Utjecaj motoričkih sposobnosti na natjecateljsku uspješnost u stolnom tenisu

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Sažetak: Osnovni cilj ovog istraživanja bio je utjecaj pojedinih motoričkih sposobnosti na natjecateljsku uspješnost stolnotenisača. Uzorak ispitanika činilo je 48 najboljih seniora uzrasta 17-36 god (reprezentativni uzorak) u Bosni i Hercegovini. Uzorak ispitanika je odabran na osnovu kvalifikacionog turnira svih registriranih stolnotenisača Bosne i Hercegovine. Mjerni instrumenti za ovo istraživanje su: dvanaest varijabli za procjenu bazičnih motoričkih sposobnosti i jedna varijabla za procjenu natjecateljske uspješnosti u stolnom tenisu. Metode obrade rezultata uključivale su deskriptivne statističke procedure i multiplu regresijsku analizu.

Motorički prediktori primjenommultiple regresijske analize značajno su objasnili kriterijsku varijablu natjecateljska uspješnost stolnotenisača.Na osnovu rezultata multiple regresijske analize koja je sprovedena na šest neovisnih, prediktorskih varijabli iz skupa bazične motoričke sposobnosti i pozicije ispitanika na rang ljestvici stolnotenisača (BODRNG), kao i ovisnom varijablom natjecateljske uspješnosti, uz korištenje enter metode, dobivena je jedna statistički značajna regresijska funkcija. To ukazuje na to da između navedenih varijabli postoji linearna povezanost. Dobiveni koeficijent multiple korelacije je statistički značajan i iznosi R=.65, što govori da se oko 41% varijance rezultata varijable pozicija ispitanika na rang ljestvici stolnotenisača (BODRNG), može objasniti uz pomoć uključenih prediktorskih varijabli.

Kao ukupno gledano najznačajniji prediktor može se izdvojiti varijabla tapinga rukom, to jest varijabla za procjenu frekvencije pokreta. Međutim, ne treba zanemariti i varijable za procjenu eksplozivne snage i to kako onih za procjenu apsolutne, tako i procjenu relativne eksplozivne snage.

Ključne riječi: stolnotenisači, motoričke sposobnosti, multipla regresijska analiza, natjecateljska uspješnost.

Influence of Motor Abilities on Competitive Efficacy in Table Tennis

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Abstract: The aim of this research was the influence of basic motor skills of table tennis players on their performance efficacy. The sample of participants was made by 48 elite seniors aged 17-36 yr (representative sample) in Bosnia and Herzegovina. The sample of participants was chosen based on the qualification tournament of all registred table tennis players in Bosnia and Herzegovina. The measuring instruments in the research are 12 variables for evaluation of basic motor skills and 1 variable for evaluation of competitive efficacy of table tennis. Analyzing results methods included descriptive statistic procedures and multiple regression analysis.

The motor predictors of applying multiple regression analysis significantly explain the criterion variable competitive success of table tennis players. Based on the results of multiple regression analysis, which was conducted on six independent, predictor variables from a set of basic motor skills and position subjects the ranking table tennis (BODRNG) as the dependent variable and competitive performance, using the enter method showed a single statistically significant regression function. This indicates that between these variables a linear relationship. The resulting multiple correlation coefficient is statistically significant and amounts to R=.65, which indicates that about 41% of variance in variable position of respondents to the ranking table tennis (BODRNG), can be explained with the help of predictor variables involved.

In most regression analysis, the motor factors significantly explained criterion variables of technical-tactical efficacy of table tennis players. In general, it can be said that the most important factor is hand tapping variable or in other words the variable evaluating the movement frequency. But we cannot forget variables evaluating explosive strength both evaluating total and relative explosive strength.

Keywords: table tennis, motor abilities, multiple regression analysis, competitive success.

Uvod

Stolni tenis kao sportska igra, pripada prema kriteriju strukturalne složenosti grupi polistrukturalnih kompleksnih sportova u kojima dominiraju otvorene ili poluotvorene kretne strukture koje se izvode u varijabilnim uvjetima.

