.

5. Stylian : It is the deepest point on the styloid process of radius while the arm is hanging by the side of the subject.

6. Dactylion : It is the lowest point on the anterior margin of the middle finger with the arm hanging on the side of the subject.

7. Tibiale : It is the highest point on the inner glenoid margin of the head of tibia. This point is difficult to locate in subjects having well developed adiposity on the knee-cap, specially among the female.

8. Spherion : It is the lowest point on the tip of the medial malleolus of tibia when the subject is standing in natural position.

4. Operational definitions :

a. Standing height (Fig: 2) :

1. Stature :

It is the height of the individual when standing in erect position by stretching the arm straight down and heels together touching the ground. It is the measurement of vertical distance from vertex to floor.

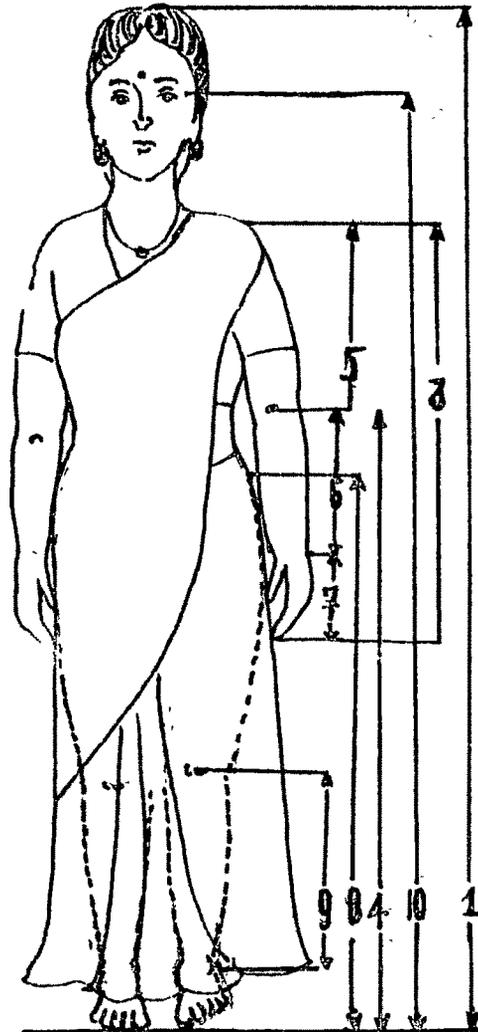


FIG.2. STANDING HEIGHT MEASUREMENTS

2. Arm span :

It is the straight distance between right dactylion point to left dactylion point when the subject is standing in erect position with the back touching the rear wall and arms stretched fully and parallel to the floor.

3. Arm length :

It is the distance between right acromion and right dactylion when the subject is standing in attention position by stretching the arm straight down.

4. Elbow height :

It is the vertical distance measured from right radiale to floor when the subject is standing in erect position.

5. Upper arm length :

It is the distance between right acromion and right radiale when the subject is standing in erect position with the arm hanging down freely.

6. Forearm length :

It is the distance between right radiale and right stylium when the subject is standing in erect position with the arms hanging straight down.

7. Hand length :

It is the distance between the right stylium and right dactylion when the subject is standing in erect position with the stretched arm hanging down.

8. Leg length :

It is the vertical distance measured from right anterior iliospinale to the floor when the subject is standing in erect position.

9. Lower leg length :

It is the height measured from right tibiale to right spherion when the subject is standing in erect position.

10. Eye height :

It is the vertical distance measured from the inner canthus (corner) of the right eye to the floor when the subject is standing in erect position.

11. Functional reach-1 :

It is the horizontal distance from the right acromion to the tip of the thumb and forefinger in a holding position while standing. The measurement was taken with the subject standing straight, in a corner of the room with the shoulders pressed against the wall with right arm and hand extended horizontally along the side wall except that the tip of the thumb and forefinger pressed in a holding position.

12. Functional reach-2 :

It is the horizontal distance from the right acromion to the tip of the thumb when all the fingers are closed to form a grip position. The standing position was same as in functional reach-1.

b. Sitting height measurements (Fig: 3) :

13. Sitting height :

It is the distance measured from vertex to the sitting surface, while sitting on a stool.

14. Elbow height :

It is the vertical distance measured from the right radiale to the floor while the subject is sitting on a stool with the upper arm hanging and forearm extended horizontally.

15. Eye height :

It is the vertical distance measured from the inner canthus (corner) of the right eye to the floor when the subject is sitting on a stool.

16. Stool height :

It is the vertical distance measured between the surface of the adjustable stool to the floor, when the subject is sitting.

c. Circumferential measurements while standing :

17. Chest girth :

It is the chest circumference of the subject measured when the subject is standing relaxed with normal breathing.

18. Upper arm girth :

It is the maximum circumference of the upper arm of the subject with the arms hanging down freely.

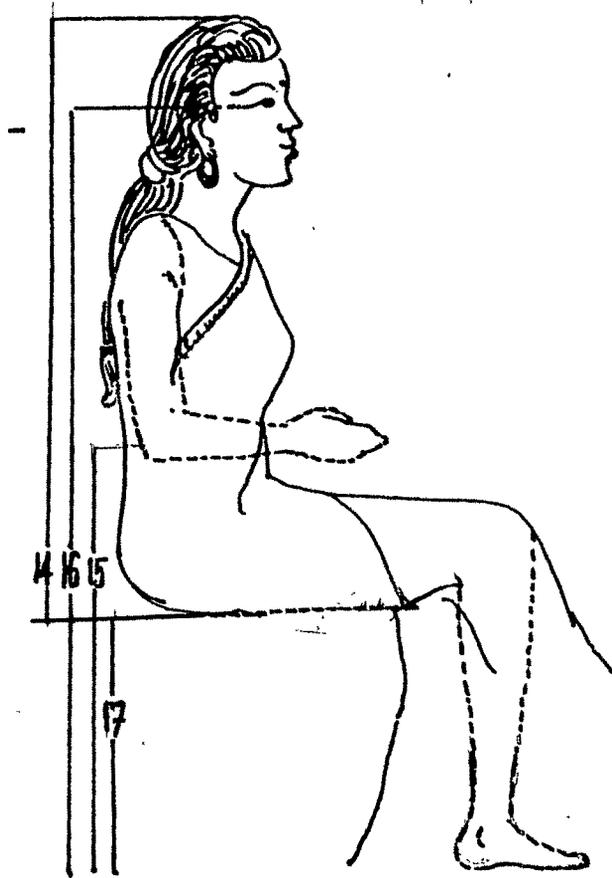


FIG.3. SITTING HEIGHT MEASUREMENTS

19. Forearm girth :

It is the measurement of the circumference of the lower arm of the subject when the arms are hanging freely down.

