Papers on Anthropology XX, 2011, pp. 251–257

CORRELATION BETWEEN ANTHROPOMETRICAL VARIABLES AND BODY SURFACE AREA

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ABSTRACT

The goal of the present study was to investigate correlation between the body surface area created by various formulas and other anthropometric measurements.

The subjects of the present investigation were 17-year-old conscripts of the town of Tartu and Tartu County.

In all of them height, weight, 33 anthropometric variables and 12 skinfolds were measured. The measurements were made according to the recommendations of Martin (Knussmann, 1988).

The body surface area was calculated by five different formulas.

There was significant correlation between the body surface area and the other anthropometric variables.

Key words: *correlation analysis, anthropometrical variables, body surface area.*

INTRODUCTION

In the second half of the 20th century anthropologists from Estonia Tiik [1] and Kaarma [2, 3] in their studies were interested in applying the correlation analysis in physical anthropology. It was shown that there is significant correlation between the weight and the other anthropometrical variables and also between the height and the others anthropometrical variables [1, 2]. In this situation Kaarma made an essential novelty corollary and named the height and weight as leading variables among all the investigated anthropometrical variables. In the studies of Kaarma also the body surface are was used, but there we did not find any investigations of the correlation between the body surface area and the other anthropometrical variables.

The goal of the present study was to investigate the correlation between the body surface area and the others anthropometrical variables.

The second goal of the study was to investigate the difference of the mean results of the body surface area calculated by various formulas in 17-year-old conscripts.

MATERIAL AND METHODS

The subjects of the present study were 739 seventeen-year-old conscripts from the town of Tartu and the Tartu County. Measurements were taken of each subject in all 47 anthropometric variables. Total body weight was measured with Soehnle digital scale with precision of 0.05 kg. During the anthropometric investigation the rules of Martin (Knussmann 1988) [4] were followed. Height measurements included eight variables: height, suprasternale height, processus xiphoideus height, umbilical height, symphyseal height, acromiale height and height of anterior superior iliac spine.

Breadth and depth measurements were as follows: biacromiale breadth, chest breadth and depth, waist breadth, bicristal diameter, elbow breath, wrist, femur and bimalleolar breadth. Abdomen depth was measured between umbilicus and processus spinosus columnae vertebralis lumbalis on horizontal plane.

Circumferences were as follows: chest, waist, neck, hip, arm relaxed and arm flexed and tensed, forearm, wrist, upper thigh, calf and minimum ancle circumference. Pelvis circumference was measured laterally at the level of the iliac crests. Midthigh was measured in the middle of distance between spina iliaca anterior superior and upper crest of patella. Head circumference was measured superior to the eyebrow line and encompassing the occipital protuberance. Skinfolds were measured as follows: chin, chest, midaxillary, suprailiac, supraspinale (the fold was picked up three-four centimeters above the anterior superior iliac spine on a diagonal line going downwards and inwards), subscapular, abdominal, biceps and triceps, femoral, calf and dorsal surface of right hand. In skinfolds measuring recommendations of Lohman et al. [5] and Heyward and Stolarzcyk [6] were also followed.

All anthropometrical variables were measured on the right side.

Sternal length was calculated as suprasternale height minus processus xiphoideus height.

Abdominal length was derived as processus xiphoideus height minus symphyseal height.

Trunk length was calculated as suprasternale height minus symphyseal height. Upper limb length was calculated as acromiale height minus dactylion height.

Lower limb length was calculated as sum of the heights of anterior superior iliac spine and symphyseal height

For predicting the body surface area several different formulas are recommended.

In 1916 Du Bois and Du Bois [7] measured in nine individuals the body surface area directly using molds. From these results they generated a formula to predict body surface are using height and weight alone.

We used the following variant of the formula BSA (m^2) = 0.007184 x height (cm)$^{0.725}$ x weight (kg)$^{0.425}$.

The second formula was generated by Haycock [8]: BSA (m^2) = 0.024265 x height (cm)$^{0.3964}$ x weight (kg)$^{0.5378}$.

The third formula was produced by Gehan and George [9]: BSA (m^2) = 0.0235 x height (cm)$^{0.42246}$ x weight (kg)$^{0.51456}$.