Specifičnost stolnoteniske igre dovela je do toga da stolnotenisači za razliku od drugih sportaša pokazuju u prostoru motorike veću fleksibilnost, superiornost u eksplozivnoj snazi, bržu frekvenciju pokreta, agilnosti, superiornost u situacionoj preciznosti, (Đokić, 2007b.).

Osnovna karakteristika stolnoteniske igre je brzina izmjene udaraca i pokreti koji se u velikoj mjeri izvode u promjenjivim uvjetima. Suvremena stolnoteniska igra se karakterizira brzinom segmentarnih pokreta (ekstremiteta), eksplozivnom snagom, brzinom reakcije udarca uz optimalno savladavanje (poznavanje) rotacije loptice koja u velikoj mjeri utječe na samu izvedbu pojedinih udaraca - topspin elemenata u cijelom prostoru igre (Kondrič, i sur. 2007.). Brzina i spin su dva ključna elementa modernog sporta koji se igra s reketom. Brzina loptice je relativno vidljiva i od strane samog gledatelja, ali rotaciju loptice ili spin nije lako detektirati (Chiu i Tu, 2006.). Ovo bi istraživanje trebalo doprinijeti boljem razumjevanju pojedinih sistema stolnoteniske igre te omogućiti dobivanje važnih saznanja o motoričkim znanjima potrebnim za postizanje uspjeha u ovom sportu.

Konkretno, istraživanja koja su se bavila problematikom motoričkih sposobnosti i natjecateljske uspješnosti postoje, ali se u pravilu radi o studijama koje su provjeravale razlike između igrača različitih kvalitativnih razina (Toriola i sur. 2004.; Munivrana, 2011.; Malagoli i sur. 2011.; Bankosz, 2012.). Iz navedenih razloga zanimljivo je ponoviti koji su motorički faktori bitni za natjecateljsku uspješnost u stolnom tenisu.

Osnovni cilj ovoga istraživanja je utvrđivanje utjecaja primijenjenih motoričkih sposobnosti na natjecateljsku uspješnost stolnotenisača.

Metod rada
Uzorak ispitanika

Uzorak ispitanika čini 48 najboljih seniora uzrasta od 17 do 36 god. (reprezentativni uzorak) u Bosni i Hercegovini. Uzorak ispitanika je odabran temeljem kvalifikacijskog turnira svih registriranih stolnotenisača Bosne i Hercegovine. Najboljih 48 stolnotenisača s kvalifikacija su izborili sudjelovanje na državnom prvenstvu.

Introduction

As a sports game, based on the criterion of structural complexity, table tennis belongs to a group of semistructural complex sports in which opened or semiopened movement structures made in variable conditions are dominated.

A unique table tennis play has made table tennis players, unlike other athletes, more flexible in the area of motor skills, more superior in explosive strength and it has led them to a higher movement frequency, agility and situational preciseness superiority. (Đokić, 2007b.).

The main characteristic of table tennis game is the speed of hits exchange and movements which are mostly done in variable conditions.Modern tabel tennis game is characterised by segmented movements speed (extermities), explosive strength, the speed of hits reaction with the maximum overcoming (knowing) of ball rotation which has a great influence on the performance of individual hits-topspin elements in the whole game area. (Kondrič, i sur. 2007.). Speed and spin are two key elementsof modern sport played with racket. The ball speed is relatively visible by the viewer but the ball rotation or spin is not easy to detect (Chiu i Tu, 2006.).This research should help better understanding of individual table tennis systems and it should enable getting important knowledge about motor knowledge necessary for success achievement in this sport.

There are researches which dealt with the problem of motor abilities and competitive efficacy but they are mostly studies which checked differences between players of different quality levels (Toriola i sur. 2004.; Munivrana, 2011.; Malagolii sur. 2011.; Bankosz, 2012.). For the mentioned reasons, it is interesting to repeat motor factors important for competitive efficacy in table tennis.

The main aim of this research is to establish the influence of applied motor abilities on competitive efficacy of table tennis players.

Research method
Participant sample

The sample of participants was made of 48 elite seniors aged 17-36 yr (representative sampel) in Bosnia and Herzegovina. The sample of participants was chosen based on the qualification tournament of all registred table tennis players in Bosnia and Herzegovina.The best 48 table tennis players from the qualifications have won participation in the national championship.

