Coll. Antropol. **32** (2008) 3: 829–834
Original scientific paper

Sex Differences in Motor Characteristics of Elementary School Children Included/Not Included in Swimming Training

Renata Pavić, Viktorija Trninić and Ratko Katić

Faculty of Kinesiology, University of Split, Split, Croatia

A B S T R A C T

The aim of the study was to assess the development of motor abilities in elementary school fifth- to eighth-graders (age 11–14 years) according to sex, age and physical activity. Study sample included 312 subjects divided according to age and sex into four groups: male subjects aged 11–12 (n=93) and 13–14 years (n=84); and female subjects aged 11–12 (n=65) and 13–14 years (n=70). Then, differences in basic motor abilities between children included (experimental group) and those not included (control group) in swimming training were analyzed. In male fifth- and sixth-graders, experimental group was superior to control group in the variables of trunk repetitive strength, sprint, flexibility and coordination, while in male seventh- and eighth-graders experimental group showed better performance than control group in agility, aerobic endurance and explosive throw and jump strength. In female fifth- and sixth-graders, experimental group proved superior to control group in the variables of explosive strength, coordination, trunk strength and aerobic endurance, whereas in female seventh- and eighth-graders experimental group had better performance in coordination, endurance, explosive strength, speed and flexibility. Discriminative analysis of motor variables between male and female subjects revealed male subjects to be superior in explosive strength, throw strength in particular, coordination and aerobic endurance, whereas female subjects showed better performance in the variables of flexibility and movement frequency, leg movement in particular. Study results showed the formation of appropriate motor system determining achievement of top results in swimming to be influenced by swimming training from age 11 to 14. In male children, motor system was found to integrate coordination/agility, aerobic endurance and explosive strength, whereas in female children it integrated coordination in terms of cortical movement regulation, aerobic endurance, explosive strength and psychomotor speed.

Key words: *motor status of children, swimming training, sex differences*

Introduction

The growth and maturation are influenced by gene, hormone, dietary and environmental interactions[1]. During growth and aging, the body composition undergoes constant changes related to health status, dietary habits and physical activity[2]. Intensive physical activity is one of the environmental factors that exert favorable effects on the growth and maturation. If properly organized and age-adjusted, physical activity has beneficial impact on the body growth, skeletal, muscular and circulatory systems in particular, and on body composition[3–5]. During the process of growth, significant changes in anaerobic strength and aerobic capacity occur under the influence of exercise[6]. Physical exercise influences development and oxygen consumption[7], aerobic capacity and muscle strength[8], aerobic capacity, coordination and muscle endurance[9].

Evaluation of the relevant dimensions of anthropologic status is a basis of every programmed training process in physical education. Anthropologic status is defined by the level and relations of the dimensions evaluated[10–13]. Due knowledge of anthropologic characteristics of the individual and characteristics determining successful performance in the respective sports activity is necessary as a basis of conducting the training process toward successful outcome[14–23].

The concepts on the impact of physical activity and training on the growth and maturation are mostly based

Received for publication August 29, 2008

on the results of comparison of growth and maturation indicators between children not included in sports activities and children included in sports training. However, in such comparisons it is quite difficult to identify the extent to which differences in the area of functional and motor changes are due to training process or selection of children, or simply children with higher level of abilities tend to join such training activities[24–30].

Swimming as a monostructural kinesiologic activity of cyclic type, with acyclic structure of motion on performing start, turn and reaching goal, is predominantly activated by the motor-locomotor system and functional--transport system responsible for energy transformation, especially in the form of pulmonary ventilatory function[31,32]. Thus, swimming primarily influences development of the basic motor and functional abilities. Being performed in water (sea water in the present study) as a specific medium of specific physical properties, swimming also has health/rehabilitation related effects.

