

Anthropometry for planning work place layout in rural areas of Punjab

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ABSTRACT: The anthropometric measurements and reaches of 25 selected homemakers belonging to each of the two selected localities of Ludhiana city were taken in standing, sitting and squatting postures in order to optimise kitchen dimensions in accordance with the user's dimensions, capabilities and limitations. In all the three postures, eye level, height, shoulder and elbow heights, right and left knee height, popliteal height, buttock knee length, buttock popliteal heights and thigh clearance heights were measured. However, in standing posture the right and left leg heights were also measured. The right and left total arm, upper arm, fore arm and hand lengths were also recorded. Since it was not feasible to consider the average values of various anthropometric measurements, for developing standards of ideal kitchen design, the 5th, 50th and 95th percentile values of anthropometric measurements were also recorded. For convenience and easy access, the height of storage shelves were decided as per the 5th percentile value of vertical reaches of homemakers. As the human being varied from group to group within groups with respect to their dimensions and capabilities, adjustability becomes a key note of design for human use, since a simple equipment or dimensions will never fit to entire user population. The 5th and 95th percentile values of the population help to establish the minimum and maximum limits of the workers for designing work surfaces and storage spaces.

Key words: Anthropometry, ergonomics.

Anthropometric measurements provide important tools and guidelines to architects for designing of work areas, storage spaces and other facilities in the house. It also helps in establishing the maximum and minimum levels of working plans like storage height, worker's comfortable reaches and workplaces. Travelling or reaching farther than the maximum work areas permitted by the limitation of human body is bound to affect one's efficiency and ultimately one's health (Pheasant, 1991). Measurements of anthropometric parameters of a large section of population of various age groups provide complete picture of diversity in anatomical measurements of human body, which could be used as a reference data for planning ergonomically sound work place layouts in terms of area specifications, work surface heights, reach dimensions, zone of comfortable reach and postural demands during working. The ideal work place layout determined by the limitations of the human body is helpful in enhancing operationability, safety, convenience and comfort to women while performing the domestic work. In good standing posture the head, chest and abdomen are balanced vertically one upon the other so that the weight is carried mainly by the body framework and minimum of effort and strain

is placed upon the muscles and ligaments (Nickel and Dorsey, 1976; Bredger, 1995).

MATERIALS AND METHODS

The Anthropometric measurements viz. height, weight, eye level height, shoulder height, elbow height, leg height, knee height, popliteal height, buttock knee length, buttock popliteal length, thigh clearance height and reaches of respondents in both horizontal and vertical reaches were recorded by conducting a field survey of 25 homemakers each from two purposively selected villages namely, Hasanpur and Sunet of Ludhiana district. For this purpose, a pretested relevant questionnaire was formulated keeping in mind the critical ergonomic parameters affecting the kitchen activities. Data so collected was tabulated for accurate and systematic analysis.

RESULTS AND DISCUSSION

The vertical and horizontal distances that homemakers can reach with ease and comfort are of considerable importance in kitchen designing. The

results of anthropometric and reach measurements of 50 women from rural areas are presented below:-

Anthropometric Measurements

Mean standing heights including the total standing heights of homemakers, eye level height, shoulder height, elbow height, knee height, popliteal height, buttock knee length, buttock popliteal length and thigh clearance height etc. as defined by (Sumangla, 1995) are presented in Table 1.

worked out and are presented in Table 2. The overall 5th, 50th and 95th percentile values of the population help to establish the minimum and maximum limits of the workers, so they may be used for designing work and storage spaces.

The vertical reaches for all the three shelves viz. top, middle and lower, while standing near shelf were found more than that of standing away from the shelf at the counter (Table 3). It was further noted that the maximum upward reach of both right and left hands were almost the same. Almost similar results were obtained