Uzorak varijabli

Izbor varijabli izvršen je temeljem dosadašnjih istraživanja problematike slične ovoj (Đokić, 2001.; Dong, 2005.) a imajući u vidu njihov značaj za uspješnost odigravanja elemenata tehnike i taktike u suvremenom stolnom tenisu.

Testovi motoričkih sposobnosti

Za mjerenje bazičnih motoričkih sposobnosti upotrijebljeni su standardizirani testovi (Ahmetović, 1987.; Hadžikadunić, 2000.; Mikić, 2000.). Testovi su kroz dosadašnja istraživanja pokazali zadovoljavajuće metrijske karakteristike.

Za procjenu eksplozivne snage primijenjeni su sljedeći testovi:
- (MFESDM) - skok u dalj s mjesta
- (MFE20V) - trčanje iz visokog starta na 20 metara
- (MESFOR) - bacanje medicinke 1kg imitacijom forhend tehnike
- (MFEBML) - bacanje medicinke iz ležanja na leđima

Za procjenu repetitivne snage primijenjeni su testovi:
- (MRCDLC) - ležanje i podizanje u sijed za 30 sec.
- (MRCIST) - ispravljanje trupa

Za procjenu koordinacije – agilnosti primijenjeni su testovi:
- (MAGTUP) - trčanje u pravokutniku – koverta test
- (MAGKUS) - koraci u stranu

Za procjenu brzine frekvencije pokreta primijenjeni su testovi:
- (MBFTAP) - taping rukom
- (MBFTAN) - taping nogom

Za procjenu fleksibilnosti primijenjeni su testovi:
- (MFLDSI) - dohvat u sijedu
- (MFLISK) - iskret s palicom

Varijabla za procjenu natjecateljske uspješnosti

Za procjenu natjecateljske uspješnosti korištena je jedna varijabla:
- (BODRNG) - broj bodova na rang ljestvici (pozicija na rang ljestvici).

Metode obrade rezultata

Obrada rezultata provela se u nekoliko faza.

Primjenjeni su deskriptivni pokazatelji varijabli za procjenu motoričkih sposobnosti stolnotenisača.

Izračunata je serija linearnih korelacijskih analiza Personovog tipa i izračunati su numerički pokazatelji korelacijskih koeficijenata.

Variable sample

Variables are chosen based on the previous researches dealing with similar problems (Đokić, 2001; Dong, 2005.) and considering their influence on efficacy of playing technique and tactics elements in modern table tennis.

Motor skills tests

Standard tests were used for measuring basic motor skills (Ahmetović, 1987; Hadžikadunić, 2000; Mikić, 2000.). In previous researches the tests have showed satisfying metric characteristics.

The following tests were used for assesing explosive strength:
- (MFESDM) - distance jump from one place
- (MFE20V) - high start running on 20 meters
- (MESFOR) - throwing of a 1kg ball imitating forhend technique
- (MFEBML) - throwing of a ball by lying on the back

The following tests for assesing repetative strength were used the:
- (MRCDLC) - lying and getting up into the sitting position in 30 seconds
- (MRCIST) - body correction

The following tests were used for assesing coordination/agility:
- (MAGTUP) - square running-envelope test
- (MAGKUS) - side steps

The following tests were used for assesing speed frequency movement:
- (MBFTAP) - hand tapping
- (MBFTAN) - leg tapping

The following testswere used for assesing flexibility:
- (MFLDSI) - reach in the sitting position
- (MFLISK) - bat movement

Varible assesing competitive efficacy

For assesing competitive efficacy one variable was used:
- (BODRNG) -number of points on the rank scale (ranking position).

Analysing results methods

Result analysis was done in several stages.

Descriptive characteristics of variables assesing motor skills of table tennis players were used. Multiple regression analysis were calculated (Bartlet, 1947.) in order to establish the influence of predictor variables (motor skills) on criterion variable (competitive efficacy of

Izračunate su multiple regresijske analize (Bartlet, 1947.), kako bi se utvrdio utjecaj prediktorskih varijabli (motoričke sposobnosti) na kriterijsku varijablu (natjecateljska uspješnost stolnotenisača).

Korištena je razina značajnosti od 95%.

Za sve obrade korišten je paket SPSS ver. 17.0.

