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# An anthropometric data bank for the Iranian working population with ethnic diversity

Fatemeh Sadeghi [a], Adel Mazloumi [b, *], Zeinab Kazemi [b]

[a] Ministry of Health and Medical Education, Tehran, Iran
[b] Department of Occupational Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

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ABSTRACT

This study constructed an anthropometric data bank for the Iranian working population. In total, thirty-seven body dimensions were measured among 3720 Iranian workers with different ethnicities (3000 male and 720 female; aged 20–60 years). Statistical analysis revealed significant differences for most of body dimensions among the ethnical groups. Moreover, the authors compared Iranian anthropometric characteristics with those of four Asian populations: Taiwanese, Chinese, Japanese, and Korean. Overall, 16 body dimensions for the five Asian populations were selected and compared. Accordingly, different morphological characteristics of these five populations were observed. The Iranian population showed wide shoulders and hips and long legs; the Chinese population showed narrow hips and shoulders and a short height relative to the other populations. The Korean sample recorded moderate body size comparing the other populations. The Taiwanese had large hands, relatively wide shoulders and short upper limbs. These differences in population dimensions should be taken into consideration for product and process design when expanding regional markets.



## 1. Introduction

The compatibility of all products and working environments with the dimensions of the human body is an inevitable requirement for designing an ergonomic product or workstation. This is not possible unless the anthropometric characteristics of users or workers are considered. Determining body dimensions is important to clothing design, forensics, physical anthropology, and ergonomic design of workplaces, tools, equipment, machinery, and consumer products (Agrawal et al., 2010; Botha and Bridger, 1998; Hanson et al., 2009; Hughes and Johnson, 2012; Ismaila, 2009; Paul et al., 2012). According to the principles of ergonomics, a workplace should be designed prior to use in accordance with worker characteristics. In this sense, anthropometry provides measurements of the human body that can be used to design an ergonomically fit workplace (Reis et al., 2012). The use of anthropometric data allows the development of more effective designs that enhance user performance and productivity (Agrawal et al., 2010; Gouvali and Boudolos, 2006; Klamklay et al., 2008; Kozey et al., 2009). In addition, health problems, such as musculoskeletal disorders, are the most important consequences of mismatching anthropometric dimensions (Dewangan et al., 2008; Grimes and Legg, 2004; Trevelyan and Legg, 2010; Westgaard and Aarås, 1984), and these health issues can be reduced using anthropometric data during the design process.

Anthropometric dimensions vary based on factors such as age, gender, nutrition, socioeconomic status, ethnicity, and race (Agrawal et al., 2010; Chuan et al., 2010; Farkas, 1996; Lin et al., 2004; Mohammad, 2005). Anthropometric data are assumed to be different between nations and between regional populations (Chandna et al., 2010; Mandahawi et al., 2008; Roebuck et al., 1975). These factors can lead to problems in product design (Chandra et al., 2013). Pheasant (1996) found that mean anthropometric dimensions and the ratio of body dimensions are two suitable indicators to compare the morphological variation among different groups. Bodily proportion is calculated as the ratio of one body dimension to a specific reference dimension. The mean stature is the most common body reference dimension.

A few anthropometric studies were conducted in Iran. In this regard, Mououdi (1997) reported on 28 body dimensions of 179 Iranian university students aged 20–30 years. In the study

* Corresponding author. P.O. BOX: 6446 Tehran 14155, I.R. Department of Occupational Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran. Tel.: +98 21 8895 1390; 0912 6994 414 (mobile); fax: +98 21 8895 4781.
*E-mail address:* amazlomi@tums.ac.ir (A. Mazloumi).

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conducted by Mirmohammadi et al. (2011), 20 body dimensions of 911 Iranian university students aged 18–25 years (475 males and 436 females) were recorded. Dianat et al. (2013) measured nine body dimensions for 978 Iranian high school students (498 girls and 480 boys) aged 15–18 years. In all these studies, the sample size was small and specific populations or age groups were investigated, which limit the generalization of the reported data. Moreover, none of these studies have considered the ethnic diversity of the Iranian population as a factor that may affect body dimensions. Iran has a multiethnic population, settled in different regions of the country. Fars, Turk, Kurd, Lor, Arab, and Baluch are the most dominant ethnic groups of whom the Fars people comprise the largest proportion (over 65% of the total population).

Considering the abovementioned points, and the fact that Iran is a country with ethnic diversity, the present study was carried out to provide an anthropometric data bank of the Iranian working population with different ethnicities.

## 2. Methods

The present study gathered anthropometric data for various ethnic groups (Fars, Turk, Kurd, Lor, Arab, and Baluch) to ensure that the sample collected was representative of the Iranian working population.