Table 1: Anthropometric Measurements of Selected Rural Homemakers in Different Postures

| Parameters Heights | Standing | | Sitting | | Squatting | |
|-------------------------|-------------|-----------|-------------|-----------|-----------|----------|
| | Range | Mean | Range | Mean | Range | Mean |
| Total | 143.0-169.0 | 154.8±5.6 | 69.5-93.0 | 80.2±5.7 | 67.4-90.5 | 78.9±5.3 |
| Eye level | 134.2-155.8 | 145.3±5.4 | 59.0-83.0 | 72.5±5.4 | 58.1-82.5 | 71.5±5.4 |
| Shoulder | 119.0-142.0 | 129.4±5.9 | 43.7-72.0 | 58.7±5.6 | 43.8-69.1 | 58.1±5.3 |
| Elbow | 86.5-115.0 | 97.6±6.3 | 24.0-54.5 | 38.5±9.2 | 23.4-54.5 | 38.1±9.4 |
| Right Leg | 85.0-104.0 | 91.6±4.5 | - | - | - | - |
| Left Leg | 85.0-103.1 | 91.6±4.4 | - | - | - | - |
| Right Knee | 37.2-54.0 | 45.8±3.6 | 34.6-50.0 | 44.5±3.5 | 36.3-49.5 | 43.9±3.3 |
| Left Knee | 37.2-54.1 | 45.7±3.7 | 35.0-50.0 | 44.2±3.7 | 36.8-50.0 | 44.0±3.4 |
| Right Popliteal | 36.9-53.0 | 44.0±8.1 | 33.7-47.0 | 39.9±3.4 | 32.6-45.0 | 39.6±3.4 |
| Left Popliteal | 36.9-52.5 | 44.0±8.1 | 34.0-47.0 | 39.8±3.3 | 31.6-45.0 | 39.6±3.5 |
| Thigh Clearance | 9.4-18.0 | 14.7±2.1 | 10.0-17.5 | 14.1±1.7 | 11.0-16.7 | 14.3±1.5 |
| Lengths | | | | | | |
| Right Buttock Knee | 43.5-56.0 | 48.9±2.5 | 35.0-51.3 | 43.0±5.9 | 31.8-52.0 | 42.6±6.1 |
| Left Buttock Knee | 43.5-56.0 | 48.5±2.5 | 35.0-51.3 | 42.9±6.0 | 32.0-52.0 | 42.5±6.0 |
| Right Buttock Popliteal | 35.5-60.0 | 47.2±5.9 | 31.6-56.0 | 44.8±4.1 | 33.2-52.0 | 42.5±4.4 |
| Left Buttock Popliteal | 35.5-60.0 | 47.2±5.9 | 31.6-56.0 | 43.4±6.3 | 33.6-52.0 | 45.5±4.4 |
| Right | | | | | | |
| Total Arm | 62.0 - 75.0 | 68.8± 3.8 | Left | | | |
| Upper Arm | 26.0 - 38.0 | 32.8±2.3 | 62.0 - 75.0 | 68.6± 3.8 | | |
| Fore Arm | 32.0 - 46.0 | 40.9±3.1 | 26.0 - 38.0 | 32.9±2.3 | | |
| Hand | 15.0 - 20.0 | 17.2±1.2 | 32.1 - 45.7 | 40.9±3.0 | | |
| | | | 15.0 - 20.0 | 17.2±1.2 | | |

These anthropometric values are used in ergonomics to specify the physical dimensions of work place, equipment, furniture and clothing so as to "fit the task to the man" (Sumangla, 1995) and ensure that physical mismatches between dimensions of equipment and products and the corresponding user dimensions are avoided (Pheasant, 1991). Since it was not found feasible to consider the average values of various anthropometric measurements for developing standards of ideal kitchen designs, the 5th, 50th and 95th percentile values were

for normal upward reach. It was similar for right and left hands and little difference was observed when both hands were used together as compared to individual hands used separately. These results are in conformity with those of Grandjean *et al.* (1988) who indicated that while standing close to the wall, maximum two handed reach was always more than that of standing away from the wall. In her study she observed higher upward one handed reach when standing away from the wall than that of mean reach of two hands, used separately.

