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Determination of the Some Anthropometric Data of Turkish Men Population

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ABSTRACT

The technical composition's properties should be appropriate to the physical and mental characteristics of human who will use or produce them. The goal of this research is the estimation of some anthropometric data of Turkish men population. For this goal, anthropometric measurements have been done on 220 male subjects according to the method used for design activities in the automotive industry. On human body, 29 anthropometric parameters have been measured. A multiple regression analysis was conducted to estimate the anthropometric parameters on human body by using two statistical variables, which are stature and weight. According to the results, 17 anthropometric parameters have been formulated depending on stature and weight. The determined formulations can be used especially by automotive industry during design.

Key Words: *anthropometric measurements, Turkish man population, multiple regression analysis.*

1. INTRODUCTION

Most important of the physical characteristics are the anthropometric characteristics, namely the dimensions of the human. During designing every technical product, the dimensions of human, who will use them, should be considered. As the anthropometric characteristics of the people, living in various parts of the world, show variations according to their birth and growing places and also show variations between generations who are living in the same place by the diversity in health and nutrition conditions in the course of time.

The first anthropometric survey in Turkey was conducted in 10 regions of Turkey (Government Statistics Department, 1937). In this survey, weight, height, span and sitting height were measured. In 1960, anthropometric characteristics of 2501 females between the ages of 18 and 40 were measured (Ciner, 1960). The Turkish females, who are under age of 20 and above age of 21, were compared with each other. 50 anthropometric parameters from 1000 laborers working in different industrial facilities were measured by Ozok (1981). According to this research results, the average stature of Turkish men was 168.08 cm and in every ten years average stature increase by 0.7 cm and average weight increase by 1.05 kg. In 1989, 51 different anthropometric measurements are taken from 5109 Turkish army men by Kayis and Ozok. Gonen and Kalinkara (1991) conducted a survey on female population of Turkey with 195 participants. In this survey, anthropometric characteristics were compared according to age groups. Another study was performed by Gultekin (2004) with 610 female and 812 male, between 18 and 90 years old in Ankara. The results of this study showed that males in the 18-35 years age group were less heavy than female, but after 35 years of age female were equal to or heavier than males. Also, a secular trend was observed in stature with an increase

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of 3 cm for female and male over the past decade. Over the last two decades, the average knee height has increased 2 cm in females and 2.5 cm in males. Body fat mass values showed increase until 60 years of age in females and until 50 years in males. According to Basibuyuk and Akin (2007), individuals average value of height in males was defined 1679.58 mm. Value of average weight was 78.94 kg, Body Mass Index (BMI) was 27.99 kg/m^2 and value of average waist circumference / hip circumference was 0.93. The last anthropometric survey of Turkish population was conducted with 2100 subjects (1050 of them were women and 1050 of them were men) by Gulec (2007). According to this survey results, average stature, weight, sitting height, the entire arm length, height of lower part, and average fat percentage in the body for women has been found 155.03 cm, 67.12 kg, 82.07 cm, 68.37 cm, 86.91 cm, 31.90 mm respectively. Average stature, weight, sitting height, the entire arm length, height of lower part and average fat percentage in the body for men has been found 168.88 cm, 74.74 kg, 88.73 cm, 74.85 cm, 96.42 cm, 20.77 % respectively. Hip width of women (30.95 cm) is larger than men (31.21 cm) according to the height average; average height of women has been determined 13.85 cm shorter than men. Sitting height has been found higher on both men and women according to Europeans and Americans. 2263 male and 1942 female were measured by Iseri and Arslan (2009). In this study, height and weight of the subjects were measured by age and these data were used for estimating anthropometric measurements of the Turkish population. It was found that age is an important factor for both stature and weight. There were no ethnic differences between residents of different geographical regions of Turkey. So there were not big differences between regions in anthropometric measurements.

Incorrect product and workplace adjustments to anthropometric characteristics lead to discomfort, pain and disorders in the neck, shoulder, back (Westgaard and Aaras, 1984), arm, hand and wrist (Snook, 1978). Musculoskeletal disorders due to these reasons have been found in a driver environment (Hedberg, 1987).
In the literature, it can be found some anthropometric research papers in different areas e.g. for sport (Caruso et al., 2012, Ayan et al., 2012), for dietetic practice (Lai et al., 2010), for elderly researches (Bouabdallah, 2012), and for the relations between computer mouse and anthropometric data of children (Hughes and Johnson, 2012).

