Occupational Safety and Hygiene II – Arezes et al. (eds)
© 2014 Taylor & Francis Group, London, ISBN 978-1-138-00144-2

Anthropometric study of the student population of a Portuguese faculty

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ABSTRACT: In recent years, there has been an increasing need of knowledge of the human population's anthropometrics, particularly in Portugal. Changes in the anthropometric characteristics of the Portuguese people have been reported in some studies, leading to an increasing interest on the study of the evolution of these characteristics. This study aimed to collect and analyze the anthropometric dimensions of the student population of FEUP. For that purpose, a stationary anthropometer was built and a portable anthropometer was also used. Two hundred and six students (131 males and 75 females) with ages ranging from 18 to 35 years old, were measured. A set of 14 static anthropometric measures was collected. The results show significant differences in some anthropometric dimensions, when compared with studies performed by other authors, as well as between genders for almost all anthropometric dimensions.

1 INTRODUCTION

Ergonomics aims to fit the environment and the task, whether it is work or leisure, to the user so that they can work easily, effectively and safely (Mokdad & Al-Ansari, 2009). This aim may be summarized by the principle of user-centered design. Pheasant & Haslegrave (2006) defined it as the fit of the design of an object, a system or an environment that are intended to human use to the physical and mental characteristics of its human users, as well as for the demand of the task.

One way of designing the task, based on the physical characteristics of the user, is doing it according to her/his anthropometric characteristics, such as body size (reach, body segment length, and height), shape (segment circumferences, widths), strength and working capacity (Barroso et al., 2005).

Until 2005, there was a lack of anthropometric data from the Portuguese population. Padez (2002) conducted a study which gathered data obtained by the army that measured the stature of the 18 year-old young men that went to military service.

Later Barroso et al. (2005) measured a sample of the Portuguese population, creating the first anthropometric database of this population comprising 25 static anthropometric dimensions. Although the latter provides an accurate database, the student population of a university is, in its majority, much more narrowed to young people (18 to 25 years old). Thereby, the use of this database would probably result in some error due to two main reasons: (1) its age range goes from 18 to 65 years old; (2) the time gap between the two studies. The first one reflects the accentuation of the spinal curvature in people with ages greater than 40 years old (Pheasant & Haslegrave, 2006) which results in a lowering of the people's stature. The second reason may be supported by the expected change in some characteristics due to the secular trend (Arezes et al., 2006) that, accordingly to Padez (2002), estimated an increase of 9.9 mm per decade in Portuguese male stature, while other study suggested that the anthropometric databases should be updated every five years due to effects in the national anthropometric properties caused by regional altitude and climate, as well as sexual ones (Kaya et al., 2003).

The need for the anthropometric study of the Portuguese student population shows a relevant pertinence. Therefore, this paper aims to study the anthropometric dimensions for a sample of the Portuguese students of Faculty of Engineering of the University of Porto (FEUP).

2 METHOLOGY

2.1 *Subjects*

One hundred and thirty one men and 75 women from a universe of 7295 students were measured.

The sample was mostly composed by students from the integrated master programs, but also from undergraduate and master programs. With ages range between 18 and 35 years old, students were selected when passing through the hall of the building where most of the classes are taken.

2.2 *Equipment used*

Measurements were taken on a stationary anthropometer (Figure 1) built for the specific purpose of this study. Wood panels were arranged as a corner and covered with graph paper. To calibrate the anthropometer was used a self-retracting tape measure which insured the match of the lines of the paper with the lines of the measure. As aid to the measurements, grid lines were drawn every 100 mm and the corresponding value was marked.

For the collection of some anthropometric dimensions a portable anthropometer (Holtain's Harpender anthropometer) was used. Those dimensions required postures that could influence the measurement. Therefore was used the portable anthopometer to ensure that the gathered data had the best accuracy and precision.

For the sitting measurements a bench was also used.

Figure 1. Stationary anthropometer with 1200 × 1500 × 2100 (depth, width, height), in mm.

2.3 *Procedure*

2.3.1 *Data collection*

A total of 14 static anthropometric dimensions were measured for each individual. Six dimensions were measured with the individual standing, while the remaining were obtained while the individual was seated.

