ORIGINAL ARTICLE

Anthropometric Dimensions of Iranian Male Workers and Comparison with Three Asian Countries

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This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Anthropometry is the study of human body dimensions and proportions among different races. In work environments, poorly designed workstations and tools reduce productivity and can lead to fatigue and musculoskeletal injuries. This study aimed to determine the anthropometric characteristics of Iranian workers in comparison to three other Asian countries. This cross-sectional study evaluated 400 male workers between the ages of 25 and 55 yr from all ethnicities working at Iran Khodro Automobile Factory. Results showed that the average height of the Iranian worker is 173.73±6.84 cm and the average sitting height 90.79±3.55 (cm). In comparison to Indian and Philippine workers, Iranian workers are 100% and 83% taller, respectively. This data can be useful for designing workplace space (e.g. height), work levels (e.g. elbow height) and peripheral equipment size, such as chairs (e.g. the width of hips and height of thighs).

Keywords: *Anthropometry, Body Dimension, Body Proportion, Iran, Workers, Asia*

INTRODUCTION

Anthropometry is the study of body dimensions within different races. Anthropometry is used in the proper design of industrial and educational workstations in order to decrease awkward postures while working [1-2] and also to increase productivity, health, safety and comfort [3-4]. Age, gender, race, body structure and socioeconomic factors all affect human body anthropometric dimensions [4-5]. Race is an effective factor because anthropometry dimensions of different races have remarkable differences [6-7].
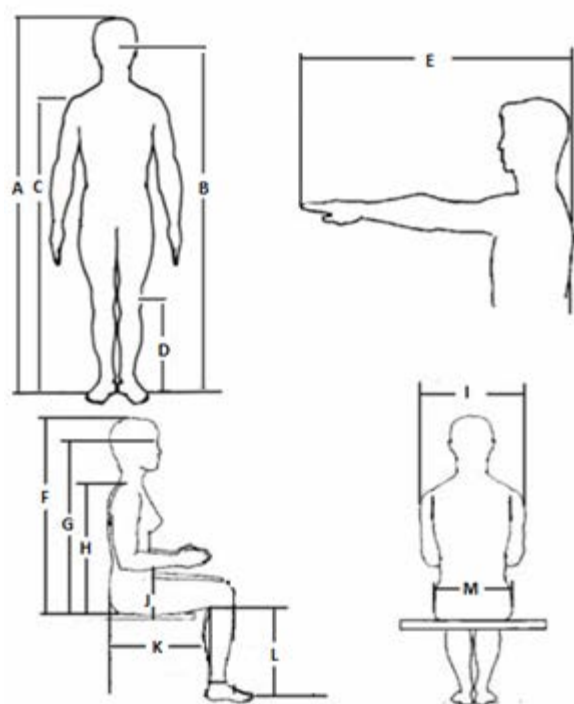
Anthropometric ratio is the measurement of body dimension in respect to one specific dimension. These dimensions provide some useful information about the estimation of anthropometric data of whole populations and the comparing of the dimensions of various populations.

In the Industrial age, workers are increasingly forced to adapt themselves to the unsuitable conditions that are imposed on them [8]. The Iranian center for occupational health and environment safety states that 32% of Iranian workers are working in an unsuitable physical state and 75% use tools that are not designed for them [9-10].

Currently there is no database of Iranian workers' anthropometry dimensions for designing these tools and workstations and while little changes in the dimensions of workspace can have remarkable effects on workers' productivity and occupational health and safety, the lack of statistical information halters any change [4, 11]. By

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Fig 1. Anthropometrical dimensions based on the method of standard measurements ISO/IDS7250- sitting and standing postures

A	Stature	G	Sitting eye height
B	Standing eye height	I	Shoulder width
C	Standing shoulder height	J	Sitting elbow height
D	Tibial height	K	Buttock- popliteal lengths
E	Forward reach	L	Popliteal height
F	Sitting height	M	Buttock width
H	Sitting shoulder height		

using the principles of anthropometry in workspace design, it is possible to enable people with different body dimension to regain their physical comfort at work and reduce musculoskeletal disorders [12]. Therefore it is necessary to have reliable anthropometrics dimensions databases for the intended user population to aid in better design [13].

The lack of an Iranian workers' anthropometrics database means manufacturers are forced to refer to other non-native databases from other countries [14]. Furniture in Isfahan University of Medical Sciences is not designed to fit native Iranian anthropometric dimensions and anthropometric dimensions standards should be revised [15]. In all cases, except table height, there is no proportion between table/chair dimensions and the students' body dimensions [16]. Iranian students are different in body dimensions to American and British students [14].