Opincă et al. (2013) were examined the anthropometric data impact in the design applications of some military equipment. Fantozzi (2013) was used the anthropometry to some applications such as the planning the reshaping of the torso in torsoplastic surgery. Nadadur and Parkinson were presented an exploration of certain synergistic objectives of anthropometry-based ergonomic design and Design for Sustainability. There is a new research area in anthropometry named 3D Anthropometry. Olds et al. (2013) were given a 3D scanning and cluster analysis method and its results.
Anthropometric measurements that form the fundamental data should be taken into account for the ergonomic design of automobiles. The aim of this study was to determine anthropometric characteristics of drivers who are older than 18 years of age. To decrease some of the design difficulties, the results of these anthropometric measurements can be used.

2. MATERIAL AND METHOD

2.1. Subjects and experimental procedure

2007 population statistics of Turkey were taken into account for the determination of subject numbers in order to match well with the population distribution of Turkey. Age criteria were taken into account during selection of participants for the measurements. Subjects were basically separated to five age groups. Numbers of subjects for different categories were determined according to the age distributions gathered from the general census of population (Turkish Statistical Institute, 2007). Figure 1 shows 2007 population statistics for Turkey. According to this approach subject numbers are determined as shown in below Table 1. The proportion of each age group in all 220 subjects was equaled to the proportion of total population of Turkish men.

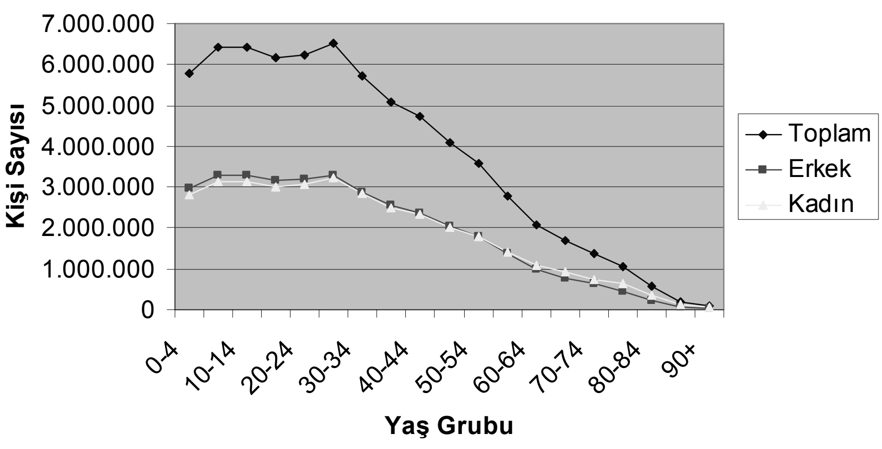


Figure 1. Turkish population data in 2007.

Table 1. Descriptive statistics of the participants

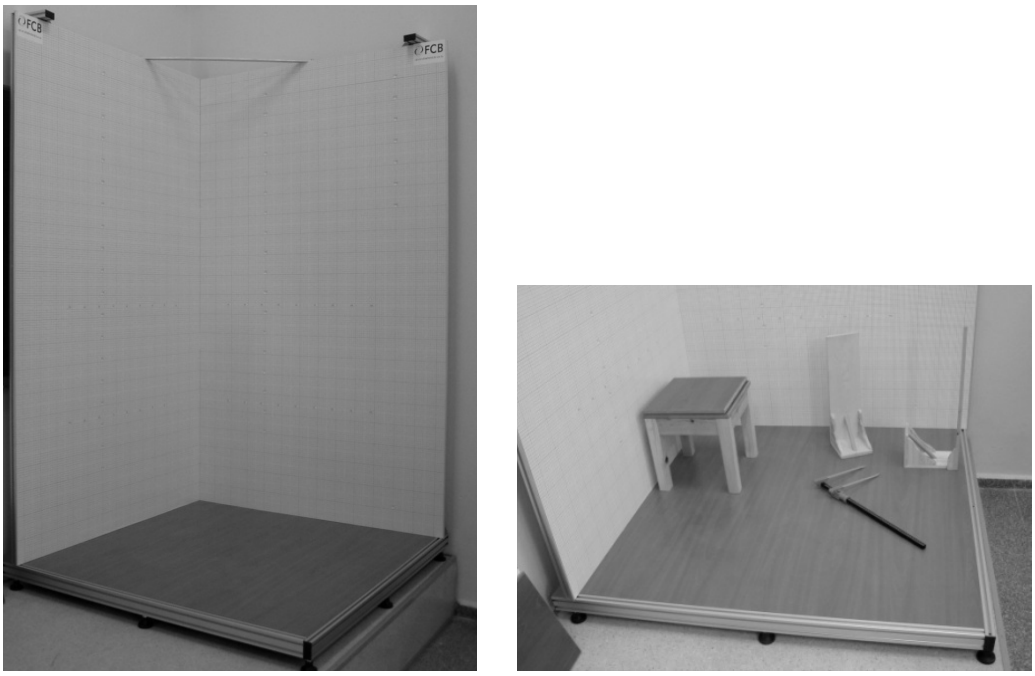
Age group	Age range	% Population in Turkish men	Number of subjects
1	18-24	18	40
2	25-34	26	57
3	35-44	21	46
4	45-54	16	35
5	55- +	19	42
Total		100	220

