

## Anthropometric Measurements and Body Composition Parameters of Farm Women in North Gujarat

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### Abstract

Anthropometric data of agricultural farm women is very essential for appropriate and efficient designing of farm machinery. The anthropometric data of 150 farm women was collected in three villages of Dantiwada taluka namely, Nilpur, Lodpa and Madivas in North Gujarat. For making the data comprehensive and more useful, a set of 20 body dimensions, which were found to be applicable in the design of various agricultural equipments, were selected, which included stature, vertical reach, vertical grip reach, eye height and so on. The data was further analyzed and the efforts had been made to illustrate the applications of these measurements for designing and standardization of women friendly equipment. In the study, in addition to the descriptive values, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile values were also calculated.

The Body composition of farm women was recorded by using Body Fat Analyzer. Various characteristics of body composition such as L.B.M. (Lean Body Mass), M.B.F. (Mass Body Fat), S.L.M. (Soft Lean Mass), mineral, protein, T.B.W. (Total Body Water), P.B.F. (Percent Body Fat), B.M.I. (Body Mass Index) and B.M.R (Basal Metabolic Rate) were measured in the present study.

Efforts had been made to correlate these body parameters with increment of age. In conclusion, the present study shows some significant changes with increment of age in body composition characteristics of selected farm women.

**Keywords:** Body composition; Farm women; Anthropometry; Gujarat

### Introduction

Anthropometry is the science of measurement and the art of application that establishes the physical geometry, mass properties, and strength capabilities of the human body [1]. It involves the systematic measurement of the physical properties of the human body, primarily dimensional descriptors of body size and shape. The knowledge of body dimensions is essential for designers of equipment and work places. The anthropometric measurements are essential for the correct design of the work areas [2]. Anthropometric data of female agricultural workers are also important for the rationalization of the design of agricultural hand tools and equipment [3,4].

Three major factors must be considered in specifying the dimensions of a workstation or design, which causes variability in body size, i.e., sex, age and race or ethnicity. Women constitute a major component of agricultural workforce in India. Women have to do jobs that are time and labor intensive such as sowing, transplanting, weeding, intercultural, harvesting, threshing, and post-harvest operations like, shelling, cleaning, grading and processing. Many agricultural projects aimed at men with the assumption that they will some how automatically benefit women though the ergonomical characteristics of women are different than men workers [5]. These tools or equipments will increase work load and occupational disorders in spite of decreasing, if not fit for the subject. Poor design and excessive use of hand tools are associated with increased incidence of both acute and subacute cumulative trauma of hand, wrist and fore arm [6]. In Indian agriculture, hand tools, animal-drawn equipment and tractor/power operated machinery are extensively used for various operations. These equipments are either operated or controlled by human workers [7]. Use of anthropometric data can help in the proper design of equipment for better efficiency and more human comfort. Available anthropometric data or Indian farm workers could be useful in farm machinery design [8-10] pointed

out that there was considerable difference between the anthropometric data of Indian and Westerners. Hence, anthropometric data is requisite for designing any tool for the woman.

In the light of above discussion, 20 body dimensions of 150 farm women were measured in the present study, which are found to be applicable in the design of various agricultural equipment. The Body composition of farm women was also recorded by using Body Fat Analyzer.

### Materials and Methods

Three villages were selected from sixteen adopted villages of Dantiwada under RKVY. One village was selected from the villages having large number of big farmers, i.e., Lodpa, one village was selected from the villages having comparatively less number of big farmers, i.e., Nilpur and one village was selected from the villages having no big farmer, i.e., Malivas. Fifty farm women aged between 20-60 years from each selected village of Dantiwada block under RKVY were selected for the research. Simple random sampling was used to select farm women. Various anthropometric measurements of farm women such as vertical reach, vertical grip reach, eye height, acromial height, elbow height, olecranon height, metacarpal height, knee height, arm reach from the wall, chest breadth, vertical grip reach sitting, sitting eye height, buttock

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popliteal length, hip breadth sitting, elbow-elbow breadth sitting, shoulder grip length, hand breadth at metacarpal III, palm length and pinch force were taken by using Herpenden Anthropometer, set of large and small anthropometer and digital pinch force gauge. Subjects were screened so that those in normal health without any serious disease or physical handicapped were selected. During the measurement of body dimensions, care was taken to avoid any excessive compression of underlying tissues and to record the measurement correctly.

All measurements were conducted by trained research fellows using similar techniques. All subjects wore light clothing without foot wears. For standing dimensions, subjects were asked to stand upright on the base of the anthropometer, facing forward, and arms hanging beside the body. For sitting dimensions, subjects were asked to sit erect on a chair without armrests, with knees bent 90°, and feet flat on the surface, facing forward, and arms hanging beside the body. All the measurements of each subject were taken three times. The data was further analyzed and in addition to the descriptive values, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile values were also calculated. Each group of data was included in statistical analysis.

