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STATIC ANTHROPOMETRIC CHARACTERISTICS OF TURKISH PRIMARY SCHOOL CHILDREN: THE CASE OF ANKARA

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ABSTRACT

This investigation is aimed to update characteristics of static anthropometric measurements of Turkish primary school children aged between 7 and 12. In this purpose, the study groups consist of 246 boys and 198 girls in total: 41 boys and 33 girls from each age group between 7 and 12. As a result, 19 different measurements and their arithmetic means and standard deviations were determined of children for boys and girls separately. The ages of children and measurements were compared and correlation equations were defined for each value and indicated the 3rd, 10th, 25th, 75th, 90th and 97th percentile values of each anthropometric measurement. These findings can be used for any kind of new design and also these findings are suggested for using references for Turkish primary school children. Accordingly, the new definition is suggested as "variable standard values" instead of static standards which are used for all times.

***Keywords*:** Anthropometry, Ergonomics, Variable Standard Values, Product Design.

TÜRKİYE'DE İLKÖĞRETİM OKULU ÖĞRENCİLERİNİN STATİK ANTROPOMETRİK ÖZELLİKLERİ: ANKARA ÖRNEKLEMİ

ÖZET

Bu araştırma ile 7-12 yaş arasında bulunan Türkiye'deki ilkokul çocuklarının statik antropometrik değerlerine ait özelliklerin güncellenmesi amaçlanmıştır. Bu amaç doğrultusunda, 7-12 yaş arasındaki her bir yaş için, 41 erkek ve 33 kız öğrenci olacak şekilde toplam 246 erkek ve 198 kız öğrenciden oluşan bir örneklem grubu seçilmiştir. Araştırma sonunda kız ve erkek öğrenciler için ayrı ayrı olacak şekilde, 19 farklı ölçüm değeri ve bu değerlere ait aritmetik ortalamalar ve standart sapmalar hesaplanmıştır. Çocukların yaşlarına bağlı olarak, alınan ölçüm değerlerine ait korelasyon eşitlikleri hesaplandı ve her antropometrik ölçüme ait 3, 10, 25, 75, 90 ve 97. persentil değerleri belirlendi. Bu bulgular, ilkokul çocukları için gerçekleştirilecek yeni tasarımlarda kullanılmak üzere referans değerler olarak önerilmektedir. İnsan ölçüleri zamanla değişmektedir; bu nedenle, zamanla değişmeyen ve yıllarca sabit olarak kullanılan standart değerler yerine, "değişken standart değerler" teriminin kullanımı tavsiye edilmiştir.

Anahtar Kelimeler: *Antropometri, Ergonomi, Değişken Standart Değerler, Ürün Tasarım.*

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1. INTRODUCTION

In a great number of investigations on ergonomics, it is emphasized that the positive anthropometric changes depend on environmental conditions. There are meaningful differences between former and new data, which have same study groups, about the anthropometric values especially height. The authors had decided that these differences were depended on environmental factors changings and nutritional habits. These findings were accepted as positive improvement by authors (Komlos 2003, Neyzi et al. 1996).The body measures of individuals vary in relation to factors like age, gender, nutritional status, genetic structure etc. For this reason, in designing ergonomic products, it is necessary to consider the differences in body measures and adjust product sizes accordingly. The values are correlated, which is obtained from their investigation and former investigations, and realized the mathematical changing. According to their observations, they suggested to update of industrial product designs (Burdurlu *et al*. 2006).

The anthropometric investigations can be used for developing ergonomic products and designing living areas according to data of sample groups which are determined by scientific methods. The study groups were represented for whole investigation space. The investigations indicate that the changing environmental factors can affect positively anthropometric values such as height, weight, which is called secular trend. The results of the investigations show that the designers must consider these factors in new designs (Buchholz *et al*. 1992, Chung and Wong 2007, Jeong and Park 1990, Milanese and Grimmer 2004).

In addition to these studies, there are also a number of researches concerning the use of static anthropometric measurements in designing ergonomic products for students in Turkey (Duyar 1992, Elibol 2005). The determinations of secular changes and growing standards have been investigated by using anthropometric measurements in some of studies especially after the 1990s (Mayda 1997, Ozer 2007). Because static anthropometric measurements of children change in time, they are the subject of many similar researches. Therefore, similar investigations must be repeated and updated constantly. In this study, thus, anthropometric characteristics of students from the age of 7 to 12 in Turkey have been determined and updated.

2. MATERIAL AND METHODS

2. 1. SUBJECTS

Anthropometric measures and percentiles data were collected from 444 children (246 boys, 198 girls) between the ages of 7 -12 in public primary schools in Ankara, the capital of Turkey, the location of which is also geographically at the centre of country. The city has been an immigration attraction for people from all over the country since the foundation of the republic. That’s why it has a cultural and economic diversity that represents the demographic character of the whole country.

