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Review Paper

## RAZLIKE U MORFOLOŠKIM KARAKTERISTIKAMA ATLETIČARKI SKAKAČICA FINALISTA OLIMPIJSKIH IGARA U PEKINGU

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**Sažetak:** Antropološki prostor je vrlo značajan i primaran u selekciji, usmjeravanju i postizanju rezultata u sportu. To se naročito ispoljava u vrhunskom sportu gdje se postižu izuzetni rezultati. Zavisno od sporta, sportske discipline zavisi i učešće i uticaj antropološkog prostora, odnosno njegovih segmenata na ukupan rezultat. Kada se opisuje i definiše određena populacija sportista, njihov morfološki prostor, najčešće se kao parametri analiziraju tjelesna visina, tjelesna masa, bodi mass index, a vrlo često i starosna dob ispitanika. Ovi parametri su vrlo pouzdani i daju realnu sliku o morfološkom prostoru ispitivane populacije. U radu su analizirane razlike u segmentima morfološkog prostora atletičarki skakačica, finalistkinja Olimpijskih igara u Pekingu. Uzorak je obuhvatio 32 takmičarke u četiri discipline (skok u dalj, skok u vis, troskok, skok motkom). Analizirane su razlike u tjelesnoj visini, masi tijela, BMI i starosnoj dobi. Za obradu podataka primjenjen je T-test za male nezavisne uzorke koji je potvrdio postojanje statistički značajnih razlika u tjelesnoj visini atletičarki u disciplinama: skok u dalj - skok u vis ( $T=-2.906$ ,  $p<0.05$ ), skok u vis - troskok ( $T=3,448$ ;  $p<0.01$ ), skok u vis - skok motkom ( $T=3,469$ ;  $p<0.01$ ). Razlike su potvrđene i u vrijednostima BMI u disciplinama: skok u vis-skok u dalj ( $T=3,496$ ;  $p<0.01$ ) i skok u vis-troskok ( $T=-3,136$ ;  $p<0.01$ )

**Ključne riječi:** morfološke karakteristike, atletičarke, Olimpijske igre, skakačke discipline.

**Uvod**

Atletika kao grana sporta sa velikim brojem disciplina u muškoj i ženskoj konkurenciji zauzima vrlo važno mjesto u hijerarhiji sportova, a vrlo često je nazivaju kraljicom sportova, zbog istorijskog nastanka i razvoja, velikog broja disciplina (hodanja, trčanja, skokovi, bacanja) i uticaja atletskih kretanja u razvoju jed-

## DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS OF FEMALE ATHLETICS JUMPERS FINALISTS OF THE BEIJING OLYMPICS

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**Abstract:** Anthropological space is very important and primary in the selection, targeting and achieving results in sport. This is particularly apparent in professional sport where remarkable results are achieved. Depending on the sport and sport discipline, the participation and influence of human space, or its segments depend on the total score. When describing and defining specific populations of athletes, their morphological status, the most common parameters that are taken are body height, body weight, body mass index, and very often the age of the respondents. These parameters are very reliable and give a true picture of the morphological area of the studied population. This paper analyzes the differences in the segments of morphologic space of female jumpers, the finalists of the Beijing Olympics. The sample included 32 competitors in four jumping disciplines (Long jump, High jump, Triple jump, Pole vault). Differences in Body height, Body weight, BMI and age were analysed. For data processing T-test has been applied for small independent samples that confirmed the presence of statistically significant differences of Body height female competitors between disciplines: Long jump- High jump ( $T=-2,906$ ;  $p<0.05$ ), High jump-Triple jump ( $T=3,448$ ;  $p<0.01$ ) and High jump-Pole vault ( $T=3,469$ ;  $p<0.01$ ). The differences were confirmed in BMI values in the disciplines: High jump-Long jump ( $T=3,496$ ;  $p<0.01$ ) and High jump-Triple jump ( $T=-3,136$ ;  $p<0.01$ ).

**Key words:** morphological characteristics, female jumpers, jumping disciplines, differences, Olympic game.

**INTRODUCTION**

Athletics as a branch of sport with a large number of sports disciplines in the men and women competition occupies a very important place in the hierarchy of sports and is often called the queen of sports, because of the historical emergence and development, of a large number of disciplines (walking, running, jumping, throwing), and the impact

nog normalnog psihosomatskog i motoričkog razvoja organizma čovjeka u smislu ovladavanja, usavršavanja, nadogradnje i provjere motoričkih i funkcionalnih sposobnosti čovjeka (Pavlović, 2010). Ono što je interesantno i vrlo česta tema mnogih razgovora, kad se govori o atletici uopšte, jesu njene discipline i rezultati koji se u njima postižu, odnosno koje atletičari ostvaruju kao svoje lične rekorde. Tu se nameću brojna pitanja? Obično se govori o njihovim trenažnim tehnologijama, vrsti i sastavu opreme, neke novine u njihovim modelima, načinu ishrane i njenom uticaju na organizam atletičara (unos UH, masti, proteina), trenažnom procesu (trajanje mikro, mezo, makrociklusa, obimu i intenzitetu rada), korišćenju (ne) dozvoljenih stimulativnih sredstava kojima u poslednje vrijeme pribjegava veći broj atletičara u cilju postizanja što boljeg rezultata, iako svjesni posljedica koje slijede, diskvalifikacija, zabrane takmičenja na kraćem i dužem vremenskom periodu, a vrlo često negativnim posljedicama na trajno zdravlje sportiste. Pored ovih pitanja na koje imamo nekada potpune a nekada nepotpune odgovore, česta su i ona koja se tiču morfološkog i motoričkog prostora atletičara. Oba prostora su vrlo važna u rezultatskoj uspješnosti i plasmanu i obično se analiziraju u korelaciji, zavisno od discipline i njenog načina izvođenja. Ipak, najbolji rezultati se postižu ukoliko postoji visoka korespondencija između ovih prostora, a što zahtijeva određena disciplina. Pored motoričkih sposobnosti koje imaju vrlo važnu ulogu, ništa manje ne zaostaju i morfološke dimenzije na bazi kojih se pravi selekcija i usmjeravanje mladih atletičara u određenu disciplinu u kojoj se očekuje postizanje najboljih rezultata (Milanović, i sar. 1986; Radić i Simeonov, 2012). Naime, poznato je da skakačke discipline karakteriše povećana longitudinalnost i transversalnost skeleta, manja tjelesna masa i na bazi kojih se pravi jedan model skakača (Pavlović, 2013). Generalno uzevši, skakači su visokog rasta i relativno manje tjelesne mase, dugih nogu, dugih i tankih mišića. Po konstituciji je vodeći leptosomni tip sa učešćem atletskog tipa (Kobrinskij, Juškevič, Konikova, 2005). Skakači u dalj i u troskoku se po izgledu i konstituciji približavaju sprinterima (Radić i Simeonov, 2012). Jedna od osnovnih karakteristika koja je opšta za sve skakače u vis, jeste njihova tjelesna visina. Osam finalista Olimpijskih igara u Pekingu imali su visinu tijela od 181-199 cm kod muških i 175-193 kod žena (Pavlović, 2012). Skakači u vis imaju duge noge i srazmjerno tome kraći trup. Mogućnost procjene definitivne tjelesne visine skakača dječaka i djevojčica početnika može se suditi po njihovoj dužini šaka i stopala. Ukoliko su

