PHYSICAL ACTIVITY AND PHYSICAL ABILITES TEST RESULTS BY ANTHROPOMETRIC CHARACTERISTICS OF APPLICANTS TO THE ESTONIAN ACADEMY OF SECURITY SCIENCES

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ABSTRACT

The purpose of this study was to assess the main health-related anthropometric characteristics of young adults in order to evaluate the relationship of their anthropometric characteristics with the quantity and type of physical activity and the physical abilities according to sex. The study was carried out using a sample of young adults applying to the Estonian Academy of Security Sciences (EASS) for programs which require physical ability tests upon application in order to ensure that public safety employees are capable of meeting the physical demands of their jobs.

The present study confirms that regular weekly physical activity is significantly correlated to body composition parameters as well as with the physical ability to perform fitness tests well.

Keywords: *young adults, physical abilities test, anthropometrics, weight, height, body mass index, waist circumference, waist to hip ratio, waist to height ratio, bodyfat, obesity*

INTRODUCTION

Physical abilities are necessary components of an officer's training program in the field of internal security and candidates have to pass the physical abilities tests (PAT) annually. PATs are used in many countries for their candidates and the cadets of the police, rescue and correctional services as well as military personnel.[1] Military personnel studies have shown a correlation between

anthropometric parameters and blood pressure, as well as anthropometry and physical fitness to self-control. (2, 3, 4) There is another important connection besides physical fitness to be kept in mind as well. It has been reported that waist to hip ratio (WHR) and waist to height ratio (WHtR) are the predictors of cardiovascular and metabolic risk factors. (5, 6) Obesity is one of the most common health problems in modern societies and is assuming epidemic proportions in both developed and developing countries. In 2012, for example 24.6% of Estonian males and 15.3% of females between the ages of 16–24 had body mass index (BMI=weight/height^2) of more than 25 kg/m^2 and this trend is on the increase. (7) Several studies have reported lower BMI among the persons with higher levels of self-reported physical activity. (8, 9) Today the trend is towards increased phyical inacivity. For example, when in 2010 HBSC in Estonia asked 15-year-olds to report the number of days over the past week that they were physically active for a total of at least 60 minutes per day, only 13% of boys and 9% of girls answered positively. (10)

However, physically active individuals usually have a higher body density and fat free mass compared to physically inactive individuals, so body fat percentage, WHtR and waist circumference (WC) are supposed to have a greater discriminatory power compared to BMI (6).

The object of this paper is to find connections between self-reported physical activity, PAT results and anthropometric measures of EASS applicants.

MATERIAL AND METHODS

During the survey period, 2006–2014, 461 female and 695 male applicants of EASS voluntarily participated in anthropometric measurements. Weight was measured with a Tanita body composition monitor UM072 and height with a metallic measuring stick. WC was measured in centimetres without the compression of the soft tissue at the midway level between the lower rib margin and the iliac crest using a nonstretchable measuring tape (by precision ±0.5 cm). The hip circumference (HC) was also measured in centimetres using the same measuring tape at the widest portion of the buttocks, with the tape parallel to the floor. Both measurements were taken while the subject was wearing little clothing, standing with feet closed together, arms at the side, body weight evenly distributed. The measurements were taken at the end of a normal expiration. All the measurments were taken by the same person.

WHR was calculated by taking the WC (cm) and dividing by the HC (cm) and WHtR was calculated by taking WC (cm) and dividing by height (cm).

Two excercises which have remained the same in EASS PAT in these years – 1500m run and sit-ups – were included in the survey. The run was held on the same flat 500m track where candidates run three laps every year. Sit-ups results were incorporated into this study only from those years where the candidates performed as many sit-ups as they could within two minutes without rest breaks.

The significant alpha for analyses was set at 0.05. The Statistical Package for Social Sciences (SPSS) version 20 for Windows was applied to all the statistical analyses.

Anthropometric characteristics

The anthropometric characteristics of applicants who have participated in EASS entrance physical abilities tests during the period 2006–2014 are presented as follows.