The Body composition of farm women was recorded by using Body Fat Analyzer that directly measures percent body fat using harmless near-infrared technology. Various characteristics of body composition such as L.B.M. (Lean Body Mass), M.B.F. (Mass Body Fat), S.L.M. (Soft Lean Mass), mineral, protein, T.B.W. (Total Body Water), P.B.F. (Percent Body Fat), B.M.I. (Body Mass Index) and B.M.R (Basal Metabolic Rate) were measured in the present study. Efforts had been made to correlate these body parameters with increment of age.

## Results and Discussion

Various Anthropometric Measurements had been taken for the designing of Agricultural tools and equipment for the drudgery reduction of Farm women. Further, observations were analyzed and max, min, STDEV, mean, mode, 5<sup>th</sup>, 95<sup>th</sup> and 50<sup>th</sup> percentile of above anthropometric measurements were calculated.

Mean stature of farm women in north Gujarat was found 1506.4 mm whereas, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile were 1434.5, 1525.0 and 1635.5 mm respectively. Mean weight of farm women was found 33.08 kg, however 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile of weight were 24 kg, 30.5 kg and 46.55 kg respectively. Weight of farm women ranged between 22 – 60 kg. It shows the fact that weight of tools or equipment for women should be handy and comfortable to use. Heavy weight tools or equipment may be heavy for them to operate.

Mean vertical reach and vertical grip reach were 1869.2 and 1824.5 mm respectively whereas 5<sup>th</sup> percentile of the above measurements was 1691.0 and 1683.4 mm respectively. This suggests that the maximum grip reach of equipment during operation should be minimum 1680 mm for operating properly. Mean eye height of women was observed 1382.2 mm. The most favorable working height for handwork while standing is 50-100 mm below elbow level. The mean elbow height of farm women was found 911.2 mm, hence average working height of 900-905 mm will be comfortable for them.

Observations regarding acromial height, olecranon height, metacarpal III height and knee height can be used in the designing of handle of various equipment and tools such as wheel hoe, hand ridger etc. The 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile values of hand breadth at metacarpal III were found to be 66 mm, 76 mm and 82 mm respectively and palm length were found to be 73 mm, 90 mm and 108 mm respectively. 95<sup>th</sup> percentile values of hand breadth at metacarpal III and palm length should be considered for designing diameter of handle. 50<sup>th</sup> percentile value of pinch force of women was found to be 5 kg, which should be considered for optimum control of pinch force. Various anthropometric measurements of farm women were taken in sitting position. These values can be used in designing various equipments which are operated in sitting position.

Further, body composition of farm women was also analyzed to make out their physical fitness. The body is composed of water, protein, minerals, and fat. The total amount of body fat consists of essential fat and

Anthropometric measurements	Mean	Max	Min	STD	5 <sup>th</sup> percentile	95 <sup>th</sup> percentile	50 <sup>th</sup> percentile	Mode	Median
Age	33.08	60.00	22.00	7.80	24.00	46.55	30.50	35.00	30.50
Stature (mm)	1506.4	1680.0	1331.0	63.1	1434.5	1635.5	1525.0	1440.0	1525.0
Vertical reach (mm)	1869.2	2143.0	1328.0	112.1	1691.0	1991.4	1871.0	1970.0	1871.0
Vertical grip reach (mm)	1824.5	1987.0	1462.0	92.6	1683.4	1946.1	1845.5	1852.0	1845.5
Eye height (mm)	1382.2	1963.0	819.0	112.8	1255.8	1474.1	1382.0	1358.0	1382.0
Acromial height (mm)	1243.6	1786.0	1006.0	85.3	1131.8	1324.1	1247.0	1295.0	1247.0
Elbow height (mm)	911.2	1077.0	731.0	57.5	793.5	989.1	921.5	915.0	921.5
Olecranon height (mm)	892.2	1000.0	513.0	64.5	791.8	969.7	901.0	860.0	901.0
Metacarpal- III height (mm)	608.8	974.0	300.0	59.6	524.5	674.0	617.0	583.0	617.0
Knee height (mm)	388.5	499.0	250.0	41.5	304.0	436.5	395.0	411.0	395.0
Arm reach from the wall (mm)	735.9	921.0	541.0	91.2	631.0	843.1	743.0	757.0	743.0
Chest breadth (mm)	247.3	330.0	134.0	26.3	205.0	290.0	245.0	240.0	245.0
Vertical grip reach sitting (mm)	1047.9	1517.0	792.0	108.6	878.5	1206.1	1040.5	1022.0	1040.5
Sitting eye height (mm)	592.1	958.0	302.0	90.8	450.4	720.1	596.0	612.0	596.0
Sitting popliteal height (mm)	355.8	732.0	192.0	53.7	288.3	413.1	354.0	337.0	354.0
Buttock popliteal length (mm)	402.4	520.0	244.0	46.4	330.0	477.8	405.0	430.0	405.0
Hip breadth sitting (mm)	308.9	385.0	235.0	35.7	257.3	373.0	309.0	260.0	309.0
Elbow - elbow breadth sitting (mm)	368.8	492.0	225.0	50.0	310.0	477.8	360.0	350.0	360.0
Shoulder grip length (mm)	67.48	97.90	50.70	8.30	54.30	81.99	67.65	60.30	67.65
Hand breadth at metacarpal III (mm)	75.3	87.0	60.0	5.2	66.0	82.0	76.0	80.0	76.0
Palm length (mm)	89.8	119.0	68.0	10.2	73.0	108.0	90.0	90.0	90.0
Pinch force (kg)	56.0	150.0	30.0	15.3	40.0	85.5	50.0	50.0	50.0