Education levels of subjects were classified in three primary groups: (1): Elementary school graduates, (2): High school graduates (3): Graduates. The place of birth was asked to subjects. Hence, a background to make statistical analysis depending on Turkey's geographic district was provided.

The measurement technique involves the linear dimension measurements on a particular number of people in a rapid way by a single team. By this measurement technique, subjects are measured wearing their everyday clothing. Experimental set-up used by this method is a triple right angled and a triple faced device which is also called "anthropometric corner". Measuring platform, which is separated by 0,5 cm sections and composed of three panels standing on 3 axis-planes (x,y,z), is a supplementary device used to obtain subject dimensions. A height-adjustable chair, enables a constant posture of subjects, is used for the measurements in sitting positions. Nevertheless, some measurements like height and breadth of arm sections are hard to achieve and even impossible with this technique. This kind of measurements is achieved by using height-adjustable chair with the help of Martin Anthropometry (Figure 1).

In this research, 29 body dimensions were taken from 220 Turkish men and all the data were taken in millimeters (Table 2).

Measurements were implemented by FCB Research Center in the Industrial Engineering Department Laboratories of Uludag University.



(a) (b)

Figure 1. Measurement equipments: (a) Measuring platform, (b) Auxiliary devices used for the measurements

Table 2. Anthropometric parameters

Parameter	Description
P1	Body Mass (weight)
P2	Stature (body height) (without shoes on)
P3	Stature (body height) (with shoes on)
P4	Sitting Height (erect)
P5	Sitting Height (relax)
P6	Eye Height, Sitting
P7	Shoulder Height, Sitting
P8	Chest Height, Sitting
P9	Eye Measure (Distance between the Head and Eye)
P10	Shoulder-elbow length
P11	Forearm-fingertip length
P12	Shoulder-fingertip length
P13	Wall-fingertip length
P14	Grip reach, forward reach, sitting
P15	Wall-foreknee length
P16	Buttock-popliteal length (seat depth)
P17	Knee height
P18	Lower leg length (popliteal height)
P19	Thigh Clearance
P20	Height of the Heel
P21	Foot Length with Shoe
P22	Foot Breadth with Shoe
P23	Shoulder (bidetoid) breadth
P24	Elbow-to-elbow breadth
P25	Chest breadth, sitting
P26	Body Breadth
P27	Hip Breadth
P28	Chest Depth, Sitting
P29	Buttock-abdomen depth, sitting

2.2. Data Analysis

Multiple regression analysis is an appropriate method when the research problem includes one unique metric-dependent variable that is related to more than one metric-independent variable. The general purpose of the multiple regression analysis is to learn about the relationship between several independent or predictor variables and a dependent or criterion variable. Multiple regression analysis can be generally represented in the following form:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots + b_nX_n$$

where, Y is the predicted score or the estimated value and represents the dependent variable. X_1, X_2, …, X_n are measures of distinguishable variables that may help in estimating Y. The coefficient b_0 is the estimated constant, and b_1, b_1, …, b_n are called the regression coefficients and represent the variation of the predicted score. (Hair et al., 1999). In this statistical procedure, standardized b coefficient indicates the relative predictive power of individual parameters. The dependent variable is the anthropometric parameter on human body which is normally distributed.

In general, stature and weight of people are basically known. Depending on stature and weight, other anthropometric parameters can be estimated. For normally distributed parameters, multiple regression analysis was done. In the present work the dependent variable ‘‘Y’’ is the anthropometric characteristic on human body.

The fit to normal distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. As a regression method, the multiple stepwise regression was applied for this study. The multiple stepwise regression was used for obtaining the significant parameter which mostly influence anthropometric parameter. The procedure involves computing a regression equation with all of the variables, then going back and deleting those independent variables that do not contribute significantly to the dependent variable. Each variable is considered for inclusion prior to developing the equation. The purpose of the stepwise linear regression model was to identify the important parameters in prediction equations. This analysis helped to identify the best set of predictors one after the other based on the highest partial correlation for estimating the dependent variable.

