DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS BETWEEN ATHLETES, SPRINTERS AND JUMPERS, AN EDUCATIONAL-SPORTS STUDY

DIFERENÇAS NAS CARACTERÍSTICAS ANTROPOMÉTRICAS ENTRE ATLETAS, VELOCISTAS E SALTADORES, UM ESTUDO EDUCACIONAL-ESPORTIVO

DIFERENCIAS EN CARACTERÍSTICAS ANTROPOMÉTRICAS ENTRE ATLETAS, VELOCISTAS Y SALTADORES, UN ESTUDIO EDUCATIVO-DEPORTIVO

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ABSTRACT: The purpose of this study was to determine the differences in anthropometric characteristics between sprinters and jumpers to aim education more accurately in these fields. The study included 24 men in athletics, they were divided into two groups: 14 sprinters (age 21.57 ± 1.16 years) and 10 jumpers (21.80 ± 1.03 years). The variables included 13 anthropometric measures. To determine the differences between groups of variables it was used Mann-Whitney U test and analysis of variance (ANOVA). The results of the Mann-Whitney U test showed statistically significant difference ($p \leq 0.05$) in two variables for estimating subcutaneous adipose tissue, chest skinfold, and midaxillary skinfold. Other analyzed variables for assessing the longitudinal of the skeleton, and body mass and volume differences were not statistically significant ($p \geq 0.05$). These findings may give coaches better knowledge, suggest following recent methods and be more careful in training programs with different athletics.

KEYWORDS: Anthropometric characteristics. Sprinters. Jumpers. Athletics. Education.

RESUMO: *O objetivo deste estudo foi determinar as diferenças nas características antropométricas entre velocistas e saltadores para direcionar a educação com mais precisão nesses campos. Participaram do estudo 24 homens do atletismo, divididos em dois grupos: 14 velocistas (idade 21,57 ± 1,16 anos) e 10 saltadores (21,80 ± 1,03 anos). As variáveis incluíram 13 medidas antropométricas. Para determinar as diferenças entre os grupos de variáveis foi*

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utilizado o teste U de Mann-Whitney e análise de variância (ANOVA). Os resultados do teste U de Mann-Whitney mostraram diferença estatisticamente significante (p ≤ 0,05) em duas variáveis para estimativa do tecido adiposo subcutâneo, dobra cutânea torácica e dobra cutânea axilar média. Outras variáveis analisadas para avaliação longitudinal do esqueleto e diferenças de massa corporal e volume não foram estatisticamente significantes (p ≥ 0,05). Esses achados podem dar aos treinadores um melhor conhecimento, sugerir seguir métodos recentes e ter mais cuidado em programas de treinamento com diferentes modalidades de atletismo.

PALAVRAS-CHAVE: *Características antropométricas. Velocistas. Jumpers. Atletismo. Educação.*

RESUMEN: *El propósito de este estudio fue determinar las diferencias en las características antropométricas entre velocistas y saltadores para orientar la educación con mayor precisión en estos campos. El estudio incluyó a 24 hombres en atletismo, se dividieron en dos grupos: 14 velocistas (edad 21,57 ± 1,16 años) y 10 saltadores (21,80 ± 1,03 años). Las variables incluyeron 13 medidas antropométricas. Para determinar las diferencias entre grupos de variables se utilizó la prueba U de Mann-Whitney y análisis de varianza (ANOVA). Los resultados de la prueba U de Mann-Whitney mostraron diferencia estadísticamente significativa (p ≤ 0,05) en dos variables para la estimación de tejido adiposo subcutáneo, pliegue cutáneo torácico y pliegue cutáneo medioaxilar. Otras variables analizadas para evaluar la longitud del esqueleto y las diferencias de masa y volumen corporal no fueron estadísticamente significativas (p ≥ 0,05). Estos hallazgos pueden brindar a los entrenadores un mejor conocimiento, sugerir seguir métodos recientes y ser más cuidadosos en los programas de entrenamiento con diferentes atletismo.*

PALABRAS CLAVE: *Características antropométricas. Velocistas. Saltadores. Atletismo. Educación.*