20. Waist girth :

It is the measurement of the circumference of the abdomen at the most lateral contour of the body between ribs and intestine.

21. Hip girth :

It is the measurement of the circumference of the hip at widest portion with both the feet together and relaxed.

22. Abdominal girth :

It is the measurement of the circumference of mid part of abdomen at the umbellical (naval) level when the subject stands with both the feet together and relaxed.

II. DATA COLLECTION

1. Locale of study :

The survey was conducted in Dharwad city of Northern Karnataka State. It is a district head quarters. It is located on seven hills, they are ; Killa, Ulavi, Basappa hill, Mailarlingana hill, Malamaddi, Madarmaddi, Rajatagiri and Chotamahabaleshwar. Historians say, Dharwad got the present prime position during the time of the British Empire when it was accepted as district head quarters. It has all antique beauty with cosy hill tops, bushy greenary and air conditioned

like atmosphere. Dharwad is situated at longitude 75.6, latitude 15.27, at a height of 2580 feet from sea level. It has an area of 5284.5 sq. miles. Its length is 102 miles and breadth is about 72 miles. The district is now bound on the north by Belgaum and Bijapur districts, on the East by Raichur and Bellary districts. On South by Shimoga and Chitradurga districts and on the West by North Kanara district. It is a well-known educational centre with two universities viz., University of Agricultural Sciences and Karnataka Univeristy located in Dharwad proper. The climate of the district is healthy and pleasant.

Dharwad town has been traced back to the 12th century A.D. Since then it has developed appreciably and had grown into Hubli Dharwad Muncipal Corporation. The total population of this twin city corporation is 6,47,298 (1991 census report), of which population of Dharwad city is 2,23,894 (1991 census report, corporation office Dharwad). The total female population of Hubli-Dharwad Muncipal corporation is 3,11,712 (1991 census report). Total number of occupied residential houses in Hubli-Dharwad Muncipal Corporation is 1,08,536 and total number of houses in Dharwad city alone is 37,315 (1991 census report).

2. Sample selection :

Dharwad city is divided into 18 electoral divisions consisting of 131 residential areas (Fig: 4). Sampling was done in two stages as follows ;

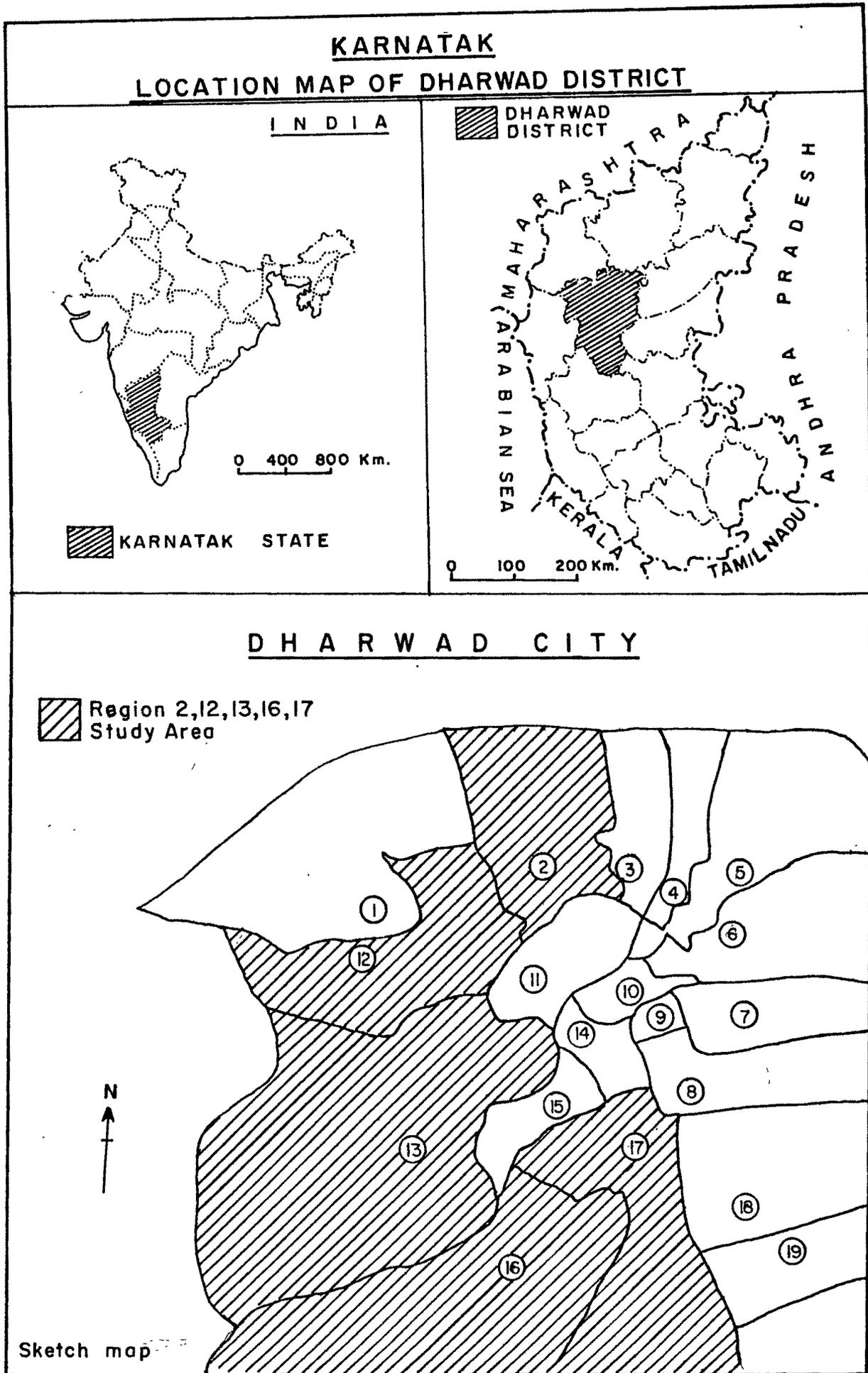


FIG.4. MAP OF DHARWAD CITY

1. Five divisions (more than 25 per cent) and 15 areas or residential extensions (12 per cent) were purposively chosen for data collection because of access to respondents through Maheela Mandals in newly coming up areas with modern houses with working counters and storage facilities in the kitchen.