REZULTATI I DISKUSIJA

Raspršenje rezultata na svim varijablama je relativno nisko, osim kod varijable ispravljanje trupa (MRCIST) (*Tabela 1.*). Varijabla trčanje iz visokog starta 20 metara (MFE20V), je negativno asimetrična, pa je primjenjena logaritamska transformacija uz refleksiju rezultata.

Tabela 1. Deskriptivni pokazatelji varijabli za procjenu motoričkih sposobnosti stolnotenisača

table tennis players).

Calculated by a series of linear correlation analysis Person type and calculate the numerical parameters of correlation coefficients.

The level of significance of 95% was used. The package SPSS ver. 17.0 was used for each processing.

RESULTS AND DISCUSSION

Result spreading on each variable is relatively low, except with body correcting variable (MRCIST) (*Table1.*). High start running on 20 meters variable (MFE20V), is negatively asymmetric ,and therefore logarithmic transformation with the result reflexion was used.

Table 1. Descriptive characteristics of variables assessing motor skills of table tennis players

	N	M	σ	S_k	K	Min	Maks	W	p
Skok u dalj s mjesta / *Distance jump*	48	232.91	21.19	-.85	.14	180.00	261.00	.97	.44
Sprint iz visokog starta 20m / *High start sprint 20m*	48	3.38	.25	1.29	8.79	2.24	4.01	.98	.45
Bacanje med.1kg.forh. / *Throwing of a.1kg.ball forh.*	48	13.91	2.01	-.53	1.11	10.10	16.90	.96	.06
Bacanje medicinke iz lez. / *Throwing of a ball from lying position.*	48	7.59	1.02	-.04	-.35	5.36	9.80	.98	.84
Lezanje-sijed 30 sec. / *Lying-sitting in 30 sec.*	48	27.37	5.39	1.82	5.89	20.00	50.00	.97	.08
Ispravljanje trupa / *Body correcting*	48	34.06	9.31	.74	.03	20.00	60.00	.96	.78
Koverta test / *Envelope test*	48	24.72	.96	.05	-.64	22.73	26.80	.98	.63
Koraci u stranu / *Side steps*	48	7.55	.64	.70	-1.01	6.82	8.90	.96	.07
Taping rukom / *Hand tapping*	48	44.54	5.87	.07	-1.05	34.00	55.00	.96	.14
Taping nogom / *Leg tapping*	48	21.80	1.76	.24	-.19	18.00	26.00	.96	.24
Dohvat u sijedu / *Reach in sitting position*	48	11.00	4.32	.37	-.30	1.00	20.00	.96	.78
Iskret s palicom / *Bat movement*	48	87.29	9.89	.44	.47	65.00	110.00	.96	.19

Legenda: *N – broj ispitanika; M – aritmetička sredina; σ – standardna devijacija; Sk – zakrivljenost (Skewness); K – zaravnjenost (kurtosis) Min – minimalna vrijednost; Maks – maksimalna vrijednost. W – Shapiro-Wilkov test; p – nivo značajnosti*

Legend: *N - number of respondents; M - mean; σ - standard deviation; Sk - curvature (Skewness); K - flatness (kurtosis) min - the minimum value; Max - maximum value. W-- Shapiro-Wilkov test; p - level of significance*

Primjenom navedene transformacije asimetričnost i spljoštenost su umanjene. Vrijednost koeficijenta asimetrije nakon transformacije je Sk=-0.31, a kurtosisa K=4.5. Pored normalizacije spomenute varijable napravljene su još i normalizacije na varijablama: bacanje medicinke 1kg forhend (MESFOR), ležanje-sijed 30 sec. (MRCDLC), koraci u stranu (MAGKUS). Pregled vrijednosti koeficijenata asimetrije i spljoštenosti za sve varijable koje su bile objektom fitovanja dat je narednoj tablici. (*Tabela 2.*).

Applying the mentioned transformation, asymmetry and flatness are minimized. The value of asymmetry coefficient after transformation is Sk=-0.31, and the value of curtosis (kurtosisa) is K=4.5. Besides normalizing the mentioned variable, normalization of other variables was also done: throwing of a 1kg ball forehand (MESFOR), lying-sitting in 30 sec. (MRCDLC), side steps (MAGKUS). Survey of coefficient values of asymmetry and flatness for all variables subjected to the fitting is shown in the following table. (*Table 2.*).