The anthropometric measures were taken with the subject in a relaxed and erect posture. Each student was measured in thin cloths (T-shirt, shirt or thin sweatshirt), jeans, skirts or dresses. The standing dimensions were taken with the student standing erect to the anthropometer without shoes. The sitting dimensions were taken with the student seated erect onto the anthropometer, with knees bent 90°, and feet (without shoes) flat on the floor. The body dimensions were measured as described in ISO 7250-1:2008 (ISO, 2008).

The dimensions measured in both standing and sitting positions as well as the apparatus used for the measurements are detailed in Table 1.

2.3.2 *Data treatment*

First, Kolmogorov–Smirnov test was performed to study the normality of the anthropometric data's distribution. Then, mean and standard deviation were calculated for all the measured dimensions. Later, Student's t-test was used to test if the anthropometric dimensions of female and male populations were statistically different.

In order to measure data dispersion, the Coefficient of Variation (CV) was calculated as shown in equation 1:

$$CV = \frac{s}{m} \times 100\% \tag{1}$$

where CV = Coefficient of Variation; s = standard deviation; and m = mean.

Table 1. Dimensions measured in standing and sitting positions.

Dimensions	
Standing	Sitting
Abdominal depth*	Buttock–knee length
Elbow–knuckle length	Buttock–popliteal length
Eye height	Popliteal height
Forward grip reach	Sitting elbow height
Hip breadth*	Sitting eye height
Shoulder breadth (bi-deltoid)*	Sitting stature
Stature	Thigh thickness*

*Measured with the portable anthropometer.

3 RESULTS AND DISCUSSION

A great majority (84%) of the participants are younger than 25 years old (Table 2).

The sample used includes subjects from several lecture courses of FEUP, and several curricular years. That is reflected on the range of ages of the sample, 18–35 years. However, there is a predominance of younger students, 18–24 years. Accordingly to statistics from FEUP, the sample characteristics (age and female percentage) ensure the intended representativeness of the student population.

The coefficient of variation (CV) (Table 3) of this study was compared with the CV obtained in the previous study of Barroso et al. (2005) and with the characteristic value range of Pheasant & Haslegrave (2006).

Comparison between the results obtained and the previous study from Barroso et al. (2005) indicates a significant difference for the CV values in almost 80% of the anthropometric dimensions. It can be explained by the uneven sample size, which could be corrected by increasing the sample size. When compared with the characteristic ranges defined in Pheasant & Haslegrave (2006), lower CV was found in one anthropometric dimension (male and female stature). Nevertheless, about 70% of the dimensions are between the recommended ranges. Exceptions also occur with the values obtained for forward grip reach, hip breadth, popliteal height, thigh thickness and abdominal depth whose values are higher than the reference values by Pheasant & Haslegrave (2006). For the last two, a possible explanation can be the fact that these dimensions are associated with soft body tissue, particularly fat and muscle. Other possible explanation for the differences between them can be the fitness habits of the different people.

With regard to the other dimensions, explanation for the CV values found is possibly associated with the need for a larger sample.

Table 4 displays mean and standard deviation values for the 14 anthropometric dimensions measured in both genders, as well as the p-value obtained by Student's t-test. The results indicate that male have greater anthropometric dimensions, except for the hip breath. In this case, there is no significant difference between both genders. This can be explained by the participant's young age, which bodies are still developing. The p-value for sitting elbow height was very close to the value of 0.05 but it was still below the significance level established. In all the other dimensions, males are bigger than females.

Table 5 and Table 6 compares the mean values, for the male population, obtained in this study with the Portuguese population anthropometric database from Barroso et al. (2005), with British adults aged 19 to 25 (Pheasant & Haslegrave, 2006), with Malaysian adults aged 19 to 25 (Chong & Leong, 2011), and with Iranian adults aged 20 to 30 (Mououdi, 1997).

The comparison between the results of the current study and the Portuguese anthropometric data

Table 2. Distribution of the participants by age group and gender.

	Male		Female	
Age group (years)	N	%	N	%
Less than 20	47	35.9%	18	24.0%
20–24	71	54.2%	48	64.0%
25–29	8	6.1%	6	8.0%
30–35	5	3.8%	3	4.0%

Table 3. Coefficient of variation: Results of the current study, values found by Barroso et al. (2005) and the characteristic value range according to Pheasant & Haslegrave (2006).