2. After identifying the residential extensions from the electoral list, the researcher contacted the office bearers of the Maheela Mandals (Appendix-1) in the selected areas to fix up the date to meet the members. On that visit, the investigator explained the aim of the study and briefed them about the research. The respondents were selected keeping in view certain criteria viz., family monthly income of Rs. 2201=00 and above (middle income group according to Karnataka Housing Board's income classification), age (18 to 50 years), no physical deformity and with no gestation period and lactation. Availability of work counter in the kitchen and storage shelves for kitchen possessions were also considered. Along with the eligible members of the Maheela Mandal other eligible residents of the respective areas were also covered under the study.

a. Sample size :

The purposive sampling technique was adopted to select 526 respondents for anthropometric and various reach measurements. The investigator selected the respondents based on the above mentioned criteria. Hence the sample of 526

subjects comprised of housewives and other female member/s from the same households if available.

From the above a sub sample of 100 houses was chosen purposively to study the existing housing, kitchen and storage conditions. It was a representative sample covering all the selected residential areas under the study.

3. Research tools :

Study was carried out with two research tools namely an interview schedule and observation and measurement (Appendix-2).

a. An interview schedule with a structured questionnaire was constructed keeping in view the objectives of the study. It comprised of Part-1 and Part-2.

Part-1 : Background information consisting of questions to elicit information on socio-economic characteristics of the sample.

Part-2 : Housing data dealt with the close end questions on type of housing, problems related to designing of kitchen, storage and adequacy of kitchen and storage design.

b. Observation and measurement tool consists of Part-3 and Part-4.

Part-3 : Anthropometric and reach measurements.

Part-4 : Recording of existing kitchen condition i.e., measurement of dimensions of work surface and storage shelves in the kitchen.

4. Method of data collection :

Data for Part-1 and 2 were collected with the help of a structured questionnaire.

Part-3 and 4 information was recorded by using the following instruments :

A. Anthropometric measurements :

a. Tools used :

1. Anthropometer rod :

It is most widely used instrument for many of the anthropometric measurements on the living beings. It is used to take height measurements as well as transverse measurements like breadth of the body. It consists of four detachable segments. These segments are joined together for a rigid rod of 200 cm. There is a fixed sleeve on the top of the rod with an adjustable graduated cross bar. There is also a movable sleeve with an adjustable graduated cross bar, which registers the height measurements (Fig: 5).

2. Measuring tape :

It is available in varieties of material namely, metal, cloth and plastic. The length of the tape also varies. It is graduated in millimetres. In the present study the metallic tape measuring 300 cm of length and plastic non-stretchable 150 cm length are used. Both are graduated in millimetres.

SCALE 1:20

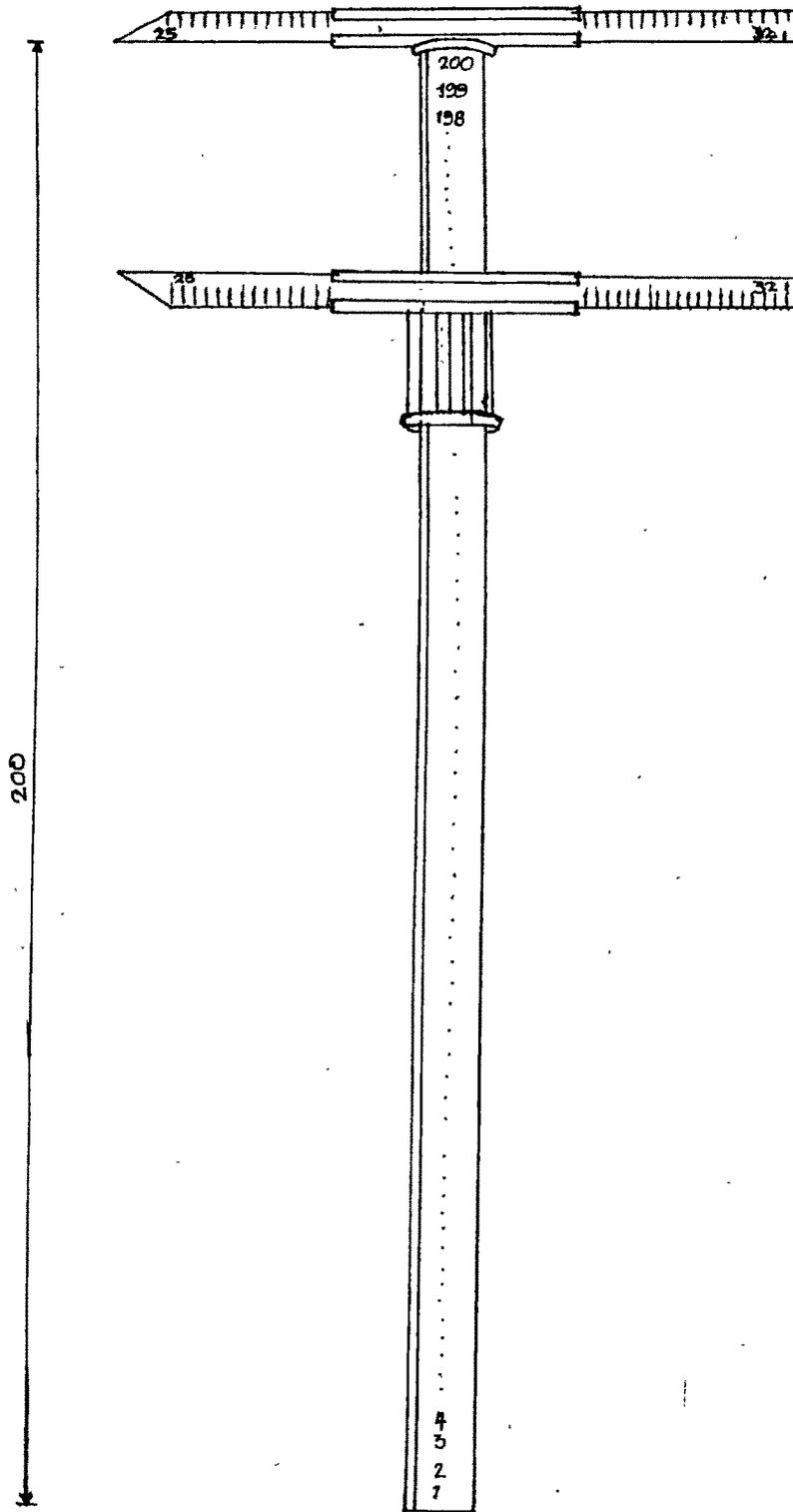


FIG. 5. ANTHROPOMETER ROD

b. Procedure to record anthropometric measurements :

Measurements of all anthropometric characteristics viz., standing heights, sitting heights and circumferential measurements were recorded in the morning i.e., between 9 a.m. to 1 p.m., with the help of anthropometer rod, metallic tape and non-stretchable plastic tape. Standardized technique of anthropometric measurement was adopted to measure the above mentioned parameters based on operational definitions.