The aim of the present study was to assess the development of motor abilities in elementary school fifth- to eighth-graders according to age, sex and physical activity. To be more precise, the aim was to determine differences in basic motor abilities between children included in swimming training organized during summer months in a sea swimming basin and children not included in the program. The objective was to obtain information on the formation of the specific motor system as influenced by swimming activities, which would limit performance in particular swimming styles during subsequent stages of development.

Subjects and Methods

Study sample included 312 subjects of both sexes, Korčula elementary school fifth- to eighth-graders, aged 11, 12, 13 or 14 ± 2 months at the beginning of the 2002–2003 academic year. The subjects were classified according to age and sex into four groups: male subjects aged 11–12 (n=93) and 13–14 years (n=84); and female subjects aged 11–12 (n=65) and 13–14 years (n=70). These four groups were subdivided into subjects included (experimental group) and those not included (control group) in swimming training during the summer, as follows: male subjects aged 11–12 included (n=37) and those not included in swimming training (n=56); male subjects aged 13–14 included (n=36) and those not included in swimming training (n=48); female subjects aged 11–12 included (n=22) and those not included in swimming training (n=43); and female subjects aged 13–14 included (n=20) and those not included in swimming training (n=50).

The study was performed at Petar Kanavelić Elementary School in Korčula on the Island of Korčula at the beginning of the 2002–2003 academic year. The following 12 variables were used on motor status assessment: polygon backwards (s), sidesteps (s), bench standing (s), forward bow (cm), hand tapping (taps/min), foot tapping

TABLE 1
RESULTS OF DISCRIMINATIVE ANALYSIS OF MOTOR VARIABLES BETWEEN CONTROL AND EXPERIMENTAL GROUPS OF BOYS

Variable	5 and 6 graders (n=93)			7 and 8 graders (n=84)		
	Control	Exp	DF	Control	Exp	DF
POLYGON#	13.88 ± 3.20	12.42 ± 2.02	0.39	11.25 ± 2.47	10.42 ± 2.25	0.30
SIDESTEP#	10.19 ± 1.19	9.61 ± 1.38	0.34	9.68 ± 0.94	9.03 ± 0.79	0.62
B-STAND	7.85 ± 7.89	7.33 ± 5.31	0.06	6.22 ± 3.68	8.08 ± 9.67	–0.23
FORWARD	56.26 ± 11.49	63.04 ± 12.60	–0.43	54.17 ± 15.86	57.13 ± 15.12	–0.16
HANDTAP	31.30 ± 4.74	33.46 ± 3.19	–0.39	35.52 ± 5.00	35.91 ± 4.67	–0.07
FOOTTAP	22.17 ± 2.90	22.99 ± 1.67	–0.25	24.78 ± 2.24	24.75 ± 2.04	0.01
L-JUMP	158.42 ± 13.5	161.22 ± 15.5	–0.15	179.66 ± 30.8	192.93 ± 21.1	–0.41
THROW	18.07 ± 6.41	18.48 ± 6.96	–0.05	27.23 ± 5.29	29.99 ± 4.86	–0.46
20M#	4.20 ± 0.33	4.00 ± 0.24	0.50	3.88 ± 0.28	3.80 ± 0.27	0.25
SIT-UP	31.64 ± 5.06	37.05 ± 4.45	–0.84	43.56 ± 7.02	45.50 ± 6.51	–0.24
BENTARM	36.92 ± 24.92	45.24 ± 24.42	–0.25	55.20 ± 28.42	53.71 ± 22.32	0.05
3MINRUN	753.68 ± 123.8	791.08 ± 98.8	–0.24	768.96 ± 94.6	828.61 ± 93.3	–0.54
Centroids	0.53	–0.80		0.50	–0.67	
CanR			0.55*			0.51*

Control – control group, Exp – experimental group, DF – structure of discriminative function, CanR – coefficient of canonic discrimination, #variable with opposite metric orientation, *p<0.01
POLYGON – polygon backwards, SIDESTEP – sidesteps, B-STAND – bench standing, FORWARD – forward bow, HANDTAP – hand tapping, FOOTTAP – foot tapping, L-JUMP – long jump, THROW – ball throwing, 20M – 20-m run, SIT-UP – sit- ups, BENTARM – bent arm hang, 3MINRUN – 3-min run