There is a registration system for public primary schools in Ankara initiated and conducted by the Turkish Ministry of Education. In this process, the most important factor is the distance students have to travel between school and their home. This has been regarded as one of the basic elements determining students' socioeconomic status. In order to keep the study objective, schools were selected from three different districts, each coming from different social stratum (such as, lower, middle and upper income classes). These classifications were determined by using Household Budget Survey of Turkish Statistical Institute for 2006. Students in study groups were chosen randomly. Besides, age distribution groups were determined by asking students their dates of birth.

2. 2. APPARATUS

The weight measurements were taken by using digital scales and approximately 100 g sensitivity. Martin type anthropometer was used for linear measurements while Glisser Calliper was used for lateral measurements. It should also be reminded that international protocols were followed during the anthropometric measurement processes (Lohman et al. 1988).

2. 3. MEASUREMENTS

The primary aim of this research is to find solutions to ergonomic problems. All anthropometric measurement positions were determined according to Hertzberg standardization (1968) and International Biological Program (Weiner and Lourie 1969). The measurement positions used in investigation are given in Fig. 1 and Fig. 2. The anthropometric measurements, on the other hand, were taken from Prado-Leon *et al*. (2001) with some proper modification. In this way, 19 different static measurements were determined to be used in ergonomic values to design tools and equipment for school children between the ages of 7 and 12 in Turkey. Turkish education environment and data were also taken into consideration for more accurate results.

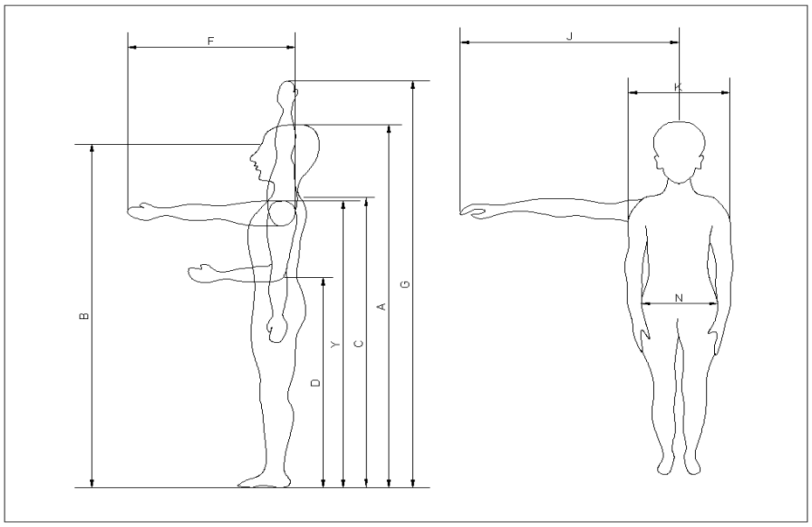

Figure 1. *Anthropometric measurements of standing posture*

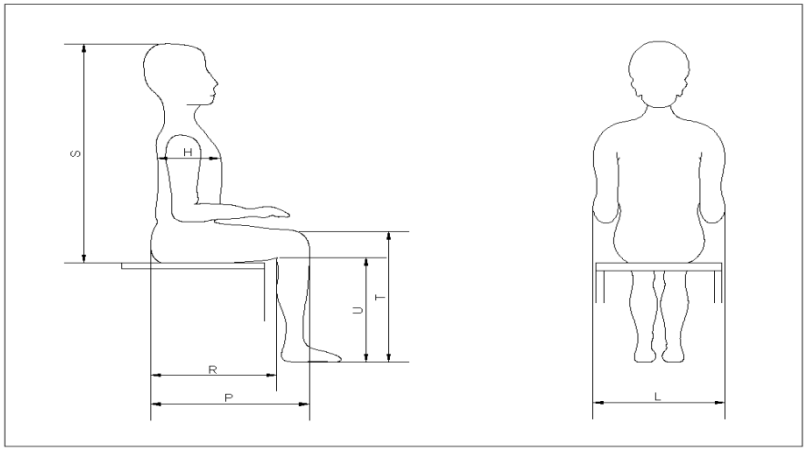

Figure 2. *Anthropometric measurements of sitting posture*

3. DATA ANALYSIS

Statistical Analysis showed that there are no significant differences between students from different economic status. Therefore all anthropometric measurements, taken from different economical categories, were evaluated together. Data were tested with Kruskal-Wallis (K-W) test to determine properties of distribution (Özdamar 2004). The non-parametric one-way K-W variance analysis (Özdamar 2004) was applied in order to find similarities in behaviour with or without normal distributions. According to K-W analysis,

data of each age group and for both sexes have not shown any abnormalities in terms of distributions. After normal distributions were determined and the Duncan and Scheffe tests, which depended on the average data and results, were applied and T-test was used to find if there was any significant difference between variations in each age group or for each sex.

The correlation of H and R values were analysed for age and sex factor relationships in the light of T-test results. However others were analysed only for the relationship between age groups. In turning designs into products, there are a number of common dimensions and these dimensions usually depend on the features of these products as well as on user profiles. While some product designs need 3rd percentile, which is the smallest anthropometric measurement, some other product design may require 97th percentile, the greatest anthropometric measurement. This percentile values were calculated according to the needs behind these designs. In this way, the ergonomic data have been obtained for optimum solutions.