Tabel 1. Anthropometric characteristics for male applicants (N=695)

	Mean	Std. Deviation	Minimum	Maximum
Age (yrs)	20.3	3.47	17.0	46.0
Height (cm)	180.6	6.89	155.0	201.0
Body weight (kg)	77.6	12.09	46.2	139.9
Body Mass Index (kg/m²)	23.7	3.23	14.7	41.2
Waist circumference (cm)	80.7	7.81	61.3	126.0
Hip circumference (cm)	100.5	6.95	71.7	162.5
Waist to hip ratio	0.80	0.045	0.56	1.01
Waist to height ratio	0.45	0.044	0.32	0.68

The mean weight of the participating applicants by year of application to EASS during the years 2006–2014 is presented in Figure 1. The total body weight mean for males was 77.6 kg and for females 63 kg. For males, the lowest mean weight (75.0 kg) was seen in 2006 and the highest one in 2010 (80.6 kg), a difference of 5.6 kg. For females the lowest mean weight was seen in 2012 (60.1 kg) and the highest in 2008 (65.6 kg), a difference of 5.5 kg. Statistically the significant correlation coefficent of male and female applicants height was 0.733 and weight 0.568.

Tabel 2. Anthropometric characteristics for female applicants (N=461)

	Mean	Std. Deviation	Minimum	Maximum
Age (yrs)	20.5	4.58	17.0	48.0
Height (cm)	167.2	6.12	146.0	189.5
Body weight (kg)	63.0	9.79	41.5	107.0
Body Mass Index (kg/m^2)	22.5	3.22	16.1	39.0
Waist circumference (cm)	71.9	7.24	48.3	103.0
Hip circumference (cm)	98.1	70.9	65.5	127.0
Waist to hip ratio	0.73	.045	0.58	0.91
Waist to height ratio	0.43	.046	0.12	0.61
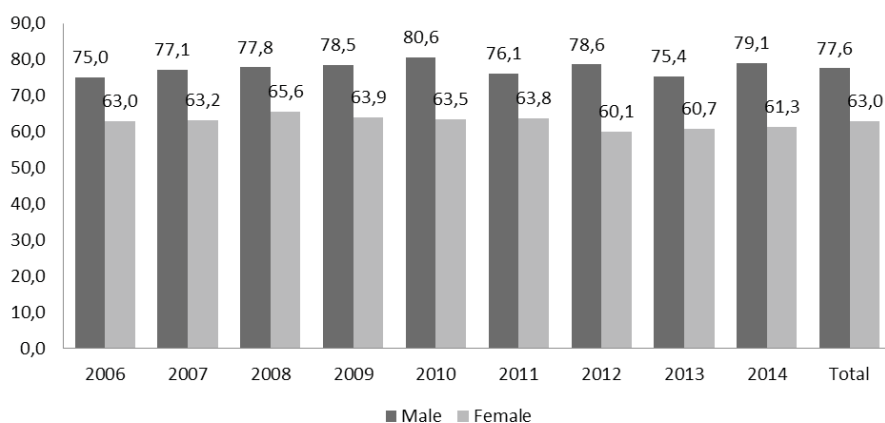
Figure 1. Mean weight (kg) of applicants by sex (2006–2014).

The height of applicants who participated in EASS entrance physical abilities tests during the period 2006–2014 is presented in Figure 2. The total mean height for males was 180.6 cm and for females, 167.2 cm. For males, the lowest mean height (179.8 cm) was seen in 2006 and 2013 and the highest one (181.1 cm) in 2008 and 2010, a difference of 1.3 cm. For females the lowest mean height was seen in 2010 (165.1 cm) and the highest (168.8 cm) in 2013, a difference of 3.7 cm.