Introduction

Athletics is a group of sporting events that involves competitive running, jumping, throwing, and walking. It's known that anthropometric characteristics are significantly associated with sports results in these disciplines. Furthermore, anthropometrics characteristics (skinfolds and circumferences) are used to identify the health status in athletes, but also in non-athletes (KRUSCHITZ *et al*., 2013; GILLIAT-WIMBERLY *et al*., 2001). National Academy of Sports Medicine - NASM recommended for normal function and better health status for athletes and in non-athletes, it necessary to a minimum of essential fats, whose percentage is higher in females compared to males (ŠOLAJA *et al*., 2017). Anthropometrics characteristics of the athlete's body and fractional somatotype can be used as guidelines for sport selection, for the implementation of relevant training methods, and for application of appropriate nutrition strategies during sports season for elite athletes (GARRIDO-CHAMORRO *et al*., 2012;

GUTNIK *et al*., 2015). In this regard, anthropometrics characteristics are a very important factor contributing to success in sports (BRUNKHORST; KIELSTEIN, 2013).

In sports that involve strength, speed, and endurance, such as athletics, a great amount of body fat may cause athletes to underachieve or prevent them from achieving their maximum performance in jumping or sprinting. While low body fat percentage is associated with conditions such as irregular eating behaviors, anemia, amenorrhea, premature osteoporosis, and sports injuries (BENTZUR *et al*., 2008).

Anthropometric characteristics, such as skinfold thickness, circumferences, length of the upper and lower limbs, body weight, and body fat percentage affect the performance in running athletic events (KNECHTLE *et al*., 2015) and it is inversely proportional (HETLAND *et al*., 1998). Individually measured skinfolds have been singled out as success indicators in running, where a high-degree positive correlation is found between the lower limb skinfold thickness and the running speed in sprinting and longer sprint events (ARRESE; OSTÁRIZ, 2006) as well as a sum of skinfold thicknesses (KNECHTLE *et al*., 2010). Also, this applies to jumping events, where a take-off from the surface is performed (PAJIĆ, 1998).

The aim of this study was to determine the differences in anthropometric characteristics between athletics sprinters and jumpers.

Methods

Participants

The sample of the conducted study involved 24 male subjects, including 14 sprinters (age=21.57±1.16 years) and 10 subjects engaged in jumping track and field events (age=21,80±1,03 years). The sample population belongs to the category of U23 athletes who have been actively practicing athletics for 5 years minimum and have 5 to 6 training sessions a week, in the territory of the Republic of Serbia.

Procedures

The study was carried out in a gym in Novi Sad, in November 2019, by the Helsinki Declaration and with consent obtained from the competent ethic committee. All subjects signed informed consent for the research and participated in the study voluntarily. The coaches and subjects were informed in detail about the aim of the study, applied methods, benefits, and potential risks of the research. The subjects under the age of 19 were excluded from the study as well as those subjects who were injured and those who had not been included in the training process for the last three months.

Measurements

The measurement of anthropometric variables was carried out in the mornings. The instruments used were of standard design, whose accuracy was checked, and the calibration thereof was performed prior to each measurement, whereas the morphological dimensions were always measured by the same measurer.

The body height measurement was performed using the Martin anthropometer (SECAGmBH & Co, Hamburg, Germany), the subjects' body weight was measured using the digital scale TANITA UM-72 (Body Composition Monitor, Tanita Corp, Tokyo, Japan).

The John Bull caliper (CMS instruments, London, UK) was used for measured skinfolds (triceps skinfold, subscapular skinfold, abdominal skinfold, thigh skinfold, calf skinfold, chest skinfold, supra-iliac skinfold, and midaxillary skinfold). The measurements were carried out three times on the right side of the body (ACSM, 2014) and the arithmetic means of these measurements were applied in the further analysis.

Body circumferences (upper arm circumference, thigh circumference, and calf circumference) were measured with an anthropometric tape measure (Gulick tape) with ± 1 mm precision. The measurements were carried out three times on the right side of the body (ACSM, 2014) and the arithmetic mean of these measurements was applied in the further analysis.