4. RESULTS

The minimum and maximum averages of anthropometric measurements and standard deviation, provided in Table 1 and Table 2 (see appendix), were evaluated and classified for both boys and girls separately according to their ages.

The Correlation Coefficient is different from zero in ($p < .05$) confidence interval so that, these results are statically significant. And the model in Table 3 is available with in the ($p < .05$) confidence interval.

Table 3. *Correlation between dimensions and age values*

Dimensions		Coefficients of Correlation ($p < .05$)	Equation
A: Height		0.771	y = 51.66 x + 863.33
B: Eye Height		0.782	y = 51.33 x + 759.67
C:Shoulder Height		0.788	y = 37.34 x + 736.66
D:Elbow Height		0.825	y = 34.67 x + 484.33
E:Elbow-Hand Extremity		0.817	y = 12.66 x + 206.38
F: Forward Arm Reach		0.803	y = 22.00 x + 316.00
G: Maximum Vertical Reach		0.809	y = 73.33 x + 953.69
H:Thorax Depth	boy	0.665	y = 4.60 x + 118.60
	girl	0.672	y = 4.00 x + 122.00
J:Side Arm Reach		0.809	y = 25.34 x + 356.67
K: Maximum Bideltoideal Breadth		0.717	y = 9.32 x + 219.76
L:Elbow to Elbow Breadth		0.803	y = 13.00 x + 254.00

N:Hipbreadth		0.786	y = 11.00 x + 170.00
P: Buttock to Knee Length		0.833	y = 20.67 x + 265.31
R: Buttock to Popliteal length	boy	0.830	y = 16.67 x + 212.82
	girl	0.848	y = 17.67 x + 213.32
S: Height, Sitting		0.654	y = 20.66 x + 508.38
T:Knee Height		0.831	y = 19.65 x + 232.45
U:Popliteal Height		0.816	y = 15.67 x + 202.31
Y:Acromion Height		0.738	y = 15.00 x + 297.00

The results showed that there are no significant differences between the age groups or girls and boys, either. These data were tested by Duncan and Scheffé methods but these tests did not provide significant statistics. The influences of static anthropometric measurement on each age group and for each sex were tested by applying T-test. The significant values were investigated and it has been found out that the thorax depth (H) and buttock to popliteal length (R) values had differences dependent on sex. These differences can be evaluated as a "sex factor" with a visible influence on H and R anthropometric measurements. The correlation of static anthropometric measurements was also analysed and coefficients of correlation were determined for each relationship. Moreover, the prediction equation was determined and it has been discovered that it indicated the existence of a relationship between age and sex factors. These data were given in Table 3.

The result of study is presented as tables including gender (boys and girls) age (7-12 years old) that have been arranged separately. Standard deviations and means are also included. Comparison of percentiles were shown as A (Height), H (Thorax Depth), R (Buttock to popliteal length), and W (Weight) from Fig. 3 to Fig. 10 respectively. In almost all anthropometric investigations, A and W have important roles and they can be compared with each other. On the other hand, H and R values present the most drastic differences about the relationship between age and sex as far as this study is concerned.