Tabela 2. *Koeficijenti asimetrije i zaobljenosti nakon logaritamskih transformacija skorova*

Table 2. *Asymmetry and roundness coefficient after logarithmic transformation results*

Varijabla	Reflesija	S_k	K
Sprint iz visokog starta 20m / *High start sprint on 20m*	Da	-0.3	4.53
Bacanje med.1kg.forhend / *Throwing of a.1kg ball.forhend*	Da	-0.25	-0.42
Ležanje-sijed 30 sec. / *Lying-sitting in 30 sec.*	Ne	0.87	2.14
Koraci u stranu / *Side steps*	Ne	0.64	-1.11

S_k-Skewness; K- kurtosis

S_k-Skewness; K- kurtosis

Utjecajmotoričkih prediktora na kriterijsku varijablu natjecateljska uspješnost – pozicija na rang lististolnotenisača

The influence of motor predictors on criterion variable competitive efficacy -table tennis players ranking position

Tabela 3. *Deskriptori i pokazatelji multikolinearnosti za prediktorske varijable koje su uključene u regresijski model*

Table 3. *Multilinear descriptor and characteristics for predictor variables which are included in regression model*

	M	σ	N	FIV**
Taping rukom / *Hand tapping*	44.54	5.87	48	1.07
Bacanje medicinke forhend 1kg / *Throwing of a.1kg ball.forhend*	13.91	2.01	48	1.07
Koraci u stranu / *Side steps*	7.55	.64	48	1.07
Dohvat u sijedu / *Reach in sitting position*	11.00	4.32	48	1.07
Skok u dalj s mjesta / *Distance jump*	232.91	21.19	48	1.07
Bacanje medicinke iz ležanja* / *Throwing of a ball from lying position**	7.59	1.02	48	1.07

**faktor inflacije varijance; M-aritmetička sredina; σ-standardna devijacija; N-broj ispitanika

**inflation variance factor M-arithmetic mean; σ-standard deviation; N-number of respondents

Na osnovu korelacione analize detektirano je šest (6) varijabli iz domena bazične motoričke sposobnosti koje statistički značajno koreliraju sa kriterijskom varijablom: *taping rukom (MBFTAP)* (.96), *bacanje medicinke forhend (MESFOR)* (-.93), *koraci u stranu (MAGKUS)* (.82), *dohvat u sijedu (MFLDSI)* (.74), *skok u dalj s mjesta (MFESDM)* (.73) i *bacanje medicinke iz ležanja na leđima (MFEBML)* (.47).

U koloni FIV date su vrijednosti indikatora multikolinearnosti. Budući da su sve vrijednosti faktora povećanja varijance relativno niske, može se konstatirati da nema povrede multikolinearnosti.

Based on correlation analysis six variables was detected from the domain of basic motor skills which statistically have a significant correlation with the criterion variable: hand tapping *(MBFTAP)* (.96), throwing of a ball *forehand (MESFOR)* (-.93), side steps *(MAGKUS)* (.82), reach in sitting position *(MFLDSI)* (.74), distance jump *(MFESDM)* (.73) and throwing of a ball from back lying position *(MFEBML)* (.47).

In the column FIV there are values of multilinear indicators. Since all the values of variance increasing factors are relatively low, we can conclude that there is no multilinear disturbance.

Tabela 4. *Koeficijent multiple korelacije i koeficijent determinacije za model procjene pozicije stolnotenisača na rang ljestvici*

Table 4. *Multiple correlation coefficient and determination of the coefficient for model assessing ranking position of a table tennis player*

Model	R	R^2	Korigovani / *Restated* R^2	Standardna greška / *Standard mistake*
1	.65	.41	.36	11.41

R-koeficijent multiple korelacije; R^2-koeficijent determinacije

R-multiple correlation coefficient; R^2-coefficient of determination

Na osnovu podataka koji su uključeni u regresijski model izdvojena je jedna regresijska funkcija. Koeficijent multiple korelacije iznosi $R=.65$ što znači da je povezanost varijabli iz domena bazičnih motoričkih sposobnosti statistički značajna sa kriterijskom varijablom *pozicija igrača na rang ljestvici (BODRNG)*, te se time može objasniti oko 41% varijance uspješnosti stolnotenisača (*Tabela 4*.).