All the measurements of anthropometric characteristics and reaches were recorded to $1/_{10}$ th of a cm.

B. Measurements of vertical reaches :

a. Tools used

1. Black rexin rolling board :

A black rexin board with 136 cm length and 188 cm width was fixed with half an inch thick wooden frame at the top and at the bottom.

b. Procedure to record vertical reaches :

1. Maximum and normal two handed reaches :

A black rexin board was hung to the wall at a height of 60cm above the floor level. Two markings i.e., 15 and 30 cm in front of the board and away from the wall were marked on the floor. The subjects were given two chalkpieces of equal size and instructed to stand erect, close to the board and draw an arc with a sweep, overlapping both the arcs with extended arms. Measurement was recorded with the metallic tape from the intersecting point to the floor, to know the

subject's maximum two handed reach (Plate-1). The subject was asked to draw a similar arc by standing erect on 15cm marking away from wall and keeping the elbow close to the body at right angle position to know normal two handed reach (Plate-2). Measurement was recorded from intersecting point to the floor. Similarly, both maximum and normal arcs were repeated standing at 30 cm marking.

2. Reach span :

The reach span was noted by measuring the distance from the starting point of right hand arc to starting point of left hand arc.

3. Upward and downward reaches :

Upward and downward reaches for right hand were measured when the subjects drew semicircular arcs by standing on 15 cm marking on the floor (Plate-3).

C. Measurements of shelf height and depth reaches :

a. Tools used :

1. The Wooden adjustable shelf :

A wooden adjustable shelf consists of a wooden stand with a base and detachable planks which can slide along the stand for fixing decided height of a shelf. A measuring tape is fixed to the stand. Angles with wingnuts are provided for fixing planks at a particular height. The width (depth) of the plank-2 is almost equal to the average depth of the counter found in the prevailing kitchens. Plank-2 was used as an obstacle between the worker and shelf to measure the shelf height reach with the obstacle (Fig: 6).



PLATE 1. MAXIMUM VERTICAL TWO HANDED REACH CLOSE TO THE WALL



PLATE 2. NORMAL VERTICAL REACH 15 CM AWAY FROM WALL



PLATE 3. MAXIMUM VERTICAL ONE HAND REACH 15 CM AWAY FROM WALL

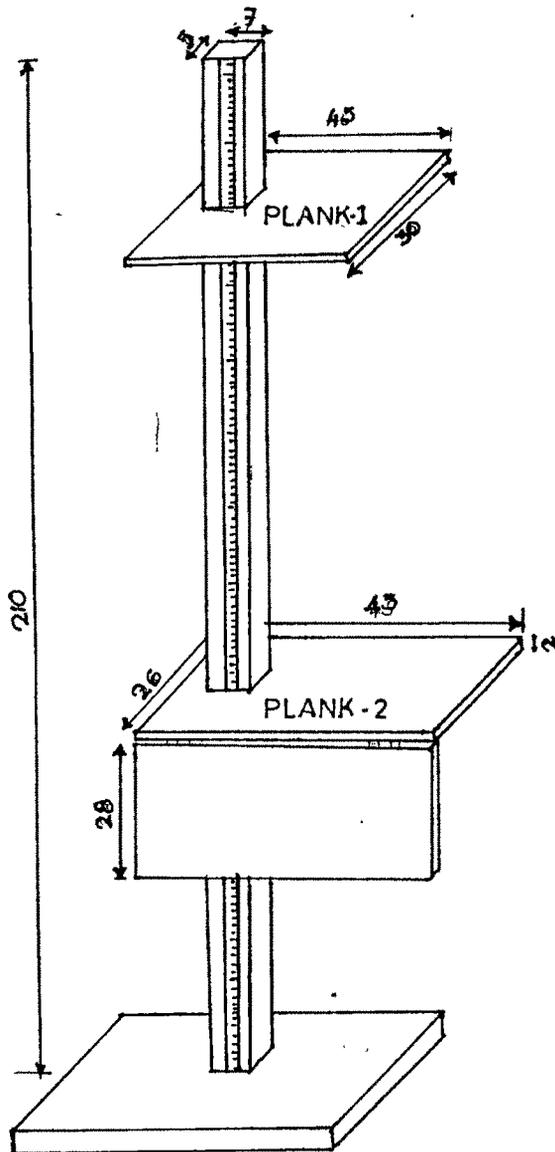


FIG. 6. WOODEN ADJUSTABLE SHELF

b. Procedure to record shelf height and depth reaches :

1. Top shelf height without obstacle :

The base of the stand was placed close to the wall (lower line of skirting). The plank-1 was inserted and this was used to measure top shelf, eye level shelf height, lower shelf height and depth reach. The subject was instructed to stand erect, close to the stand and to place her hand flat on the plank surface comfortably without lifting her shoulder and heels. The height of shelf from the floor at which the subject could place her hand comfortably was recorded as the top shelf height reach (Plate-4).

2. Eye level shelf height :

The same plank-1 was moved down to the subject's eye level height where she could see the distant edge of the plank (wall side) without lifting her head. This was considered as the middle shelf or eye level shelf height reach.

3. Lower shelf height :

Further, the plank-1 was moved down to the height where the subject could place her hand on the plank surface comfortably without bending her shoulder down. This was recorded as lower shelf height reach from the floor (Plate-5).

4. Depth reach :

In case of top and lower shelf, the depth was recorded by measuring the distance from the distant edge of the plank (from wall side) to the tip of the middle finger while subject's hand was on the surface.