Measurement of anthropometric dimensions is time consuming and costly and in some cases measurements can be faulty therefore mathematical and programming formulas with high correlation can be used to reduce error. For instance horizontal accessibility has a correlation with Stature and so we can obtain that just by measuring Stature.

This study aimed to determine the anthropometric characteristics of Iranian workers in comparison to three other Asian countries.

MATERIALS AND METHODS

This case study was carried out in 2012 and 18 anthropometric dimensions of 400 male workers were measured. Body dimensions of samples were compared with those of three Asian countries. This research was carried out in the cities of Tehran, Tabriz and Mashhad for better ethnic sampling. Sample size of the study was determined based on pre-test analysis on a group of 40 male workers. The clustering method was used for sampling. Finally, in order to investigate the similarity of Iranian Stature to other countries, the stature average of the Iranian population was compared to East Asian and Western countries.

Measurements were taken in static form and included length, width and height. All the measurements were done according to the standard method of measuring anthropometric data's ISO/IDE7250. In this study, tools such as 1: Standard anthropometric chair, 2: Caliper in large and small sizes, 3: Tape meter and metal meter (1mmaccuracy), 4: Steadio meter (1mm accuracy) and scaled board of anthropometry were used for body measurement. The measurements were done by occupational health experts who had passed essential training for anthropometry. Fig 1 is demonstrated measured dimensions in standard physical statements of anthropometry in two postures: sitting and standing. A separate questionnaire was used to gather demographic information of the subject during the dimension data gathering process.

Table 1. Iranian men's anthropometric dimensions (N=400)

No	Dimension	Mean	SD	5th	50th	95th
1	Stature	173.73	6.84	161.71	173.75	185.69
2	Standing shoulder height	145.30	6.53	134.70	145	156.50
3	Standing elbow height	110.21	5.36	100.81	110.25	120.00
4	Overhead reach	194.74	8.65	181.50	195	208.95
5	Forward reach	69.64	3.53	64.02	69.50	76.27
6	Knuckle standing height	69.56	4.00	63.20	69.2	75.50
7	Tibial height	47.73	2.96	43.02	47.65	43.02
8	Sitting height	90.79	3.55	84.31	90.95	97.30
9	Sitting eye height	80.25	3.56	73.81	80.60	85.89
10	Sitting elbow height	27.00	2.84	22.02	27	31.68
11	Thigh thickness	16.88	1.54	14.60	16.80	19.69
12	Buttock-knee length	59.12	3.06	54.61	59.1	64.58
13	Buttock-popliteal length	47.79	2.89	43.20	47.65	53.00
14	Sitting popliteal height	38.86	2.32	35.20	38.6	43.49
15	Buttock width	38.50	2.81	34.20	38.25	43.20
16	Elbow-elbow breadth	51.15	4.13	44.62	50.85	58.29
17	Shoulder width	45.66	5.10	41.52	45.60	51.63
18	Interpupillray distance	5.38	0.35	4.80	5.45	6.00

In this study the correlation coefficient of anthropometric dimensions among studied population, was studied by Pearson Statistical coefficient of correlation.

In this study statistical analysis and graphs were drawn using SPSS (ver.16) and Microsoft Excel.

RESULTS

Eighteen anthropometric dimensions were measured and 10 cases from the most practically acquired body dimensions were compared with body dimensions of one South Asian and two East Asian countries. Table 1 shows the average of 18 dimensions of Iranian men's body with standard deviations and percentiles of 5th, 50th and 95th in sitting and standing postures.

To investigate the correlation of anthropometric dimensions in the under study Samples, the Pearson Statistical test was used (Table 2).

Table 3 shows the comparison between Iranian workers anthropometric dimensions and 3 other Asian countries i.e. China, the Philippines and India [7, 17]. The average of 10 dimensions from four populations represented by means of column graph is shown in Fig. 2.

Body ratios in the sitting posture of 4 Asian countries have been presented in Fig. 3. The ratios were

obtained by dividing the length of each body's anthropometric dimensions by the total length of their bodies. Ratios provide information about the estimation of anthropometric data of whole populations [6-7].

DISCUSSION

The result of comparison showed that 100% of all average Iranian workers' body dimensions are higher than that of average Indian workers. Stature length of Iranian workers is 173.73 cm with a standard deviation of 6.84 cm which is taller than the average stature length of Indian workers by about 13 cm [18] as well as Chinese and Philippine workers by about 6 cm [7, 17].