Based on data included in regression model, one regression function is singled out. Coefficient of multiple corelation is $R=.65$ which means that by including variables from the domain of basic motor skills which are statistically significant with the criterion variable ranking position of a players *(BODRNG)* we can explain about 41% of efficacy variance of table tennis players (*Table 4*.).

Tabela 5. *Procjena značajnosti regresijskog modela u predikciji pozicije ispitanika na rang ljestvici*

Table 5. *Assesing significance of regression model in prediction of ranking position of the participants*

Model		Suma kvadrata / *The sum of squares*	df	Prosječni kvadrat / *Average square*	F	p.
1	Regression / *Regression*	3353.238	6	1676.619	12.878	.000
	Residual / *Residual*	5858.762	41	130.195		
	Ukupno / *Total*	9212.000	47			

F-regresijska funkcija; p-nivo značajnosti; df-prediktorske varijable

F-regression function; p-level of significance; df-predictor variables

Procjena značajnosti regresijskog modela izvršena je putem analize varijance. Dobivena regresijska funkcija je statistički značajna (F= 12.87) (p<0.01) (*Tabela 5*.).

Doprinosi pojedinih varijabli iz prostora bazičnih motoričkih sposobnosti ispitanika regresijskom modelu prikazani su u narednoj tabeli (*Tabela 6*.).

Assessing significance of regression model is done by analyzing the variance. Regression function that was given is statistically significant. (F= 12.87) (p<0.01) (*Table 5*.).

Contribution of individual variables from the area of participants` motor skills to regression model is shown in the following table (*Table 6*.).

Tabela 6. *Parcijalni doprinos varijabli regresijskom modelu*

Table 6. *Partial contribution of variables to the regression model*

Model		B	B_{se}	β	t	p.
1	konstanta / *constant*	78.92	12.58		6.27	.00
	Taping rukom / *Hand tapping*	.09	.04	.68	3.88	.00
	Bacanje medicinke forhend 1kg / *Throwing of a ball forhend 1kg*	.06	.04	.41	2.26	.02
	Koraci u stranu / *Side steps*	-.07	.03	-.39	- 2.11	.03
	Dohvat u sijedu / *Reach in sitting position*	.17	.11	.27	1.96	.06
	Skok u dalj s mjesta / *Distance jump*	.10	.02	.53	2.86	.00
	Bacanje medicinke iz ležanja / *Throwing of a ball from lying position*	-4.95	1.68	.36	-2.93	.00

β -parcijalni *doprinos prediktora; p – nivo značajnosti;*

β-partial contribution *of predictors; p - level of significance*

Na osnovu visine standarnih regresijskih koeficijenata te njihove značajnosti, može se konstatirati da pet (5) varijabli statistički značajno doprinose regresijskom modelu: *taping rukom (MBFTAP), bacanje medicinke forhend 1kg (MESFOR), koraci u stranu (MAGKUS), skok u dalj s mjesta (MFESDM)* i *bacanje medicinke iz ležanja na leđima (MFEBML).*

Kada je riječ o parcijalnim doprinosima najbolji prediktori su: taping rukom (MBFTAP (β =.68), skok u dalj s mjesta (MFESDM) (β =-.53), bacanje medi-

Based on the level of standard regression coefficient and their significance we can conclude that five variables statistically contribute to the regression model: hand tapping *(MBFTAP), throwing of a ball forehand 1kg (MESFOR), side steps (MAGKUS), distance jump (MFESD)* and *throwing of a ball from back lying position (MFEBML).*

Talking about partial contributions, the best predictors are: hand tapping (MBFTAP (β =.68), distance jump (MFESDM) (β =-.53), throwing of a ball forehand 1kg (MESFOR)

cinke forhend 1kg (MESFOR) (β =.41), koraci u stranu (MAGKUS) (β =.39) i bacanje medicinke iz ležanja na leđima (MFEBML) (β =.36).