The means of WHR and the BMI (kg/m^2) of the applicants is presented by age (in years) and sex in Table 3. The total mean WHR was 0.80 for men and 0.73 for females. The mean BMI was 23.7 kg/m^2 for men and 22.5 for females.
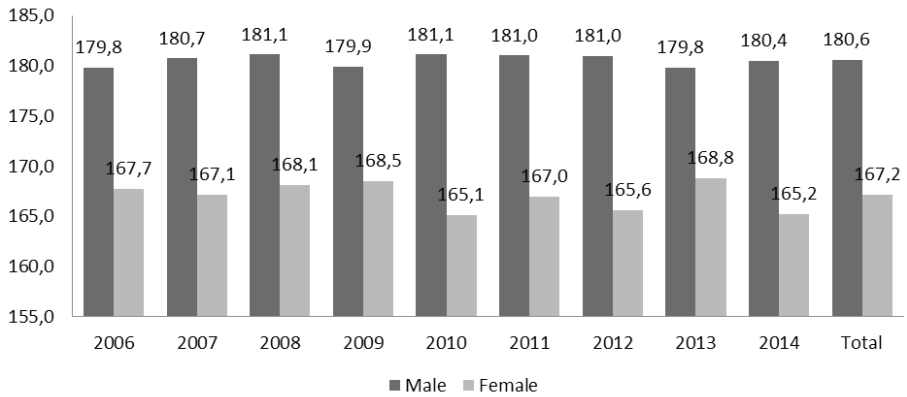
Figure 2. Mean height (cm) of applicants by sex (2006–2014).

Table 3. Means of waist to hip ratios and BMI by age and sex

Age	Male		Female	
	WHR	BMI	WHR	BMI
18	.79	23.5	.73	22.2
19	.80	23.2	.73	22.4
20	.80	23.6	.73	22.7
21	.82	24.2	.73	22.1
22	.82	24.9	.74	23.3
23	.81	24.5	.72	22.8
24	.82	24.3	.75	21.9
25	.84	24.1	.76	23.6
26	.83	25.2	.78	25.4
27 and over	.86	26.6	.74	24.1
Total	.80	23.7	.73	22.5

The mean WHtR was 0,45 for male applicants and 0.43 for females (see Figure 3).
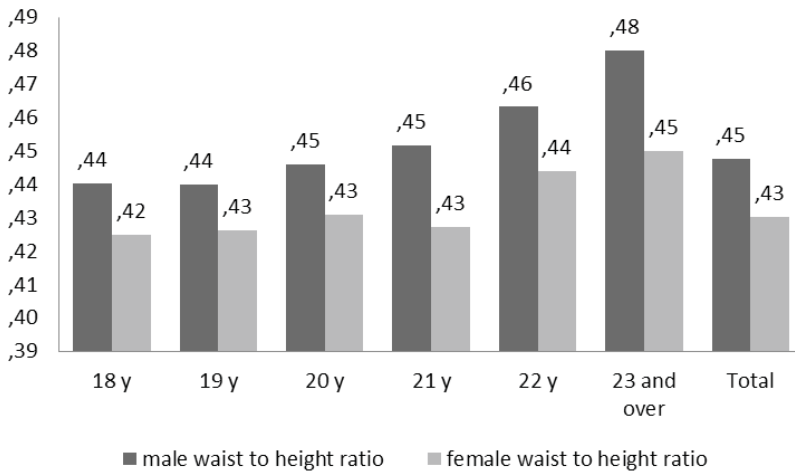
Figure 3. Mean waist to height ratio by age and sex.

Sports activities

The main sport discipline or disciplines were mentioned by 89% of subjects. However, 11% of subjects did not practice any discipline. The most popular sports disciplines among EASS applicants (n=1079) were running (27%), weight training (17%), soccer (16%), basketball (12%), cycling and volleyball (10%).

Other endurance diciplines i.e swimming, skating, roller skating, skiing, orienteering, hiking and triathlon were mentioned by 151 subjects, fighting disciplines (boxing, kick-boxing, taekwondo, judo, karate, wrestling) by 94 subjects and track and field by 84 subjects. Altogether almost 50 disciplines were mentioned.

76% of applicants reported that they practice sports at least 1–2 hours per week.