TABLE 2
RESULTS OF DISCRIMINATIVE ANALYSIS OF MOTOR VARIABLES BETWEEN CONTROL AND EXPERIMENTAL GROUPS OF GIRLS

Variable	5 and 6 graders (n=65)			7 and 8 graders (n=70)		
	Control	Exp	DF	Control	Exp	DF
POLYGON#	17.06 ± 4.17	13.74 ± 1.75	0.50	13.16 ± 1.82	11.08 ± 1.54	0.73
SIDESTEP#	10.40 ± 0.70	9.91 ± 0.86	0.34	10.36 ± 0.90	9.82 ± 0.79	0.39
B-STAND	6.24 ± 4.19	6.39 ± 4.93	–0.02	9.27 ± 10.04	13.29 ± 14.31	–0.22
FORWARD	64.34 ± 8.38	66.81 ± 9.26	–0.15	69.37 ± 10.10	75.10 ± 7.97	–0.37
HANDTAP	32.25 ± 4.51	34.68 ± 5.02	–0.28	34.85 ± 4.37	37.73 ± 3.41	–0.43
FOOTTAP	23.17 ± 2.09	23.59 ± 2.78	–0.10	24.97 ± 1.86	26.25 ± 2.00	–0.42
L-JUMP	148.67 ± 14.34	163.01 ± 15.72	–0.51	167.21 ± 19.19	181.05 ± 23.28	–0.42
THROW	12.92 ± 3.12	16.62 ± 3.25	–0.62	21.78 ± 4.24	25.47 ± 4.19	–0.54
20M#	4.29 ± 0.30	4.09 ± 0.24	0.39	4.12 ± 0.23	4.01 ± 0.22	0.32
SIT-UP	33.09 ± 4.66	35.77 ± 4.17	–0.32	42.12 ± 8.18	45.00 ± 9.27	–0.21
BENTARM	35.69 ± 24.52	44.53 ± 19.57	–0.20	45.14 ± 20.54	49.50 ± 24.53	–0.12
3MINRUN	692.09 ± 86.51	736.36 ± 103.9	–0.25	710.20 ± 89.70	794.75 ± 77.38	–0.61
Centroids	0.63	–1.24		0.46	–1.15	
CanR			0.67*			0.59*

Control – control group, Exp – experimental group, DF – structure of discriminative function, CanR – coefficient of canonic discrimination, #variable with opposite metric orientation, *$p<0.01$
POLYGON – polygon backwards, SIDESTEP – sidesteps, B-STAND – bench standing, FORWARD – forward bow, HANDTAP – hand tapping, FOOTTAP – foot tapping, L-JUMP – long jump, THROW – ball throwing, 20M – 20-m run, SIT-UP – sit- ups, BENTARM – bent arm hang, 3MINRUN – 3-min run

(taps/min), long jump (cm), ball throw (dm), 20-m run (s), sit-ups (*per* min), bent arm hang (s) and 3-min run (m)[33,34]. The measurements were taken by qualified and trained professionals with rich experience in collecting these initial data.

Canonic discriminative analysis was used to determine between-group differences.

Results

Motor differences between male and female experimental and control groups were analyzed first (Tables 1 and 2, respectively). These differences were determined by use of canonic discriminative analysis. The degree of global and partial differences was determined between the two groups, i.e. fifth-/sixth-graders and seventh-/eighth-graders.

In male fifth-/sixth-graders, discriminative analysis differentiated experimental and control groups, the former being superior to the latter in repetitive trunk strength, sprint, flexibility and coordination.

In male seventh-/eighth-graders, discriminative function yielded differences between experimental and control groups other than those recorded in fifth- and sixth--graders. Now, experimental group was superior to control group in agility, aerobic endurance, and explosive throw and jump strength.

