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CORRELATIONS AMONG HANDEDNESS, HANDGRIP STRENGTH AND FRONT CRAWL SWIMMING PERFORMANCE IN ADOLESCENTS

KORELACIJE MED DOMINANTNOSTJO LEVE ALI DESNE ROKE, MOČJO OPRIJEMA ROKE IN USPEŠNO IZVEDBO PRSNEGA KRAVLA PRI MLADOSTNIKIH

ABSTRACT

This study aims to investigate the relationships among hand grip strength, handedness and front crawl swimming performance in male and female adolescents. Data were collected from 22 female and 19 male, totally 41 swimmers aged from 13 to 18 years. Handedness was determined by using the Edinburgh Handedness Scale (Oldfield, 1971). Hand grip strength of right and left hands was measured by using an adjustable digital hand grip dynamometer. A nonparametric Mann-Whitney U test was used for comparison between right and left handed participants. Spearman correlation coefficients were calculated among variables in male and female adolescents. No significant difference was observed between right and left hand grip strength depending hand preferences in male and female adolescents. There was also no significant difference between right and left handers in 50 and 100 meters front crawl swimming performance. In both genders, there was significant negative correlation between left hand grip strength and 50 m front crawl swimming. On the other side, right and left hand grip strengths were also negatively well correlated with 100 m front crawl swimming in males. There was only significant correlation between handedness and right hand grip strength in males. It can be concluded that hand grip strength symmetry in swimmers can result in better short distance swimming performance due to resultant force effect on technique.

Keywords: Swimming, Handedness, Handgrip Strength

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IZVLEČEK

Namen raziskave je preučiti povezavo med močjo oprijema, dominantnostjo leve ali desne roke in uspešno izvedbo prsnega kravla pri mladostnicah in mladostnikih. Vzorec za zbiranje podatkov je zajemal 22 plavalk in 19 plavalcev (skupaj 41), starih od 13 do 18 let. Dominantnost roke smo ugotavljali z Edinburghovo lestvico dominantnosti rok (Oldfield, 1971). Moč oprijema desne in leve roke smo merili z nastavljivim digitalnim dinamometrom za merjenje moči oprijema rok. Neparametrični Mann-Whitney U test smo uporabili za primerjavo desničarjev in levičarjev. Pri mladostnicah in mladostnikih smo izračunali Spearmanove korelacijske koeficiente za različne spremenljivke. Med močjo oprijema desne in leve roke mladostnikov in mladostnic nismo opazili nobenih značilnih razlik glede na dominantnost roke. Prav tako ni bilo značilnih razlik med desničarji in levičarji v uspešnosti izvedbe prsnega kravla na 50 in 100 metrov. Pri moških smo zaznali značilno negativno korelacijo med močjo oprijema leve roke in prsnim kravlom na 50 metrov. Po drugi strani pa sta pri ženskah moč oprijema desne in leve roke močno korelirala s prsnim kravlom na 100 metrov. Značilna korelacija je bila ugotovljena samo med dominantnostjo roke in močjo oprijema desne roke. Lahko zaključimo, da simetričnost moči oprijema rok pri plavalcih pripomore k uspešnejšemu plavanju na kratke razdalje zaradi vpliva moči na tehniko plavanja.

Ključne besede: plavanje, dominantnost rok, moč oprijema roke

INTRODUCTION

Short distances swimming including 50 and 100 meters requires continuous and high stroke rate and stroke length from the beginning to the end (Chollet et al., 1997; Sidney, Delhaye, Baillon and Pelayo, 1999). The swimming speed in competition of short distance races is generated by propulsive force due to the movement of arms and legs in the right and left side of the body.

These body segments should equally produce power during the short distance swimming in horizontal direction. Because the strokes of right and left arms and legs produce the resultant forces for the displacement of the body during swimming. Sanders, Thow and Fairweather (2011), emphasized that asymmetries during the propulsive force application could cause undesirable body movements and reduce the efficiency of swimming by increasing drag force. In sports and daily activities one hand is generally preferred more than the other hand. Handedness is the natural or biological preference for using one hand more than the other in performing special tasks due to brain hemispheric dominance (Rice, 1998). Handedness as an indicator of cerebral lateralization can create the performance differences in motor and movement skills (Eikenberry, McAuliffe, Welsh, Zerpa, McPherson & Newhouse, 2008). It may leads to performance differences in arms of swimmers depending on strength differences between right and left hand. On the other side, handedness related performance differences was reported not only in swimming but also sprint running among left and right handers in pre-pubertal males (Ziyagil, 2011).

