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RELATIONSHIP AMONG SPRINT PERFORMANCE, BODY COMPOSITION, AND AEROBIC POWER IN COLLEGIATE PEOPLE

ODNOS MED USPEŠNOSTJO ŠTUDENTOV V ŠPRINTU, NJIHOVO TELESNO ZGRADBO IN AEROBNO MOČJO

ABSTRACT

This study was aimed to investigate relationship among aerobic power, 10 meters and 100 meters sprint running speed, vertical jump and physical properties of male and female adolescents who engaged in regular physical activity. This study consisted of a total of 877 adolescents including 725 male and 142 female. A 12 minutes run for aerobic power test, vertical jump for anaerobic power, 10 meters and 100 meter sprints, body height, body weight, skinfold measurements and body mass index (BMI) assessments were made respectively. Independent t-test analysis was performed for comparison between the male and female in all variables. To determine the relationship variables, the correlation coefficients were calculated. It was determined that 100 meters test was highly correlated than 10 meters speed tests, vertical jump score was more powerful indicator than anaerobic power, and the sum of seven skinfold was also more powerful indicator than BMI in determination of aerobic power in males. Aerobic power showed no significant correlation with body weight, body height, BMI, vertical jump score, anaerobic power and 10 meters sprint in females. The aerobic power increases with increasing the sprint distance. The vertical jump height, anaerobic power, 10 m sprint running speed, 100 m sprint running speed, body weight, BMI and the sum of 7 skinfolds measurement have more assocations of aerobic power in males while 100 m sprint running speed, and the sum of 7 skinfolds measurement were strongly correlated with aerobic power in females.

Keywords: Aerobic Power, Speed, Vertical Jump, Skinfold, BMI

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IZVLEČEK

Cilj raziskave je bil proučiti povezavo med aerobično močjo, šprintom na 10 in 100 metrov, vertikalnimi skoki in telesnimi značilnostmi mladostnikov in mladostnic, ki se redno ukvarjajo s telesno dejavnostjo. V raziskavi je sodelovalo skupaj 877 mladostnikov, in sicer 725 fantov in 142 deklet. Meritve so zajemale testiranje aerobne moči pri 12-minutnem teku, anaerobne moči pri vertikalnih skokih, šprinte na 10 in 100 metrov, telesno višino, telesno težo, merjenje kožne gube in indeks telesne mase (BMI). Izvedli smo neodvisno analizo t-testa, da smo lahko merjence in merjenke primerjali v vseh spremenljivkah. Za določitev spremenljivk odnosa smo izračunali korelacijske koeficiente. Ugotovili smo višjo korelacijo pri hitrostnem testu na 100 metrov kot na 10 metrov; rezultat vertikalnega skoka je bil močnejši pokazatelj kot anaerobična moč; vsota sedmih meritev kožnih gub je bila tudi močnejši pokazatelj kot BMI pri ugotavljanju aerobne moči merjencev. Aerobna moč merjenk ni bila pomembno povezana s telesno težo, telesno višino, BMI, rezultatom vertikalnih skokov, anaerobično močjo in šprintom na 10 metrov. Aerobna moč se je povečevala z večjo šprintersko razdaljo. Pri moških sta bili višina vertikalnega skoka in vsota meritev kožne gube bolj povezani z aerobično močjo, medtem ko sta pri ženskah šprint na 100 metrov in vsota meritev kožne gube močno korelirala z aerobno močjo.

Ključne besede: aerobna moč, hitrost, vertikalni skok, kožna guba, BMI

INTRODUCTION

It was confirmed that physical performance in numerous competitive sports events depends mainly on the incorporated status of the diverse physiological mechanisms of the individual. It was suggested that, to develop optimal physical fitness training programs, it is important to know which parameters of physical fitness, and to what extent, are associated with performance (Nikolaidis et al., 2013), and evaluation of the aerobic performance of athletes is one of the most important issues in sports, many test used in order that selection measures, for screening candidates, or to screen the efficiency of training regimes (Norkowski, 2002). In spite of sports performance professionals and sports facilitators focus on performance evaluation, it was reported that there is limited research investigating the relationships between maximal oxygen uptake and various motor skills including speed, anaerobic power and body composition (Vescovi and McGuigan, 2008).