In female fifth-/sixth-graders, experimental group proved superior to control group in the variables of explosive strength (ball throw in particular), coordination, trunk strength and aerobic endurance, whereas in female seventh-/eighth-graders experimental group performed better than control group in the variables of coordination, endurance, explosive strength, speed and flexibility.

Motor differences between male and female subjects recorded in control, experimental and total groups (experimental + control) of fifth-/sixth-graders and seventh-/eighth-graders in separate are presented in Table 3.

In motor space, total sample of fifth- and sixth-graders showed male subjects to be superior to female ones in explosive strength, throw strength in particular, coordination and aerobic endurance, whereas female subjects were superior in the variables of flexibility and movement frequency, leg movements in particular. Sex differences were observed to have markedly decreased in experimental group as compared with control group in the variables of explosive strength (throw strength in particular) and flexibility.

In motor space, total sample of seventh- and eighth--graders revealed male subjects to be also superior to female subjects in explosive strength (ball throw), coordination (agility) and aerobic endurance, while being inferior in flexibility.

TABLE 3
RESULTS OF DISCRIMINATIVE ANALYSIS OF MOTOR VARIABLES BETWEEN CONTROL AND EXPERIMENTAL GROUPS OF BOTH SEXES

Variable		5 and 6 graders			7 and 8 graders		
		Control	Exp	Total	Control	Exp	Total
		DF	DF	DF	DF	DF	DF
POLYGON#		–0.38	–0.50	–0.47	0.32	0.09	0.27
SIDESTEP#		–0.09	–0.18	–0.15	0.27	0.28	0.32
B-STAND		0.11	0.13	0.13	0.15	0.13	0.13
FORWARD		–0.34	–0.24	–0.34	0.42	0.38	0.43
HANDTAP		–0.09	–0.22	–0.12	–0.05	0.12	0.00
FOOTTAP		–0.17	–0.20	–0.20	0.03	0.20	0.10
L-JUMP		0.31	–0.08	0.24	–0.18	–0.15	–0.21
THROW		0.43	0.23	0.43	–0.42	–0.27	–0.41
t120M#		–0.13	–0.26	–0.20	0.35	0.23	0.34
SIT-UP		–0.13	0.21	–0.02	–0.07	–0.02	–0.07
BENTARM		0.02	0.02	0.04	–0.15	–0.05	–0.12
3MINRUN		0.25	0.39	0.34	–0.23	–0.11	–0.23
Centroids:	Girls	–1.29	–0.86	–0.99	1.33	2.32	1.50
	Boys	0.99	0.51	0.69	–1.39	–1.29	–1.25
CanR		0.75*	0.56*	0.64*	0.80*	0.87*	0.81*

Control – control group, Exp – experimental group, Total – (control + experimental group), DF – structure of discriminative function, CanR – coefficient of canonic discrimination, #variable with opposite metric orientation, *$p<0.01$
POLYGON – polygon backwards, SIDESTEP – sidesteps, B-STAND – bench standing, FORWARD – forward bow, HANDTAP – hand tapping, FOOTTAP – foot tapping, L-JUMP – long jump, THROW – ball throwing, 20M – 20-m run, SIT-UP – sit-ups, BENTARM – bent arm hang, 3MINRUN – 3-min run

Discussion

The differences recorded in motor abilities between the children included and those not included in swimming training were influenced by two inter-related reasons:

- one possible reason was that children with a higher level of motor abilities tended to join particular sports activities, offering them better prospects for success in this activity, i.e. natural selection; and
- the other possible reason was that swimming training had influenced the development of those motor abilities yielding between-group differences.

It should be noted that the differences recorded in motor abilities between the children included and those not included in swimming training are relevant for high performance in swimming and should be considered in the orientation process (large-scale inclusion of children in swimming training) and subsequent selection directed towards achievement of top results in particular swimming styles.