It was also showed that hand grip strength (HGS) is as an indicator of muscular strength in the hand and the forearm (Bassey and Harries, 1991). HGS symmetry as an indicator of forearm and upper arm strength can result in better short distance performance by power production of strokes in linear direction. Similarly, it was reported that strength asymmetry depending on hand preferences can hinder the mean speed during sprint running performance leading to low mechanical efficiency (Singh, 1970; Ziyagil, 2011). Bassey and Harries (1991) hypothesized that handedness and strength asymmetry in both arms and legs may result in low swimming performance in adolescent males. Coaches need the information about swimmers for talent identification and monitoring trainings. They should know the importance of HGS symmetry in swimmers can result in better short distance swimming performance. In literature there is limited numbers of studies only investigating the relationships between swimming performance and hand grip strength regardless of handedness. These studies reported that an increase in the dynamical asymmetry of the upper and lower extremities might have decreased the efficiency of the shoulder girdle muscles' symmetrization in breast stroke swimming (Czabanski, 1975; Czabanski and Koszcyc, 1979; Sanders et al. 2011; Jaszczak and Zaton, 2011). The asymmetries in upper and lower limbs may result in decreasing swimming performance by the differences in strength, flexibility and posture depending on hand preferences. This study aims to investigate the relationships among short distance front crawl swimming performance, hand grip strength and handedness in pubescent male and females.

MATERIAL AND METHOD

Data were collected from 22 female and 19 male, totally 41 swimmers aged from 13 to 18 years. Handedness was expressed as the Geschwind Score (GS) by using the Edinburgh Handedness Scale (Oldfield, 1971). This generated scores from 100 to -100. Participants having handedness scores from -100 to zero (including zero) were considered to be left-handed and those with scores

from zero to 100 were considered to be right-handed. Positive GS shows the degree of right handedness and negative GS indicates the level of left handedness.

HGS of right and left hands was measured by using an adjustable digital hand grip dynamometer (Takei Scientific Instruments Co. Ltd., Japan). The participants were asked to squeeze the dynamometer with as much force as possible, considering careful to squeeze only once for each measurement. Three trials should be made with a rest of about 10-20 seconds between each trial to avoid the effects of muscle fatigue. The mean value of the highest two of three trials was recorded as a score.

All statistical analyses were performed using SPSS Version 20. Descriptive statistics were calculated for male and females with respect their hand preferences. Normality of data distribution was checked, using Kolmogorov-Smirnov tests. A nonparametric Mann-Whitney U test was used for comparison between right handed and left handed participants. Also, Spearman correlation coefficients were calculated among variables in male and female adolescents official Turkish national competition results for 50 and 100 m front crawl swimming were obtained from Turkish Swimming Federation records obtained in long course.

RESULTS

Physical and performance characteristics of left handers and right handers in males and females is presented in Table 1, while comparison of HGS and swimming performance among handedness groups in males and females was shown in table 2. Also Table 2 shows Spearman correlations coefficients among variables in male and female adolescents.

The results of this study showed that physical characteristics including age, body height, body weight and BMI were not differentiated depending on handedness in males and females. There

Table 1. Physical and performance characteristics of left handers and right handers in males and females.

Variables	Groups	MALES					FEMALES				
		N	M	SD	Diff. %	Asymp. Sig.	N	M	SD	Diff. %	Asymp. Sig.
Age (year)	**LH**	6	16.00	1.26			5	15.40	0.89		
	RH	16	15.81	0.91	1.19	.590	14	15.93	1.44	3.33	.362
	Total	22	15.86	0.99			19	15.79	1.32		
Body Height (cm)	**LH**	6	176.67	5.99			5	163.60	6.66		
	RH	16	174.06	10.37	1.48	.711	14	165.93	9.30	1.40	.353
	Total	22	174.77	9.31			19	165.32	8.57		
Body Weight (kg)	**LH**	6	66.00	10.97			5	60.60	7.57		
	RH	16	68.94	10.88	4.26	.530	14	59.50	11.39	1.82	.889
	Total	22	68.14	10.72			19	59.79	10.33		
Body Mass Index (BMI)	**LH**	6	21.16	3.47			5	22.55	1.04		
	RH	16	22.70	2.73	6.78	.224	14	21.44	2.79	4.92	.308
	Total	22	22.28	2.95			19	21.73	2.47		

LH=Left Hander. RH=Right Hander.

was no significant difference in the means of HGS and swimming performance between left handed and right handed in males and females. In addition, right and left HGS, 50 m and 100 m front crawl swimming performance were not differentiated depending on handedness in males and females.

There was no significant difference between right and left handed males and females in physical characteristics. These differences for male left and right handers were 1.19 % for age, 1.48 % for body height, 4.26 % body weight and 6.78 % for BMI, respectively. These values for female left and right handers were 3.33 % for age, 1.40 % for body height, 1.82 % body weight and 4.92 % for BMI, respectively

There was also no significant difference between right and left handed males and females in HGS and swimming performance. These differences between right and left HGS were 3.98 % for the left handed males, 0.86 % for the right handed males, 15.75 % for the left handed females, 8.94 % for the right handed females, respectively (Table 2).