Tabel 4. EASS applicants' sports hours per one week (by sex)

	Men (n=650)	Women (n=429)	Total
Very few or never	7%	17%	11%
1 hour	10%	18%	13%
1–2 hours	23%	26%	24%
3–7 hours	39%	31%	36%
7 or more hours	21%	8%	16%

49% of male and 52% of female applicants participate in competitions but very few do this at the international level.

Tabel 5. Participation in competitions (by sex)

	Men n=647	Women n=428	Total n=1075
No participation	51%	48%	50%
Only school competitions	10%	22%	15%
Local competitons	15%	13%	14%
National competitions	16%	12%	14%
International competitions	9%	5%	7%

Table 6. Results of 1500m run by age and sex

	Men			Women		
Age	N	Mean	Std. Deviation	N	Mean	Std. Deviation
18	95	6:09	0:35	90	7:32	0:56
19	306	6:06	0:37	175	7:32	0:47
20	102	6:00	0:34	37	7:18	0:45
21	42	6:13	0:35	18	7:16	0:50
22	38	6:16	0:38	9	8:18	1:16
23	24	5:59	0:37	9	7:36	0:40
24	11	6:37	0:41	7	7:37	0:25
25	9	5:57	0:25	8	7:31	1:09
>= 26	30	6:32	0:43	32	8:05	1:09

There was a statistically significant difference between male and female 1500m run (–.710) and sit-ups results (.358).
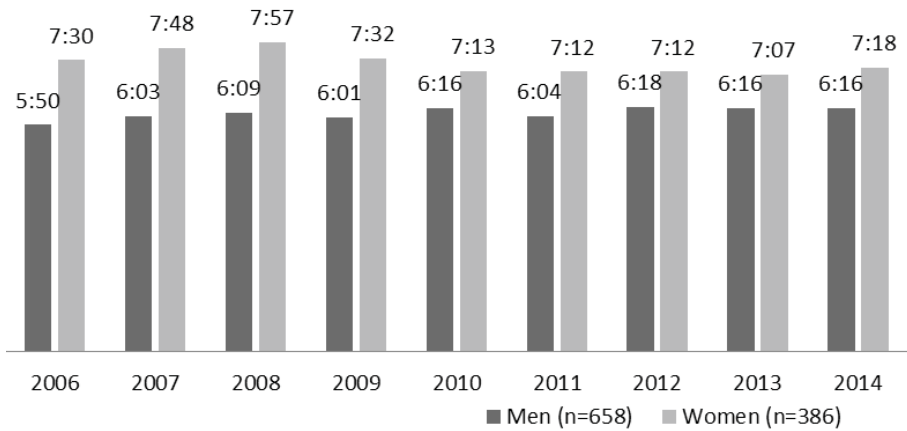
Figure 4. 1500m run mean results (min:s).

RESULTS

The female applicants' height and weight and male applicants' height were not statistically significant by age. Male weight significance coefficent by age was 0.175. Other correlations regarding to age are presented in Table 7.

Table 7. Male and female applicants' correlation coefficents to their age

	waist circumference	hip circumference	sit-ups	competing level	practicing sports activity	eating breakfast	waist to hip ratio	BMI	waist to height ratio
Male	,270**	,161**	–,215**	,215**	–,279**	,154**	,256**	,185**	,255**
Female	,128**	Ns	Ns	Ns	–,177**	Ns	,115*	,097*	,124**
Ns – statistically not significant									

 * Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

The statistically significant correlation coefficent between WC and 1500m run results for men was 0.234 and for women 0.226. Between WC and sit-ups those connections were weaker: –0.179(male) and –0.143 (female).

Table 8. Sports activity hours per week (by age and sex)

	Female			Male		
	N	Mean age (yrs)	StD	N	Mean age (yrs)	StD
Never	20	25.8	8.92	20	21.3	3.03
0,5 hour	53	21.5	6.01	24	22.7	5.62
1 hour	78	20.1	3.36	64	21.0	3.99
1–2 hours	110	19.9	3.58	151	20.2	2.67
3–7 hours	134	20.1	3.57	254	20.3	3.97
7 or more hours	34	21.1	5.97	137	19.5	1.73
Total	429	20.6	4.64	650	20.3	3.43

Older applicants tend to practice less sports (Table 8), although some were very active. Those who answered that they did not practice sports at all (20 men and 20 women) were with higher BMI than others. Men's mean BMI was respectively 24.5 (StD 3.97) for non-sporting group and varied from 23.6–24.0 (StD 2.79–5.1) in multi-level sports participants groups. For women those data were 25.7 (StD 5.86) versus 22.0–22.9 (StD 2.6–4.05).