Comparison of differences obtained in younger and older age groups provided information on the development of motor abilities that determine swimming performance.

In male fifth-/sixth-graders, the subjects included in swimming training were superior to their counterparts not included in this activity in the following variables:

- repetitive trunk strength based on successive performance of swimming technique by providing the initial impulse for it;
- sprint that includes the mechanisms of force and speed, the regulation of which is necessary for efficient performance of swimming technique;
- flexibility, i.e. muscle tone regulation that facilitates successive (repetitive) performance of swimming technique;
- movement frequency, arms in particular, upon which the swimming rate depends most at this age; and
- coordination upon which harmonious movements of all body segments on performing swimming technique depend.

All differences recorded between these groups of subjects were predominantly determined by the information component of the movement structure. The achieved level of development of the energy component of movement in the form of basic trunk strength and explosive sprint strength is closely associated with the development of the muscle tone regulation ability, psychomotor speed and whole body coordination. In this stage of de-

velopment, integration of these motor abilities is necessary for efficient motor learning[12,13], i.e. mastering swimming technique.

In older male subjects (seventh- and eighth-graders), the years of swimming training and greater work volume had led to the specific development of motor abilities relative to their age-matched population other than those recorded in younger male subjects. In younger subjects, it was the first phase of selection where a satisfactory level of motor abilities determining successful performance at this developmental stage was achieved.

In older male subjects, however, it was the second phase of selection with the following variables predominantly influencing successful performance in swimming:

- coordination/agility that enables greater motor efficiency in performing swimming technique, which now takes place at subcortical level and is specifically related to explosive strength;
- aerobic endurance, which is the basis for the development of speed endurance in swimming; and
- explosive strength that enables strong and swift movements of upper and lower extremities in swimming.

The differences obtained in older male subjects describe motor system that is formed by long-term swimming training and determines achievement of top results in swimming.

In contrast to male subjects, younger female subjects included in swimming training showed the formation of appropriate motor system that determines swimming performance to form earlier. This primarily referred to the predominant development of explosive throw strength and jump strength (sprint to a lesser extent), paralleled by the development of whole body coordination and basic trunk strength. Accordingly, the integration of explosive strength and coordination into a system manifesting dominant motor efficiency in swimming had already occurred at this younger age. Further development of explosive strength along with even more intensive development of coordination would enable development and manifestation of other motor abilities, primarily aerobic endurance and speed of movement frequency as well as the ability of muscle tone regulation, in the next stage.

A motor system characterized by high interaction of various abilities was formed in older female subjects, as follows:

- coordination in terms of cortical regulation of movements, integrating, regulating and including lower level mechanisms, i.e. endurance regulator, force regulator and speed regulator;
- aerobic endurance as a mechanism of energy regulation of movement, regulating the relationship of force and speed mechanisms, which is manifested as strength endurance and speed endurance[13,35];
- explosive strength as a mechanism of force regulation that ensures strong swift movements of upper and lower extremities while overcoming the medium, i.e. water resistance; and
- psychomotor speed as a mechanism of regulation of the speed of movement frequency of particular body segments on performing particular swimming style technique.

Comparison of the results on differences in motor abilities between experimental and control groups according to sex yielded certain sex differences (Tables 1 and 2) that were additionally clarified by the results of discriminative analysis of motor variables between male and female study subjects (Table 3).

In female subjects, swimming training resulted in faster and more pronounced quantitative and qualitative development of motor abilities. In younger subjects (fifth- and sixth-graders), a satisfactory level of the speed of movement frequency was achieved, along with development of explosive strength and coordination, and their integration in the form of motor system that predominantly determines swimming performance in this stage of development. In the next stage, i.e. in female seventh- and eighth-graders, the developmental level achieved (explosive strength) was followed by the formation of a motor system integrating endurance and speed of movement frequency in addition to coordination and explosive strength, which together determine swimming performance.

