

Body Anthropometry on a Sample of Jordanian Males

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Abstract

In Jordanian industry, work stations and supporting equipment are used widely for various types of operations. However, most of these stations and tools are imported from countries which do not consider the anthropometric and biomechanical characteristics of Jordanians or Middle Eastern peoples. Since anthropometric data for Jordanians are lacking, one cannot determine how suitable these foreign designed workstations are for Jordanians, except to say that anecdotal evidence indicates that improvements may be necessary for comfort, health and safety. This research study is aimed at initiating the development of an anthropometric data base for Jordanian males. Twenty five body dimensions, based on international standards, were collected from a sample of 70 Jordanian males; such data have never been measured in Jordan. The mean, standard deviation, and 1st, 5th, 25th, 75th and 95th percentile values were calculated. The anthropometric measurements has been presented and compared with those from similar developing countries including Algerian, Taiwanese and North Eastern Region of India, using data from previous research papers. The Jordanian anthropometric data could be used in the design of work stations, equipment and other devices, as well as work clothes, in order to enhance productivity, comfort and health.

Keywords

Body dimensions; Workplace design; Jordan

1 Introduction

When designing or using work stations and hand tools it is important to consider the anthropometric dimensions of the potential users. Anthropometry—the science of human measurements- is of vital importance [1]. Mismatches between human anthropometric dimensions and equipment dimensions may be a contributing factor to increased accident rates and health problems, including musculoskeletal strains and cumulative traumas [2-6]. The extent of hand tool injuries has been documented by Aghazadeh and Mital (1987), for example. Body anthropometric measurements, relevant to the design of workstations, have been published for various nationalities, such as Indian agricultural workers [8], Algerian males farmers [9], male farmers in the north eastern region of India [10], Mexican primary school children [3], Chinese elderly living in the Beijing area [11], Taiwanese workers [12], Korean female industrial workers [13], Norwegian light industry and office workers [14], and others.

In developed countries, researchers have gathered a large set of body dimensions for different populations and different segments within populations, such as elderly and children. On the other hand, anthropometric body dimension for many other populations are scarce or totally absent in some cases. Recent trends in

globalization and free trade agreements have forced some developing countries to import tools and other equipment from the Industrialized Countries without considering the anthropometric dimensions of the importing countries. Researchers have therefore stressed an urgent need to collect anthropometric data for the populations of industrialized developing countries (IDC) in order to introduce changes in equipment design and use [15].

Jordan has enrolled on many of the world trade agreements and organizations such as World Trade Organization (WTO), and the Jordan Free Trade Agreement (FTA), in April 2000 and December 2001, respectively. These agreements have forced Jordan to open its doors to import tools and equipment from the Industrialized Countries (IC), without considering body the anthropometric dimensions of the Jordanian population, especially since such data have never been documented. Thus, the main objective for this research paper is to minimize the existing gaps in such data bases for the Middle East Region by collecting relevant anthropometric dimensions from the Jordanian population. Twenty five body dimensions were measured in males and were compared with the corresponding dimensions from other similar developing countries.

2. Methods

2.1. Subjects

A convenience sample of 70 male Jordanian adults was measured. Subjects were selected according to their availability and willingness to participate without payment or any other reward. All subjects were in good health, as self-reported. Subjects were mainly industrial workers, students, engineers, and secretaries. Sixty percent were from the capital city Amman, which contains the majority of industries, universities, and schools in Jordan, 26% from Hallabat, and the rest from Zarqa, Irbid, Ma'an, and Al-Karak. The purpose of the study was explained to each subject prior to the measurements. Permission to conduct this study was granted by the Hashemite University research council. Subject's age ranged from 18-46 years, with a mean of 23.8 years. Their weight ranged from 112-53 kg, with a mean of 77 kg.