of athletic movement in a normal psychosomatic development and motor development of a human in sense of mastery, training, upgrading and testing of motor and functional abilities of man (Pavlovic, 2010). What is interesting and a very common topic of many conversations, when it comes to athletics in general, is its disciplines and the results achieved in them, that is which the athletes achieve as their personal records. This imposes a number of questions. Usually we talk about their training technologies, type and composition of the equipment, what is the equipment made of, some new things in their models, diet and its impact on athletes' body (carbohydrates, fats, proteins), the training process (duration of the micro, meso, macrocycle, scope and intensity of work); using (not) allowed stimulants which lately use a number of athletes in order to achieve better results, although aware of the consequences that follow, a disqualification, prohibition of competition in the short and long periods of time, and often negative consequences on the permanent health of athletes. In addition to these questions at which we have complete and sometimes incomplete answers, often are those concerning the morphological and motor space of athletes. Both spaces are very important in the result success and placement and usually are analyzed in correlation, depending on the discipline and its method of execution. However, best results are achieved if there is a high correspondence between these spaces, which requires a certain discipline. In addition to motor skills, which have a very important role, no less lag have morphological dimensions on the basis of which selection and guidance of young athletes in a particular discipline is made, in which is expected the achievement of the best results (Milanović, et al. 1986; Radić & Simeonov, 2012). Namely, it is known that jumping disciplines are characterized by increased longitudinality and transversality of the skeleton, lower body weight and on the basis of which is made one model of jumper (Pavlović, 2013). Generally, the jumpers (male and female) are tall and relatively of less weight, long legs, long and thin muscles. According to the constitution the leading is leptosom type with the participation of thletics (Kobrinskij, Juškevič & Konikova, 2005). Long jumper and triple jumper are by their appearance and constitution closer to the sprinters (Radić & Simeonov, 2012). One of the main characteristic that is general for all the jumpers in the air is their body height. Eight finalist jumpers in the Olympic Games Beijing have a height of 181-199cm for males and 175-193 for females (Pavlović, 2012). Jumpers in the air have long legs and comparatively short torso. About the possibility of increasing the body height of boys and girls jumping beginners can be judged by their long hands and feet. If the child's hands and feet are long, that is the assumption that in the future will come to the leveling of body proportions (Đurašković, 1997).

šake i stopala djeteta dugi, to je pretpostavka da će u budućnosti doći do izravnavanja proporcije cijelog tijela (Đurašković, 1997). Kao pokazatelj motoričkog stanja skakača javlja se potencijal brzinske snage, koji se ispoljava kod brzog i maksimalno snažnog odskoka, kada pritisak na tlo prevazilazi težinu sportiste 6-7 puta. Za ovo je potrebna specifična snaga, ne samo nogu već i svih mišićnih grupa. U svim daljinskim i visinskim skokovima, od faze odskoka pa do doskoka, dolazi do izražaja sinhronizovano djelovanje mišićnih kinetičkih lanaca, koji se prostire od stopala do mišića ruku i ramenog pojasa. Za izvođenje složenih radnji, kako prilikom ulaska u odskok, tako i prilikom samog skoka, potreban je visok nivo koordinacije pokreta i dobro stanje vestibularnog aparata. Potreba većih amplituda prilikom zamajnih pokreta kod varijanti skokova zahtijeva da skakači postignu visoku pokretljivost i mišićnu elastičnost (Bowerman et al. 1998).

U okviru skakačkih disciplina uočavaju se određene razlike ali i sličnosti u pogledu morfološkog statusa atletičara skakača u dalj, troskoku, skoku u vis, skoku motkom. Postojeće razlike i sličnosti između ovih disciplina su uslovljene fizičkim stanjem takmičara, tehnikom izvođenja svake od disciplina, uticajem endogenih faktora itd. U istraživanju (Pavlović, Radić, Simeonov, i sar. 2013) analizirane su razlike u antropološkom prostoru skakača finalista Olimpijskih igara u Pekingu. Primjenjen je T-test za male nezavisne uzorke koji je potvrdio postojanje statistički značajnih razlika samo u tjelesnoj visini između skakača u dalj i skakača troskoka ( $T=-2,747$ ;  $p<0,05$ ) i skakača u dalj i skakača u vis ( $T=-2,280$ ;  $p<0,05$ ).

Upravo iz tih razloga je interesantno definisati cilj ovog istraživanja a koji tretira problem morfološkog statusa atletičarki skakačica finalistkinja na Olimpijskim igrama u Pekingu 2008. godine gdje bi se na bazi njihovih parametara mogla dobiti realna slika o morfološkom statusu i starosnoj strukturi ženskih finalista.

## METOD

Istraživanjem je obuhvaćen uzorak od 32 vrhunskih atletičarki u skakačkim disciplinama (skok u dalj, skok u vis, troskok, skok motkom) koje su nastupile u finalu Olimpijskih igara u Pekingu 2008. godine. Varijable koje su uzete u analizu su one koje definišu: visinu tijela (Body Height-cm), masu tijela (Body Weight-kg), Body Mass Index (BMI-kg/m<sup>2</sup>) i godine života (Age).

Da bi se dobili relevantni rezultati na bazi kojih se mogu dobiti odgovori, primjenjeni su osnovni statistički parametri, a u pogledu utvrđivanja razlika izvršena je analiza primjenom T-testa za male nezavisne uzorke.

As an indicator of physical condition of jumper, there is the potential of speed power, which is expressed at speed and a maximum strong rebound when the pressure on the soil exceeds the weight of athlete 6-7 times. This requires a specific power, not only of legs but of all muscle groups.

In all the remote and high-altitude jumps from the stage of take-off until drop jumps, comes into play synchronized actions of muscular kinetic chains, which extends from the foot to the muscles of arms and shoulders. To perform complex actions, both when entering the bounce, and during the jump, a high level of coordination of movements is needed and a good state of the vestibular apparatus. The need of larger amplitude in swing movements at variants of jumps requires that jumpers achieve high mobility and muscle elasticity (Bowerman et al. 1998). Within jumping disciplines some differences can be observed but also similarities in terms of the morphological status of athlete jumping long jump, triple jump, high jump, pole vault. The existing differences and similarities between these disciplines are conditioned by the physical condition of athletes, technique of performing each of the disciplines, the influence of endogenous factors and so on.

In the research (Pavlović, Radić, Simeonov, et al. 2013), the differences in the segments of human space of male jumpers, the finalists of the Beijing Olympics were analyzed. For data processing T-test has been applied for small independent samples that confirmed the presence of statistically significant differences of body height between long jump and triple jump ( $T=-2,747$ ;  $p<0.05$ ) and long jump and high jump ( $T=-2,280$ ;  $p<0.05$ ). For these reasons, it is interesting to define the objective of this research which treats the problem of the morphological status of female finalists jumpers at the Olympic Games in Beijing in 2008, where would be possible, on the basis of their parameters, to get a realistic picture of the morphological status and age structure of the finalists female jumpers.