This data can help in designing work places that are in accordance with workers [2, 7] .This data is also useful in the morphological features of Iran and other Asian countries and should be considered in economical exchanges among countries [2, 6, 7, 18].

The elbow's height in standing positions for the Iranian population, used for designing work levels, is about 10 cm and is higher than that of the Indian population and is about 5 cm more than the average of acquired dimensions in the Philippine [2, 6]. Sitting position dimensions are important for designing office workstations, desks, and chairs and are also used for

Table 2. Correlation coefficients between sample anthropometric dimensions

Dimension	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Stature	1																
Standing shoulder height	0.94	1															
Standing elbow height	0.87	0.89	1														
Overhead reach	0.82	0.79	0.72	1													
Forward reach	0.75	0.73	0.63	0.70	1												
Knuckle standing height	0.77	0.78	0.83	0.58	0.45	1											
Tibial height	0.62	0.61	0.58	0.55	0.58	0.42	1										
Sitting height	0.77	0.70	0.64	0.60	0.46	0.63	0.38	1									
Sitting eye height	0.73	0.67	0.61	0.59	0.43	0.62	0.36	0.87	1								
Sitting elbow height	0.33	0.36	0.37	0.32	0.06	0.39	0.17	0.53	0.55	1							
Thigh thickness	0.37	0.34	0.29	0.37	0.30	0.31	0.25	0.33	0.31	0.29	1						
Buttock-knee length	0.72	0.70	0.65	0.65	0.66	0.53	0.46	0.42	0.44	0.15	0.51	1					
Buttock-popliteal length	0.64	0.61	0.55	0.61	0.63	0.44	0.40	0.36	0.34	0.06	0.39	0.82	1				
Buttock width	0.37	0.32	0.28	0.37	0.31	0.27	0.25	0.39	0.39	0.27	0.51	0.51	0.43	1			
Sitting popliteal height	0.64	0.61	0.54	0.66	0.67	0.41	0.52	0.40	0.35	0.03	0.15	0.53	0.52	0.36	1		
Shoulder width	0.17	0.15	0.15	0.19	0.11	0.14	0.11	0.20	0.21	0.26	0.56	0.34	0.15	0.62	0.13	1	
Interpupillray distance	0.16	0.16	0.08	0.2	0.21	0.13	0.06	0.12	0.09	0.03	0.16	0.15	0.14	0.13	0.22	0.15	1

determining sitting workspace. These dimensions are used in designing different dimensions of chairs such as chair height and length of seat [2, 6, 19-20]. Results among the 4 studied populations are similar. Seat length in the Iranian population is bigger than the Indian population. Small difference between these countries can be attributed to increasing lipid tissue in parts of the bottom, hip and legs of Iranian individuals. Although knee height in Iranian individuals is higher than Chinese individuals, chair height in the Chinese population is higher in comparison with the Iranian population which is caused by lipid tissue expansion as mentioned in Mirmohammadi et al. [21].

In 83% of cases, Iranian individuals have bigger body dimensions in comparison with the Philippines and in 100% of cases body dimensions of Iranian individuals are bigger than Indians. Moreover in all cases Philippine individuals have bigger body dimensions in comparison with Indian individuals. The results showed that in 18% of cases, lower limb body dimensions (i.e. Length of seat, height of knee, standing) of Philippine individuals are bigger than Iranians. Study of Yu-Cheng Lin et al. also showed that

East Asian populations shave more extensive lower limb body dimensions in comparison with upper body organs. Result of this study verifies Yu-Cheng Lin et al. [7].

An examination of body ratios showed that the ratio of sitting height in Iranian populations is higher than the three other populations, while the sitting popliteal height is less than the other populations. Body ratios are an important factor in the determination of anthropometric dimensions thus these ratios provide useful information in workspace designing.

Besides, the result of this study showed that the width of shoulder and the width of buttocks in the Iranian population is higher than the 3 other Asian populations. These dimensions are very important in designing of back rests and width of chairs, office furniture, conference rooms and theatre halls [2, 6].

At the end in order to investigate the similarity of Iranian body length to other countries, stature averages of the Iranian population was compared to some East Asian and Western countries. As indicated in Table 3 anthropometric dimensions of Indian, Philippine and Chinese population are 161.40, 167.01 and 167.8 cm,

respectively. Furthermore, the average stature of Japanese workers was 165.80 cm [18] and of the Korean population was 170.7 cm [7]. The comparison of 5 Asian countries indicated that the Korean population is the most similar population compared to Iranians [7].