PLATE 4. MAXIMUM SHELF REACH HEIGHT WITHOUT OBSTACLE



PLATE 5. LOWER SHELF REACH HEIGHT



PLATE 6. MAXIMUM SHELF REACH HEIGHT WITH OBSTACLE

5. Top shelf height with obstacle :

To measure top shelf height reach over the obstacle plank-1 was removed and replaced again after inserting plank-2 (obstacle). The obstacle was fixed at the elbow level of the subject and she was instructed to stand erect and close to it. In this position, she was instructed to place her hand flat on the surface of the top plank over the obstacle comfortably (Plate-6). The top shelf height and depth reach, over the obstacle was measured in a similar manner as mentioned above.

D. Measurement of horizontal reaches :

a. Tool used

1. Adjustable table surface :

The adjustable table is detachable, foldable and adjustable in height. It consists of two parts namely, foldable laminated table top (surface) and two tripod stands (Fig: 7). The top is provided with full length hinges at the center so that it can be folded while carrying from place to place. The top is fixed to the tripod stand with wingnuts. Tripod stand is made up of steel pipe with a telescopic pipe inside. The height of the stand can be altered by raising or lowering the inner pipe and can be fixed to a particular height by tightening the wingnuts. The tripod legs also are flexible and they can be spread apart to keep the stand firmly on the ground. A black rexin sheet measuring 90 cm in length and 136 cm in breadth is spread on the table top to facilitate the subjects to draw arcs. The minimum height of the table surface is 75 cm and can be raised upto 125 cm.

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Y-AXIS - 1:20

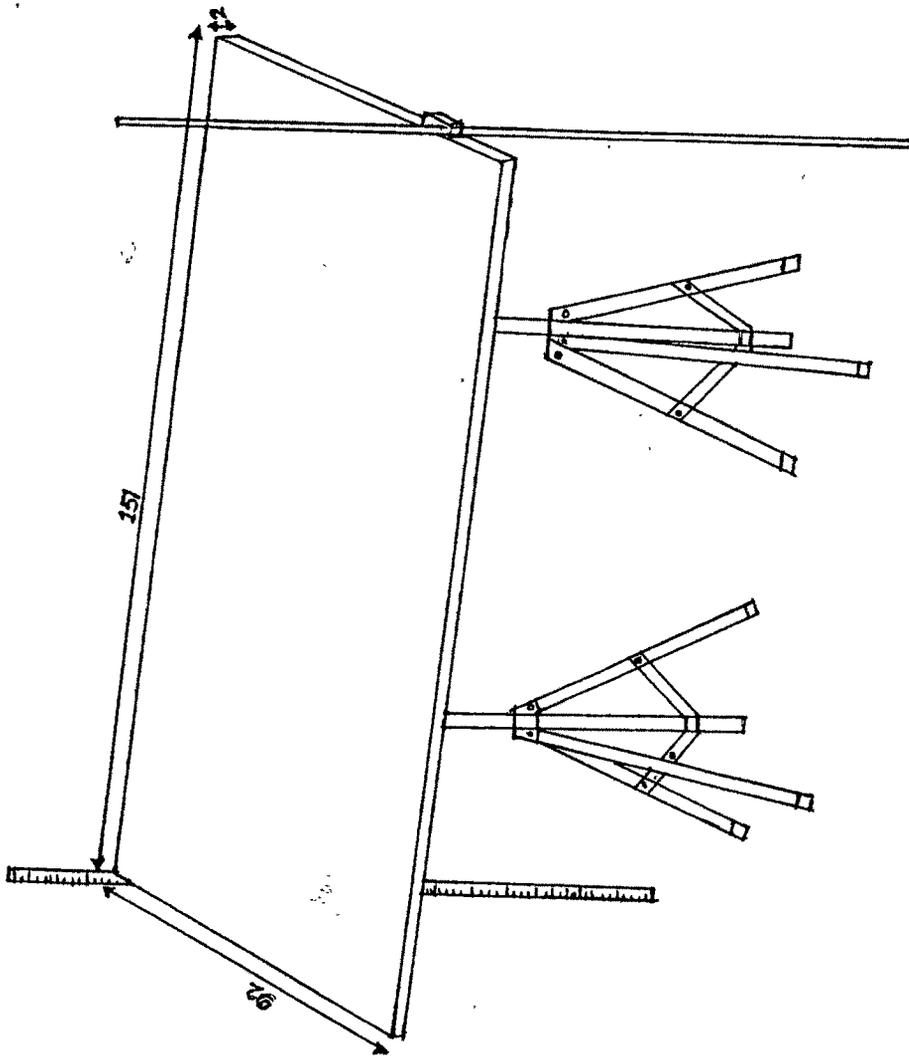


FIG. 7. ADJUSTABLE TABLE

b. Procedure to record horizontal reaches :

1. Horizontal reaches at elbow height surface :

The adjustable table surface was placed close to the wall. The height of the table was adjusted to the subject's elbow height from the floor while standing (Plate-7). The subjects were provided with two chalkpieces of equal size and they were guided to stand erect and close to the table. Maximum and normal arcs similar to those as mentioned above in case of vertical reaches were drawn. The maximum two handed and normal two handed reaches were measured from the intersecting point of the arc to the near edge of the table top. The reach span also was recorded in a similar manner as in the case of vertical reach measurements. Upward reach for one hand was also measured with the help of semicircular arc.

2. Horizontal reaches on the surface below elbow height :

Further, table height was lowered to 5 and 10cm below the elbow height and at each height all the above mentioned measurements were recorded in a similar manner (Plate-8).

E. Recording sheet :

All the measurements and responses were recorded in the recording sheet by the researcher. The format was in a coded form (Appendix-3).



PLATE 7. MAXIMUM HORIZONTAL TWO HANDED REACH AT ELBOW HEIGHT



PLATE 8. MAXIMUM HORIZONTAL TWO HANDED REACH AT 10 CM BELOW ELBOW HEIGHT

TABLE 6: Instruments to Measure Anthropometric Variables and Reaches and Existing Kitchen Condition.