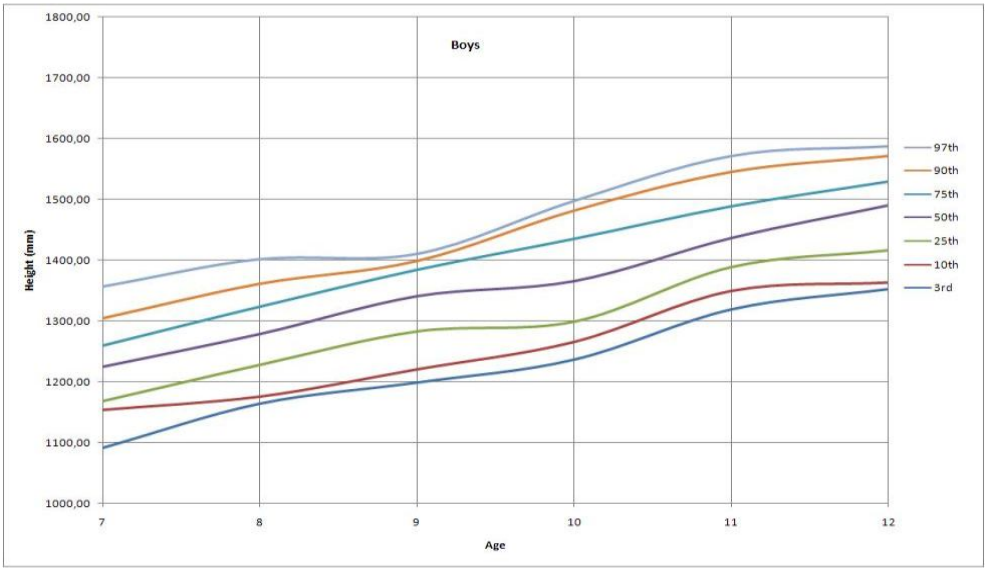

Figure 3. *Percentile curves of height (A) for boys*

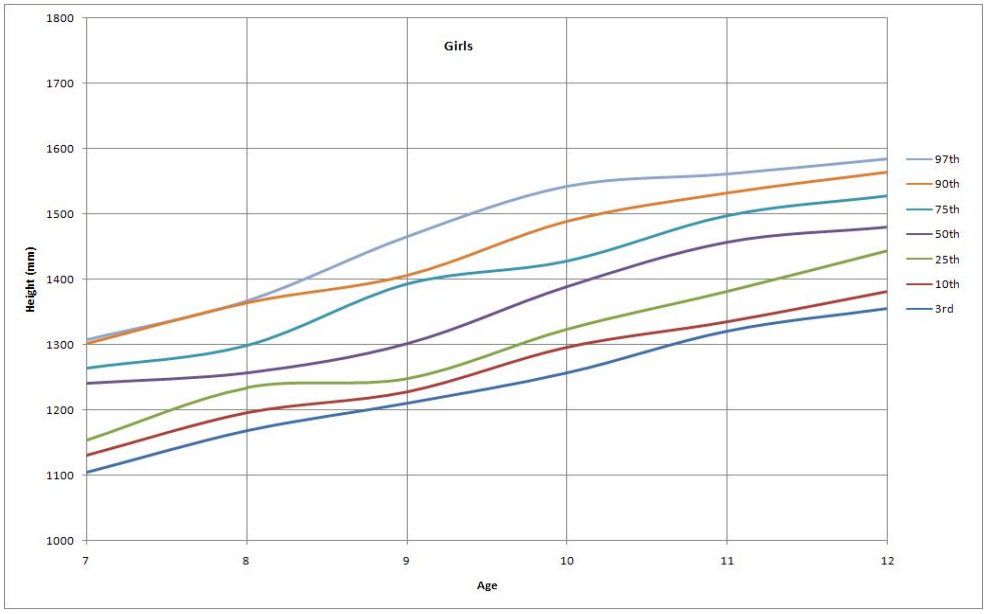

Figure 4. *Percentile curves of height (A) for girls*

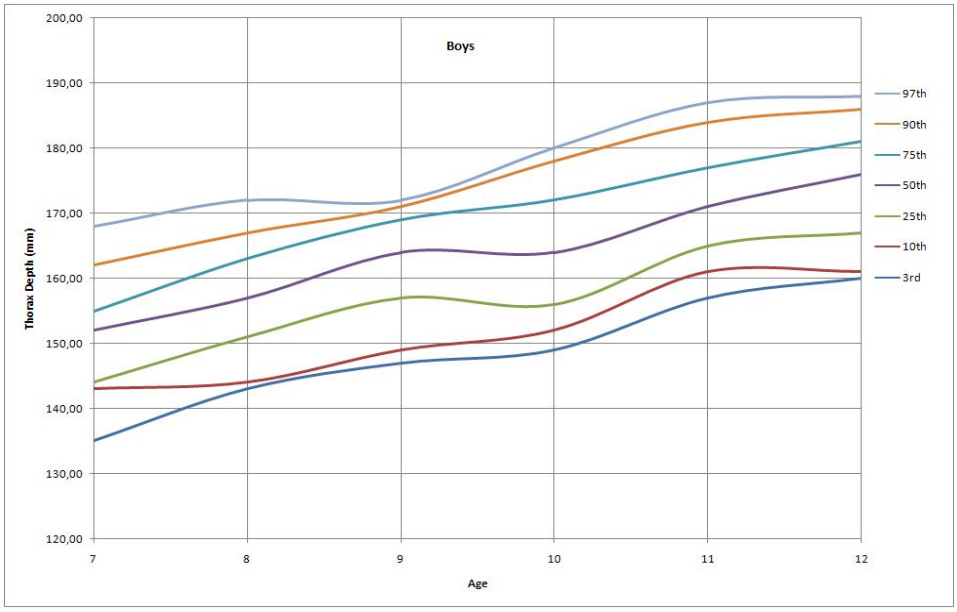

Figure 5. *Percentile curves of thorax depth (H) for boys*

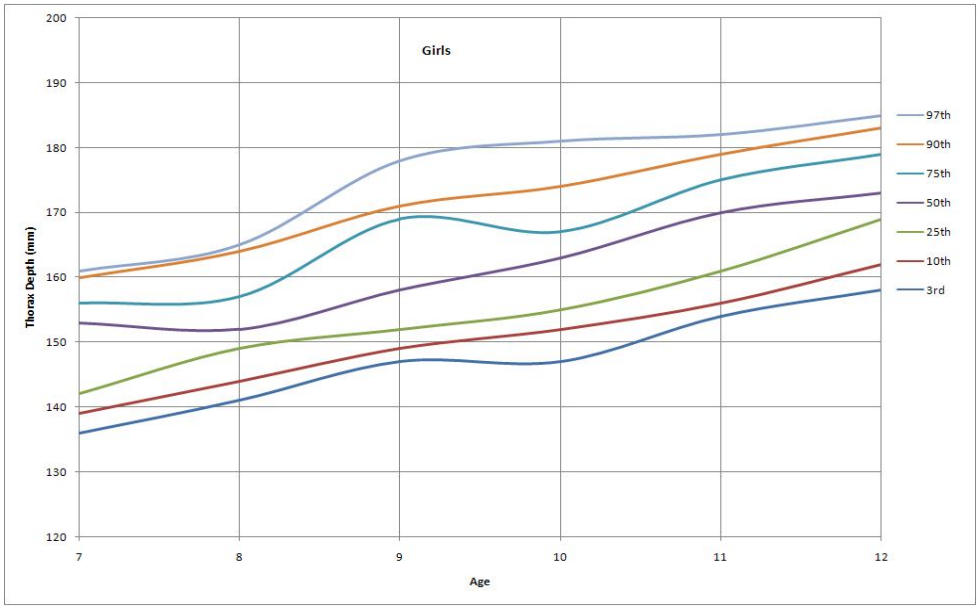

Figure 6. *Percentile curves of thorax depth (H) for girls*

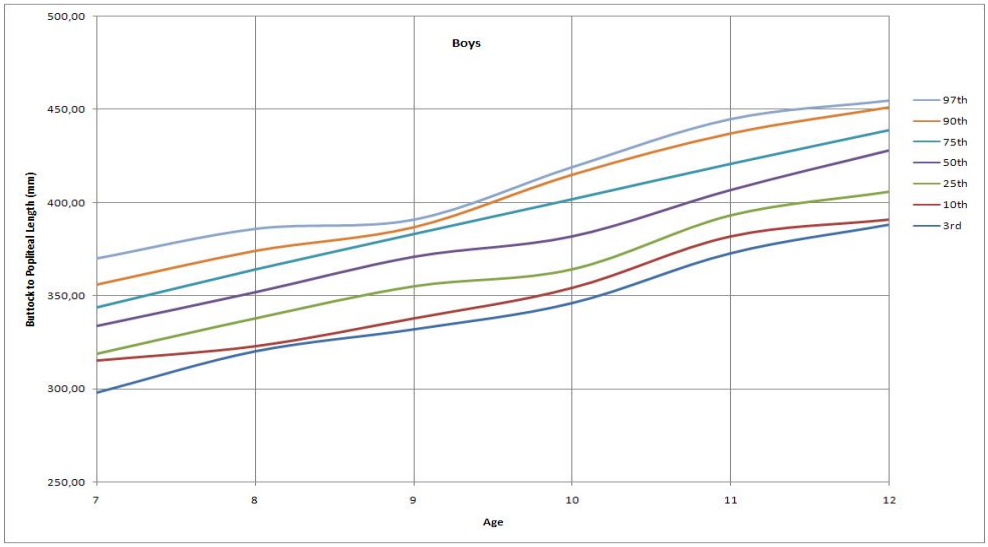

Figure 7. *Percentile curves of buttock to popliteal lenght (R) for boys*