Maximal oxygen uptake (VO_2max) is generally accepted as the component of health and performance related physical fitness. The direct measurement of VO_2max requires sophisticated equipments and qualified labour to conduct the tests while the indirect methods of estimating VO_2max are preferentially used in large population. Due to the limited time and costs, the direct measurement of VO_2max is also not useful in assesement of athlete performance during talent idendification and training. It was reported that training at or little above the anaerobic threshold intensity improves both the aerobic capacity and anaerobic threshold level. This intensity is greatly correlated with distance running performance and even training at or a little above this intensity is efficient in enhancement of anaerobic threshold not only in elite athletes, but also in sedentary people (Ghosh, 2004). The very short maximal effort can be feasible in the prediction of the aerobic power as practical alternatives to the assesment of aerobic power instead of the laboratory or field tests. Weston, Castagna, Helsen and Impellizzeri (2009) found that the fastest 40-m sprint of soccer refrees was related to total distance covered during the match. This can be evaulated as an indirect indicator of aerobic performance. Also, it was suggested that the use of peak speed itself, rather than the estimated maximum oxygen uptake, could be an integrated measure of aerobic performance, concurrently accounting for both running economy and aerobic power (Rampinini, 2007). Several authors speculated that the sprint test scores would be related to distance covered at high-intensity running and sprinting during matches (Weston, Castagna, Helsen & Franco İmpellizzeri, 2009). So, those studies imply that athletes with higher sprint speed can have higher performance at distance running than athletes with lower sprint speed because athletes with higher running speed can run with the lower percentage of their maximal effort at the real competetion running pace. Thus, maximal sprinting speed could play an important role in the determination of their effort level during competetion.

İt was also suggested that body fat is predictive of physical function (Lord et al., 2002). Body composition is another factor that is commonly accepted to have an enormous power on athletic performance (Reilly et al., 2000). In particular, body fat and fat free mass have been accepted as critical components of anaerobic performance. Body weight, lean body mass and body fat are crucial factors in relation with anaerobic performance (Mayhew et al., 2001).

Consequentlly, researchers have generated various non-exercise based tests for predicting VO_2max that utilize variables of physical parameters such as age, gender, body height, body weight, BMI, body fat percentage (Sweate, 2012). To evaluate the aerobic power during training and talent identification needs much effort and a long recovery time for athletes. The capability to evaluate the aerobic power with short-term effort may be useful in the talent identification and training. Therefore, this study aims to find the assosations among aerobic power, 10 meters and 100 meters sprint mean running speed, vertical jump and physical properties of male and female adolescents engaged in regular physical activity.

METHODS

This study consisted of a total of 877 adolescents including 725 male and 142 female. A 12 minutes run for aerobic power test, vertical jump for anaerobic power, 10 meters and 100 meter sprints, body height, body weight, skinfold measurements and body mass index (BMI) assessments were made respectively. All measurements were taken during talent scouting of physical education and sport department designed to select successful candidates. The participants were not informed of the outcomes until the study was concluded.

Anthropometric Measurements

A stadiometer with the accuracy to 1 cm (SECA, Germany), while electronic scales (Tanita BC 418, Japon) accurate to 0.1 kg were used for body mass and percentage of body fat measurements (Lohman et al., 1988).

BMI and Skinfold Assesments

Body mass index (BMI) was calculated using the formula: weight (kg) divided by height (m) squared. Skinfold thicknesses were measured from seven different anatomical regions including biceps, triceps, subscapula, abdominal, chest, femur and calf with a Holtain skinfold caliper at the right side of the body by the same person. The body fatness was evaulated by sum of seven skinfolds.

Vertical Jump Test Protocol

Sargeant jump test was used to evaluate jump height (cm) of the subjects. The participant warms up for 10 minutes and chalks the end of his/her finger tips. The participant stands side onto the wall, keeping both feet remaining on the ground, reaches up as high as possible with one hand and marks the wall with the tips of the fingers (M1). The participant from the stationary position jumps as high as possible and marks the wall with the chalk on his fingers (M2). Then the distance between M1 and M2 was measured and jumpimg height was calculated. The best value of two trials was recorded as vertical jump height.

The athlete's anaerobic power was calculated by following formula:

$P= (\sqrt{4.9}\ (w)\ \sqrt{D}\ )$

Where:

P: Anaerobic power (kg.m/sec)
W: Body weight (kg)
D: Jumping distance (m)
$\sqrt{4.9}$: Standard time (sec)

During the jump, an approach step was not allowed. A 0.5- to 1.0- minute rest period was given between trials (Fox et al., 1988).

Sprint Tests

After a standardized 15-min warm-up including low-intensity running, several acceleration runs, and stretching exercises, the participants underwent a sprint test that consisted of two maximal 100 m sprints with timing at 10 and 100m, with a 3 min rest period between each sprint.