In male subjects that proved superior in coordination and explosive strength, but inferior to female subjects in flexibility and movement frequency, swimming training first influenced the development of flexibility and movement frequency, followed by the development of agility and explosive strength in the next stage of development.

Acknowledgement

This study was supported by the grant No. 177-0000000-3410 from the Croatian Ministry of Science, Education and Sport.

REFERENCES

1. MALINA RM: Human growth, maturation and regular physical activity. (Human Kinetics Book, Champaign, 1984) — 2. GUALDI-RUSSO E, GRUPPIONI G, GUERESI P, BELCASTRO MG, MARACHESINI V, J Sports Med Phys Fitness, 32 (1992) 303. — 3. PARISZKOVA J: Body fat and physical fitness. (Maritims Nijhoff BV, Hague, 1977) — 4. MALINA RM, BOUCHARD C, Growth, maturation and physical activity (Human Kinetics Books, Champaign, 1991) — 5. KATIĆ R, ŽIVIČNJAK M, LIXIN S, CHENG LW, RUDAN P, JUAN YG, Chinese J School Doctor, 11 (1997) 7. — 6. BOUCHARD C, THIBAULT MC, JOBIN J, Advances in selected areas of human work physiology. Yearbook Phys Antro, 24 (1981) 1. — 7. BUNC V, Heller J, J Sports Med Phys Fitness, 33 (1993) 233. — 8. SHEPHARD RJ, ZAVALLEE H, J Sports Med Phys Fitness, 34 (1994) 323. — 9. CAHPER (Canadian Association for Health, Physical Education and Recreation): Fitness performance test manual for boys and girls 7 to 17 years of age. (Ottawa, 1966) — 10. KATIĆ R, ZAGORAC N, ŽIVIĆNJAK M, HRASKI Ž, Coll Antropol, 18 (1994) 141. — 11. KATIĆ R, VISKIĆ-ŠTALEC

N, Croat Sports Med J, 11 (1996) 16. — 12. KATIĆ R, Coll Antropol, 27 (2003) 351. — 13. KATIĆ R, PEJČIĆ A, VISKIĆ-ŠTALEC N, Coll Antropol, 28 (2004) 261. — 14. KATIĆ R, BLAŽEVIĆ S, KRSTULOVIĆ S, MULIĆ R, Coll Antropol, 29 (2005) 79. — 15. KATIĆ R, BLAŽEVIĆ S, ZAGORAC N, Coll Antropol, 30 (2006) 829. — 16. KATIĆ R, GRGANTOV Z, JURKO D, Coll Antropol, 30 (2006) 103. — 17. BLAŽEVIĆ S, KATIĆ R, POPOVIĆ D, Coll Antropol, 30 (2006) 327. — 18. GRGANTOV Z, KATIĆ R, JANKOVIĆ V, Coll Antropol, 30 (2006) 87. — 19. KRSTULOVIĆ S, ŽUVELA F, KATIĆ R, Coll Antropol, 30 (2006) 845. — 20. SRHOJ V, ROGULJ N, ZAGORAC N, KATIĆ R, Coll Antropol, 30 (2006) 601. — 21. GRGANTOV Z, NEDOVIĆ D, KATIĆ R, Coll Antropol, 31 (2007) 267. — 22. KATIĆ R, ČAVALA M, SRHOJ V, Coll Antropol, 31 (2007) 795. — 23. ĆAVALA M, ROGULJ N, SRHOJ V, SRHOJ LJ, KATIĆ R, Coll Antropol, 32 (2008) 231. — 24. SEKULIĆ D, KRSTULOVIČ S, KATIĆ R, OSTOJIĆ LJ, Pediatr Exerc Sci, 18 (2006) 329. — 25. SRHOJ LJ, KATIĆ R, KALITERNA A, 30 (2006) 335. — 26. DELAŠ S, BABIN J, KATIĆ R, Coll Antropol, 31 (2007) 979. — 27. MIHALJEVIĆ D, SRHOJ LJ, KATIĆ R, Coll Antropol, 31 (2007) 817. — 28. BAVČEVIĆ T, ZAGORAC N, KATIĆ R, Coll Antropol, 32 (2008) 433. — 29. DELAŠ S; ZAGORAC N, KATIĆ R, Coll Antropol, 32 (2008) 443. — 30. ERCEG M, ZAGORAC N, KATIĆ R, Coll Antropol, 32 (2008) 241. — 31. MEHROTRA PK, VERMA N, YADAV R, TIWARI S, SHUKLA N, Indian J Physiol Pharmacol, 41(1997) 83. — 32. MEHROTRA PK, VERMA N, TIWARI S, KUMAR P, Indian J Physiol Pharmacol, 42 (1998) 412. — 33. KATIĆ R, Biol Sport, 12 (1995) 251. — 34. BABIN J, KATIĆ R, ROPAC D, BONACIN D, Coll Antropol, 25 (2001) 153. — 35. KATIĆ R, PEJČIĆ A, BABIN J, Coll Antropol, 28 (2004), Suppl 2; 357.