2.2. Apparatus and Measurements

Twenty five body anthropometric measurements were measured using "TTM" Martin's Human Body Measuring Kit Type "PM", with an accuracy of 0.01 mm. Grip strength was also measured using a standard grip strength dynamometer. The twenty five measurements were selected because they were relevant to the design of school furniture, workstation tools, and other work equipments. The methods used for measurements were taken from the handbook of adult anthropometric and strength measurements – data for design safety by the department of trade and industry at U.K. Before starting the study, each item to be measured was precisely defined and a training session of one week was provided by the main author to the experimenters. Furthermore, to ensure reliable measurements and recording, some measurements have been selected randomly and repeated by the main author. The measurements were 11 in standing position and 14 in sitting position. For the seated measurements, the seat was adjusted so that the person sat with the lower legs vertical, thigh horizontal and feet flat on the floor. The definitions of the measurements are given below:

- 1 **Overhead Fingertip Reach:** measured vertically from the floor to the tip of the middle finger. The person stands erect, weight evenly balanced, with the arm extended vertically above the head and the hand and fingers held straight.
- 2 **Stature:** measured vertically from the floor to the top of the head. The person stands erect, looking ahead, the arms hanging loosely at the sides.
- 3 **Eye Height:** measured vertically from the floor to the outer border of the eye socket. The persons stands erect, looking ahead.
- 4 **Shoulder (acromial) Height:** measured vertically from the floor to the bony tip of the shoulder (acromion). The person stands erect with the arms hanging loosely at the side.
- 5 **Elbow Height:** measured vertically from the floor to the bony tip of the flexed elbow. The person stands erect.
- 6 **Knuckle Height:** measured vertically from the floor to the knuckle of the middle finger. The person stands erect, the arms hanging at the side.
- 7 **Forward Fingertip Reach:** measured horizontally from the vertical seat back to the tip of the middle finger. The person stands erect, the arm and hand stretched horizontally in front of them.

- 8 **Upper Arm Length:** measured from the bony tip of the shoulder to the tip of the elbow (olecranon). The person stands erect, with one hand on the hip, thumb towards the back, fingers in front. The wrist is kept in a straight line with the forearm.
- 9 **Shoulder Breadth:** measured horizontally between points of maximum protrusion of the deltoid muscles on the upper, outer boarder of the arm and shoulder. The person stands erect with the arms at the sides.
- 10 **Chest Breadth:** measured horizontally across the surface of the chest between the skin creases that border the armpits (axillae). The person's arms and shoulders should be relaxed and they should breathe quietly.
- 11 **Chest Depth:** measured horizontally from the front of the chest at the junction of the fourth rib and the breast bone to the spine. The measurement is taken at the end of quietly breathing out.
- 12 **Overhead Fingertip Reach:** measured vertically from the seat surface to the tip of the middle finger. The person sits erect, looking ahead, with the arm and hand extended straight above the head.
- 13 **Sitting Height:** measured vertically from the seat surface to the top of the head, compressing the hair. The person sits erect, looking straight ahead, hand in lap. The feet are either unsupported at a level that ensures the thighs are horizontal.
- 14 **Eye Height-Sitting:** measured vertically from the seat surface to the outer border of the eye socket. The person sits erect, looking straight ahead, hand in lap. The feet are either unsupported or supported at a level that ensures the thighs are horizontal.
- 15 **Shoulder Height-Sitting:** measured vertically from the seat surface to the bony tip of the shoulder (acromion). The person sits erect, looking straight ahead, hands in lap. The feet are supported at a level that ensures the thighs are horizontal.
- 16 **Underside of Elbow Height to floor- sitting:** measured vertically from the floor to the underside of the elbow. The person sits erect, looking straight a head, the elbow is flexed at 90 degrees. The feet are supported at a level that ensures the thighs are horizontal.
- 17 **Shoulder (Acromion) to Underside of Elbow – Sitting:** measured vertically from the bony of the shoulder (acromion) to the underside of the elbow. The person sits, with the upper arm vertical and the elbow flexed to 90 degrees.
- 18 **Underside of Elbow Height to seat– Sitting:** measured vertically from the seat surface to the underside of the elbow. The person sits erect, looking straight ahead, the elbow flexed at 90 degrees. The feet are left supported at a level that ensures the thighs are horizontal.
- 19 **Back of Elbow to Tip of Middle Finger – Sitting:** measured from the back of the elbow (olecranon) to the tip of the middle finger. The person sits with the upper arm vertical and the elbow flexed to 90 degrees. The hand and fingers are held straight and in alignment with the forearm.
- 20 **Maximum Hip Breadth – Sitting:** measured horizontally across the widest part of the hips. The person sits erect and with the legs and feet together.
- 21 **Top of Knee Height – Sitting:** measured vertically from the floor to the top of the knee.
- 22 **Back of Knee Height (popliteal) - Sitting:** measured vertically from the floor to the popliteal tendon which extends back from the knee along the lower, outer part of the thigh.
- 23 **Buttock to Front of Knee _ Sitting:** measured horizontally from the most posterior part of the buttock to the front of the knee.
- 24 **Buttock to Back of Knee (popliteal) – Sitting:** measured horizontally from the most posterior part of the buttock to the underside of the knee.
- 25 **Buttock to Sole of Foot:** measured horizontally from the most posterior part of the buttock to the sole of the foot. The person sits erect with one leg extended horizontally in front of them.