VO_2max Test

Each subject completed the Cooper 12 minute run fitness test. Marking cones, a stopwatch and an oval running track were used to conduct the test. The objective of the test was to run or walk as much as you can in the 12-minute period. With the obtained result, VO_2max level was determined using the following formula (Cooper, 1968).

$VO_2max\ (ml \cdot kg^{-1} \cdot min^{-1}) = (22.351 \times \text{distance covered in kilometres}) - 11.288.$

Statistical Analyses

The data are reported as means and standard deviations. Before using parametric tests, the assumption of normality was verified using the Kolmogorov Smirnov test. İndependent t-test analysis was performed for comparison between the men and women in all variables. The relationships between fitness parameters were evaluated by the Pearson Product Moment Correlation analysis. All analyses were executed in SPSS 22 and the statistical significance was set at $p < 0.05$.

RESULTS

The comparative results between two genders indicated that males' speed, BMI, age, body height, anaerobic power, and VO_2max were significantly different and superior than females (Table 1).

The corrrelations analysis indicated that physically active males's anaerobic power siginificantlly correlated with VJ (0.84), body weight ($p< 0.05$, r=0.636), height($p< 0.05$, r=0.382), skinfold ($p< 0.05$, r=0. 133), 10 meters speed ($p< 0.05$, r=0,19) and 100 meters speed ($p< 0.05$, r=0.348). The mean 10 meters sprint running speed were siginificanlyy corelated with $MaxV0_2$ ($p< 0.05$, r=0.12), VJ ($p< 0.05$, r=0.225), and ($p< 0.05$, r=0.53) 100 meters mean sprint running speed. Hundred meters speed is significantly corelated with Max $V0_2$ ($p< 0.05$, r=0.388) and VJ ($p< 0.05$, r=0.394)

The corrrelations analysis of females indicated that physically anaerobic power siginificantlly correlated with VJ ($p< 0.05$, r=0.86), body weight ($p< 0.05$, r=0.51), height ($p< 0.05$, r=0.41), BMİ ($p< 0.05$, r=0. 29), 10 meters speed ($p< 0.05$, r=0,23) and 100 meters speed ($p< 0.05$, r=0.46). Ten meters scores were also correlated with VJ ($p< 0.05$, r=0.23) and moderatelly correlated with (0.56) hundred meters speed. Hundred meters speed is significantlly corelated with $MaxV0_2$ ($p< 0.05$, r= 0.40), VJ ($p< 0.05$,r=0.51) (Table 2).

DISCUSSION AND CONCLUSION

An athlete's speed and aerobic fitness is a vital component of performance regardless of the sporting event. Yet, direct VO_2max testing requires expensive equipment and it is not practical in the field. This study aims to investigate the relations among aerobic power and 10 meters and 100 meters sprints, vertical jump and body fat of male and female adolescents who engaged in regular physical activity. The results of the evaluations indicated that the aerobic power significantly

Table 1. Comparison of BMI, speed, aerobic and anaerobic power of physically active male and female adolescents.

Variables	Group	N	M± SD	Min-Max.	n	t-value	Sig.
Age (year)	Males	735	21,54 ± 2,36	17-32			
	Females	142	20,92 ± 2,38	17-29	875	2,891	,004**
	Total	877	21,44 ± 2,38	17-32			
Body Height (cm)	Males	735	172,66 ± 6,37	151-195			
	Females	142	163,04 ± 5,92	145-177	875	16,667	,000**
	Total	877	171,1 ± 7,22	145-195			
Body Weight (kg)	Males	735	64,23 ± 6,9	43-87			
	Females	142	51,56 ± 5,74	40-74	875	20,548	,000**
	Total	877	62,18 ± 8,19	40-87			
Body Mass Index (BMI)	Males	735	21,64 ± 2,73	15,74-59,52			
	Females	142	19,37 ± 1,95	14,87-26,85	875	9,432	,000**
	Total	877	21,27 ± 2,75	14,87-59,52			
Sum of 7 Skinfolds (mm)	Males	735	48,68 ± 15,07	25,4-121,2			
	Females	142	99,43 ± 23,06	45,8-158,5	875	-33,312	,000**
	Total	877	56,9 ± 25,02	25,4-158,5			
Vertical Jump (cm)	Males	735	48,77 ± 7,47	23-76			
	Females	142	32,54 ± 5,97	19-52	875	24,430	,000**
	Total	877	46,15 ± 9,4	19-76			
Anaerobic Power (kg.m/sec)	Males	735	123,42 ± 12,31	85,59-167,12			
	Females	142	90,16 ± 9,79	68,23-118,38	875	30,378	,000**
	Total	877	118,03 ± 17,11	68,23-167,12			
10 m Sprint Mean Running Speed (m/sn)	Males	735	4,97 ± 0,28	4,27-8,78			
	Females	142	4,18 ± 0,27	3,46-5,76	875	30,887	,000**
	Total	877	4,84 ± 0,4	3,46-8,78			
100 m Sprint Mean Running Speed (m/sn)	Males	735	7,34 ± 0,4	5,86-8,39			
	Females	142	5,77 ± 0,37	4,75-6,91	875	43,739	,000**
	Total	877	7,09 ± 0,7	4,75-8,39			
12 minutes Run Test (m)	Males	735	3038,22 ± 175,44	2800-3681			
	Females	142	2412 ± 158,99	2200-2968	875	39,511	,000**
	Total	877	2936,83 ± 288,33	2200-3681			
Max. VO_2 (ml.kg.dk^{-1})	Males	735	56,62 ± 3,92	51,29-70,99			
	Females	142	42,62 ± 3,55	37,88-55,05	875	39,512	,000**
	Total	877	54,35 ± 6,44	37,88-70,99			