## METHODS

The study encompassed a sample of 32 top women athletes in jumping disciplines (long jump, high jump, triple jump, pole vault) that occurred in the finals of the Olympic Games in Beijing in 2008. Variables that were taken in the analysis are those that define the morphological space and the age structure of competitors: *Body Height* (Height-cm), *Body mass* (Weight-kg), *Body mass index* (BMI- kg/m<sup>2</sup>) and *Age*. In order to get relevant results on the basis of which one can get answers, basic statistical parameters were applied, and in terms of identifying the differences the analysis has been performed by using T-test for independent small samples.

**REZULTATI I DISKUSIJA**

U tabeli 1. prezentovani su parametri atletičarki za svaku disciplinu pojedinačno. U tabelama 2-7 nalaze se osnovni statistički parametri morfološkog statusa istraživog uzorka atletičarki-skakačica kao i rezultati T-testa.

**Tabela 1.** *Morfološki parametri finalista skakačica*

<b>SKOK U DALJ / / LONG JUMP</b>	<b>Visina / Height (cm)</b>	<b>Masa / Weight (kg)</b>	<b>Godine života / Age</b>	<b>BMI (kg/m<sup>2</sup>)</b>	<b>TROSKOK / TRIPLE JUMP</b>	<b>Visina / Height (cm)</b>	<b>Masa / Weight (kg)</b>	<b>Godine života / Age</b>	<b>BMI (kg/m<sup>2</sup>)</b>
M H. Maggi (BRA)	173	61	32	20,40	F. Etone (CAM)	172	63	32	21,35
T. Lebedeva (RUS)	170	61	32	21,10	T. Lebedeva (RUS)	170	61	32	21,10
B. Okagbare (NIG)	180	60	20	18,51	H. Devetzi (GRE)	170	59	33	20,41
C. Hammond (JAM)	175	62	25	20,26	O. Rypakova (KZH)	182	61	24	18,42
B. Reese (USA)	170	61	22	21,10	Y. Savigne (CUB)	165	55	24	20,22
O. Udmurtova (RUS)	172	58	26	19,66	M. Šestak (SLO)	173	59	29	19,73
J. Johnson (GBR)	185	70	28	20,46	V. Gurova (RUS)	178	62	26	19,62
G. Upshaw (USA)	173	59	33	19,73	A. Pyatikh (RUS)	175	60	27	19,60
<b>SKOK U VIS / / HIGH JUMP</b>	<b>Visina / Height (cm)</b>	<b>Masa / Weight (kg)</b>	<b>Godine života / Age</b>	<b>BMI (kg/m<sup>2</sup>)</b>	<b>SKOK MOTKOM / POLE VAULT</b>	<b>Visina / Height (cm)</b>	<b>Masa / Weight (kg)</b>	<b>Godine života / Age</b>	<b>BMI (kg/m<sup>2</sup>)</b>
T. Hellebaut (BEL)	182	62	21	18,73	Y. Isinbayeva (RUS)	174	65	26	21,52
B. Vlašić (CRO)	193	70	25	18,81	J. Stuczinski (USA)	183	63	26	18,86
A. Chicherova (RUS)	180	57	26	17,59	S. Feofanova (RUS)	164	52	28	19,40
Y. Slesarenko (RUS)	179	54	26	16,87	Y. Golubchikova (RUS)	175	54	25	17,64
V. Palamar (UKR)	187	66	31	18,91	M. Pyrek (POL)	168	52	28	18,43
C. Howard (USA)	175	60	24	19,60	C. Hingst (GER)	170	60	28	20,76
A. Friedrich (GER)	179	61	24	19,06	S. Spiegelburg (GER)	173	64	22	21,40
R. Beitia (GER)	192	71	29	19,29	A. S. Bennett (USA)	175	61	28	19,93

**RESULTS AND DISCUSSION**

Table 1 presents the parameters of female athletes in each discipline individually. Tables 2-7 are the basic statistical parameters of the morphological status of the study sample of female athletes-jumpers and the results of T-test.

**Table 1.** *Morphological parameters female jumper finalists*

**Tabela 2.** Razlike između skoka u dalj i troskoka**Table 2.** Differences Long jump- Triple jump

		Mean	SD	T	p
Visina / Height	Skok u dalj / Long	174,75	5,23	,620	,545
	Troskok / Triple	173,13	5,25		
Masa / Weight	Skok u dalj / Long	61,50	3,66	,963	,352
	Troskok / Triple	60	2,45		
Godine / Age	Skok u dalj / Long	27,25	4,86	-523	,609
	Troskok / Triple	28,38	3,66		
BMI / BMI	Skok u dalj / Long	20,15	,85	,215	,833
	Troskok / Triple	20,06	,93		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti

**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \* Sig. ( $p < 0.05$ )

**Tabela 3.** Razlike između skoka u dalj i skoka u vis**Table 3.** Differences Long jump - High jump

		Mean	SD	T	p
Visina / Height	Skok u dalj / Long	174,75	5,23	-2,906	,012*
	Skok u vis / High	183,38	6,57		
Masa / Weight	Skok u dalj / Long	61,50	3,66	-,453	,658
	Skok u vis / High	62,63	6,00		
Godine / Age	Skok u dalj / Long	27,25	4,86	-,735	,474
	Skok u vis / High	25,75	3,11		
BMI / BMI	Skok u dalj / Long	20,15	,85	3,496	,004**
	Skok u vis / High	18,61	,91		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti \*Sig. ( $p < 0.05$ ); \*\*Sig. ( $p < 0.01$ )

**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \*Sig. ( $p < 0.05$ ); \*\*Sig. ( $p < 0.01$ )

**Tabela 4.** Razlike između skoka u dalj i skoka motkom**Table 4.** Differences Long jump - Pole vault

		Mean	SD	T	p
Visina / Height	Skok u dalj / Long	174,75	5,23	,735	,475
	Skok motkom / Pole	172,75	5,65		
Masa / Weight	Skok u dalj / Long	61,50	3,66	1,136	,275
	Skok motkom / Pole	58,88	5,41		
Godine / Age	Skok u dalj / Long	27,25	4,86	,466	,648
	Skok motkom / Pole	26,38	2,13		
BMI / BMI	Skok u dalj / Long	20,15	,85	,702	,494
	Skok motkom / Pole	19,74	1,42		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; t-t test; p-nivo značajnosti \*Sig. ( $p < 0.05$ ); \*\*Sig. ( $p < 0.01$ )

**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \* Sig. ( $p < 0.05$ ); \*\*Sig. ( $p < 0.01$ )

**Tabela 5. Razlike između skoka u vis i troskoka****Table 5. Differences High jump-Triple jump**

		Mean	SD	T	p
Visina / Height	Skok u vis / High	183,38	6,57	-3,448	,004**
	Troskok / Triple	173,13	5,25		
Masa / Weight	Skok u vis / High	62,63	6,00	-1,146	,271
	Troskok / Triple	60	2,45		
Godine / Age	Skok u vis / High	25,75	3,11	-1,546	,144
	Troskok / Triple	28,38	3,66		
BMI / BMI	Skok u vis / High	18,61	,91	-3,136	,007**
	Troskok / Triple	20,06	,93		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti \*\*Sig. (p<0.01)