The Spearman's correlation coefficient between men's sports hours per week and 1500m run result was –0.30 and between the level of participation in competitions and 1500m run result –0.34. For women these results were –0.33 and –0.36 ($p < 0.01$ in all cases). These data show the connection between practicing and results.

Since most of the candidates who failed in the 1500m run were female, their anthropometric results were analyzed. There was a difference in the distribution of BMI – in the group of unsuccessful candidates there were more with a BMI over 25 kg/m^2 (Figure 5); also their mean WHR and WHtR were higher than in the womens group of those who passed the 1500m run. Those mean results were – WHR 0.735 and 0.729; WHtR 0.438 and 0.423.
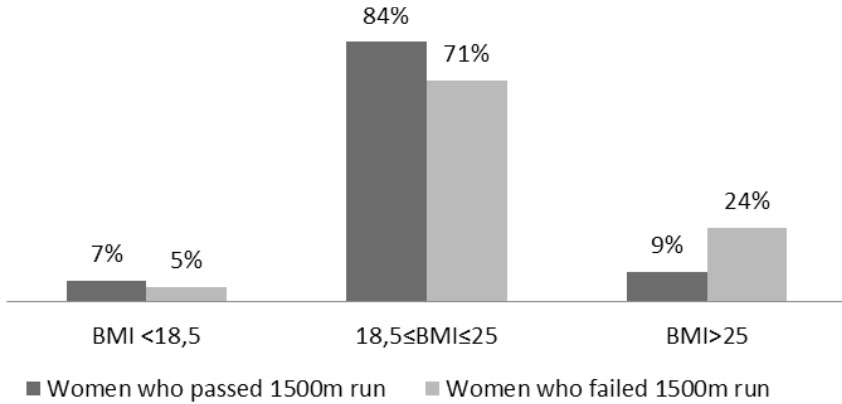
Figure 5. Female BMI distribution of 1500m run results.

The EASS entrance test results worsened as the sports activity or competition participation level of candidates decreased.

Tabel 9. EASS applicants' level of participation in competitions related to physical abilities tests results

		1500 m run men (min:s)	1500 m run women (min:s)	Sit-ups men (repetitions)	Sit-ups women (repetitions)
No participation	Mean	6:20	7:53	44.1	37.0
	N	307	172	202	152
	Std. D	0:38	0:58	10.12	11.13
Only school competitions	Mean	6:11	7:29	44.2	39.8
	N	60	76	41	68
	Std. D	0:32	0:43	7.699	8.989
Local competitons	Mean	5:58	7:12	47.1	41.0
	N	93	49	57	40
	Std. D	0:34	1:14	6.51	10.12
National competitions	Mean	5:52	7:03	49.4	45.0
	N	101	43	67	32
	Std. D	0:33	0:46	7.54	10.72

		1500 m run men (min:s)	1500 m run women (min:s)	Sit-ups men (rep-etitions)	Sit-ups women (rep-etitions)
International competitions	Mean	5:48	6:53	48.5	46.9
	N	52	22	31	8
	Std. D	0:28	0:32	11.50	11.09
Total	Mean	6:08	7:34	45.8	39.3
	N	613	361	398	300
	Std. D	0:37	0:54	9.38	10.81