** Significant difference at 0.01 level.

Table 2. Correlations coefficients of BMI, speed, aerobic and anaeorobic power of physically active male and female adolescents.

Gender Groups	**Males**	**Females**
Variables	**MaxVO$_2$**	**MaxVO$_2$**
MaxVO$_2$	1	1
Vertical Jump	**,178****	,109
Anaerobic Power	**,079***	,011
10 m sprint mean running speed	**,122****	,161
100 m sprint mean running speed	**,388****	**,401****
Body Weight	**-,106****	-,165
Age	,043	,136
Body Height	,002	-,073
BMI	**-,083***	-,117
Sum of 7 Skinfolds	**-,273****	**-,294****

correlates with increasing sprint distance. The vertical jump height and the sum of 7 skinfold measurement were highly correlated with aerobic power in males while 100 meters sprint run and sum of seven skinfolds was strong indicator of aerobic power in females.

Anaerobic performance depends on many factors (Kin-İşler et al., 2008). İt was reported that muscular strength is one of the significant factors that have a major role in anaerobic performance and this is because with increased muscular strength the ability of muscles to generate power in short-term high intensity activities also increases (Ozkan et al., 2012). Vertical jump performance (VJ) can be used to measure of lower limb muscular power. In the present study, the correlational analysis indicated that physically active males's anaerobic power siginificantly correlated with VJ ($p< 0.05$, $r=0.84$), body weight ($p< 0.05$, $r=0.636$), BMI ($p< 0.05$,$r=0.338$), 10 meters sprint mean running ($p< 0.05$, $r=0,19$) and 100 meters sprint mean running ($p< 0.05$, $r=0.348$). On the contrary to our results, in some studies, it was also reported that there were important association reported between peak anaerobic power (assessed using the Wingate test) and repeated sprint indices (Bishop et al., 2004; Haj-Sassi et al., 2011). Yet, there were still some moderate correlations bewen anerobic power and 100 meters speed in our study and previous studies used Wingate test in comparison to our study. Also, the findigs of our study also determined that anerobic power performance was highly correlated with VJ values similar to the findings of several studies. For example, Arnason et al. (2004) reported a linear relationship between counter-movement jump, leg power and team success; that is, teams with higher fitness levels and lower percent body fat had a higher league ranking. In addition, Burr et al. (2008) has demonstrated that leg power, as measured by a vertical jump test, was moderately correlated with National Hockey League Entry Draft selection order. According to another study, all jump performance variables had a significant relationship with peak power and mean power ($p<0.05$ and $p<0.01$)(Brooks et al., 2000). In our study, vertical jump height had higher corelation than anerobic power in VO$_2$max; thus, it can be said that vertical jump height is more powerful indicator of VO$_2$max than anerobic power performance.

In the present study, body composition was not significantly correlated with anerobic power. Previous studies noted similar findings. In a study, it was found there was not any significant correlation between BMI and the rest indices of WAnT. The findings in that study suggested that the players with higher BMI have lower jumping abilities and lower anaerobic capacity (Nikolaidis and İngebrigtsen, 2013). They found that there was a opposite correlation between BMI and mean power during the 30 s WAnT, which was not significant neither for adolescent nor for adult team handball players. It was reported that having low training experience may be one of the reasons for not finding an association between body composition, anaerobic performance and one possible explanation for the lack of association may be the different energy systems that each measure demands (Özkan et al., 2012).