**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \*\* Sig. (p <0.01)

**Tabela 6. Razlike između skoka u vis i skoka motkom****Table 6. Differences High jump - Pole vault**

		Mean	SD	T	p
Visina / Height	Skok u vis / High	183,38	6,57	-3,469	,004**
	Skok motkom / Pole	172,75	5,65		
Masa / Weight	Skok u vis / High	62,63	6,00	-1,313	,210
	Skok motkom / Pole	58,88	5,41		
Godine / Age	Skok u vis / High	25,75	3,11	-,469	,646
	Skok motkom / Pole	26,38	2,13		
BMI / BMI	Skok u vis / High	18,61	,91	-1,905	,077
	Skok motkom / Pole	19,74	1,42		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti \*\*Sig. (p<0.01)

**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \*\*Sig. (p <0.01)

**Tabela 7. Razlike između troskoka i skoka motkom****Table 7. Differences Triple jump - Pole vault**

		Mean	SD	T	p
Visina / Height	Troskok / Triple	173,13	5,25	,138	,893
	Skok motkom / Pole	172,75	5,65		
Masa / Weight	Troskok / Triple	60	2,45	,536	,601
	Skok motkom / Pole	58,88	5,41		
Godine / Age	Troskok / Triple	28,38	3,66	-1,335	,203
	Skok motkom / Pole	26,38	2,13		
BMI / BMI	Troskok / Triple	20,06	,93	,524	,609
	Skok motkom / Pole	19,74	1,42		

**Legenda:** Mean-srednja vrijednost, SD-standardna devijacija; T-t test; p-nivo značajnosti

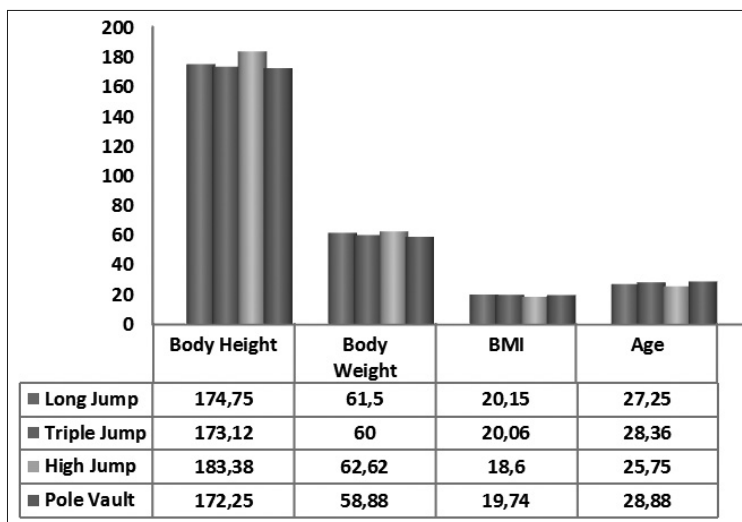
**Legend:** Mean-standard deviation, SD-standard deviation; T-value-test p-level of significance \* Sig. (p <0.05)

**Slika 1.** Srednje vrijednosti antropometrijskih parametara

Pregledom i analizom razlika aritmetičkih sredina definisanih segmenata morfološkog prostora atletičarki uočavaju se razlike u visini tijela i to u disciplinama skok u dalj - skok u vis ( $t=-2,906$ ;  $p<0.01$ ) gdje su skakačice u vis u prosjeku bile višije od skakačica u dalj (mean=183,38cm). Razlike su zabilježene između skakačica u vis i troskoku ( $T=3,448$ ;  $p<0.01$ ), u korist skakačica u vis koje su imale veću tjelesnu visinu (mean=183,38cm) i disciplini skok u vis - skok motkom ( $T=3,469$ ;  $p<0.01$ ).

Statističke razlike su zabilježene i u vrijednostima BMI u disciplinama skok u dalj-skok u vis ( $T=3,496$ ;  $p<0.01$ ) i skok u vis-troskok ( $T=-3,136$ ;  $p<0.01$ ). U drugim parametrima su također evidentirane razlike ali one nisu ostvarile statističku značajnost ili su bile na samoj granici statističke značajnosti. Ova analiza je pokazala sličnosti u morfološkom statusu skakača ženskih finalista OI U Pekingu. Slične rezultate istraživanja dobili su Pavlović, Radić, Simeonov i sar. (2013) kod muških finalista u Pekingu. Analizirajući muške finaliste također su zabilježene razlike u visini tijela u disciplinama: skok u dalj - troskok ( $T=-2,747$ ;  $p<0.05$ ) i skok u dalj-skok u vis ( $T=-2,280$ ;  $p<0.05$ ).

Na slici 1. predstavljene su srednje vrijednosti **visine tijela (Body Height)** u skakačkim disciplinama. Uvidom u numeričke parametre može se zaključiti da sužene u disciplini skok u vis imale najveću visinu tijela (Mean=183,38cm) u rasponu od 175-193cm. Odmah iza njih su takmičarke u skoku u dalj (oko 175cm) i troskoku (Mean=173,12), a kao najmanje tjelesne visine su bile atletičarke u skoku motkom (Mean=172,25). Iz ovih numeričkih pokazatelja može se zaključiti da su ova tri rezultata (skok u dalj, troskok, skok motkom) kvantitativno dosta homogena u pogledu longitudinalnosti skeleta (razlika je oko 2,5 cm). Kod skakača u vis, generalno, je potrebna tjelesna visina, koju prati povećana dužina ekstremiteta, visina težišta tijela od podloge, sam način izvođenja tehnike, gdje pored brzine, fleksibilnosti, eksplozivne snage važna dužina trkačkih, odnosno skakačkih koraka. Atletičarke u skoku motkom su u prosjeku bile najniže sa prosječnom visinom (Mean=172,25cm).



**Figure 1.** Mean values of anthropometric parameters

By review and analysis of mean differences of defined segments of the morphological space in female athletes we can see differences in body height, in these disciplines Long Jump - High jump ( $T=-2.906$ ,  $p<0.01$ ) where

the high jumpers were on average taller than long jumpers (Mean = 183,38cm). Differences were observed between the high jumpers and triple jump ( $T= 3.448$ ;  $p<0.01$ ), in favor of the female high jumpers that had greater body height (Mean = 183.38 cm) and discipline high jump - pole vault ( $T= 3.469$ ;  $p<0.01$ ).

Statistical differences were also observed in BMI values in the disciplines Long Jump- High jump ( $T=3.496$ ;  $p<0.01$ ) and High Jump-Triple jump ( $T=-3.136$ ;  $p<0.01$ ). In other parameters, differences were also recorded but these differences did not achieve statistical significance or were on the verge of achieving it. This analysis showed similarities in the morphological status of women jumper finalists of the Olympic Games in Beijing. Similar research results obtained Pavlovic, Radic, Simeonov, et al. (2013) in male finalist in Beijing. Analyzing the men's finalists differences were also observed in the body height in the following disciplines: Long jump-Triple jump ( $T=-2.747$ ;  $p<0.05$ ) and Long Jump-High jump ( $T=-2.280$ ;  $p<0.01$ ).