Table 1: Anthropometric measurements of farm women.

storage fat. Fat in the marrow of bones, in the heart, lungs, liver, spleen, kidneys, intestines, muscles, and lipid-rich tissues throughout the central nervous system is called essential fat, whereas fat that accumulates in adipose tissue is called storage fat. Essential fat is necessary for normal bodily functioning. The essential fat of women is higher than that of men because it includes sex-characteristic fat related to child-bearing [11,12]. Storage fat is located around internal organs (internal storage fat) and directly beneath the skin (subcutaneous storage fat). It provides bodily protection and serves as an insulator to conserve body heat. The relationship between subcutaneous fat and internal fat may not be the same for all individuals and may fluctuate during the life cycle. Lean body mass represents the weight of muscles, bones, ligaments, tendons, and internal organs. Since there is some essential fat in the marrow of bones and internal organs, the lean body mass includes a small percentage of essential fat.

Results presented in the tables (Tables 1-4) shows that mean Body Mass index was in the range of optimal health. On the other hand, value of 5<sup>th</sup> percentile was found to be in the range of severe CED Grade III. There was a significant difference between maximum and minimum range of various body parameters.

It is revealed from the data that maximum farm women were having standard weight; almost 29 percent were low fat. One fourth of selected farm women were found obese while a small proportion of them was over fat, i.e., 8.7 percent. This data shows variation in farm women's body type.

Further, an effort was made to know the correlation of age of respondents with body parameters. The analysis of data showed that PBF, BMI and minerals of their body is significantly correlated with the age. It can be inferred from the results that as the age of respondents was increasing, their PBF, BMI and minerals of the body were also increasing. In other words, fat of their body was also increasing with the increment of age. As far as BMR is concerned, the only parameter was showing a decreasing trend with the increment of their age, though insignificantly. Physical fitness of women is directly related to their work performance. Their work performance can be reduced resulting from out of optimal range rise of these parameters.

### Conclusion

The compilation of anthropometric data is a much needed and worthwhile to design tools and equipment as well as to assess them ergonomically. The data can be used to design area specific tools and equipment for the target group which would be fit for them. This can reduce the occupational health problems and injuries. Further, analysis of body composition of the women would be helpful to know their physical fitness as well as their nutritional health. The present study shows some significant changes with increment of age in body composition characteristics of selected farm women. These results indicate that it is essential to study the physical fitness of women in their increasing age. The increase in fat in the body may cause some serious health implications.

Parameters	Mean	Max	Min	STDEV	5 <sup>th</sup> percentile	95 <sup>th</sup> percentile	50 <sup>th</sup> percentile	Mode	Median
Age	33.08	60.00	22.00	7.80	24.00	46.55	30.50	35.00	30.50
Weight in kg	48.27	73.20	31.10	8.96	34.74	65.04	47.50	51.00	47.50
L.B.M in kg	34.54	45.90	13.80	4.49	27.54	41.67	34.75	37.70	34.75
M.B.F in kg	13.42	28.00	1.50	5.54	6.10	24.02	12.60	7.30	12.60
S.L.M in kg	31.77	41.90	13.40	4.04	25.39	38.01	31.95	30.20	31.95
MINERAL in kg	2.77	5.00	1.80	0.53	2.05	3.70	2.70	2.60	2.70
PROTEIN in kg	6.95	8.90	5.00	0.75	5.65	8.00	7.00	7.60	7.00
T.B.W in kg	25.20	33.60	17.40	3.24	19.90	31.02	25.15	27.10	25.15
P.B.F.	26.95	41.60	10.90	6.63	16.99	37.67	26.50	26.50	26.50
B.M.I in kg/m	21.01	33.40	12.90	4.08	15.49	28.28	20.30	20.90	20.30
B.M.R Kcal	1122.45	1705.00	922.00	87.88	1012.25	1207.00	1119.50	1132.00	1119.50

Table 2: Body composition of farm women.

Body type of farm women	Frequency - 150	%
Standard	56.0	37.3
low fat	44.0	29.3
Obese	37.0	24.7
over fat	13.0	8.7
Total	150.0	100.0

Table 3: Body Type of farm women.

PBF	0.289842**
BMR	-0.091392
BMI	0.210274*
LBM	0.130137
MBF	0.36006**
SLM	0.07255
Mineral	0.2499085**
Protein	0.10628
TBW	0.16164

\*\* p<0.01, \* p <0.05

Table 4: Correlation of age of farm women with parameters of body composition.

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