Swimming performance differences between left handed and right handed males were 3.88 % for 50 meters front crawl swimming and 1.76 % for 100 meters front crawl swimming, respectively. In other side, swimming performance differences between left handed and right handed females were 1.15 % for 50 meters front crawl swimming and 3.24 % for 100 meters front crawl swimming, respectively.

Table 2. Comparison of HGS and swimming performance among handedness groups in males and females.

Variables	R HGS		L HGS		Diff	% Diff	Mann-Whitney U	Asymp. Sig.
	M	*SD*	*M*	*SD*				
LH males	32.33	5.20	33.67	6.47	1.34	3.98	16.5	.809
RH males	39.34	8.05	39.00	7.51	0.34	0.86	125.0	.910
LH females	24.60	3.21	29.20	6.18	4.6	15.75	5.5	.142
RH females	27.96	5.31	25.46	4.25	2.5	8.94	71.5	.222
Variables	**LH Males**		**RH Males**		**Diff**	**% Diff**	**Mann-Whitney U**	**Asymp. Sig.**
	M	*SD*	*M*	*SD*				
50 m swimming	29.71	1.75	30.91	4.98	1.2	3.88	40.0	.555
100 m swimming	63.71	6.92	62.59	8.30	1.12	1.76	43.5	.740
Variables	**LH Females**		**RH Females**		**Diff**	**% Diff**	**Mann-Whitney U**	**Asymp. Sig.**
	M	*SD*	*M*	*SD*				
50 m swimming	30.95	4.77	31.31	4.10	0.36	1.15	31.5	.745
100 m swiming	64.80	10.13	62.70	20.50	2.1	3.24	29.5	.610

LH=Left Handed, HGS=Hand Grip Strength.

In females, there was a significant negative correlation (r= -.554, p< .05) between left HGS and 50 m front crawl swimming. On the other side, right and left HGS were well correlated (r= -.616, p< .01; r= -.653, p< .01) with 100 m front crawl swimming in males. There was also significant correlation (r= -.480, p< .05) between left HGS and 50 m front crawl swimming in males. There was only significant correlation (r= .468, p< .05) between handedness and right HGS in males.

Table 3. Spearman correlations coefficients among variables in male and female adolescents.

Variables	MALES				FEMALES			
	50 m Swimming	100 m Swimming	Right HGS	Left HGS	50 m Swimming	100 m Swimming	Right HGS	Left HGS
Age	-.150	.077	.136	.254	.234	.129	.232	.019
Body Height	**-.513***	**-.536***	**.596****	**.545****	-.276	-.173	.446	.373
Body Weight	-.336	-.411	**.536***	**.654****	-.116	-.142	.283	.430
BMI	-.085	-.020	.215	.364	.178	.004	-.019	.264
Right HGS	-.384	**-.616****	1.000	**.906****	-.392	-.258	1.000	**.575***
Left HGS	**-.480***	**-.653****	**.906****	1.000	**-.554***	-.355	**.575***	1.000
Handedness	.129	-.073	**.468***	.371	.077	.120	.306	-.275

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level

BMI=Body Mass Index. RHGS: Right Hand Grip Strength. LHGS: Left Hand Grip Strength

Physical characteristics including body height and weight were significantly correlated with HGS measurements and 50 and 100 meters front crawl swimming in males. In contrast there were only was no significant correlation between body weight and HGS measurements in females (Table 3).

DISCUSSION

This study aimed to investigate the correlations among handedness handgrip strength and the individual best scores of 50 and 100 meters front crawl swimming in adolescent swimmers aged 13 -18 years.

Results of this study showed that no significant differences was observed between left handed and right handed male and female adolescents in the mean of HGS. In generally, approximately 90 percent of population is right handed and 10 percent is left handed (Coon and Mitterer, 2013). Considering limited number of left handed individuals; this study had a disadvantage due to its small sample size. It is necessary to increase number of left handed male and female swimmers for comparison of functional laterality of swimmers depending on handedness in future research. According to obtained results, significant correlations were observed between HGS measurements and swimming performance but significant correlation was only found between handedness and right HGS in males. Ziyagil, Gürsoy, Dane, Türkmen and Çebi (2015) investigated the effects of handedness on the HGS asymmetry in Turkish athletes. They found that hand dominance was weakly correlated with right and left HGS in males while only left-HGS was significantly correlated with handedness in females. In contrast to the study of Ziyagil et al. (2015) the present study demonstrated that there was only significant correlation between handedness and right HGS in males. In this study left HGS showed also significant correlation with 50 meters front crawl swimming in males and females while right and left HGS were well correlated with 100 m front crawl swimming in males.