3. Results and Discussions

Results have been summarized using the SPSS software on a desktop computer. Descriptive statistics including mean, standard deviation, and percentiles (1st, 5th, 25th, 75th, and 95th) have been calculated and tabulated in Table 1. Percentage differences between Jordanian body anthropometric dimensions and other similar developing countries including Algerian farmers, North Eastern Region of India, and Taiwanese workers were summarized on Table 2. Furthermore, an *F*-test was first performed to test the equality of the two population variances being compared in order to determine the appropriate t-test statistic to be used for comparing the two population means. The levels of statistical significance were reported as 5%.

Table 1. Summary data of body dimensions for Jordanian males (measurements in mm)

Anthropometric Dimension	Mean	Std. Dev.	Percentiles				
			1 st	5 th	25 th	75 th	95 th
Standing Measurements							
Overhead Fingertip Reach	2231	28.45	1742	1970	2145	2285	2348
Statures	177.46	12.15	1596	1635	1720	1805	1906
Eye Height	1636.6	6.54	1490	1520	1600	1680	1730
Shoulder Height (acromion)	1467.3	7.22	1260	1360	1430	1510	1569
Elbow Height	1098.8	9.97	877.1	988.75	1057.5	1131.2	1189.5
Knuckle Height	731.4	5.73	629	665	700	755	793
Forward Fingertip Reach	849.3	11.97	411.4	626	836	889	935.6
Upper Arm Length	367.4	7.23	280.4	306	347	380	399.4
Shoulder Breadth	477.6	5.9	346.4	404	454	510	542.3
Chest Breadth	320.9	5.29	224	276	298	342	371.7
Chest Depth	240.5	13.8	168.6	181	204	231	285.3
Sitting Measurements							
Overhead Fingertip Reach	1286.6	14.76	621.2	1199	1265	1350	1394
Sitting Height	837.8	9.54	523.2	744	814	880	922.2
Eye height	729.7	6.87	528.6	621	705	770	833.6
Shoulder Height	581.5	7.89	287.2	508	560	611	634.4
Underside of Elbow Height to floor	707.4	64.75	385.8	504	605	665	717.9
Shoulder (Acromion) to Underside of Elbow	367.8	3.77	264.2	320	354	383	399.5
Underside of Elbow Height to seat	224.7	5.41	132.4	150	203	243	279
Back of Elbow to Tip of Middle Finger	471.1	3.56	377.4	415	458	488	510
Maximum Hip Breadth	366.5	3.99	300.6	314	340	384	424.3
Top of Knee Height	554.4	3.6	441.6	493.5	537	576	602.8
Back of Knee Height (popliteal)	467.7	6.66	352.2	376	440	480	541.8
Buttock to Front of Knee	579.8	4.45	439.6	522	565	608	627.2
Buttock to Back of Knee (popliteal)	471.8	3.53	387.6	418	451	489	526.6
Buttock to Sole of Foot	1084.6	20.64	653.8	940	1002	1100	1588.9
Grip Circumference	527.4	3.5	440	479.6	503.5	556.2	581