Figure 1 represents the mean values of body height (Body Height) in jumping disciplines. After examining the numerical parameters it can be concluded that the women in the discipline high jump, had the greatest height of the body (Mean=183.38 cm) in the range of 175-193cm. Right behind them are competitors in the long jump (about 175cm) and triple jump (Mean=173.12), and a minimum body height were athletes in the pole vault (Mean=172.25cm). From these numerical results, it could be concluded that these three results (Long Jump, Triple Jump, Pole Vault) are quantitatively quite homogeneous in terms of longitudinally skeleton (the difference is about 2.5cm). In high jumpers, generally, the more necessary is body height, accompanied by increased limb length, the height of the center of gravity of the body from the ground, a way of performing a technique, where in addition to the speed, flexibility, explosive strength, length

Ova visina atletičarki u skoku motkom može se obrazložiti na sledeći način, a tiče se tehnike izvođenja i motoričkih sposobnosti. Visina tijela kao parametar uspešnosti skoka motkom nije toliko važan segment, jer skok motkom predstavlja jedno kombinovano kretanje gdje skakač upotrebljava motku kao rekvizit. Ostvareni rezultat najčešće zavisi od sinhronizacije njegovih, prvenstveno motoričkih sposobnosti, brzine, eksplozivne snage, koordinacije, fleksibilnosti, ravnoteže, kao i sposobnosti takmičara da kinetičku energiju (brzina zaleta) pretvori u potencijalnu (pokreti nakon uboda motke u kutiju).

Manju prosječnu tjelesnu visinu su zabilježile takmičarke u disciplini skok u dalj (Mean=174,75cm) i troskoku (Mean=173,12cm). Naime, poznato je da visina tijela ne igra važnu ulogu kod ovih skakačkih disciplina, mada je i tu poželjno da su skakači viši, naročito kod troskoka. Rezultat, pored tehničke izvedbe uglavnom zavisi od motoričkih komponenti, u prvom redu od brzine i eksplozivne snage (u toku zaleta i momentu odraza) a zatim od koordinacije i fleksibilnosti (nakon odraza do doskoka) što opet zavisi od toga o kojoj se varijanti radi (uvinuće ili koračna). Poznato je da je skok u dalj ciklično-aciklično kretanje gdje rezultat zavisi od brzine zaleta i početne brzine prilikom odraza i taj odnos je 2:1 u korist brzine, gdje vrhunski skakači u toku zaleta postižu brzinu preko 10m/s, a početna brzina u momentu odraza preko 8,5m/s (Čoh, 2002; Pavlović, 2010). Kod troskoka je taj odnos 3:1, gdje se sa opadanjem brzine kretanja, povećava ugao odraza između odraza, koraka i skoka (14°-21°).

Analizom srednjih vrijednosti **mase tijela (Body Weight)** finalistkinja u skakačkim disciplinama (slika 1), evidentne su najveće vrijednosti numeričkih parametara, takođe kod skakačica u vis (Mean=62,62kg) u rasponu od 54-71kg. Na drugoj poziciji su skoro ujednačene, takmičarke u skoku u dalj (Mean=61,50kg) i troskoku (Mean=60kg) u rasponu od minimalnih 59kg pa do maksimalnih 71kg. Najmanju tjelesnu masu u prosjeku su imale atletičarke u skoku motkom (Mean=58,88kg) u rasponu od 52kg do 65kg.

Ovakav poredak atletičarki, po tjelesnoj masi je možda i neočekivan (naročito u skoku u vis), jer povećana tjelesna masa, sa jednog aspekta predstavlja remeteći faktor u rezultatskoj uspešnosti, naročito kod visinskih skokova, gdje postoji veliki uticaj sile teže na tijelo, u momentu odraza, koja nastoji da prizemlji skakača na tlo. Posmatrajući sa drugog aspekta, odraz kod svih skokova se izvodi sa jedne noge i vrlo je teško izdržati veliku tjelesnu masu na jednoj nozi (4-6 puta veća od mase skakača), pa je manja tjelesna masa poželjna. Kod skoka s

of race is important, that is the jumping movements. Female pole-vaulters were on average the lowest average height (Mean=172.25 cm). This height in the pole vault female athletes can be explained as follows, and refers to the techniques involved, and motor skills. Body height as a parameter of success of pole vault is not so important segment because pole vault is one combined movement where jumper uses the pole as a prop. The achieved result usually depends on the synchronization of its primarily motor skills, speed, explosive strength, coordination, flexibility, balance, and the ability of competitors to kinetic energy (speed running) turn into a potential (movements after sticking the pole in a box).

Lower average height was recorded among the competitors in the long jump discipline (Mean=174.75cm) and triple jump (Mean=173.12 cm). Namely, it is known that the height of the body does not play an important role in this jumping discipline, although it is preferred that the jumpers are taller, particularly for triple jump. The result, in addition to technical performance mainly depends on the motor components, primarily from the speed and explosive power (during acceleration and moment of reflection) and then from the coordination and flexibility (after reflection to landing) which in turn depends on which variant it is about (twist or stepping). It is known that the high jump is cyclic-acyclic movement where the result depends on the speed of run up and initial velocity during the take off and the ratio is 2:1 in favor of speed, where the top jumpers in the course of running speed achieved over 10m/s, and the initial speed in the moment of take off was over 8.5 m/s (Čoh, 2002, Pavlovic, 2010). In triple jump the ratio 3:1 is; where the decrease in speed increases the angle of take off between take off, step and jump (14° - 21°).

By the analysis of the mean body weight (Body Weight) in female finalists in the jumping disciplines (Figure 1), the highest values of numerical parameters are evident, also in female high jumpers (Mean=62.62kg) in the range of 54-71kg. The second position is almost uniform, competitors in the long jump (Mean=61.50kg) and triple jump (Mean=60kg) ranging from a minimum 59kg to a maximum of 71kg. The lowest body weight on average had athletes in the pole vault (Mean=58.88 kg) in the range of 52kg-65kg.

This order of women athletes, by the body weight is perhaps surprising (especially in the high jump), because increased body mass, with one aspect, is a disturbing factor in the result success, especially in high jumps, where we have a large influence of gravity on the body at the moment of take off, which seeks to ground jumper to the ground. Looking from another perspective, take off in all jumps is per-



motkom veća masa tijela ima negativan uticaj zbog ograničene čvrstoće kao i elastičnosti motke i njenog boljeg dejstva u momentu opružanja, kada tijelo skakača treba da podigne na određenu visinu, gdje se mnogo bolje dejstvo ispoljava kod skakača sa manjom tjelesnom masom, djelujući kao luk i strijela, odnosno u fazi skupljanja koja prethodi fazi opružanja, gdje tijelo skakača podsjeća na strijelu, a savijena motka na luk (Jovović, 2006; Pavlović, 2010).