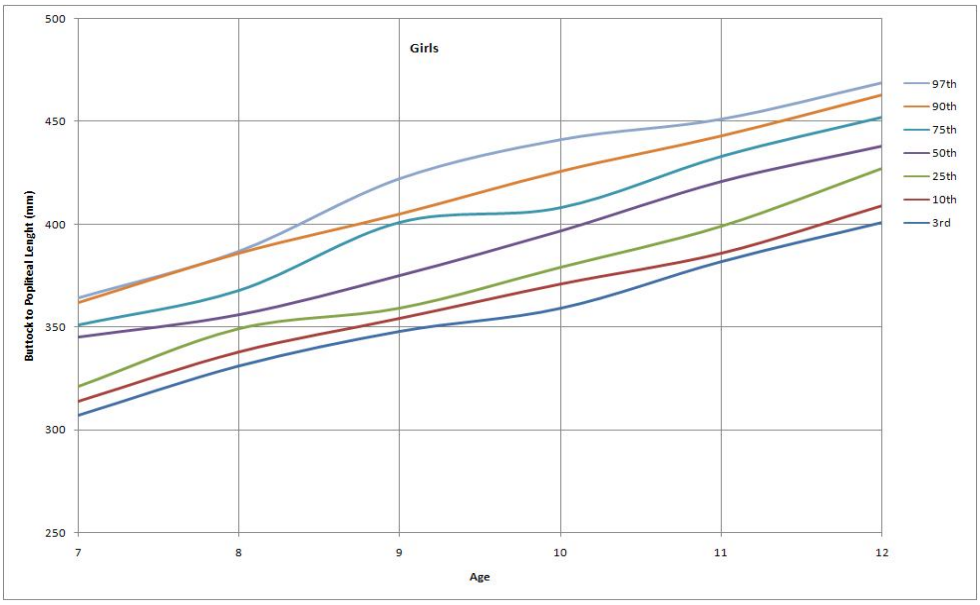

Figure 8. *Percentile curves of buttock to popliteal lenght (R) for girls*

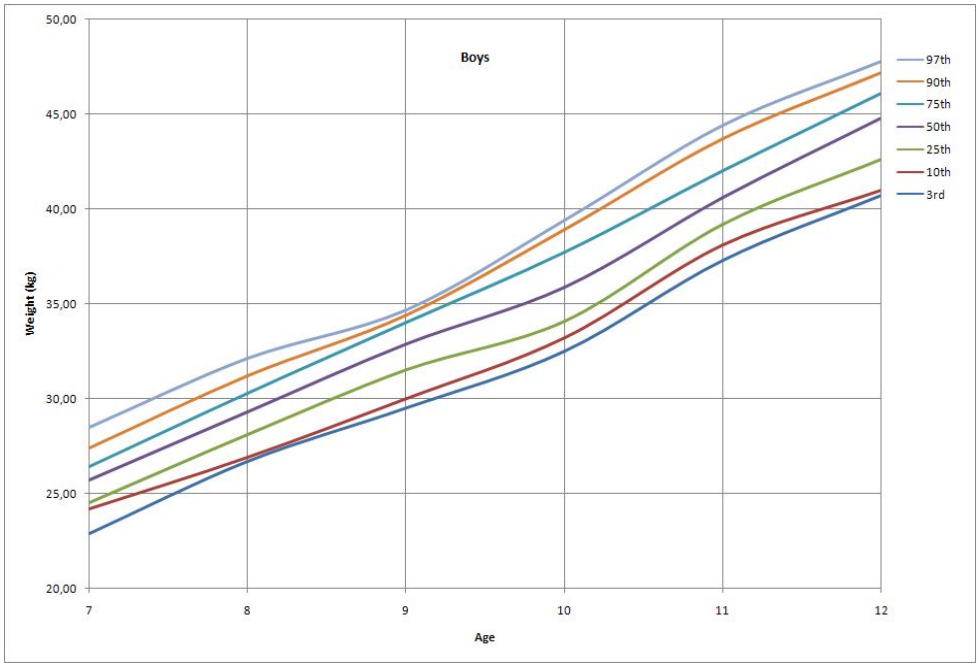

Figure 9. *Percentile curves of weight (W) for boys*

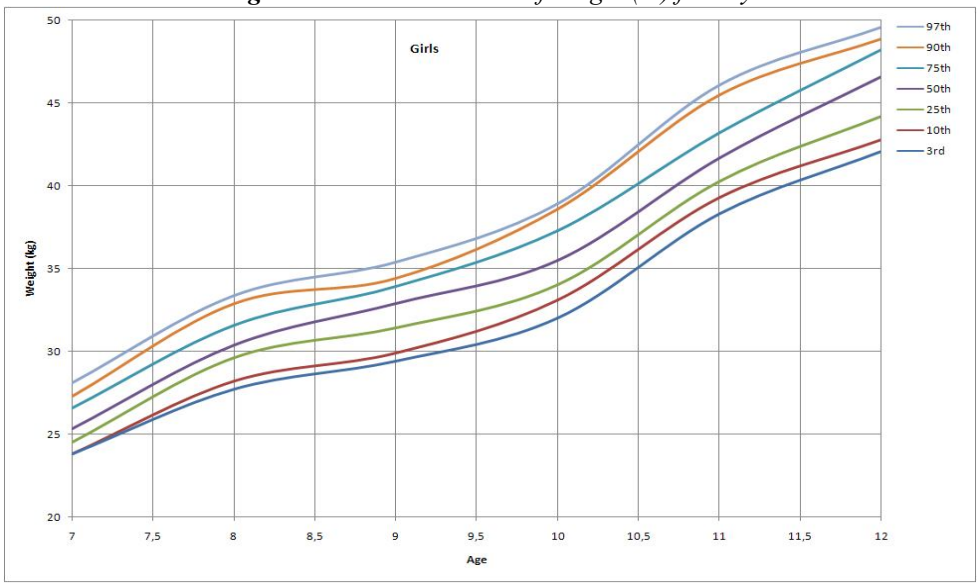

Figure 10. *Percentile curves of weight (W) for girls*

5. DISCUSSION

This study, which reflects the anthropometrical diversity of socio-cultural and economic backgrounds in primary school students in Turkey, can be regarded as reference especially because the results of this study can be easily applied to same age groups in Turkey. If these investigations are supported by the government or private sector investments, results can be extended and used national-wide in a more accurate way simply because such researches may put forward valuable statistical data representing the anthropometric panorama of the country.

This investigation consists of anthropometric values in different date. When the values are arranged chronologically, it can be observed that the anthropometric values increased to one previous value (Table 4).