Studies related to force symmetry in front crawl swimming showed a tendency to asymmetry of limbsí force productions (Pereira, Schutz, Ruschel, Roesler & Pereira, 2015; Santos, Pereira, Papoti, Bento, Rodacki and Dos Santos, 2013). Santos Dos et al. (2013) found significant differences between forces produced by arms at all times of execution during swimming. In addition,

Morouco, Keskinen, Vilas-Boas and Fernandes (2011) analyzed force performed by arms using tethered front crawl swimming performance and there were significant differences in the maximum force production between right and left arms for during the first 19 strokes during a 30-seconds execution. This means that handedness related differences were observed in the first part of the test duration. The correlations were increased with increasing swimming distance in the present study. Because 100 meters front crawl swimming had stronger correlations with right and left HGS than 50 meters front crawl swimming performance.

Pereira et al. (2015) reported that distribution of force asymmetries were changed from 10 % to 30 % for most swimmers. The present study showed smaller strength difference for right and left handed male and female than the results reported by Pereira et al. (2015).

This study showed that handgrip strength had a higher correlation with swimming performance compare to handedness. Strength difference between right and left HGSs were 3.98 % for left handed males and 0.86 % for right handed males, respectively. These differences were 15.75 % for left handed females and 8.94 % for right handed males, respectively. Females had a higher HGS asymmetry than males in this study. In addition left handed male swimmers had higher HGS asymmetry than right handed males. In spite of insignificant differences between right and left handed male and female groups in swimming performance. It is clear that left handers had a faster 50 m front crawl swimming while right handers had a faster 100 m front crawl swimming in adolescent males and females. In both genders, superiority of left handers in 50 m front crawl swimming and superiority of right handers in 100 m front crawl swimming can be partly explained by the study of Eikenberry et al. (2008). They stated that the right brain hemisphere had an advantage in the quick initiation of action while the left hemisphere played an important role in the controlling movements from starting to finish. Same authors (2008) also stated that reaction time of sprinters was shorter with the starting position of their left foot to the rear. In contrast total response time decrease with the rear position of right foot. This means that starting left limb stimulates to the activation of the right brain hemisphere gaining with its advantage in reaction time. In other side, starting right limb stimulates to the activation of the left brain hemisphere gaining with its advantage in the controlling of whole movement (Eikenberry, McAuliffe, Welsh, Zerpa, McPherson & Newhouse, 2008). In this study results showed that left handed swimmers were strongly consistent with left hand preference (right hemisphere dominance) and they had advantage in 50 m front crawl swimming in contrast to the advantage of right handed swimmers in 100 m front crawl swimming in both genders. Although these differences were not statistically significant, right and left HGS well correlated with 50 meters front crawl swimming in both gender but right and left HGS showed only a significant correlation with 100 meters front crawl swimming in females. These results indicated that there was indirect relationship between swimming performance and handedness. Because handedness was only strongly correlated with right HGS in males while the right HGS of males showed only strong correlation with 100 m front crawl swimming at .01 significance level. This study also demonstrated that hand grip strength is suitable indicator of muscular strength in the hand and the forearm for adolescent front crawl performance swimmers.

Similar to the study of Maglischo et al. (1988); Seifert, Chollet and Allard (2005) reported that there was no significant difference in arm coordination asymmetry depending on handedness. Because swimmers could use different motor strategies to compensate to the asymmetry of coordination. In this study, it is impossible to observe this kind of compensation during short distance swimming in adolescents. On the other hand, there are several studies explaining the

development of asymmetry only depending on anatomical and mechanical factors. These studies indicated that the dynamical symmetry of the upper and lower extremities might lower the efficiency of body limbs in breast stroke swimming (Czabanski, 1975; Czabanski and Koszcyc, 1979; Sanders et al. 2011; Jaszczak and Zaton, 2011). The asymmetries in the body limbs can create an imbalance in the body shape and posture, strength and flexibility affecting arm pull and leg kick during swimming.

Physical characteristics including body height and weight were significantly correlated with HGS measurements and 50 and 100 meters front crawl swimming in males. In contrast there was no significant correlation between body weight and HGS measurements in females (Table 3).

Coaches can use the information about swimmer's strength asymmetry for talent identification and monitoring their performance during training. It can be concluded that HGS symmetry in swimmers can result in better short distance swimming performance due to resultant force effect on technique. Future studies should investigate the relationship among variables including strength asymmetry handedness and swimming performance in different age, gender and categories.

CONCLUSION

It can be concluded that handedness was only moderately correlated with right HGS in males. The strong correlation between right HGS and 100 m front crawl swimming showed that there was indirect relationship between swimming performance and handedness. HGS symmetry as an indicator of forearm and upper arm strength may result in better short distance performance due to resultant force effect on technique in male swimmers.

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