Tabel 10. Sports activity correlations with physical abilities tests results

		1500m run men (min:s)	1500m run women (min:s)	Sit-ups men (rep-etitions)	Sit-ups women (rep-etitions)
Not at all	Mean	6:30	8:39	40.3	28.9
	N	19	19	17	19
	Std. D	0:57	1:18	7.72	11.55
<0,5 hr	Mean	6:31	8:00	35.9	34.3
	N	22	39	18	42
	Std. D	0:45	0:58	7.60	9.94
0,5–1 hr	Mean	6:24	7:44	42.8	39.0
	N	57	65	41	59
	Std. D	0:31	0:53	9.33	9.33
1–2 hrs	Mean	6:14	7:33	44.3	40.0
	N	146	95	95	71
	Std. D	0:37	0:43	8.45	10.08
3–7 hrs	Mean	6:06	7:18	47.0	42.3
	N	238	111	149	86
	Std. D	0:32	0:43	9.29	10.73
>7 hrs	Mean	5:51	6:58	50.0	45.4
	N	134	33	79	23
	Std. D	0:37	0:46	8.69	10.11

The 1500m run and sit-ups mean results were constantly increasing by age and the yearly comparison showed that men's aerobic fitness results worsened in the last 3 years, whereas women's results showed a small improvement in the last 5 years as compared to the earlier period.

In most cases WHtR and WHR were correlated with other anthropometric measurments and physical tests results.

Table 11. WHtR and WHR correlations with other data (male n=694, female n=461)

	WHtR male	WHtR female	WHR male	WHR female
Age	,255**	,124**	,256**	,115*
Height	–,243**	–,247**	–,104**	–,180**
Weight	,590**	,619**	,380**	,286**
WC	,872**	,900**	,663**	,640**
HC	,636**	,595**	,197**	Ns
Sit-ups	–,148**	–,114*	–,128**	Ns
1500m run	,219**	,199**	,119**	Ns
WHR	,710**	,696**	1,000	1,000
BMI	,841**	,853**	,497**	,417**
WHtR	1,000	1,000	,710**	,696**

Ns – statistically not significant, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The mean height and weight of studied candidates who participated in the EASS entrance physical abilities tests do not vary statistically significantly by year. The total means for males were 77.6 kg and 180.6 cm and for females 63 kg and 167.2 cm and these anthropometric measures have mostly remained the same. As per the latest studies the mean weight of first year EASS male students (n=57) in 1998 was 76 kg and mean height 181.4 cm. For female students (n=41) the mean weight was 61.2 kg and mean height 166.7 cm. (11)

Compared to Estonian schoolchildren growth charts 2006–2009, an EASS applicant's mean height has been approx. 1–2 cm shorter than for 18–19 year old girls and boys and their weight was approx. 2–3 kg heavier; (12) whereas compared to the Estonian Adult Population Study (2006–2012) for the 16–24

age group the men's mean height varied from 181.0 to 182.3 cm and the women's height from 167.5 to 168 cm, which is also higher than the mean heights in the EASS study. The mean weight of Estonian young adults showed a growth tendency from 75 to 77.6 kg for men and from 59.8 to 62.7 kg for women (Table 12).

Tabel 12. Estonian Adult Population Study (2006–2012), age group 16–24

Year of Study		2006	2008	2010	2012
Mean weight (kg)	Men	75	76.4	77.4	77.6
	Women	59.8	61.8	61.2	62.7