The stature of German workers was 174.50 cm [22], English workers 173.87 cm [22], and American workers 175.74 cm [23]. This comparison shows that the Iranian population's average stature is similar to western countries rather than East Asian ones.
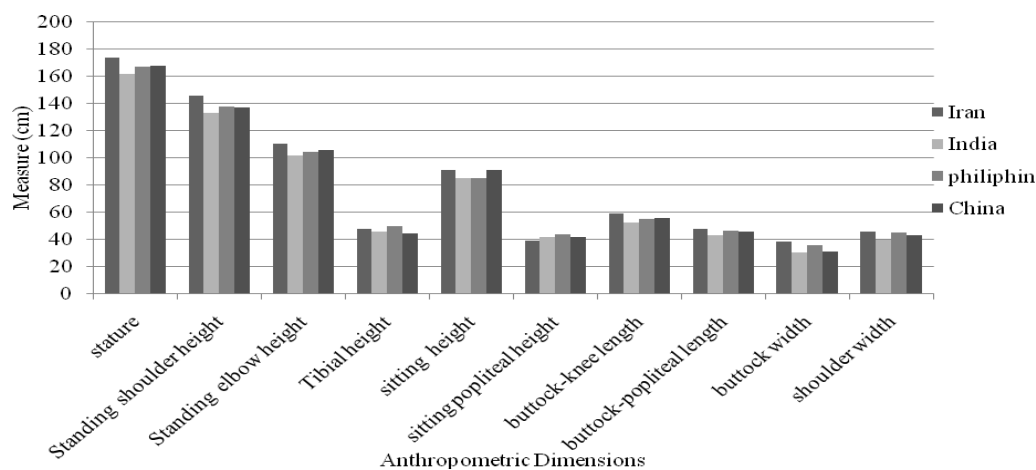

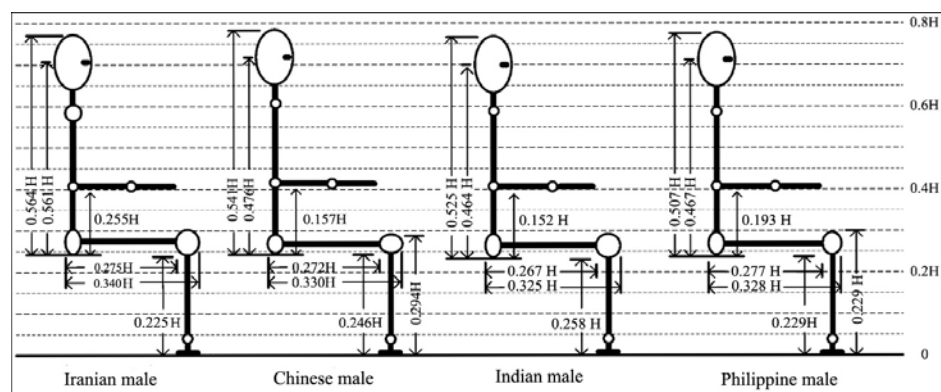**Fig 2.** Comparison of anthropometric dimensions of four Asian countries

Fig 3. Comparison of body ratios in sitting posture of four Asian countries

Table 3. Comparison of anthropometric dimensions of Iran, India, Philippine and China (Cm)

No	Dimension	Iran	India	Philippine	China
		N= 400	N= 540	N= 840	N= 1116
1	Stature	173.73	161.40	167.01	167.80
2	Standing shoulder height	145.30	132.70	137.45	136.70
3	Standing elbow height	110.21	101.40	104.14	105.40
4	Tibial height	47.73	45.80	49.73	44.40
5	Sitting height	90.79	84.80	84.84	90.80
6	Sitting popliteal height	38.86	41.70	43.33	41.30
7	Buttock-knee length	59.12	52.50	54.80	55.40
8	Buttock-popliteal length	47.79	43.10	46.40	45.30
9	Buttock width	38.50	30.00	35.60	30.60
10	Shoulder width	45.66	39.70	44.67	43.10

CONCLUSION

Anthropometry and anthropometric databases of different races is important in proper designing of workspaces, furniture, safety equipment and tools so as to increase productivity, physical health, easiness, utility and satisfaction in the workplace, hence particular attention should be paid to these dimensions.

In addition, in an ever growing global market for trade and commerce of goods, tools and machinery, attention to anthropometric dimensions of the target consumer is essential and further attention must be paid.

ACKNOWLEDGEMENTS

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