R. Katić

Faculty of Kinesiology, University of Split, Teslina 12, 21000 Split, Croatia
e-mail: katic@pmfst.hr

SPOLNE RAZLIKE U MOTORIČKIM OBILJEŽJIMA DJECE OSNOVNE ŠKOLE UKLJUČENE ILI NEUKLJUČENE U TRENING PLIVANJA

S A Ž E T A K

Osnovni cilj istraživanja bio je utvrditi razvoj motoričkih sposobnosti učenika osnovne škole od 5. do 8. razreda (u dobi od 11 do 14 godina) u odnosu na spol, dob i tjelesnu aktivnost. U tu svrhu uzorak od 312 ispitanika je podijeljen po spolu i dobi na četiri skupine: učenike stare 11–12 godina (n=93) i 13–14 godina (n=84), te učenice u dobi od 11–12 godina (n=65) i 13–14 godina (n=70). Zatim su analizirane razlike u bazičnim motoričkim sposobnostima između djece koja su uključena u trening plivanja (koji se odvija u ljetnim mjesecima) kao eksperimentalne skupine i djece koja nisu obuhvaćena takvim programom rada kao kontrolne skupine. Kod učenika 5. i 6. razreda eksperimentalna skupina bila je bolja od kontrolne skupine u repetitivnoj snazi trupa, sprintu, fleksibilnosti i koordinaciji, dok je kod učenika 7. i 8. razreda eksperimentalna skupina bila bolja od kontrolne u agilnosti, aerobnoj izdržljivosti, te eksplozivnoj snazi tipa bacanja i skoka. Kod učenica 5. i 6. razreda eksperimentalna skupina je bila bolja od kontrolne u varijablama eksplozivne snage, koordinaciji, snazi trupa i aerobnoj izdržljivosti, dok je kod učenica 7. i 8. razreda eksperimentalna skupina bila bolja od kontrolne u koordinaciji, izdržljivosti, eksplozivnoj snazi, brzini i fleksibilnosti. Diskriminativna analiza motoričkih varijabla između dječaka i djevojčica je utvrdila kako je muški spol bolji od ženskog u eksplozivnoj snazi, osobito tipa bacanja, koordinaciji i aerobnoj izdržljivosti, dok je ženski spol u odnosu na muški bio bolji u fleksibilnosti i frekvenciji pokreta, osobito nogom. Rezultati su pokazali kako se pod utjecajem treninga plivanja od 11. do 14. godine stvara odgovarajući motorički sklop koji određuje postizanje vrhunskog rezultata u plivanju. Kod učenika muškog spola motorički sklop integrira koordinaciju/agilnost, aerobnu izdržljivost i eksplozivnu snagu, dok kod učenica motorički sklop integrira koordinaciju u smislu kortikalne regulacije kretanja, aerobnu izdržljivost, eksplozivnu snagu i psihomotornu brzinu.