Table 4. *The average heights for boys and girls from anthropometric investigations for different part of Turkey.*

Investigations			Boy (Age)				Girl (Age)			
Year	**Area**	**References**	8	9	10	11	8	9	10	11
1950	Ankara	Binbaşıoğlu, 1950	1230	1290	1350	1390	1240	1270	1330	1370
1954	Ankara	Bostancı, 1954	_	1243	1287	1340	_	1243	1287	1355
1968	Etimesgut	Nasdeh, 1968	1206	1270	1321	1370	1212	1259	1313	1373
1978	İstanbul	Neyzi, 1978	1255	1305	1370	1450	1270	1320	1375	1435
1979	Bursa	Neyzi, 1978	1247	1300	1344	1399	1251	1290	1326	1386
1986	Trabzon	Baki, 1986	1246	1296	1353	1410	1250	1311	1348	1394
1990	Bursa	Günay, 1990	1260	1309	1359	1409	1254	1300	1344	1394
1990	Diyarbakır	Hatipoğlu, 1990	1213	1270	1313	1377	1230	1280	1318	1375
1990	Gemlik	İkiz, 1990	1233	1292	1350	1380	1247	1302	1347	1390
1991	Gemlik	Şendemir, 1991	1233	1292	1350	1390	1247	1302	1347	1390
1995	Van	Akın, 1995	1163	1212	1275	1316	1165	1230	1275	1316
2002	Ankara	Özgün, 2002	1273	1330	1355	1427	1273	1304	1364	1419

The results also can be used as a reference and resource for designing better furniture, especially school furniture. Some anthropometric measurements are defined as manufacturing standards by standardization institutes. However, these measurements must be updated all the time to make sense because the validity of similar researches is always bound to change as the anthropometric values keep changing every day. This will supply not only new information for ergonomic designers to design new products but also will provide economical profit. Thus, it could be concluded that, anthropometric designs need a new standardization definition, which might be called “variable standard values”.

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REFERENCES

Buchholz, B., Armstrong, T. J., Goldstein, S. A., Anthropometric data for describing the kinematics of the human hand. *Ergonomics*, 35 (3), 1992, 261-273.

Burdurlu, E., Usta, I., Ilce, A.C., Altun, S., Elibol, G.C., Static anthropometric characteristics of 12-15 aged students living in Ankara/Turkey. Hacettepe University Sosyal Arastirmalar e-Journal, 2006.

Chung J. W. Y., Wong T. K. S., Anthropometric evaluation for primary school furniture design. *Ergonomics*, 50 (3), 2007, 323-334.

Duyar, I., *Growth standarts in 12-17 years aged Turkish children*. Thesis (PhD). Hacettepe University, 1992.

Elibol, G.C., *Ankara ilinde ogrenim goren lise ogrencilerinin antropometrik degerlerinin arastirilmasi*. Thesis (MSc.). Hacettepe University, 2005.

Hertzberg, H.T.E., The conference on standardization of anthropometric techniques and terminology. *American Journal of Physical Anthropology*, Vol. 28, 1968, 1-15.

Jeong B. Y., Park K. S., Sex differences in anthropometry for school furniture design. *Ergonomics*, 33 (12), 1990, 1511-1521.

Komlos, J., Access to food and the biological standard of the living: perspectives on the nutritional status of the Native Americans. *American Economic Review*, 93 (1), 2003, 252-255.

Lohman, T.G., Roche, A.F., Martorell, R., *Anthropometric Standardization Reference Manual*. Human Kinetics Books, Illinois, 1988.

Mayda, A.S., Sivas il merkezindeki ilkokul çocuklarinda antropometrik degerlendirme calismasi. Thesis (PhD). Cumhuriyet University, 1997.

Milanese S., Grimmer K., School furniture and the user population: an anthropometric perspective. *Ergonomics*, 47 (4), 2004, 416-426.

Neyzi, O., Bundak, R., Gunoz, H., Darendeliler, F., Saka, N., Social class differences and secular trend in height in Turkish schoolchildren. In: Bodzsar, B.E., Susanne, C. (Eds.), *Studies in Human Biology*. Eotvos University Press, Budapest, 1996, pp. 139-146.

Ozdamar, K., *Paket Programlar ile Istatistiksel Veri Analizi*: Kaan Kitabevi, Eskisehir, Turkey, 2004.

Ozer, B.K., Growth reference centiles and secular changes in Turkish children and adolescents. *Economics & Human Biology*, 5, 2007, 280-301.

Ozgun, G., Ankara il merkezi 7-11 yaş grubu ilköğretim çocuklarında bazı antropometrik ölçüler ve oransal ilişkilerin incelenmesi, Thesis (PhD). Ankara University, 2002.

Prado-Leon, L.R., Avila-Chaurand,R., Gonzalez-Munoz, E.L., Anthropometric study of Mexican primary school children. *Applied Ergonomics*, 32, 2001, 339-345

Weiner, J.E.S., Lourie, J.A., *Human Biology*: A Guide to Field Methods. IBP Handbook, No:9. Blackwell, Oxford, 1969.