Kada su u pitanju numeričke srednje vrijednosti *Body Mass Index-a (BMI)* atletičarki finalista, na prvom mjestu su skakačice u dalj, sa najvećom prosječnom vrijednosti BMI (Mean=20,15) u rasponu vrijednosti od 18,51-21,10. Na osnovu ove vrijednosti može se zaključiti da su takmičarke skoka u dalj imale manju tjelesnu visinu u odnosu na masu tijela i po konstituciji odgovaraju atletiku, a njihov rezultat je uglavnom vezan sa motoričke sposobnosti. Takmičarke u troskoku su u prosjeku imale indeksne vrijednosti (BMI=20,06), raspona od 18,42–21,35. Proizilazi zaključak da su i one imale manju visinu tijela u odnosu na tjelesnu masu (kao kod skoka u dalj). Dobijeni su podaci da su takmičarke u disciplini skok u vis zabilježile najmanje srednje indeksne vrijednosti (BMI=18,60), u rasponu od minimalnih 16,87 do maksimalnih 19,69 (tabela 1). To je i očekivano što je i karakteristika skakača u vis, da imaju veću tjelesnu visinu u odnosu na masu tijela. Takođe takmičarke u skoku motkom (pole vault) su imale manji BMI u odnosu na takmičarke u disciplinama skok u dalj i troskok, ali veći BMI u odnosu na takmičarke u skoku u vis (Mean=19,74) u rasponu rezultata od 17,64-21,52. Takođe i ova disciplina zahtjeva manje vrijednosti BMI takmičara.

Što se tiče *starosne strukture (GOD)* učesnika (slika 1) takmičarke u skoku u vis su bile najmlađe učesnice finala sa prosjekom od 25,75 decimalnih godina, u rasponu od 21-31 godine. Na drugom mjestu su takmičarke skoka u dalj (Mean=27,25; Range=20-33). Atletičarke u skoku s motkom i troskoku su bile skoro ujednačene u starosnoj dobi (Triple jump=28,36). Kao najstarije učesnice finala skakačkih disciplina su bile takmičarke u skoku s motkom, 28,88 decimalnih godina. Može se napomenuti, da je u svim disciplinama bilo i većih numeričkih pokazatelja u starosnoj dobi, ali su uglavnom preovladale takmičarke sa manjim brojem godina što se odrazilo na ukupnu prosječnu starosnu dob.

Po visini i muški i ženski skakači se takođe razlikuju, zavisno o kojoj se disciplini radi. Kao "najviši" su skakači u vis, zatim troskokaši. Obzirom da visina tijela nije toliko značajan faktor za skok u dalj i skok motkom, proizilazi da su ovi skakači (muški i ženski) niži rastom u

formed with one foot and it is very difficult to sustain a large body weight on one leg (4-6 times that of the jumper), and so lower body weight is preferred. In the pole vault higher body mass has a negative impact due to the limited strength and elasticity of the pole and its better effect at the time of stretching, when the body of jumper should be raised to a certain height, where much better effect is expressed in a jumper with less body mass, acting like a bow and arrow, the body of the jumper with respect to the bent pole, respecting at the stage of collecting that precedes stage of stretching, where the body jumpers reminiscent of arrow and a bent rod on bow (Jovovic, 2006; Pavlovic, 2010).

As for the numerical median values of Body Mass Index's (BMI) in women athlete finalists at the first place are long jumpers, with the highest average value of BMI (Mean=20.15) ranging in value from 18.51 to 21,10. Based on these values it can be concluded that the contestants in long jump had lower body height in relation to the mass of the body and by the constitution correspond to athletics, and their result is mainly associated with motor skills. Contestants in the triple jump had an average BMI values (Mean=20.06), ranging from 18.42 to 21.35. This leads to the conclusion that they had smaller height of the body relative to body weight (as in the long jump). It is interesting data that the competitors in the discipline high jump recorded the lowest median BMI values (Mean=18.60), ranging from a minimum of 16.87 to a maximum of 19.69 (table 1). It is expected, which is the characteristic of the high jumpers, to have a greater height of the body relative to the weight of the body. Also competitors in the pole vault had a lower BMI compared to competitors in events long jump and triple jump, but higher BMI compared to competitors in the high jump (Mean=19.74) in the range of scores from 17.64 to 21.52. Also, this discipline requires lower values of BMI competitors.

Regarding the age structure (age) of participants (Figure 1), competitors in the high jump were the youngest participants in the finals with an average of 25.75 decimal years, ranging from 21-31 years. In second place were the contestants in long jump (Mean = 27.25, range = 20-33). Athletes in the pole vault and triple jump were almost uniform in age (Triple jump = 28,36). As the oldest participants in the finals of jumping disciplines were competitors in the pole vault, 28.88 decimal years. It may be noted that in all disciplines numerical indicators of age were larger, but generally prevailed competitors with fewer years which resulted in an overall average age.

Jumpers also differ by height, depending which discipline is in question. As the tallest are the high jumpers, then triple jumpers. Since the height of the body is not a

odnosu na discipline skok u vis i troskok. Kada je u pitanju tjelesna masa, može se zaključiti da je ona remeteći faktor kod svih skakačkih disciplina. Ona je nešto veća kod skakača u dalj u odnosu na skakače u vis, troskokaše i skakače motkom. Veće vrijednosti mase tijela imaju negativan uticaj u fazi leta zbog većeg djelovanja sile gravitacije na skakača, a takođe zbog većeg ispoljavanja mišićne sile kod momenta odraza (Kobriniskij, Juškevič, Konikova, 2005). Naime, odskok se vrši sa jedne noge gdje skakači vrše aktivni pritisak na podlogu 4-6 puta veći od svoje tjelesne mase, što iznosi od 350kg-500kg (Čoh, 2002) i vrlo je teško izdržati taj pritisak na jednoj nozi (traje vrlo kratko 0,12-0,16ms), što se naročito ispoljava kod troskoka i to prvog koraka nakon odraza. Kod troskoka karlica i kičmeni stub trpe veliko opterećenje i ukoliko bi tjelesna masa bila povećana, uspješnost tehničkog izvođenja bi bila manja, a mogućnost povređivanja bila veća, iako se radi o vrhunskoj fizičkoj pripremi tih takmičara. Skok u dalj kao disciplina je specifična, jer je brzina dominantna u rezultatskoj uspješnosti, gdje je odnos brzine i snage odraza 2:1 i vrlo često kažemo da je dobar sprinter i dobar skakač i obratno. Brzina zaleta koju postižu skakači iznosi od 10,30m/s do 11,50m/s, a početna brzina u momentu odskoka je nešto manja, oko 9,50m/s (Čoh, 2002., Pavlović, 2010; Stanković i Raković, 2010). Skakači u dalj su uglavnom jake reljefne muskulature sa snažnim ekstremitetima, širokih ramena i dugih mišića potkoljenica, koji djeluju kao poluge brzine.

Ovakve činjenice se mogu argumentovati i rezultatima ovoga rada na finalistima OI-a 2008.godine. Pored ove konstatacije poznato je da atletski skokovi pripadaju grupi balističkih gibanja u kojima se u prostor katapultira tijelo skakača posredstvom vlastitih mišićnih naprezanja ili uz pomoć rekvizita (skok motkom) u cilju ostvarenja što veće dužine skoka. Skokovi su inicirani eksplozivnom aktivacijom mišića agonista, nakon čega slijedi period njihove relaksacije, a završavaju se periodom deceleracije, uslijed djelovanja mišića antagonista ili pasivnog istezanja vezivnog tkiva. Većina istraživača koji su se bavili istraživanjem u prostoru morfoloških karakteristika se slažu, da skakači imaju u odnosu na ostale atletičare veću količinu aktivne tjelesne mase, te da su po Šeldonovoj klasifikaciji najbliži atletiku (skok u dalj i skok motkom) odnosno leptosomu (skok u vis, troskok), (Milanović i sar. 1986; Bowerman i sar., 1998; Tončev, 2001; Čoh, 2002; Pavlović, 2010).