Anthropometric and Reach measurements	Variables	Research Instruments
A. <u>Anthropometric measurements</u> :		
1. Standing height measurements	1. Stature (St)	Anthropometer rod
	2. Arm span (As)	Metalic measuring tape
	3. Right Arm length (Al)	Anthropometer rod
	4. Elbow height (Eh)	"
	5. Length of right upperarm (Lua)	"
	6. Length of right forearm (Lfa)	"
	7. Length of right hand (Lrh)	"
	8. Right leg height (Lh)	"
	9. Right lower leg height (Llh)	"
	10. Eye height (Eyh)	"
	11. Right hand functional reach-1 (Fr-1)	Metalic measuring tape
	12. Right hand functional reach-2 (Fr-2)	"
2. Sitting height measurements	: 1. Elbow height	Anthropometer rod
	2. Sitting height	"
	3. Stool height	"
	4. Eye height.	"
3. Circumference measurements (standing)	1. Bust (Buc)	Non-stretchable measuring plastic tape
	: 2. Upperarm (Uac)	"
	3. Forearm (Fac)	"
	4. Waist (Wc)	"
	5. Abdomen (Abc)	"
	6. Hip (Hic)	"

Cont...Table 6

Anthropometric and Reach measurements	Variables	Research Instruments
B. <u>Reach Measurements</u>		
1. Vertical reaches (standing) :	<ol style="list-style-type: none"> 1. Maximum vertical two handed reach close to the wall. (MVTHRCW) 2. Maximum vertical two handed reach 15 cm away from wall (MVTHR15AW) 3. Maximum vertical two handed reach 30 cm away from wall (MVTHR30AW) 4. Normal vertical two handed reach 15 cm away from wall (NVTHR15AW) 5. Normal vertical two handed reach 30 cm away from wall (NVTHR30AW) 6. Upward vertical reach 15 cm away from wall (UVR15AW) 7. Downward vertical reach 15 cm away from wall (LVR15AW) 8. Maximum vertical reach span. (MVRS) 9. Normal vertical reach span (NVRS) 	<p>Black rexin rolling board and Metallic measuring tape</p> <p>"</p>
2. Shelf height reaches :	<ol style="list-style-type: none"> 1. Top shelf height reach without obstacle (TSHRWOO) 2. Top shelf depth reach without obstacle (TSDRWOO) 3. Top shelf height reach with obstacle (TSHRWO) 4. Top shelf depth reach with obstacle (TSDRWO) 5. Eye level shelf height reach. (ELSHR) 	<p>Wooden adjustable shelf and Non-stretchable measuring tape.</p> <p>"</p> <p>"</p> <p>"</p> <p>"</p>

Cont...Table 6

Anthropometric and Reach measurements	Variables	Research Instruments
	6. Lower shelf height reach (LLSHR)	"
	7. Lower shelf depth reach (LLSDR)	" Wooden adjustable shelf and Non-stretchable measuring tape.
3. Horizontal reaches (standing) :	1. Maximum horizontal two handed reach close to the elbow height (MHTHRCE)	Adjustable table surface and Non-stretchable measuring tape
	2. Maximum horizontal one hand reach (right) close to the elbow height (MHOHRCE)	"
	3. Normal horizontal two handed reach close to elbow height (NHTHRCE)	"
	4. Maximum horizontal two handed reach 5 cm below elbow height (MHTHR5BE)	"
	5. Maximum horizontal one hand reach (right) 5 cm below elbow height (MHOHR5BE)	"
	6. Normal horizontal two handed reach 5 cm below elbow height (NHTHR5BE)	"
	7. Maximum horizontal two handed reach 10 cm below elbow height (MHTHR10BE)	"
	8. Maximum horizontal one hand reach (right) 10 cm below elbow height (MHOHR10BE)	"

Cont...Table 6

Anthropometric and Reach measurements	Variables	Research Instruments
	9. Normal horizontal two handed reach 10 cm below elbow height (NHTHR10BE)	Adjustable table surface and Non-stretchable measuring tape
<u>C. Measurements of dimensions of work surface and storage shelves</u>	Work surface height Work surface depth Storage shelf height Storage shelf depth	Metalic measuring tape " "

F. Pre-testing :

A pre-test was carried out to establish the validity and feasibility of the instruments, on a sample of 35 from Rajatagiri extension in Dharwad city. Data were subjected to statistical test for establishing the feasibility of the instruments. Minor changes were made in the schedule on the basis of the pre-test which was then utilized for the final data collection.

a. Pre-test findings :

As an outcome of the pre-testing, certain modifications were made in the tools to be used for the final study. They are :

1. In the anthropometric and reach measurements (Part-3), measurements of functional reaches were included. Since the subjects were unable to reach the black rexin rolling board for normal reach standing beyond 30cm distance from the wall, it was decided to measure vertical reaches at two distances only i.e., at 15 and 30 cm away from wall.

2. In Part-4 (existing kitchen condition), slight modifications were made. While measuring the existing work surface and storage shelves, it was observed that few families possessed indigenous movable (metal/wooden) shelves. Therefore, recording of such shelf measurements were included.

Data were gathered personally by using interview schedule with a structured questionnaire. Data were collected with the help of the pre-tested instruments reported earlier. Women in the age group of 18-50 years were the principal subjects for Part-1 (Background information) and Part-3 (anthropometric and reach measurements) investigations and housewives were interviewed to gather required data for Part-2 (Housing data) and Part-4 (Existing kitchen condition). The period of data collection was from February 1993 to September 1993. In each selected residential area a temporary research centre was established either in Maheela Mandal premises or one of the member's house to collect the data. Assistance was taken for recording the measurements.

III. DATA ANALYSIS

1. Coding :

A coding plan was developed and code numbers were given to the collected data. These were subjected to computer analysis.

2. Categorization :

For the purpose of analysis, variables under Part-1,2,3 and 4 were categorized as follows;

PART-1 : Background informationPersonal Characteristics :

Age of the subject : 18-24 years
25-34 years
35-44 years
45 and above

Marital status : Married
Unmarried
Widowed

Religion : Hindu
Muslim
Christian
Sikh
Jain

Caste : General
Scheduled caste
Scheduled tribe
Backward tribe
Backward caste

Number of children : 0
1
2-4
5-7

Family characteristics :

Monthly income : Rs. upto 4000
Rs. 4001 to 7000
Rs. 7001 to 10000
Rs. 10001 and above

Food habit : Vegetarian
Non-vegetarian

Frequency of
Non-vegetarian food
consumption : Once in a week
Twice in a week
Thrice in a week
Once in a month
Twice in a month

Place of origin
of the respondent : City
Town
Village

Family composition :

Number of children : 0-1
2-4
5-7

Number of male members in the family : One
Two
Three and above

Number of female members in the family : One
Two
Three and above

Educational background of the family :

Educational level of the respondents : Upto Pre-university
Diploma
Graduation
Technical graduation
Post-graduation

Educational level of head of the family : Upto Pre-university
Diploma
Graduation
Technical graduation
Post-graduation

Occupation :