The percentage contribution from individual factors was calculated as the percentage of ratio of sum of square obtained from individual factor and total sum of square. The existence of a multivariate relationship was determined by the square of the correlation coefficient (R^2). The critical level of statistical significance was always declared at $P < 0.05$. All statistical analyses were performed by using statistical software of SPSS 13.0.

3. RESULTS AND DISCUSSION

The participants in this study represent the Turkish population fairly well. All data populations were tested as normal by the Kolmogorov–Smirnov test. The Kolmogorov–Smirnov test results indicated that ten of the 29 parameters were not normally distributed (p<0.05). They were P3, P5, P9, P17, P19, P20, P21, P22, P25, and P29. The other 19 of the 29 parameters were normally distributed (p>0.05). The results of Kolmogorov–Smirnov test is given in Table 3.

Multiple regression is a technique that allows additional factors to enter the analysis separately so that the effect of each can be estimated. It is valuable for quantifying the impact of various simultaneous influences upon a single dependent variable.
The stepwise method was used in which the parameter with the higher correlation between the input variables and output variables is first reflected in the analysis. In order to guarantee the reliability of the regression analysis, the coefficients of the regression model were estimated at a significance level of 0.05. The equations according to the results of multiple regression analysis are given in Table 4.

Table 3. The results of Kolmogorov–Smirnov test

Normally distributed parameters (p>0.005)	Non-normally distributed parameters (p<0.005)
Symbols	Symbols
P1, P2, P4, P6 P7, P8, P10, P11 P12, P13, P14, P15 P16, P18, P23, P24 P26, P27, P28	P3, P5 P9, P17 P19, P20 P21, P22 P25, P29

Table 4. Equations for the estimation of the anthropometric parameters on human body by multiple regression analysis

Parameter	Formulation	R^2	Sig.
P4	P4 = 0.528Weight + 0.363Stature + 253.091	0.838	0.000
P6	P6 = 0.619 Weight + 0.294Stature + 261.320	0.737	0.000
P7	P7 = 0.762 Weight + 0.195 Stature + 239.264	0.587	0.000
P8	P8 = 0.675 Weight + 0.160 Stature + 144.191	0.545	0.000
P10	P10 = 0.211 Stature	0.682	0.000
P11	P11 = 0.254 Weight + 0.223 Stature + 61.385	0.816	0.000
P12	P12 = 0.420Stature	0.817	0.000
P13	P13 = 0.654 Weight + 0.321 Stature + 261.176	0.720	0.000
P14	P14 = 0.619 Weight + 0.266 Stature + 249.823	0.568	0.000
P15	P15 = 0.478 Weight + 0.290 Stature + 70.689	0.754	0.000
P16	P16 = 0.232 Weight + 106.665	0.612	0.000
P18	P18 = -0.323 Weight + 0.254 Stature	0.796	0.000
P23	P23 = 1.664 Weight + 330.512	0.814	0.000
P24	P24 = 2.395 Weight – 0.110 Stature + 547.830	0.695	0.000
P26	P26 = 2.515 Weight – 0.155 Stature + 391.237	0.914	0.000
P27	P27 = 1.924 Weight + 236.622	0.819	0.000
P28	P28 = 1.713 Weight – 0.137 Stature + 360.200	0.844	0.000

In generally, positive correlations have been found between the dependent variables and independent variables. Shoulder-elbow length (P10) and shoulder-fingertip length (P12) have only relationship with stature, not with weight. Buttock-popliteal length (P16), shoulder breadth (P23) and hip breadth (P27) have only relationship with weight, not with stature. All other parameters have relationship both weight and stature. There was a negative correlation between lower leg length (P18) and weight. Also negative correlations have been found between stature and three parameters, which are elbow-to-elbow breadth (P24), body breadth (P26) and chest depth (P28).

To decrease some of the design difficulties, anthropometric measurement results can be used. According to this, designers should gain data of automobile driver's measurements that should be done taken according to specific standards. Automobile drivers anthropometric population standards were formed 30 years ago (Rebiffe et al., 1982) and had been used for the design of vehicles between 1980 and 2000. But the necessity for updating the measurements is apparent, considering the strong variations of human anthropometric dimensions in the past years.

4. CONCLUSIONS

Some of the human dimensions should be taken into account for the inner design and driver/passenger seat design of an automobile. It is obvious to see the complications of design considering the variations in human. Considering people having various dimensions in each country, it is obvious that it will get hard to design a car that will be selling in all countries in the global world. Theoretically, the equation obtained from multiple stepwise regression analysis can be used only in the area where the stature and weight have been obtained. In spite of such limitations, this study demonstrated the usefulness of the estimation of anthropometric characters. The results of a regression analysis by the stepwise method showed most of the formulation of the human body parameters based on stature and weight.