The fourth formula was calculated by Boyd [10]: BSA (m^2) = 0.0003207 x height (cm)$^{0.3}$ x weight (grams)$^{(0.7285 - (0.0188 \text{ x LOG (grams)})}$.

The fifth formula was recommended by Mosteller [11, 12]: BSA (m^2) = ([Height (cm) x Weight (kg)]/ 3600)$^{0.5.}$

The data were processed by the SAS for Windows version 6.12 software. The level of significance was set at $p < 0.05$.

RESULTS

The results are presented in Tables 1 and 2.

Table 1. Correlations between anthropometrical variables data and body surface area calculated by five authors formulas of 17-year-old conscripts

No	Variable	Dubois and Dubois	Hay-cock	Gehan and George	Boyd	Mos-teller
1.	weight (kg)	956	987	985	991	980
	height and segments (cm)					
2.	height	684	572	584	549	608
3.	sternum length	315	296	298	290	302
4.	abdomen length	236	200	204	192	211
5.	trunk length	529	474	480	461	491
6.	upper limb length	579	459	492	481	524
7.	lower limb length	556	454	508	432	486
	breadths and depths (cm)					
8.	biacromial breadth	664	642	645	636	650
9.	chest breadth	647	672	670	676	666
10.	waist breadth	688	737	733	744	724
11.	bicristal breadth	566	562	562	558	564
12.	chest depth	652	682	680	686	674
13.	abdomen depth	654	717	711	727	700
14.	femur breadth	535	543	543	543	542
15.	ancle breadth	523	504	506	498	510
16.	elbow breadth	524	516	518	513	519
17.	wrist breadth	458	440	442	436	447
	circumferences (cm)					
18.	head circumference	563	556	557	554	559
19.	minimal neck circumference	752	793	790	799	783
20.	chest circumference	818	865	861	872	853
21.	waist circumference	770	834	828	844	817
22.	pelvis circumference	806	855	850	862	842
23.	hip circumference	846	882	879	887	873
24.	proximal thigh circumference	838	889	884	898	876
25.	midthigh circumference	771	816	812	823	804
26.	calf circumference	777	822	818	829	810
27.	ancle circumference	691	723	721	728	715
28.	arm circumference	771	835	829	846	818

29.	forearm circumference	739	785	781	793	774
30.	wrist circumference	713	736	734	739	731
	skinfolds (mm)					
31.	chin skinfold	510	570	564	580	554
32.	chest skinfold	598	661	654	670	644
33.	midaxillary skinfold	647	717	710	728	698
34.	suprailiac skinfold	645	737	731	746	720
35.	supraspinale skinfold	614	678	672	688	661
36.	abdominal skinfold	653	718	712	728	700
37.	subscapular skinfold	652	718	711	728	700
38.	biceps skinfold	510	567	561	576	551
39.	triceps skinfold	638	698	692	708	681
40.	thigh skinfold	616	669	664	677	654
41.	calf skinfold	610	661	656	668	647
	indices					
42.	body mass index	759	844	836	859	821

In Table 1 the correlations between the weight and the body surface area are given, they are very strong. The correlations between the height and the body surface area are a little weaker. All correlations are significant.

Table 2. Mean and SD of body surface area calculated by five authors formulas of 17-year-old conscripts

No.	Formula	Mean ± SD m^2	Difference significance – p
1.	Du Bois and Du Bois	1,866±0.16	
2.	by Haycock	1.848±0.02	0.396
3.	by Gehan and George	1.837±0.17	0.500
4.	by Boyd	1.847±0.18	0.499
5.	by Mosteller	1.852±0.18	0.436

In Table 2 the mean and SD values in m^2, which are calculated by five author's formulas are given. Comparing these results, using the paired sample t-test, there was no significant difference ($p>0.05$).

DISCUSSION

The present investigation showed that in the material of the 17-year-old conscripts of the town of Tartu and the Tartu County there are really the correlations between the body surface areas calculated by five different formulas and other anthropometrical variables of the body. Thus it is demonstrated, that not only the height and the weight and the body mass index, as it was shown our previous study[13], but also the body surface area calculated by height and weight is well correlated with other anthropometric variables of the body in the 17-year-old conscripts.

The body surface area is used for the adjustment of the drug dose [14, 15] and of the dose of dialysis in children and adolescents [16].

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