Statistical analyses

The collected data were processed in the statistical package SPSS.20 (Statistical Package for the Social Sciences, V.20; SPSS Inc, Chicago, Illinois, USA). For each variable, there was an arithmetic mean (AS) determined as well as a standard deviation (SD) and a coefficient of variation (CV). The deviation of the results from the normal distribution was determined at a level of significance of $p \leq 0.05$ by testing the normality of data distribution using the Shapiro-Wilk test (SW) for small sample sizes. When the data is normally distributed, to determine differences between the two groups of subjects within the system of anthropometric variables we used the multivariate analysis of variance (MANOVA). While differences between groups in one variable we determined univariate analysis of variance (ANOVA). In the cases where the Shapiro-Wilk test demonstrated that data is not normally distributed we used the Mann-Whitney U test.

Results

Table 1 shows the results of the descriptive statistics of the anthropometric variables in the two sub-samples, i.e., sprinters and jumpers. The results have shown that the sprinters were extremely homogeneous in body height and body weight, as well as in upper arm circumference, tight circumference, calf circumference, and calf skinfold. A relative homogeneity was observed in the variables: chest skinfold, subscapular skinfold, supra-iliac skinfold, and midaxillary skinfold. An extraordinary homogeneity can be found in the variables: triceps skinfold, abdominal skinfold and thigh skinfold.

The jumpers may be characterized by extremely homogeneous in terms of the skeleton longitudinally and body mass as well as the body volume shown through the variables upper arm circumference, tight circumference, and calf circumference. A relative homogeneity of this sample can be observed in the variables: subscapular skinfold, chest skinfold, supra-iliac skinfold, and midaxillary skinfold. The results extraordinary homogeneity can be found in the variables: triceps skinfold, abdominal skinfold, thigh skinfold, and calf skinfold.

The scores of the Shapiro-Wilk test and its level of statistical significance have indicated a deviation from the normal distribution ($p \leq 0.05$) in the variables: upper arm circumference, abdominal skinfold, chest skinfold, supra-iliac skinfold, and midaxillary in the group of sprinters. In the jumpers group, statistically significant deviation from the normal distribution ($p \leq 0.05$) is in: thigh skinfold and calf skinfold. There was no statistically significant deviation of the results from the normal distribution ($p \geq 0.05$) found in the remaining variables analyzed (Table 1).

Table 2 shows the results of the MANOVA for the anthropometrics variables which are normal distributed and concluded that there was no statistically significant difference ($P=0.17$) between the groups of U23 sprinters and jumpers. By individual analysis of each anthropometric variable, it may be concluded that there were no statistically significant differences between groups in the analyzed variables ($p>0.05$).

Table 3 presents the results of the Mann-Whitney U test for the anthropometric variable were data not normally distributed. By the analysis of the results in the Table 3, it can be observed that there were statistically significant differences ($p \leq 0.05$) found between the subject who practice different track and field events, sprinters and jumpers, in the variables: chest skinfold ($p=0.03$), midaxillary skinfold ($p=0.02$). There were no statistically significant differences ($p>0.05$) between groups in the remaining variables analyzed: Upper arm circumference, abdominal skinfold, thigh skinfold, calf skinfold and supra-iliac skinfold

Table 1 - Descriptive statistics for anthropometric characteristics analyzed groups

Variable	Sprinters (n=14)			Jumpers (n=10)		
	AS±SD	CV	SW	AS±SD	CV	SW
Body height (cm)	180.45±5.11	2.83	0.92	183.69±4.05	2.20	0.43
Body weight (kg)	77.38±7.95	10.27	0.09	72.87±6.29	8.63	0.96
Upper arm circumference (cm)	28.20±2.08	7.38	**0.05**	29.19±3.79	12.98	0.17
Thigh circumference (cm)	55.07±3.65	6.63	0.16	54.98±4.85	8.82	0.11
Calf circumference (cm)	36.84±2.70	7.33	0.42	38.13 ±2.60	6.82	0.60
Triceps skinfold (mm)	6.10±1.93	31.64	0.86	6.80±1.98	29.12	0.20
Subscapular skinfold (mm)	7.24±1.42	19.61	0.74	8.26±1.43	17.31	0.94
Abdominal skinfold (mm)	6.75±2.36	34.96	**0.03**	8.60±2.84	33.02	0.62
Thigh skinfold (mm)	9.23±2.94	31.85	0.72	11.72±5.84	49.83	**0.04**
Calf skinfold (mm)	5.41±0.74	13.68	0.13	6.26±1.73	27.64	**0.02**
Chest skinfold (mm)	5.33±0.84	15.76	**0.00**	6.18±0.98	15.86	0.47
Supra-iliac skinfold (mm)	6.14±1.02	16.61	**0.00**	7.03±1.30	18.49	0.33
Midaxillary skinfold (mm)	6.53±1.07	1.39	**0.01**	7.70±1.46	18.96	0.14