	Coefficient of variation (%)				
	Current study		(Barroso et al.)		
Dimensions	Male	Female	Male	Female	(Pheasant & Haslegrave)
Stature	3.7	3.4	4.5	4.2	4–11
Abdominal depth	11.8	14.9	12.1	13.7	5–9
Buttock–knee length	5.1	6.4	5.6	5.6	4–11
Buttock–popliteal length	5.7	6.2	6.7	6.3	4–11
Elbow–knuckle length	5.3	4.9	5.1	5.4	4–11
Eye height	4.0	3.5	4.7	4.5	3–5
Forward grip reach	5.2	4.6	8.6	5.0	3–5
Hip breadth	7.4	9.4	6.4	6.8	5–9
Popliteal height	6.6	5.1	6.3	6.3	3–5
Sitting elbow height	9.9	10.6	11.8	11.8	4–11
Sitting eye height	4.0	3.7	4.2	4.6	4–11
Sitting stature	3.5	3.5	4.1	4.1	3–5
Shoulder breadth (bi-deltoid)	7.0	7.6	6.4	7.0	5–9
Thigh thickness	12.0	16.4	9.9	9.2	5–9

by Barroso et al. (2005) shows a few differences, some of which are significant. For example, the stature has an increment of 61 mm in male and 55 mm in female. This difference may be related to three probable causes: (1) the age range of the sample once the spinal curvature increases above 40 years old (Pheasant & Haslegrave, 2006); (2) the secular trend, which is known to occur in other studied populations (Pheasant & Haslegrave, 2006), and was also observed in Portugal by Padez (2002); and (3) the provenience of the sample (university students that, due to different financial conditions, may adopt distinct diets).

Table 4. Mean (M), Standard Deviation (SD), in mm, of the male population (n = 131) and the female population (n = 75) and the comparison of the means.

	Male		Female		
Dimensions	M	SD	M	SD	p-value
Stature	1751	65	1625	56	<0.00001
Abdominal depth	264	31	249	37	0.00460
Buttock–knee length	615	31	580	37	<0.00001
Buttock–popliteal length	490	28	466	29	<0.00001
Elbow–knuckle length	357	19	328	16	<0.00001
Eye height	1635	65	1515	53	<0.00001
Forward grip reach	733	38	676	31	<0.00001
Hip breadth	347	26	346	33	0,76219
Popliteal height	420	28	392	20	<0.00001
Sitting elbow height	245	24	238	25	0.04678
Sitting eye height	808	32	758	28	<0.00001
Sitting stature	925	32	868	30	<0.00001
Shoulder breadth (bi-deltoid)	482	34	424	32	<0.00001
Thigh thickness	190	23	171	28	<0.00001

As for the other populations, it might be observed that some differences exist, some of which are statistically significant. For instance, for stature, the highest differences found are those registered between the Portuguese and the Malaysian population, 38 and 65 mm for female and male populations, respectively. The contrast found in the anthropometric dimensions of the different populations highlights the usefulness of this study and of the presented results.

4 CONCLUSIONS

Fourteen body measurements of Portuguese university students were summarized in this paper and they enabled the anthropometric characterization of the Portuguese student population of FEUP. This can be used for the design of more ergonomic classroom and auditoria furniture.

The contrast between the data of this study and the data of the Portuguese adult anthropometric database emphasizes the need to extend the database, as well as its segmentation in age groups for more accurate use of that resource.

One of the main limitations of this study is the sample size that, due to the lack of enough time, is smaller than would be recommendable. That was reflected in the CV's values observed.

Table 5. Mean values, in mm, for the anthropometric dimensions from the current study and different young adult male populations.

	Current study		Barroso et al. (2005)		Pheasant & Haslegrave (2006)		Chong & Leong (2011)		Mououdi (1997)	
Dimensions	M	SD	M	SD	M	SD	M	SD	M	SD
Stature	1751	65	1690	76	1760	73	1713	48	1725	58
Abdominal depth	264	31	265	32	240	26	227	27	–	–
Buttock–knee length	615	31	590	33	595	32	561	21	579	27
Buttock–popliteal length	490	28	485	32	500	34	450	23	–	–
Elbow–knuckle length	357	19	350	18	–	–	–	–	–	–
Eye height	1635	65	1585	74	1650	72	1589	52	1616	56
Forward grip reach	733	38	730	62	790	36	764	57	–	–
Hip breadth	347	26	380	24	350	31	354	29	–	–
Popliteal height	420	28	400	26	445	30	431	16	431	21
Sitting elbow height	245	24	255	30	245	32	229	28	260	26
Sitting eye height	808	32	810	34	795	36	786	37	–	–
Sitting stature	925	32	920	37	915	37	874	112	912	26
Shoulder breadth (bi-deltoid)	482	34	475	30	465	29	435	31	455	24
Thigh thickness	190	23	175	17	160	16	–	–	–	–

Table 6. Mean values, in mm, for the anthropometric dimensions from the current study and different young adult female populations.