Masa tijela atletičarki skakačica, učesnica finalnog takmičenja na OI u Pekingu je u prosjeku iznosila od 58,88-62,62kg, sa izolovanim slučajevima gdje je težina

significant factor in the long jump and pole vault, it appears that these jumpers (male and female) are of lower height compared to the previous two events. Regarding the body weight, it can be concluded that it is a disturbing factor of all jumping disciplines. It is slightly higher in long jumpers compared to the high jumpers, triple jumpers and pole-vaulters. Higher values of body weight have a negative impact on the phase of flight due to the larger action of gravity on a jumper, and also because of the higher manifestation of muscle force at the moment of take off (Kobriniskij, Juškevič, & Konikova, 2005). Namely, the bounce is carried out with the one leg, where the jumpers do active pressure on surface, 4-6 times greater than their body weight, which amounts from 350 kg-500 kg (Čoh, 2002) and it is very difficult to withstand the pressure on one leg (takes a very short 0.12 to 0.16 ms), which is specifically expressed in the triple jump and the first steps after takeoff. In triple jump, the pelvis and spinal column suffer a great load, and if the body weight was increased the success of technical performance would be lower and the risk of injury would be higher, although it is about the top physical preparation of the athletes. The long jump as the discipline is specific, because the speed is dominant in result performance, where the ratio of the speed and strength of take off is 2:1 and often we say it is a good sprinter and a good jumper and vice versa. The speed of run up achieved by jumpers is from 10.30 m/s to 11.50 m/s, and the initial speed at the moment of rebound is slightly smaller, about 9.50 m/s (Čoh, 2002nd, Pavlovic, 2010; Stankovic and Rakovic, 2010 ). The long jumpers are generally of strong relief musculature with powerful limbs, broad shoulders and long lower legs, which act as levers of speed. These facts can be argued by the results of this study on the finalists Olympics in 2008. In addition to these, it is known that athletic jumps belong to a group of ballistic motion in which body of jumper is catapulted in the space through his own muscle strain or with the help of props (pole vault) in order to achieve the greater length of the jump. The jumps are initiated by explosive activation of agonists muscles, followed by their relaxation period, and they end by period of deceleration, due to the action of the antagonist muscles or passive stretching of the connective tissue. Most researchers who were engaged in research in the area of morphological characteristics agree that the jumpers in comparison to other athletes have greater amount of active body mass, and that by the Sheldon classification they are closest to the athletics (long jump and pole) that is to leptosom (high jump, triple jump), (Milanovic et al. 1986, Bowerman et al., 1998, Tonchev, 2001; Čoh 2001; Kobriniskij, Juškevič & Konikova, 2005; Pavlovic, 2010 ).

pojedinih takmičarki i preko 70kg, dok prosječna visina deset najboljih skakačica u vis iznosi od 178-188cm. Prosječna visina učesnica finala OI-a u Pekingu iznosila je od 172,25cm (Pole vault) pa do 183, 38cm (High jump). Zbirno, za sve četiri discipline prosjek visine je iznosio (Body Height=175,87cm), a prosjek tjelesne mase (Body Weight=60,75kg). Skakačice u vis imale su najveću tjelesnu masu ali i najmanji prosjek BMI, upravo iz razloga jer su imale veću visinu u odnosu na masu tijela kod većeg broja takmičarki i u potpunosti odgovaraju leptosomu. Za razliku od skakača u dalj koji odgovaraju atletiku i koje su imale najveći BMI (Mean=20,15). Generalno, vrijednosti BMI su takođe vrlo homogene i niske, kretale su se u granicama od 18,60 (High jump) do 20,15 (Long jump). Srednja vrijednost BMI je iznosila 19,63. Niske vrijednosti BMI kod skakača su očekivane obzirom na tehniku izvođenja discipline i značaj mase tijela u izvođenju koja se karakteriše kao negativan faktor.

Vrlo je važno napomenuti da kategorizacija na osnovu BMI u ovim atletskim disciplinama je vrlo pouzdana jer se radi od kategoriji sportista kojima tjelesna masa nije balast (već masa mišića i kostiju) pomaže u izvođenju motoričkog zadatka. Ako bi kategorisali ženske finalistice OI-a u Pekingu po BMI onda bi sve takmičarke bile u kategoriji ispod normalne težine, BMI= 21-25 (Wilmore et al.1986). Obzirom da se radi o utreniranim vrhunskim sportistima, onda ova skalarna procjena se ne može uzeti za korektnu.

Prosječna starost takmičarki je bila 27,56 decimalnih godina, što je više nego kod muških finalista (Pavlović, Radić, Simeonov, i sar. 2013) gdje su najmlađe bile takmičarke u skoku u vis (Mean=25,75) a najstarije u disciplini skok s motkom (Mean=28,88 god).

Na osnovu dobijenih rezultata ovog istraživanja utvrđene su razlike između finalista skakačica, ali samo su statistički značajne u parametrima tjelesne visine i BMI. Evidentno je da su morfološke karakteristike relevantne u skakačkim disciplinama, naročito skoku u vis. Međutim, pored morfoloških karakteristika izuzetan doprinos u rezultatskoj uspješnosti daljinskih i visinskih skokova imaju motoričke sposobnosti koje nisu analizirane u ovom istraživanju. Ono što je relevantno, a potvrđeno u praksi je to, da rezultat u skakačkim disciplinama pored morfoloških dimenzija (visina, masa, BMI) je definisan biomehaničkim parametrima: brzinom zaleta, odraznim impulsom i zamahom ekstremiteta (Stefanović, 1992; Jarić, 1997; Tončev, 2001; Jovović, 2006, Pavlović, 2010; Radić i Simeonov, 2012) koji takođe imaju značajan udio u izvođenju tehnike kretanja.

Body mass of women athlete jumpers, participating at finals at the Olympic Games in Beijing averaged from 58.88 to 62.62 kg, with isolated cases where the weight of individual competitors was over 70kg, while the average height of ten best female high jumpers was between 178 - 188cm. The average height of the female participants in Olympic final in Beijing ranged from 172.25 cm (pole vault) to 183, 38cm (high jump). Collectively, for all four disciplines the average height was (Body Height=175.87 cm), and the average body mass was (body weight=60.75 kg). Women high jumpers had the highest body mass and the lowest average BMI, precisely because they had greater height in relation to body mass in a large number of competitors and entirely match to leptosome, unlike the long jumpers who match the athletics and who had the highest BMI (Mean=20.15). Generally, BMI values are also very low and homogeneous, they were in the range of 18.60 (high jump) to 20.15 (Long jump). The mean BMI was 19.63. Low values of BMI in jumpers are expected because of the technique of performing the discipline and the importance of body weight in the performance which is characterized as a negative factor.

It is important to note that categorization on the basis of BMI in these athletic disciplines is very reliable because it is the category of athletes to which the body weight is not a burden (but muscles mass and bones) and assists in the performance of motor task. If you would categorize women's Olympic finalist in Beijing by BMI then all competitors would be in the category of below normal weight, BMI 21-25 (Wilmore et al.1986). Since it is about trained elite athletes, then this scalar evaluation cannot be taken as correct.