Legend: AS – arithmetic mean; SD - standard deviation; CV – coefficient of variation; SW - statistical significance level of the Shapiro-Wilk test

Source: Devised by the authors

Table 2 - Differences between groups in the anthropometrics characteristics

Variable	Sprinters (n=14)	Jumpers (n=10)			
	AS±SD	AS±SD	f	p	η^2
Body height (cm)	180.45±5.11	183.69±4.05	2.76	0.11	0.11
Body weight (kg)	77.38±7.95	72.87±6.29	2.41	0.14	0.10
Thigh circumference (cm)	55.07±3.65	54.98±4.85	0.01	0.96	0.01
Calf circumference (cm)	36.84±2.70	38.13±2.60	1.38	0.25	0.06
Triceps skinfold (mm)	6.10±1.93	6.80±1.98	0.75	0.40	0.03
Subscapular skinfold (mm)	7.24±1.42	8.26±1.43	2.98	0.10	0.12

F=1.75 P=0.17

Legend: f – univariate f-test; p – statistical significance level of f-test; F- multivariate F-test; P – statistical significance of multivariate F-test; η^2 - partial eta squared associated with test effect and sufficient sample size

Source: Devised by the authors

Table 3 - Differences between groups in the anthropometrics characteristics

Variable	Sprinters (n=14)	Jumpers (n=10)		
	AS±SD	AS±SD	U	p
Upper arm circumference (cm)	28.20±2.08	29.19±3.79	67.00	0.86
Abdominal skinfold (mm)	6.75±2.36	8.60±2.84	47.50	0.19
Thigh skinfold (mm)	9.23±2.94	11.72±5.84	53.00	0.32
Calf skinfold (mm)	5.41±0.74	6.26±1.73	52.50	0.30

Chest skinfold (mm)	5.33±0.84	6.18±0.98	**34.00**	**0.03**
Supra-iliac skinfold (mm)	6.14±1.02	7.03±1.30	40.00	0.08
Midaxillary skinfold (mm)	6.53±1.07	7.70±1.46	**31.50**	**0.02**

Legend**:** AS – arithmetic mean; SD – standard deviation; U – value of the Mann-Whitney U test; p – statistical significance level of the U test
Source: Devised by the authors

Discussion

The present study aimed to determine the difference in anthropometric characteristics between athletics sprinters and jumpers. The main finding of this study was the difference between sprinter and jumper in anthropometric characteristics (chest skinfold and midaxillary skinfold).

The results of the study have shown that there were no statistically significant differences (p≥0.05) in body height between the sprinters and the jumpers, although the jumpers are taller. Elite athletes who are engaged in sprinting are of various body heights and it ranges between 168cm -191cm (NIELS, 2005), it can be stated that the sprinters who participated in this study have the body height of elite athletes (180.45cm). However, the participants of this study who are engaged in sprinting are taller that the sprinters from the USA (177cm) and about the same body heights as members of the Serbian national team (180.61cm) (ŠOLAJA *et al.*, 2017). A great range of the results of the sprinters' body height can be explained by the fact that sprint includes running events from 60m indoors to 400 m and 400m hurdles outdoors, and hurdle running events, especially, require a higher body height of an athlete to be able to run across hurdles as fast and easy as possible. In this regard, 400m sprinters are, on average, of higher body height (182,75±6,24 cm) compared to 100m sprinters (179.20±5.94cm) and 200m sprinters (180.99±6.17 cm) (SEDEAUD *et al.*, 2014) due to that body height can ensure benefits in 400m running, such as increased stride length (SLEIVERT; ROWLANDS, 1996).