The reason why the mean weight in the EASS study is larger than the mean weight of Estonian young adults could be explained by the applicants` heavier fatfree mass and also their older age. For example, in the EASS study women who were 21 or older (n=101) had a mean body weight of 64.7 kg (StD 11.2) and a height 166.9 cm (StD 6.4). By reducing the group to women aged 25 or older (n=47) the mean data were 66.6 kg (StD 12.9) and 166.2 cm (StD 6.6) respectively. For men 21 and older (n=170) these data were 81.3 kg (StD 13.0) and 180.6 cm (StD 6.6) and for men 25 and older, (n=46) 84.3 kg (StD 15.5) and 180.4 cm (StD 7.9). Thus, older applicants weighed more than the younger ones.
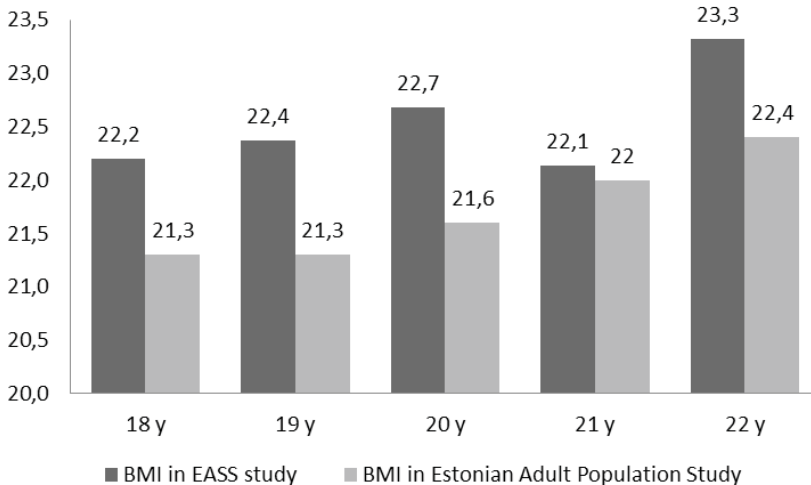

Figure 6. Female mean BMI values in the EASS study (2006–2014) and the Estonian Adult Population Study (2006–2012)[1].

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1   The data of Health Behavior among Estonian Adult Population Study are origin from Estonian National Institute of Health Development.
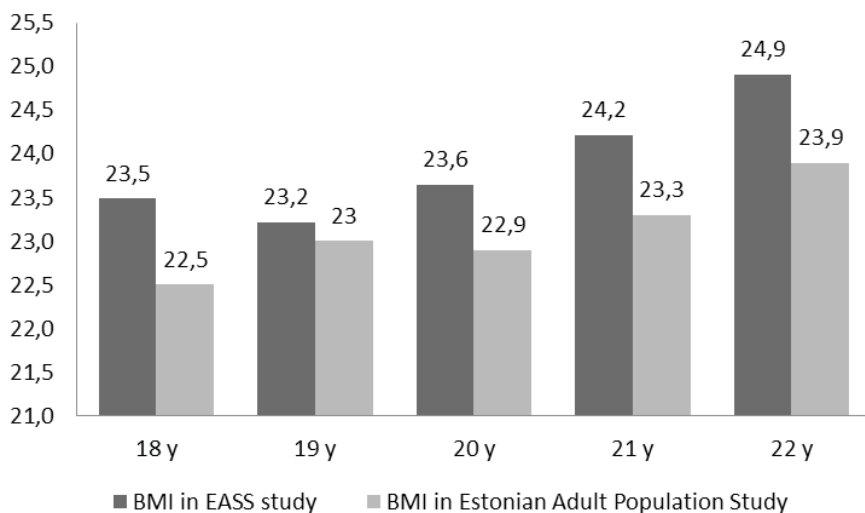
Figure 7. Male mean BMI values in the EASS study (2006–2014) and the Estonian Adult Population Study (2006–2012).

In the "Health Behavior among Estonian Adult Population Study" the mean BMI values of inactive persons were lower than the mean BMI values of those who practice sports. For example, in the years 2006–2012 Estonian 18-year-old women (25 respondents) who reported that they did not practice sports had a mean BMI of 20,8 kg/m² (StD 2.48) and the rest (99 respondents) a mean BMI of 21.4 kg/m² (StD 2.74). The mean BMI of 18-year old inactive men (12 respondents) was 21.8 kg/m² (StD 3.31) and of the rest (85 respondents) 22.6 kg/m² (StD 3.0).

The prevalence of adiposity is more common in urban than in rural populations. Many studies have found that WC is a better predictor of metabolic syndrome than BMI (13) and WHtR scored over WC as a predictor of the metabolic syndrome and the coronary artery disease. (14)

According to the International Diabetes Federation the risk of metabolic syndrome for Europid men starts from WC 94 cm and for women from 80 cm. In the EASS study 59 women and 42 men exceeded that limit. There were statistically significant differences between the normal and the risk group in mean weight, HC, BMI, WHR, WHtR, 1500m run and sit-ups results. Male applicants in the WC≥92 group tend to practice statistically significantly less sports than the rest of the group which had a smaller WC. For female applicants this connection had no statistical significance at any WC point.