The anthropometric formulation table that is extracted from this study can be used by automotive industry to produce better human oriented products for Turkish man population.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

[1] Ayan, V., Bektaş, Y., Erol A.E., "Anthropometric and performance characteristics of Turkey National U-14 volleyball players", ***African Journal for Physical, Health Education, Recreation and Dance (AJPHERD)***, 18(2): 395-403, (2012).

[2] Basibuyuk, G.O. and Akin, G., "Obesity levels of adult women and men in city centre of Sivas", ***Turkish Studies International Periodical For the Languages***, Literature and History of Turkish or Turkic Volume 2/4: 1239-1261, (2007).

[3] Bouabdallah, L., "Anthropometry of Algerian elderly", ***Work*** 41: 5415-5416, (2012).

[4] Caruso, J.F., Taylor, S.T., Lutz, B.M., Olson, N.M., Mason, M.L., Borgsmiller, J.A., and Riner, R.D., "Anthropometry as a predictor of bench press performance done at different loads", ***J Strength Cond Res*** 26(9): 2460–2467, (2012).

[5] Ciner, R., "Anthropology of Turkish Women", Ankara University, ***The Journal of Language and History Geography Faculty*** 18, (3–4): (1960).

[6] Fantozzi, F., "Applications of anthropometry in torsoplastic surgery, ***Eur J Plast Surg*** 36:519–526, (2013).

[7] Gonen, E., Kalinkara, V., "Anthropometric measures of Women in Different Age Groups in Turkey". ***In: 3rd National Congress of Ergonomics***, (1991).

[8] Government Statistics Department, "Anthropometry survey of Turkey", ***Publication Nr***. 151 (1937).

[9] Gulec, E., "Anthropometric dimension of Anatolian people". ***Final report of Scientific Research Project in Ankara University***. Project Nr. 20030901018, (2007).

[10] Gultekin, T., "Body Composition of Adults living in Ankara", PhD Thesis, ***Ankara University Institute of Social Sciences***, (2004).

[11] Hair, J.F., Anderson, R.E., Tatham, R.L., Black,W.C., ***Multivariate Data Analysis, 5th ed. Prentice Hall International***, Inc., Madrid, (1999).

[12] Hedberg, G., "Epidemiological and Ergonomic Studies of Professional Drivers", ***Arbetarskyddsverket***, Solna, Sweden, (1987).

[13] Hughes, E.E., Johnson, P.W., "Children computer mouse use and anthropometry", ***Work*** 41: 846-850, (2012).

[14] Iseri, A., Arslan, N., "Estimated anthropometric measurements of Turkish adults and effects of age and geographical regions", ***International Journal of Industrial Ergonomics***, 39: 860-865, (2009).

[15] Kayis, B., Ozok, F., "Determination of anthropometric characteristics of Turkish Man", ***The Scientific and Technological Research Council of Turkey***, Project Nr. 71a (1989).

[16] Lai, J.M., King, J.S., Walker, K.Z., "Use of anthropometric techniques in dietetic practice", ***Nutrition & Dietetics***, 67: 65–70, (2010).

[17] Nadadur, G., Parkinson, M.B., "The role of anthropometry in designing for sustainability", ***Ergonomics***, 56(3): 422-439, (2013).

[18] Olds, T., Daniell, N., Petkov, J., Steward, A.D., "Somatotyping using 3D anthropometry: a cluster analysis, ***Journal of Sports Sciences***, 31 (9): 936–944, (2013).

[19] Opincă, M., Antip, A., Deaconu, A., "Anthropometry impact in the design of military equipment", ***Global Conference on Business and Finance Proceedings***, Vol. 8, Nr 1, 261-265, (2013).

[20] Ozok, A.F., "An anthropometric survey on Turkish industrial workers", ***The Scientific and Technological Research Council of Turkey***, Project Nr: MAG-533 (1981).

[21] Rebiffé, R., Guillien, J., Pasquet, P., "Enquéte antropométrique sur les conducteurs français, Laboratoire de physiologie et de biomécanique de l'association Peugeot-Renault", 1981-1982.

[22] Snook, S.H., "Design of manual handling tasks. ***Ergonomics***", 21 (5): 404–405, (1978).

[23] Turkish Statistical Institute, 2007. http://www.turkstat.gov.tr/Start.do (2009).

[24] Westgaard, R.H., Aaras, A., „Postural muscle strain as a causal factor in the development of musculoskeletal illnesses", ***Applied Ergonomics***, 15(3): 162–174 (1984).