The studied ethnic groups are distributed in different geographical regions of the country. Therefore, the final samples were selected from various provinces including East Azerbaijan, Fars, Hormozgan, Isfahan, Khuzestan, Kurdistan, Lorestan, Sistan–Baluchestan, and Tehran. The participants were selected through the health network system divisions, covering the whole population in all parts of the country. Cluster sampling was used to select the workers according to the following stages:

1 Listing all the regional health service centers, as parts of the health network system of the country
2 Recording the number of workers being covered by each regional health service center
3 Categorizing regional health service centers into six clusters according to the ethnicity
4 Alphabetizing the regional health service units within each ethnic cluster
5 Calculating the cumulative frequency of each ethnic cluster
6 Calculating a sampling interval for each cluster by dividing the cumulated total population of each ethnic cluster by the total number of clusters
7 Selecting a random number for each ethnic cluster between one and the sampling interval number using a random number table
8 Selecting the regional health service unit within the ethnic clusters where the number of workers exceeds the random number (obtained in stage 6) as the final cluster
9 Random selection of workers from the final clusters

Table 1 shows the final clusters used to consider ethnicity. As seen, more clusters were chosen for the Fars sample, as it is the largest ethnic group in Iran. Measurements were carried out using 15 sets of anthropometry kits, made in Iran. Traditional anthropometric tools were used to measure the target dimensions: a scale for measuring weight with 0.1-kg accuracy, a goniometer for angles, a measuring tape for circumference, a steel measuring tape for length of limbs, a plumb bob for vertical distance to the floor (shoulder, elbow, wrist, knee joints, and greater trochanter of the hip), a chair with an adjustable seat height, and an anthropometric measuring board with 0.1-mm accuracy (2 × 1 m). Traditional anthropometry was considered simple and inexpensive with reliable and accurate results (Feathers et al., 2004; Ghoddousi et al., 2007; Mokdad and Al-Ansari, 2009). Sims et al. (2012) reported no significant difference in body dimensions between traditional anthropometry techniques and three-dimensional (3D) scanners.

**Table 1**
Final sampling framework.

| The regional health service unit | Total population of workers | Sample size | Number of participants | | Ethnicity |
|---|---|---|---|---|---|
| | | | Male | Female | |
| East Azerbaijan | 235,054 | 894 | 660 | 234 | Turk |
| Tehran | 130,478 | 495 | 395 | 100 | Fars |
| Fars | 129,068 | 490 | 400 | 90 | Fars |
| Hormozgan | 50,437 | 192 | 142 | 50 | Fars |
| Isfahan | 222,272 | 845 | 745 | 100 | Fars |
| Khuzestan | 136,921 | 520 | 420 | 100 | Arab |
| Kurdistan | 28,723 | 110 | 80 | 30 | Kurd |
| Lorestan | 34,736 | 132 | 105 | 27 | Lor |
| Sistan and Baluchestan | 10,294 | 42 | 22 | 20 | Baluch |
| Total | | 3720 | | | |

The measurements were performed by a group of experts including 30 technicians as examiners and nine supervisors. The protocol and procedure for measurements were explained to the technicians in a 2-day training workshop. To ensure the intermeasure reliability of the measurers, the technicians were asked to practice in trial sessions. For the actual measurement sessions, each supervisor checked the measured body dimensions for seven out of every 100 workers to ensure the accuracy of the measurements. If the measurements of two out of three workers were correct, the measurements were considered to have a good accuracy. The following issues were emphasized during the workshop:

- Before collecting data, the process should be explained to the workers to obtain a high level of cooperation.
- Making pressure points should be avoided while measuring body dimensions.
- The participants should be lightly clothed and barefooted.
- The scale and caliper should be calibrated at the beginning of each examination day.
- The anthropometric measuring board should be calibrated before each installation.

A total of 37 body dimensions, including weight, that are commonly used in industry (presented by Pheasant, 1996) were measured over the course of 6 months and 35 bodily proportions were calculated from the data acquired. Fig. 1 shows the 36 body dimensions (excluding weight) measured in the present study. The measurements were carried out according to the procedure described in ISO7250 (1996) (Figs. 2 and 3). The final data were analyzed using SPSS software version 18.

## 3. Results

Overall, 37 anthropometric dimensions of 3720 Iranian workers (3000 males and 720 females), including weight, were measured. The findings are presented separately for men and women in Table 2. The participants of the present research comprised technical workers (76.1%), service workers (15.8%), and office workers (7.6%). The mean (±standard deviation (SD)) stature was 1720 (±76.3) mm for the sampled Iranian male and 1585 (±63.2) mm for the Iranian female.

A summary of the anthropometric data of different Iranian ethnicities is also presented in Table 3 (for males) and 4 (for females). The Kruskal–Wallis test was applied to assess whether