Table 2: Percentile Values of Anthropometric Measurements

| Parameters | Standing | | | Sitting | | | Squatting | | |
|-------------------------|-----------------|------------------|------------------|-----------------|------------------|------------------|-----------------|------------------|------------------|
| | 5 th | 50 th | 95 th | 5 th | 50 th | 95 th | 5 th | 50 th | 95 th |
| Heights | | | | | | | | | |
| Total | 146.0 | 154.0 | 165.5 | 69.8 | 81.0 | 92.0 | 68.5 | 80.0 | 86.5 |
| Eye level | 136.0 | 145.0 | 155.1 | 61.1 | 73.0 | 81.0 | 60.5 | 70.8 | 80.0 |
| Shoulder | 120.1 | 130.0 | 140.0 | 49.9 | 59.0 | 67.0 | 49.5 | 58.1 | 66.1 |
| Elbow | 87.0 | 98.4 | 105.3 | 25.0 | 37.8 | 51.3 | 25.0 | 35.0 | 50.0 |
| Right Leg | 85.0 | 91.3 | 100.0 | - | - | - | - | - | - |
| Left Leg | 85.0 | 91.3 | 100.0 | - | - | - | - | - | - |
| Right Knee | 38.3 | 45.3 | 52.0 | 37.2 | 45.0 | 49.0 | 37.3 | 44.5 | 49.0 |
| Left Knee | 38.0 | 45.3 | 52.0 | 37.0 | 45.0 | 49.6 | 37.2 | 45.0 | 49.0 |
| Right Popliteal | 37.1 | 43.0 | 52.0 | 36.0 | 40.0 | 45.3 | 35.7 | 37.5 | 45.0 |
| Left Popliteal | 37.1 | 43.0 | 52.0 | 36.0 | 39.9 | 45.4 | 35.1 | 39.3 | 45.0 |
| Thigh Clearance | 10.5 | 15.1 | 17.1 | 10.5 | 14.1 | 16.3 | 11.8 | 14.3 | 16.5 |
| Lengths | | | | | | | | | |
| Right Buttock Knee | 45.0 | 48.7 | 53.0 | 38.0 | 46.0 | 51.0 | 32.7 | 43.9 | 52.0 |
| Left Buttock Knee | 44.9 | 48.6 | 53.1 | 38.0 | 46.0 | 51.0 | 32.3 | 43.7 | 52.0 |
| Right Buttock Popliteal | 38.0 | 47.0 | 58.0 | 33.0 | 45.6 | 52.0 | 36.7 | 45.0 | 51.0 |
| Left Buttock Popliteal | 38.0 | 46.9 | 58.0 | 33.0 | 45.6 | 52.0 | 36.0 | 45.1 | 51.1 |
| | Right | | | Left | | | | | |
| Total Arm Length | 62.5 | 69.0 | 73.0 | 62.5 | 68.7 | 73.0 | | | |
| Upper Arm Length | 28.0 | 32.0 | 36.0 | 28.0 | 32.0 | 35.7 | | | |
| Fore Arm Length | 35.0 | 41.9 | 45.0 | 35.0 | 41.9 | 44.8 | | | |
| Hand Length | 15.0 | 17.2 | 19.5 | 13.0 | 17.1 | 19.5 | | | |

The depth reach of work area for right and left hand was similar, but less when both the hands were used together. The depth reaches were more when standing near the shelf as compared to the one standing away from the shelf at the work counter. No difference was, however, observed between right and left hand reaches, but these were less than those when both the hands were used together to reach the shelves. Bindra (1970) indicated that the space requirements increase with the increase in the arm length.

Comparison of heights of existing storage shelves and vertical and horizontal reaches of selected homemakers revealed that the average height of top shelves above the work counter were 180.02 cm, whereas, the average height of middle and lower shelves above the work counter were 114.54 and 97.1 cm respectively. The height of the top shelves was found to be beyond the comfortable reach of the homemakers, when standing near the work counter i.e. 180.02 V/S

142.53 cm. The height of the middle and lower shelves in the kitchen were found within the comfortable reach of the homemakers.

Depth of the existing work area was 71.84 cm, which was beyond the comfortable horizontal reach of homemakers as they could not reach comfortably to depth of more than their reach of 64.14 cm. Similarly, the depth of all the three shelves viz. top, middle and lower shelves were found more than the normal depth reaches of homemakers specially for top and middle shelves there by enforcing adoption of undue stretching posture to reach or replace objects which causes great discomfort to the body. Prizeman (1966), Charti (1971) and Verghese *et al.* (1989 a & b) found that many awkward working heights and badly placed storage shelves in the kitchen results in undue stretching or bending to reach object is more taxing to the human body thereby enhancing the physiological cost of work.