Rezultati ovog istraživanja pokazuju da je statistički značajan utjecaj motoričkih prediktorskih varijabli brzine frekventnih pokreta rukom, eksplozivne snage gornjih i donjih ekstremiteta i agilnosti.

Brzina frekvencije pokreta gornjih ekstremiteta pokazala se kao ukupno gledano najvažnija varijabla u opisivanju natjecateljske uspješnosti stolnotenisača. Gotovo je sigurno da se ustvari radi o kombiniranom utjecaju brzine frekvencije pokreta i brzine jednostavnog pokreta. Naime, brzina frekvencije pokreta analizirana tapingom rukom uključuje u sebi niz ponavljanja kretnji koje odgovaraju brzom jednostavnom pokretu bekhenda i forhenda. Ova kombinacija zasigurno opisuje brzinu udaraca koje je stolnotenisač sposoban uputiti.

Međutim, ono što je za ovu priliku bitno važnije za primijetiti da je očit utjecaj eksplozivne snage donjih ekstremiteta, odnosno relativne eksplozivne snage. Ova sposobnost se prvenstveno očituje u skoku, međutim, ne treba zanemariti utjecaj ove sposobnosti na brze promjene pravca i smjera kretanja iz stabilnog stava, ali i sposobnost ponovljenih promjena pravca i smjera kretanja u određenim agilnim i kvaziagilnim kretnjama (skok u stranu, povratak na prvobitnu poziciju i sl.).

Ovo je jedno od rijetkih istraživanja koje je direktno provjeravalo povezanost motoričkih varijabli i natjecateljske uspješnosti kroz analizu povezanosti korelacijskog ili regresijskog tipa.

Konkretno, istraživanja koja su se bavila problemom motoričkih sposobnosti i natjecateljske uspješnosti postoje, ali se u pravilu radi o studijama koje su provjeravale razlike između igrača različitih kvalitativnih razina (Toriola i sur. 2004.; Munivrana, 2011.; Malagoli i sur. 2011.; Bankosz, 2012.).

Zaključak

Kao što se moglo očekivati motoričke varijable su značajan prediktor natjecateljske uspješnosti stolnotenisača.

Rezultati ovog istraživanja pokazuju da je statistički značajan utjecaj motoričkih prediktorskih varijabli brzine frekventnih pokreta rukom, eksplozivne snage gornjih i donjih ekstremiteta i agilnosti.

Test brzine frekvencije pokreta rukom značajni je prediktor natjecateljske uspješnosti, što ustvari govori o visokoj vrijednosti frekvencije pokreta kao mjere motoričkog statusa stolnotenisača. Za ovu činjenicu može se izdvojiti nekoliko razloga, ali u prvom redu razloga

(β =.41), side steps (MAGKUS) (β =.39) and throwing of a ball from back lying position (MFEBML) (β =.36).

The results of this research show statistically significant influence of motor predictor variables of speed frequency hand movements, explosive strength of upper and lower extremities and agility.

Speed of movement frequency of upper extremities is shown as generally the most important variable in description of competitive efficacy of table tennis players. It is almost certain that it is a combined influence of speed frequency movement and speed of simple movement. The speed of movement frequency analyzed by hand tapping includes the series of movement repetitions which corresponds to a fast simple movement of backhand i forehand. This combination surely describes speed of the hits which table tennis player can make.

What is important in this case is the evident influence of explosive strength of lower extremities that is of relative explosive strength. This ability is mainly evident in jumping but we should not forget the influence of this ability on fast direction change and movement direction from a firm position but also the ability of repeated direction changes and movement direction in certain agile and so called agile movements (side jump, returning to original position etc.).

Based on the results of multiple regression analysis which was conducted on 6 independent predictor variables from the area of basic motor skills and based on the ranking position of table tennis players (BODRNG), as a dependant variable of competitive efficacy with the use of enter method, one statistically significant function was given. It implies that there is a linear connection between the mentioned variables. The given coefficient of multiple correlation is statistically significant and is about 41% variance of results of participant position on a ranking list variable (BODRNG), can be explained with the help of included predictor variables.

Conclusion

As might be expected motor variables were significant predictors of the success of table tennis competition.