It was confirmed that VO_2max is highly dependent upon body composition of an individual and percentage of body fat is usually mesured by using skinfold thickness in clinical and field setting since this method is simple to use and low in cost (Shweta, 2012). In our study, sum of 7 skinfols scores had higher correlation with VO_2 max than BMI scores. Thus, skinfold measurements are anticipated to be more powerful predictor of Vo_2 max than BMI. Jackson et al., (1990) developed two models to predict cardiorespiratory fitness using body composition. One of the models used BMI as measure of body composition, and the other the amount of fat predicted by skinfold measurements. According to the authors, both models showed good predictive values. According the results of this study, correlation coefficients between predicted and observed values in the model including skinfold and BMI were of 0.82 and 0.79, respectively indicating higher correlations with skinfold measurements. Also, Williford et al. (1996) found that both, the BMI and the fat percentage models showed good correlation ($p<0.05$, $r = 0.81$ and $p<0.05$, $r=0.86$, respectively), confirming accuracy of these models also in females aged 18 to 45 years. It was proposed that as the events increase in time, the role of aerobic metabolism to performance goes up and up. The duration of that race (an hour) requires a large aerobic engine. It was reported that, during exercise, VO_2max is limited by the ability of the cardiorespiratory system to transport oxygen to the exercising muscles (Ghosh, 2004). As the distance goes up, the contribution of aerobic metabolism goes up to and this is reflected in the training done. Training intensity has been regarded as the most important variable that can be manipulated for VO_2max enhancement (Wolfarth, 2005; Rubert, 1986). In the present study, the lower correlation of VO_2 max with 10 meters has increased with 100 meters sprint test. The peak speed reached during the incremental field test was found to be significantly associated with total distance (Rampinini, 2007). Similar to those found by previous investigators were found using laboratory incremental treadmill tests of maximum oxygen uptake in junior (İmpellizzeri, Marcora, Castagna, Reilly, Sassi, İaia Rampinini, 2006), and professional (Krustrup, Mohr, Amstrup, Rysgaard, Johansen, Steensberg, Pedersen, Bangsbo, 2003) soccer players. Also, according to the study of Rampinini et al., (2007), it was found that there were significant relationships between peak speed during the incremental field test and distance covered at high and very high running speeds. It was suggested that the ability to cover greater distances at high running speeds during a match is associated with aerobic fitness (Rampinini, Bishop, Marcora, Ferrari Bravo, Sassi, & İmpellizzeri, 2007).

Several studies investigated assosiations between repeated sprint ability (RSA), muscular power and aerobic fitness. Recent study investigated the assosiations between aerobic capacity and repeated sprint ability in professional soccer players and the results of the study indicated that there were significant moderate negative correlations between VO_2 max and RSA ($p = -0.655$, $p < 0.01$) (Jones, Cook, Kilduff, Milanovi, Sporiš, Fiorentini, Fiorentini, Turner, Vuİkovi, 2013). Another study indicated that there were very large correlations between performance on the 40-m sprint test and both match high-intensity running and sprinting despite while Mallo et al. (2009)

reported that the best and mean 40-m times were poorly correlated with the distance covered at high speed running during matches. Also, Castagna et al. study (2002) reported that the 12-min run had only a low correlation with high intensity and maximal speed running (P<0.05, r= 0.51 and P<0.05r=. 0.32, respectively). According to the findings of another study, performance on the 40-m sprint test correlated with total distance covered (Weston, 2009). The findings of these studies to some extend were similar to the results of our study. Thus, these studies confirmed that athletes with higher sprint speed can have higher performance at distance running than athletes with lower sprint speed because athletes with higher running speed can run with the lower percentage of their maximal effort at the real competetion running pace. This means that running economy inreases with the increasing average sprinting speed during 12 minutes run test. These findings demonstrate a relationship between sprint performance and VO_2max due to an important role in the determination of athletes effort level during competetion.

İn the present study, the lower correlation of VO_2 max with 10 meters has increased with 100 meters sprint mean running speed. This shows that increased sprint distance is the main indicator of the VO_2 max. Also, VO_2 max was more affected by body fat percentage compared to BMI and VO_2 max was more affected by vertical jump height than anaerobic power in which jump height is multiplied by body weight. The findings of the study also indicated that the correlation coefficients varied in male and female adolescents. It was previously stated that studies children including different age groups included in the long-term follow-up studies would contribute in different facets of aerobic capacity (Sevimli & Kocyigit, 2009).

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