In high-jump athletes, a high correlation has been determined between the anthropometric characteristics and the results achieved in that jumping event (ABRAHAM, 2010; SINGH *et al.*, 2010; LAFFAYE, 2011; SINGH *et al.,* 2012; KAUR TIWANA, 2013). The results achieved in high jump definitely depend on the longitudinal dimensionality of the skeleton (body height) of an athlete, a high level of relative explosive power and flexibility. It is more likely that the jumpers who are of superior body height will accomplish better results in high jumping (MILANOVIĆ, 1980). The results of this study are in accordance with the findings of other studies which determined that the athletes who participate in jumping events are taller than sprinters (ABRAHAM, 2010; AIKAWA *et al.*, 2020).

It has been determined that there was no statistically significant difference ($p \geq 0.05$) in body weight between the sprinters and the jumpers, although the sprinters were heavier by 4.51 kg. Since runners are heavier as running distances are progressively reduced, body weight is defined as a key speed requirement (CHARLES; BEJAN, 2009). The results of this study are in accordance with the results obtained by Abraham (2010) who also determined on a sample of the non-elite athletes such as the sample included in this research, that the body weight of athletes engaged in jumping events (64.1±367kg) is lower in relation to sprinters (68.2±2.97 kg). Compared to the elite Croatian sprinters (VUCETIC *et al*., 2003), the subjects of this study who participate in sprinting events were of higher body weight. Also, the analysis must take into account that the body weight differs in elite and amateur athletes (ASFAW; PALLAVI, 2018) due to many factors and primarily because of the volume and intensity applied in training process (ARRESE *et al*., 2005), and due to diet and dietary supplements, etc. (GUALDI-RUSSO; ZACCAGNI, 2001; STRUDWICK *et al.*, 2002; GOROSTIAGA *et al*., 2005; BÁEZ *et al*., 2014). Generally, a lower relative amount of fat mass is desirable for a successful performance in most sports since an additional body fat mass contributes to a higher body weight, excluding a contribution to power production or energy production capacity, which means a reduction in relative power. In this regard, it is obvious that increased body weight may be harmful in sports activities in which the body performs movements against gravity, such as high jump and pole vault, or in which the body makes horizontal movements, such as running (ABRAHAM, 2010).

By gaining insight into the results of the study, it may be concluded that the sprinters showed lower average values of skinfold in all the variables examined, where a statistically significant difference ($p \leq 0.05$) has been determined between the groups in the chest skinfold and midaxillary skinfold variables. Such findings are in accordance with numerous previous studies (GORE, 2000; VUCETIC *et al*., 2005; SHAFEEQ *et al*., 2010) which determined that the subjects who participated in running events have a lower body skinfold in relation to the subjects who were engaged in other track and field events. The sprinters and jumpers who were included in this study had lower average values of the upper arm skinfold in relation to the athletes from India who were engaged in sprinting (8.88±2.00 mm) and jumping events (9.35 ±1.08 mm) and subscapular skinfold (sprinters: 9.15±0.55; jumpers: 9.20±1.09 mm). The average values of other measured skinfolds were significantly higher in our sprinters and jumpers in comparison to the subjects included in the study of Shafeeq *et al.* (2010) and in the abdominal skinfold (sprinters: 8.39±1.25 mm; jumpers:9.35±1.06), chest skinfold (sprinters:

6.15±1.23 mm; jumpers: 6.73±0.60 mm), calf skinfold (sprinters: 5.38±0.46; jumpers: 5.84±0.67 mm), and supra-iliac skinfold (sprinters: 7.84 ±1.27 mm; jumpers: 9.96 ±1.19 mm).

The analysis has shown that the two specified groups of athletes differed in anthropometric characteristics, only in the chest skinfold and the midaxillary skinfold. The group of athletes who participate in jumping events has great values in chest skinfold and the midaxillary skinfold compared with sprinters. The sprinters mostly have a greater muscle mass, which may be their advantage at the start of a race and during the initial acceleration stage (SHAFEEQ *et al*., 2010).

A small size of the sample represents a limitation of this study, due to a really small number of subjects belonging to this U23 category who are actively involved in athletics in Serbia.

Conclusion

It can be concluded that there are specific differences in the anthropometric characteristics between the sprinters and the athletes involved in jumping events found in the sample consisting of U23 athletes. The largest statistically significant differences have been manifested in the conditions of subcutaneous fat, whereby the sprinters demonstrated lower values in the chest and axilla region. The differences may be attributed to higher energy demands in sprint events.

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