Table 2: Comparison between Jordanian males and other nationalities (measurements in mm)

	Algerian farmers (Mokdad, 2002) [n=514] Dimensions in mm			North Eastern Region of India (Dewangan et al., 2005) [n=280] Dimensions in cm			Taiwanese workers (Wang et al., 1999) [n=735] Dimensions in mm		
	Mean	S.D.	% Diff						
Standing Measurements									
Overhead Fingertip Reach							2103.1*	85.27	5.733
Stature	1726*	76.0	2.739	1648.7*	4.54	7.095	1686.9*	60.10	4.942
Eye Height	1597*	66.3	2.420	1535.5*	5	6.177	1569.2*	59.2	4.118
Shoulder (acromial) Height	1446*	67.1	1.452	1344.7*	4.3	8.355	1383.1*	53.29	5.738
Elbow Height	1099	52.8	-0.018	1019.1*	3.56	7.253	1048.8*	41.56	4.550
Knuckle Height	786*	47.6	-7.465						
Forward Fingertip Reach							822.4*	37.68	3.167
Upper Arm Length									
Shoulder Breadth				433.4*	3.4	9.255			
Chest Breadth				290.4*	2.51	9.505			
Chest Depth	217*	19	9.771						
Sitting Measurements									
Overhead Fingertip Reach	1280	64.0	0.513				1321.5*	55.20	-2.713
Sitting Height	870*	35.4	-3.843	877*	2.88	-4.679	902.8*	31.93	-7.758
Eye height	744*	39.1	-1.960	733.8*	3.17	-0.562	785.4*	30.69	-7.633
Shoulder Height	609*	37.2	-4.729	543*	2.74	6.621			
Underside of Elbow Height to floor									
Shoulder (Acromion) to Underside of Elbow	349*	32.2	5.111						
Underside of Elbow Height to seat	191*	24	14.99						
Back of Elbow to Tip of Middle Finger	463*	33.0	1.719				306*	25.46	35.05
Maximum Hip Breadth	337*	25.8	8.049						
Top of Knee Height	522*	30	5.844				516*	28.05	6.926
Back of Knee Height (popliteal)				412.5*	2.56	11.80			
Buttock to Front of Knee	574*	38.4	1.000				552*	31.99	4.795
Buttock to Back of Knee (popliteal)	475*	28.5	-0.678	445.2*	2.45	5.638			
Buttock to Sole of Foot	1041*	48.4	4.020				851.6*	47.88	21.48

% difference = $100 * (\text{mean for Jordanian} - \text{mean for comparison nationality}) / \text{mean of Jordanian}$.

*Statistically significant at $\alpha=0.05$.

As can be seen from the tables there were many significant differences in body size between Jordanians and Indian, Taiwanese and Algerian peoples, and these differences may be large enough to influence workstations and equipment dimensions. Also, there is no reason to believe that these differences may not be larger for comparisons with the populations of the industrialized countries that produce work equipment for export. The differences do not occur in any pattern for drawing simple generalizations.

4. Conclusions

The results of this study support the findings of other anthropometric studies that human body dimensions may show significant variation not merely between genders but also between nationalities, and that the magnitude of these differences may be great enough to influence the design of work equipment, apparel, and the physical workplace. Table 2 shows statistically significant differences between Jordanians and three other populations and it is likely that such differences are present with populations from the main manufacturing countries. Countries, such as Jordan, that import equipment from manufacturers in other countries, should determine whether the design parameters that are based on anthropometric dimensions are compatible with the anthropometric dimensions of their own population. These considerations may translate into greater acceptance of imported equipment, improved ease of use, enhanced safety and, perhaps, improved productivity. At present, more data is being collected within Jordan to get more representative and reliable statistics. The effects of age will also be investigated.

Acknowledgment

This research was fully supported by a grant from the Hashemite University.

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