Homemakers : Employed
Non-employed

Girls : Studying
Education completed

Head of the family : Agriculture
Business
Professional Service
Pensioner

PART-2 : Housing data

Status of housing : Own house
Rented house

Rent paid : Less than Rs. 575.00
Rs. 576.00 to 875.00
Rs. 876.00 to 1075.00
Rs. 1076.00 and above

Specifications for
designing of kitchen
and storage

: By : home makers
By : husband
builder
architect

Type of house

: 1. Independent house
2. Twin house
3. Upstair house
4. Downstair house
5. Flat

Type of kitchen

: 1. Independent Kitchen
2. Kitchen combined with
storage shelves
3. Kitchen combined with
dining hall
4. Kitchen combined with
storage shelves and
dining hall

Problems :

Existing workcounter :

1. Length is small
2. Is high, causes shoulder pain
3. Is low, causes back ache
4. Depth is more, require
body bending
5. Depth is narrow and
cluttered

Existing storage :

1. Total shelf height is beyond
maximum reach
2. Top shelf is high, requires a
step stool
3. Shelves under the work counter
require body bending
4. Shelves under the work counter
require squatting on the floor
5. Shelves under the work counter
require both bending of body
and squatting
6. Shelves above the work counter
are high
7. Shelves above the work counter
are high, require a stool

- Existing kitchen :
1. Kitchen size is small
 2. Clearance space is not sufficient
 3. Sink height is high, causes shoulder pain
 4. Sink height is low, causes shoulder and back ache
 5. Day light is not sufficient
 6. No sufficient ventilation

Opinion on kitchen layout :

- On five aspects (The responses were recorded Yes/No categories) :
1. Work counter dimensions (4 items)
 2. Storage design (7 items)
 3. Kitchen design (4 items)
 4. Features of the kitchen (3 items)
 5. Willingness to give suggestions (2 items)

Suggestions : List

PART-3 : Anthropometric and reach measurements

Anthropometric measurements :

- Standing heights : 12 anthropometric variables (Table-6)
- Sitting heights : 4 anthropometric variables (Table-6)
- Circumferential measurements : 6 anthropometric variables (Table-6)

Reach measurements :

- Vertical reaches : 9 vertical reaches (Table-6)
- Shelf reaches : 7 shelf height and depth reaches (Table-6)
- Horizontal reaches : 9 horizontal reaches (Table-6)

PART-4 : Existing kitchen condition

- Type of kitchen : 1. L-shape
2. U-shape
3. Two wall
4. One wall
- Work counter surface material : 1. Ordinary stone (Kadapa stone)
2. Granite stone
3. Cement finish
4. Red oxide finish
5. Ceramic tile
- Existing shelf type : 1. Built-in open shelf
2. Built-in cupboard
3. Built-in wall cabinet
4. Movable shelf
- Location of storage shelves : 1. Above the workcounter.
2. Under the work counter.
3. To the side or away from work counter.
4. Away from kitchen
- Height and depth of shelves under the work counter :
- Total height : Less than 59 cm
60-69 cm
70-79 cm
80-89 cm and above
- Top shelf height : 30-39 cm
40-49 cm
50-59 cm
60-69 cm and above
- Top shelf depth : Less than 49 cm
50-59 cm
60-69 cm
- Height and depth of shelves away or beside the work counter :
- Total height : Less than 150 cm
151-200 cm
201-250 cm
251 cm and above

Top shelf height	:	Less than 150 cm 151-200 cm 201-250 cm 251 cm and above
Top shelf depth	:	20-30 cm 31-40 cm 41-50 cm and above
Middle shelf height	:	Less than 50 cm 51-100 cm 101-150 cm and above
Middle shelf depth	:	20-30 cm 31-40 cm 41-50 cm and above
Bottom shelf height	:	Less than 50 cm 51-100 cm 101-150 cm and above
Bottom shelf depth	:	20-30 cm 31-40 cm 41-50 cm and above
Kitchen light switch Location	:	1. Right side of the door 2. Left side of the door 3. Above the work counter 4. Outside the kitchen door 5. Behind the kitchen door
Height of the switch	:	Less than 155 cm 156-175 cm 175 cm and above
Types and size of cooking appliance:		
Gas stove without stand	:	Mean \pm 1 standard deviation Low height stove Medium height stove High stove
Gas stove with stand	:	Mean \pm 1 standard deviation Low height stove Medium height stove High stove
Length of existing work counter	:	Mean \pm 1 standard deviation Small work counter Medium work counter Large work counter

Height of existing work counter	:	Mean \pm 1 standard deviation Low work counter Medium work counter High work counter
Depth of existing work counter	:	Mean \pm 1 standard deviation Narrow depth work counter Medium depth work counter Wide depth work counter
Existing kitchen size	:	Mean \pm 1 standard deviation Small kitchen Medium kitchen Large kitchen
Number of window/s	:	No window One window Two windows
Size of window/s (Height and breadth)	:	Less than 75.00 cm 76-100 cm 101-150 cm and above
Height and depth of shelves above the work counter, away from kitchen and movable shelf	:	Minimum height and depth Maximum height and depth

3. Statistical Analysis :

The data collected were analysed employing descriptive as well as relational statistics. The data was computerised and statistical package for social sciences (SPSS) was used for statistical analysis. In this study the results are accepted at 0.05 level of significance.

The data collected under various sections were presented for analysis as follows :

Personal and family variables were expressed in percentages. Anthropometric characteristics were presented in

mean, standard deviation, skewness of the distribution and percentiles. The reach measurements were reported in percentiles and mean. Data related to Part-2 (Housing data) and Part-4 (Existing kitchen condition) were expressed in percentages, mean, standard deviation and co-efficient of variation.

Statistical analysis also carried out to test the relationship between the selected variables.

a) Pearson Product - Moment correlation was computed to test the following relationships :

Inter-correlation among anthropometric characteristics
Relationship of anthropometric variables with age and number of children

b) Analysis of variance was computed to find out the 'between' and 'within' group variance :

For marital status and anthropometric characteristics.

For food habit and anthropometric characteristics.

c) Stepwise multiple regression was computed to estimate the values of dependent variables, from values of independent variables. They are :

Estimation of vertical reaches, shelf height and depth reaches and horizontal reaches (dependent variables) from anthropometric variables (independent variables)

d) Student t-test was used to test the differences between standards evolved and the existing work counter and shelves measurements :

Differences in existing workcounter, shelf height and depth with the standards evolved.