A statistically significant correlation was observed between WC and cardiorespiratory fitness of young men in the study of Kawai et al.(15) Correlation coefficients in the EASS study were almost the same for male and female applicants (0.23).

Margaret Ashwell suggested boundary values of 0.5 and 0.6 for WHtR to indicate different levels of health risk in different age groups. (16) Rajesh Rajput and colleagues found in their study that the optimal cut-off of WHtR for the prediction of metabolic syndrome was 0.52, offering a simple and reliable index of identifying individuals who face increased future risk of metabolic complications. (17, 18, 6)

There was a statistically significant difference in mean age, weight, WC, HC, WHR, BMI, 1500m run and sit-ups results between groups with WHtR<0.50 (N=862) and WHtR≥0.50 (N=127), but no statistically significant difference in sports activity in the EASS study. In sports activity a statistical significant difference was found between the groups with WHtR<0.52 (N=926) and WHtR≥0.52 (N=63) when looking at male and female groups together. That statistical significance was not found for male and female groups separately. It is possible that a WHtR of 0.52 and over could be caused by too little physical activity or simlpy that sports activity is less pleasant with such a level of obesity.

The correlation between sit-ups and 1500m run tests results was higher among female candidates (–0.42 female vs –0.39 male). The sequence of statistically significant anthropometric correlation coefficients with 1500m run results was: female HC (0.25), male HC (0.24), male and female WC (0.23), male BMI and WHtR (0.22), male and female body weight (0.21), female BMI and WHtR (0.20), and male WHR (0.12). Those same connections with sit-ups results were weaker and WC, HC, BMI, WHR and WHtR were not statistically significantly connected to sports activity by sex.

It was found that sports activity and the participation level in competitions were more connected to run results than anthropometrical measures. Those participants, who practiced less sports, competed at a lower level or not at all, achieved lower results on physical tests. Quite a high correlation between sporting activity and performing physical tests was also found in earlier studies in EASS. (19)

The reason why EASS applicants' mean height remains smaller than in other similar Estonian groups could be that it is easier for shorter men and women to pass existing strength and running tests; thus taller candidates do not even bother to compete. EASS should examine whether existing PAT satisfy internal security departmental needs or there is a possibility for

improvement. The recommended healthy BMI and bodyfat values as well as sports activity levels, should be introduced to applicants on EASS webpages to encourage them earlier into training in order to achieve better results in entrance tests.

The EASS applicants' sports activity seems to be higher than the Estonian average – only 48% of men and 52% of women went in for sports at least once a week (The Adult Population Study in 2012). Surveys in the field of internal security show that officers` tend to practice more sports than the average person. For example, the latest Estonian correctional officers sports activity study found that 87% of male and 67% of female correctional officers practised sports at least 2 hours per week, which is more than in the EASS applicants study. (20)

In the EASS study there are not many persons who compete at high levels. One of the reasons for the high percentage of sports activity could be the result of the necessity to train for entrance tests because the usual sports activity of Estonian young adults is not as high as the EASS study showed.

CONCLUSION

The present study confirms that regular weekly physical activity is significantly correlated to physical ability and body composition parameters and that athletic training is required to perform fitness tests well.

1. The EASS applicants' height was not statistically significantly correlated by age. Body weight was statistically significantly correlated by age only for male subjects.
2. Older applicants, especially men, tended to be less physically active.
3. The EASS applicants' physical tests mean results constantly worsened by age and were linearly related to applicants' physical activity and competition level.
4. The physical activity and the competing level of applicants had a more statistically significant connection to physical tests results than their anthropometric data.
5. A WC≥92 for male applicants and WHtR≥0.52 for all the subjects were found as prediction points of physical inactivity.
6. The statistically significant correlation coefficents of anthropometry (HC, WC, BMI, WHR, WHtR) showed a better connection for the 1500m run than did sit-ups results and predicted that growing obesity influences aerobic fitness.

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