Table 3: Measurements of Reaches (cm)

| Parameters | Standing Near the Shelf | | | Standing at Work Counter | | |
|---------------------------------|-------------------------|-------|-------|--------------------------|-------|-------|
| | Right | Left | Both | Right | Left | Both |
| Maximum Upward Reach | | | | | | |
| Top Shelf | 180.9 | 180.5 | 196.2 | 168.1 | 168.0 | 142.5 |
| Middle Shelf | 152.7 | 152.1 | 164.2 | 141.4 | 141.3 | 116.6 |
| Lower Shelf | 98.1 | 98.1 | 112.1 | 109.1 | 109.1 | 90.7 |
| Maximum Downward Reach | | | | | | |
| Top Shelf | 65.8 | 65.7 | 62.6 | 64.3 | 64.2 | 63.8 |
| Middle Shelf | - | - | - | - | - | - |
| Lower Shelf | 16.5 | 16.5 | 15.1 | 17.3 | 17.4 | 18.0 |
| Normal Upward Reach | | | | | | |
| Top Shelf | 175.5 | 175.5 | 174.4 | 149.8 | 149.7 | 149.0 |
| Middle Shelf | 145.0 | 145.1 | 144.3 | 119.3 | 119.2 | 118.7 |
| Lower Shelf | 97.4 | 97.2 | 97.1 | 90.8 | 90.7 | 90.1 |
| Normal Downward Reach | | | | | | |
| Top Shelf | 71.8 | 71.9 | 71.3 | 67.2 | 66.7 | 66.4 |
| Middle Shelf | - | - | - | - | - | - |
| Lower Shelf | 25.6 | 25.3 | 24.8 | 27.1 | 27.3 | 26.4 |
| Maximum Depth Reach | | | | | | |
| Work Area | 70.4 | 70.4 | 70.0 | 64.1 | 64.1 | 63.6 |
| Top Shelf | 15.6 | - | 15.2 | 15.1 | 15.1 | 14.8 |
| Middle Shelf | 37.0 | - | 36.1 | 34.1 | 34.1 | 33.7 |
| Lower Shelf | 18.7 | 18.6 | 17.7 | 18.1 | 18.1 | 17.1 |
| Normal Depth Reach | | | | | | |
| Work Area | 65.3 | 65.2 | 64.1 | 66.2 | 64.9 | 65.0 |
| Top Shelf | 14.0 | 13.9 | 13.6 | 14.9 | 15.0 | 14.9 |
| Middle Shelf | 36.2 | 36.2 | 35.3 | 35.0 | 21.2 | 21.2 |
| Lower Shelf | 17.1 | 17.3 | 16.9 | 11.9 | 17.9 | 17.9 |
| Maximum Horizontal Reach | | | | | | |
| Work Area | 47.1 | 49.4 | 48.4 | 48.9 | 48.8 | 45.2 |
| Maximum Horizontal Reach | | | | | | |
| Work Area | 45.8 | 45.9 | 45.4 | 45.0 | 44.9 | 44.3 |

REFERENCES

- Bindra, A. (1970). Space requirements for some selected activities carried out in the kitchen. *M. Sc. Thesis*, M. S. University, Baroda.
- Bredger, R.S. (ed.) (1995). *Introduction to Ergonomics*. McGraw Hill Inc., New York, Pp 244-49.
- Charti, G. (1971). Working heights of cooking units. M.Sc. Thesis, M.S. University of Nagpur, Nagpur.
- Grandjean, E. Kretzschmar, H. and Wtzka, G. (1988). Arbeitsanalysen beim verkaufspersonal eines warehouses. *Zeitschrift für präventivmedizin*, 13: 1-9.
- Nickel, P. and Dorsey, J.M. (ed.) (1976). *Management in Family Living*. John Wiley and Sons, New York, Pp 21-24,
- Pheasant, S.T. (1991). *Ergonomics, work and health*. Macmillan Press, Hampshire, Pp 98-107.
- Prizeman, J. (1966). *Kitchen Design, Layout and equipment*. Mc Donald and Company Ltd. UK, Pp 50-52.

Sumangla, P.R. (1995). Development of standards based on anthropometric measurements and their implications in designing of kitchen and storage. Ph.D. dissertation, M.S. University, Baroda, India.

Verghese, M.A., Chattarjee, L., Atreya, N. and Bhatnagar, A. (1989a). Ergonomic Evaluation of Household Activities. UGC Report 8. Department

of Family Resource Management, SNDT, Bombay, India.

Verghese M.A., Chattarjee, L., Atreya, N. and Bhatnagar, A. (1989b). Ergonomics in Kitchen Design. UGC Report 9. Department of Family Resource Management, SNDT, Bombay, India.