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APPENDIX:

Table 1. *Mean and standard deviation for boys*

Dimensions	Age											
	7		8		9		10		11		12	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
A: Height	1230	71.6	1280	69.7	1332	68.6	1373	83.8	1448	76.9	1479	77.0
B: Eye Height	1122	65.0	1172	67.5	1224	66.0	1264	81.6	1338	75.3	1358	70.9
C:Shoulder Height	1002	58.5	1038	56.5	1086	55.9	1085	66.3	1191	64.1	1219	63.9
D:Elbow Height	727	41.8	760	41.4	795	40.9	824	50.3	879	46.6	905	47.1
E:Elbow-Hand Extremity	295	17.2	302	16.4	329	16.9	324	19.8	362	19.2	372	19.4
F: Forward Arm Reach	472	27.5	496	26.9	519	26.8	534	32.7	564	30.0	581	30.3
G: Maximum Vertical Reach	1473	85.8	1559	84.8	1632	83.9	1681	103	1778	94.5	1824	94.9
H:Thorax Depth	151	8.9	157	8.5	162	8.4	165	10.1	172	9.1	174	9.2
J:Side Arm Reach	538	31.3	564	30.7	587	30.2	608	37.1	645	34.2	664	34.6
K: Maximum Bideltoideal Breadth	284	16.7	292	15.9	299	15.3	313	19.1	325	17.2	331	17.3
L:Elbow to Elbow Breadth	347	20.3	363	19.7	379	19.6	386	23.5	412	21.9	428	22.3
N:Hipbreadth	248	14.5	262	14.2	269	13.8	281	17.2	292	15.6	298	15.6
P: Buttock to Knee Length	409	23.9	429	23.4	451	23.3	468	28.6	501	26.7	517	26.9
R: Buttock to Popliteal length	335	19.5	352	19.2	369	18.9	384	23.5	409	21.8	424	22.0
S: Height, Sitting	655	38.2	677	36.9	697	35.9	710	43.3	731	38.9	736	38.3
T:Knee Height	370	21.6	389	21.2	411	21.3	427	26.1	454	24.1	468	24.4
U:Popliteal Height	312	18.1	327	17.9	346	17.8	358	21.8	379	20.2	391	20.4
Y:Acromion Height	403	23.5	421	22.9	434	22.4	447	27.3	470	25.0	470	24.5
W: Weight	25.7	1.53	29.3	1.59	32.8	1.70	36.1	2.21	40.9	2.17	44.5	2.32

Table 2. *Mean and standard deviation for girls*

Dimensions	Age											
	7		8		9		10		11		12	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
A: Height	1220	71.1	1271	65.9	1317	79.9	1388	77.1	1441	76.7	1480	70.1
B: Eye Height	1116	65.1	1167	60.5	1224	74.3	1284	71.2	1339	71.2	1376	65.3
C:Shoulder Height	994	58.4	1035	53.6	1087	66.1	1142	63.5	1191	63.4	1238	58.9
D:Elbow Height	727	42.4	754	39.0	798	48.5	840	46.6	879	46.8	925	43.9
E:Elbow-Hand Extremity	295	17.2	307	15.9	326	19.8	344	19.2	357	18.9	368	17.4
F: Forward Arm Reach	468	27.3	494	25.4	517	31.4	540	29.9	563	30.0	587	27.9
G: Maximum Vertical Reach	1458	85.0	1530	79.3	1622	98.4	1694	94.1	1762	93.8	1831	86.8
H:Thorax Depth	150	8.8	153	7.9	159	9.7	162	9.0	168	8.9	173	8.2
J:Side Arm Reach	530	30.9	559	28.9	582	35.3	612	33.9	639	33.9	666	31.5
K: Maximum Bideltoideal Breadth	285	16.6	290	15.1	297	18.0	314	17.5	324	17.3	335	15.8
L:Elbow to Elbow Breadth	342	19.9	355	18.4	374	22.7	382	21.2	409	21.8	435	20.8
N:Hipbreadth	246	14.4	259	13.5	276	16.8	279	15.5	298	15.9	318	15.2
P: Buttock to Knee Length	411	23.9	433	22.5	457	27.7	477	26.5	501	26.7	525	24.8
R: Buttock to Popliteal length	339	19.8	359	18.7	379	23.1	397	22.0	416	22.1	438	20.8
S: Height, Sitting	650	37.9	672	34.8	694	42.2	722	40.1	746	39.8	765	36.3
T:Knee Height	370	21.6	390	20.2	412	25.0	431	23.9	449	23.9	469	22.2
U:Popliteal Height	312	18.2	329	16.9	346	21.1	359	19.9	373	19.8	390	18.5
Y:Acromion Height	400	23.3	419	21.8	437	26.6	458	25.5	477	25.4	485	23.1
W: Weight	25.5	1.39	30.6	1.60	32.6	1.78	35.7	2.19	42.0	2.29	46.4	2.44