Results of this study indicate that a statistically significant predictor variable speed motor frequency of hand movements, explosive strength of upper and lower extremities and agility.

Test frequency of movement by hand is a significant predictor of competitive success, which actually talks about the high value of movement frequency as a measure of motor status table tennis players. For this fact can be extracted several reasons, but first and foremost

sadržan je u tome što varijabla tapinga rukom, mada prvenstveno varijabla za procjenu frekevencije pokreta, u sebi saturira jednu izuzetno važnu motoričku sposobnost u stolnom tenisu, a to je ustvari brzina jednostavnog pokreta.

Ono što je međutim zanimljivo za primijetiti je da varijabla taping rukom saturira dvije brzine jednostavnog pokreta i to: brzinu jednostavnog pokreta u kretnji koja je definirana angažmanom prsne muskulature i muskulature prednje strane ramena (forhend kretnja), ali i kretnji jednostavnog pokreta koja je definirana angažmanom leđne i stražnje ramene muskulature (bekhend kretnja).

Eksplozivna snaga gornjih ekstremiteta u stvari je sadržana u prethodno objašnjenom utjecaju udarca. Bolje rečeno radi se o ukupnom utjecaju eksplozivne snage i to kako one apsolutnog tako i one relativnog tipa na natjecateljsku uspješnost u stolnom tenisu.

Stolni tenis je sport brzine i agilnosti (Kondrič i sur. 2013.). Premda se moglo očekivati da će agilnost igrati značajniju ulogu u predikciji kako tehničko-taktičke tako i natjecateljske uspješnosti stolnotenisača, to se nije dogodilo. Konkretno, agilnost se pokazala značajan prediktor, ali ne u onolikoj mjeri i s onolikim faktorom doprinosa koliko je autor očekivao. Osnovni razlog za ovo je vjerojatno sadržan u činjenici da testiranje agilnosti nije provedeno testovima koji bi trebali opisati pravu stolnotenisku agilnost. Ovo se u prvom redu odnosi na činjenicu da se test *koraci u stranu*, ma koliko ustvari na prvi pogled opisivao kretnje u stolnom tenisu ne izvodi u stolnoteniskim uvjetima. Prvo, dimenzije testa nisu dimenzije koje odgovaraju realnoj stolnoteniskoj igri te bi se u tom smislu test u daljnjim istraživanjima vjerojatno trebao skratiti u prostornim parametrima i modificirati tako da bude test specifičan za stolni tenis. U posljednje vrijeme ovaj pristup je očit u sportskoj znanosti, te znanstvenici u svijetu sve češće primjenjuju originalno konstruirane sport-specifične testove (Uljević i sur. 2013.). Stoga bi u narednim istraživanjima bilo potrebno pratiti ovakav pristup i u stolnom tenisu.

reason is contained in that variable taping-hand, although primarily variable for estimating frequency energies movement inside it saturates a very important motor skills in table tennis and it is in fact speed of simple movements.

What is however interesting to note is that the variable hand tapping it saturates the two speeds of simple movements, namely: the speed of simple movements in motion that is defined pectoral muscle engagement and muscular front shoulder (forehand movement), but also a simple gesture movement that is defined engagement back and rear shoulder muscles (backhand movement).

Explosive power of the upper extremities in fact contained in the previously discussed the impact of the blow. Rather it is about the overall impact of explosive power and how those absolute and those relative to the type of competitive success in table tennis.

Table tennis is a sport of speed and agility (Kondrič et al. 2013.). Although it might be expected that the agility to play a more significant role in predicting both technical and tactical competition efficacy table tennis players that did not happen. In particular, agility proved a significant predictor, but not in so far is a factor to as many contributions as the author expected.

The main reason for this is probably related to the fact that test agility is not conducted tests which should describe the real table tennis agility. This primarily refers to the fact that the test side steps, however in fact at first glance describing movement in table tennis is not running in Table tennis conditions. First, the dimensions of the test are not dimensions that correspond to real table tennis game and help in this regard the test further and probably should shorten the spatial parameters and modified to be specific test for table tennis. Recently, this approach is evident in the sports science and scientists in the world are increasingly applied originally designed sport-specific tests (Uljević et al. 2013.). Therefore, in future research was needed to follow this approach and table tennis.

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