	Current study		Barroso et al. (2005)		Pheasant & Haslegrave (2006)		Chong & Leong (2011)		Mououdi (1997)	
Dimensions	M	SD	M	SD	M	SD	M	SD	M	SD
Stature	1625	56	1565	66	1620	61	1560	61	1597	101
Abdominal depth	249	37	260	36	220	22	195	21	–	–
Buttock–knee length	580	37	570	32	565	29	529	26	563	29
Buttock–popliteal length	466	29	470	30	475	29	434	28	–	–
Elbow–knuckle length	328	16	320	40	–	–	–	–	–	–
Eye height	1515	53	1465	66	1515	60	–	–	1486	58
Forward grip reach	677	31	675	33	705	31	701	46	–	–
Hip breadth	346	33	400	27	350	29	351	22	–	–
Popliteal height	392	20	365	23	400	27	402	31	365	22
Sitting elbow height	238	25	250	28	230	28	217	30	259	37
Sitting eye height	758	28	760	35	745	33	721	40	–	–
Sitting stature	868	30	865	35	855	35	828	32	861	36
Shoulder breadth (bi-deltoid)	424	32	445	31	395	24	383	19	392	24
Thigh thickness	171	28	165	15	150	16	–	–	–	–

Hopefully this study will become the necessary starting point for new studies in this field, particularly at a university level, to enhance the anthropometric knowledge of the Portuguese young-adult students.

ACKNOWLEDGMENT

The authors would like to thank Master in Occupational Safety and Hygiene Engineering (MESHO), of FEUP, all the support in the development and international dissemination of this work.

We would also like to thank professor Joaquim Góis for sharing his knowledge on statistics which was of greater use for this work.

REFERENCES

Arezes, P.M., Barroso, M.P., Cordeiro, P., Costa, L.G. d., & Miguel, A.S. (2006). *Estudo Antropométrico da População Portuguesa*: ISHST - Institudo para a Segurança, Higiene e Saúde no Trabalho.

Barroso, M.P., Arezes, P.M., da Costa, L.G., & Sérgio Miguel, A. (2005). Anthropometric study of Portuguese workers. *International Journal of Industrial Ergonomics, 35*(5), 401–410.

Chong, Y.Z., & Leong, X.J. (2011). Preliminary Findings on Anthropometric Data of 19–25 Year Old Malaysian University Students. In N. Osman, W. Abas, A. Wahab & H.-N. Ting (Eds.), *5th Kuala Lumpur International Conference on Biomedical Engineering 2011* (Vol. 35, pp. 193–196): Springer Berlin Heidelberg.

ISO. (2008). ISO 7250-1:2008 Basic human body measurements for technological design—Part 1: Body measurement definitions and landmarks. International Organization for Standardization, Geneva, Switzerland.

Kaya, M.D., Hasiloglu, A.S., Bayramoglu, M., Yesilyurt, H., & Ozok, A.F. (2003). A new approach to estimate anthropometric measurements by adaptive neuro-fuzzy inference system. *International Journal of Industrial Ergonomics, 32*(2), 105–114.

Mokdad, M., & Al-Ansari, M. (2009). Anthropometrics for the design of Bahraini school furniture. *International Journal of Industrial Ergonomics, 39*(5), 728–735.

Mououdi, M.A. (1997). Static anthropometric characteristics of Tehran University students age 20–30. *Applied Ergonomics, 28*(2), 149–150.

Padez, C. (2002). Stature and stature distribution in Portuguese male adults 1904–1998: The role of environmental factors. *American Journal of Human Biology, 14*(1), 39–49. doi: 10.1002/ajhb.10017.

Pheasant, S., & Haslegrave, C.M. (2006). *Bodyspace: Anthropometry, Ergonomics, And The Design Of Work*: Taylor & Francis Group.