4. Testing of Hypotheses :

The null hypothesis were tested by employing the following statistical tests they are :

Hypothesis-1 : Pearson product-moment correlation, Analysis of variance, test of critical difference.

Hypothesis-2 : Inter correlations

Hypothesis-3 : Student t -test

OUTLIER :

More recently, it has been realized that real data usually do not completely satisfy the classical assumptions, often with dramatic effects on the quality of the statistical analysis. For eg. effect of 'outliers' in regression analysis or regression model.

The illustrations, Figure 1(a) and (b) and Figure 2(a) and (b) in Figure - 8, clearly indicate the effect of outliers in Simple Regression. In Figure 1(a), the $(X_5 Y_5)$ scatter plot of 5 points $(X_1 Y_1) (X_5 Y_5)$ which almost lie on a straight line. Therefore, the least squares (LS) solution fits the data very well. However, suppose someone

gets a wrong value (Y_4) thus affecting the place of decimal point then (X_4, Y_4) may be rather far away from the "ideal" line. Figure 1(b) displays such a situation, where the fourth point has moved up and away from its original position. This point is called as 'outlier' in the Y-direction and it has a rather large influence on the LS line.

However, usually also the explanatory variables $X_{i1} \dots X_{ip}$ are observed qualities subject to random variability. Therefore, there is no reason why gross errors would only occur in the response variable Y_i . In a certain sense it is even more likely to have an outlier in one of the explanatory variables $X_{i1} \dots X_{ip}$ because usually P is greater than 1, and hence there are more opportunities for something to go wrong. Figure-2, illustrates effect of such outliers in simple regression. Figure 2(a) contains five points $(X_1, Y_1) \dots (X_5, Y_5)$ with a well fitting LS line. Error in recording X_1 , results in figure 2(b). The resulting point is called an outlier in the X - direction and its effect on the LS estimator is very large because it actually tilts the LS line. Therefore, the point (X_1, Y_1) in figure 2(b) is called a leverage point. This large "pull" on the LS estimator can be explained as follows. Because X_1 lies far away, the residual r_1 from the original line (figure-2a) becomes a very large (negative) value, contributing an enormous amount of $\sum_{i=1}^5 x_{i-1} r_i^2$ for that line. Therefore the original line can not be selected for a LS perspective and indeed the line of Figure 2(b) possesses the smallest

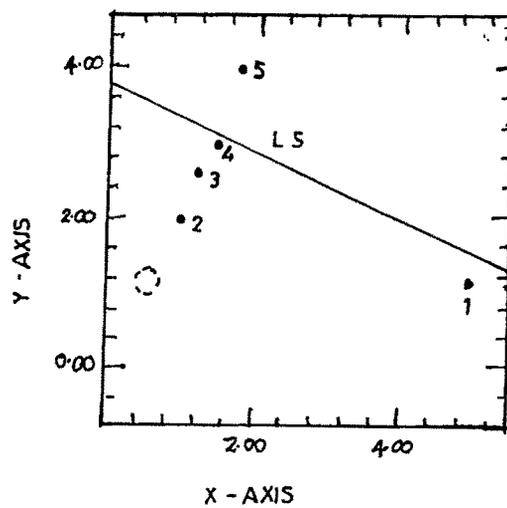
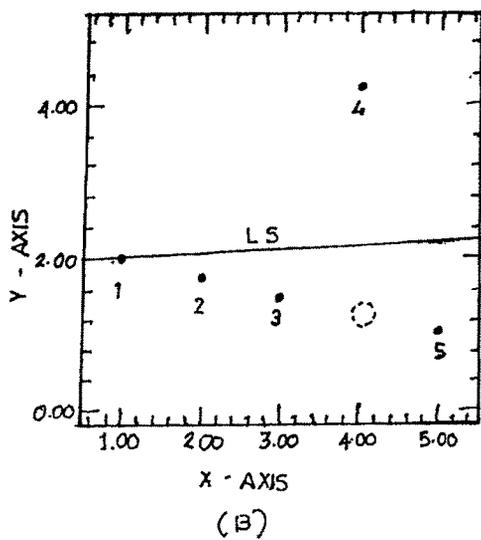
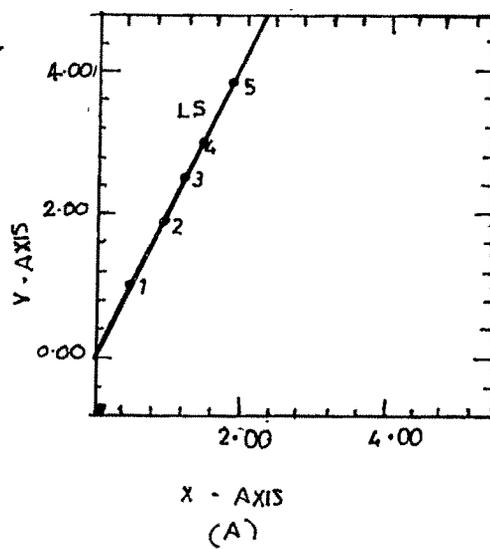
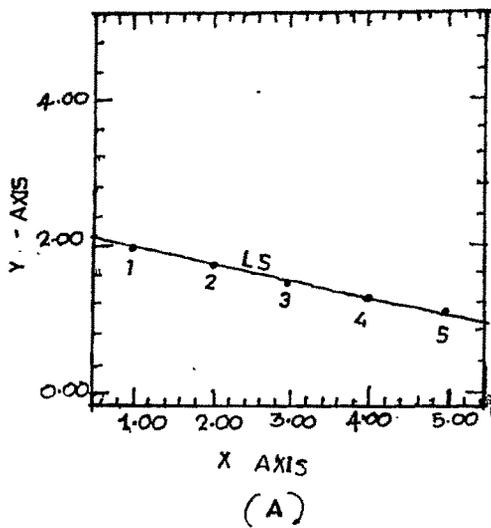


FIG.8.EFFECT OF OUTLIERS IN REGRESSION ANALYSIS

$\sum^5 x_{i-1} r_i^2$ because it tilted to reduce that large r_i^2 , even if the other four terms, r_1^2, \dots, r_5^2 , have increased.

(Source : Robust Regression and outlier Detection. By. ROUSEOUW, P.T., AND LEORY, A.M.).

According to normal distribution theory, 27 observations out of 1000 observations are expected to lie outside three sigma limit. Therefore, out of 500 observations approximately 12-13 observations are expected to become outliers. Therefore, in the present study it is fixed to be 10 outliers.