The average age of the competitors was 27.56 decimal years, which is longer than that of the male finalists (Pavlovic, Radic, Simeonov, et al. 2013) where the youngest competitors were in the high jump (Mean = 25.75) and the oldest in discipline pole vault (Mean = 28.88 years).

Based on received results of this research, there were differences between the finalists of female high jumper, but only statistically significant in the parameters of body height and BMI. It is evident that the morphological characteristics are relevant in the jumping disciplines, especially the high jump. However, in addition to morphological characteristics, an outstanding contribution to the success of scores in remote and dive jumps have motor skills that are not analyzed in this study. What is relevant, and confirmed in practice, is that result in the jumping disciplines in addition to morphological dimensions (height, weight, BMI) is defined by biomechanical parameters: speed running start, take-off impulse and momentum ex-

## ZAKLJUČAK

Na osnovu dobijenih i prezentovanih rezultata istraživanja morfološkog prostora finalistkinja u skakačkim disciplinama na Olimpijskim igrama u Pekingu 2008. godine može se zaključiti da su takmičarke u ove četiri discipline dosta sličnog morfološkog statusa. Razlike koje su zabilježene potvrđuju ranije konstatacije o mogućim sličnostima i razlikama u skakačkim disciplinama. Od ukupnog broja finalista skakačica (ukupno 32) evidentirane su razlike u pogledu tjelesne visine, mase tijela, Body Mass Index (BMI) i godina starosti (Age).

Međutim, u pogledu statističke značajnosti, to se potvrdilo u tjelesnoj visini na oba nivoa ( $p < 0.05$ ;  $p < 0.01$ ). Atletičarke u disciplinama skok u dalj i skok u vis se statistički značajno razlikuju u vrijednostima visine tijela ( $T = -2,906$ ;  $p < 0,012$ ). Razlike su takođe utvrđene između skoka u vis i troskoka ( $T = 3,448$ ;  $p < 0,004$ ), kao i skoka u vis i skoka motkom ( $T = 3,136$ ;  $p < 0,007$ ).

Razlike u vrijednostima BMI atletičarki su utvrđene u disciplinama skok u dalj - skok u vis ( $t = 3,496$ ;  $p < 0.004$ ) i skok u vis-troskok ( $T = -3,136$ ;  $p < 0.007$ ).

Od svih finalista atletičarke u skoku u vis su imale najveću visinu tijela (Mean=183,38cm). Skoro identične vrijednosti se mogu pripisati skakačicama u dalj (Mean=174,75cm) i skakačicama u troskoku (Mean=173,12cm). Kao najniže rastom su bile atletičarke u skoku motkom (Mean=172,25cm). Analizom tjelesne mase finalista može se zaključiti da su i najveću masu imale atletičarke skoka u vis (Mean=62,62). Drugu poziciju zauzimaju atletičarke u skoku udalj (Mean=61,50kg) i u troskoku (Mean=60kg), a kao 'najlakše' su skakačice s motkom, sa prosječnom masom od 58,88kg. Uvidom u vrijednosti BMI finalistkinja, može se zaključiti da su najveće vrijednosti kod skakačica u dalj (BMI=20,15). Na drugoj poziciji su atletičarke u troskoku (BMI=20,06), zatim skakačice motkom (BMI=19,74). Najmanje vrijednosti BMI su zabilježile atletičarke u skoku u vis (BMI=18,60).

Analizom starosne strukture ženskih finalista može se zaključiti da su takmičarke u skoku motkom bile najstarije učesnice finala sa prosjekom od 28,88 godina, a blizu njih i atletičarke u troskoku sa 28,36 godina. Na trećem mjestu po starosnoj dobi su bile atletičarke u skoku u dalj (27,25 godina), dok su kao najmlađe učesnice u skakačkim disciplinama bile atletičarke skoka u vis sa prosjekom 25,75 godina.

Ovakav poredak je u suprotnosti od muških finalista (Pavlović, Radić, Simeonov, i sar. 2013), jer su kod njih troskokaši ti koji su nešto više tjelesne mase od očekivane. Sve skakačke discipline u svojoj tehnici imaju

tremities (Stefanovic, 1992; Jaric, 1997; Toncev, 2001; Jovovic, 2006, Pavlovic, 2010; Radic & Simeonov, 2012) which also have a significant proportion of the technique of movement.

## CONCLUSION

Based on obtained and presented results of research of morphological space in finalists in the female jumping events at the Olympic Games in Peking 2008, it can be concluded that the female contestants in these four disciplines are of quite similar anthropological status. The differences that were observed confirm previous findings about the possible similarities and differences in the jumping disciplines. Of the total number of finalist jumpers (total of 32) there were recorded differences in body height (body height), body mass (body weight), Body Mass Index (BMI) and age (Age). However, in terms of statistical significance, that is confirmed in the body height at both levels ( $p < 0.05$ ,  $p < 0.01$ ). Female athletes in the disciplines long jump and high jump, statistically significantly differ in the values of Body Height ( $T = -2.906$ ,  $p < 0.012$ ). Differences were also observed between the high jump and triple jump ( $T = 3.448$ ,  $p < 0.004$ ), as well as the high jump and pole vault ( $T = 3.136$ ,  $p < 0.007$ ). Differences in BMI were determined in women athletes in the disciplines long jump – high jump ( $T = 3.496$ ,  $p < 0.004$ ) and high jump-triple jump ( $T = -3.136$ ,  $p < 0.007$ ). Of all the finalists, women athletes in the high jump had the highest body height (Mean = 183.38 cm). Almost identical values can be attributed to the long jumpers (Mean = 174.75 cm), the triple jumpers (Mean = 173.12 cm). As lowest by height were female pole-vaulter (Mean = 172.25 cm).

By the analysis of body mass of finalists it can be concluded that the maximum mass had high jump female athletes (Mean = 62.62). The second position is that of competitors in the long jump (Mean = 61.50 kg) and triple jump (Mean = 60kg), and with lowest weight are women pole vaulters, with an average weight of 58.88 kg. After examining the values of BMI finalists, it can be concluded that the greatest values are in long jumpers (BMI= 20.15). In the second position are the triple jumpers (BMI= 20.06), followed by pole-vaulters (BMI= 19.74). The minimum values of BMI were recorded in female athletes in high jump (BMI= 18.60). By the analysis of the age structure of women's finalists it can be concluded that the competitors in the pole vault were the oldest participants in the finals with an average of 28.88 years, and close to them are competitors in triple jump with 28.36 years. In third place by age were competitors in the long jump (27.25 years), while the youngest participants in the jumping events were high

učešće brzine i eksplozivne snage koje sa starošću opadaju (Nićin, 2000), pa ovdje imamo upravo i takav primjer starosne strukture učesnika i njihovih godina u momentu Olimpijskih igara.

jump athletes with an average of 25.75 years. This order is contrary to the male finalists (Pavlovic, Radic, Simeonov, et al. 2013), because triple jumpers are those who are of little greater body mass than expected. All the jumping disciplines in their technique have the participation of speed and explosive strength that decreases with age, so here we have just such an example of the age structure of participants and their age at the time of the Olympics.

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