The impact of a 60-minute swimming training on the quality of body posture and the level of balance in young adults

Wpływ 60-minutowego treningu pływackiego na jakość postawy ciała i poziom równowagi młodych osób dorosłych

Dżesika Aksamit[1], Tomasz Sidor[1], Adrian Gądek[2], Agnieszka Jankowicz-Szymańska[3, *]

[1] *State Higher Vocational School in Tarnow, Institute of Health Sciences, Poland (student of physiotherapy)*
Państwowa Wyższa Szkoła Zawodowa w Tarnowie, Instytut Ochrony Zdrowia (studia na kierunku fizjoterapia)

[2] *University of Physical Education in Krakow, Faculty of Physical Education, Poland (PhD student of physical education)*
Akademia Wychowania Fizycznego w Krakowie, Wydział Wychowania Fizycznego (studia doktoranckie)

[3] *State Higher Vocational School in Tarnow, Institute of Health Sciences, Poland*
Instytut Ochrony Zdrowia, Państwowa Wyższa Szkoła Zawodowa w Tarnowie

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Streszczenie

Introduction: Postural abnormalities are common in every age group. They often involve discomfort or pain. Unfortunately, specialised posture correcting exercises are almost exclusively for pre-school and school children. There is a widespread belief that swimming has beneficial effects on the body posture. Some even think that swimming can replace corrective exercises. The aim of the study was to evaluate the changes in the quality of body posture and body balance after 60-minute intensive swimming training in people aged 20-22 years old, whose level of swimming skills was determined as average.

Material and methods: The study was conducted on a group of 9 people, students of the State Higher Vocational School in Tarnów. Ultrasonic Zebris Pointer was used for three-dimensional assessment of body posture. The position of the shoulder and iliac girdle, the shape of the spine, the inclination of the sacrum bone and the inclination of the body in the sagittal and coronal plane were analysed. The examination was repeated before and after the one-hour lecture and before and after the one-hour, intensive classes at the swimming pool. The results were developed in the Statistika v10 program. Descriptive statistics, non-parametric Friedman test and Kruskal post-hoc test were used. The significance level $\alpha = 0.05$ was assumed.

Results: There was a statistically significant increase in pelvic rotation under the influence of swimming training. There was also a slight deterioration of the spine position in the coronal plane. Exercises improving the breaststroke did not affect the depth of thoracic kyphosis and lumbar lordosis. After 60 minutes spent in a relaxed sitting position, deepening thoracic kyphosis was observed. However, this change was not statistically significant.

Conclusions: It is not recommended to treat swimming as a substitute for corrective gymnastics. Intensive swimming training can exacerbate existing body posture errors in people who have just started improving their swimming technique.

Keywords: body posture, balance, swimming, water environment

Introduction

Physical activity is a prerequisite for maintaining the correct body posture of every person. It is especially important during the development of children and youth. A sedentary lifestyle, improper learning and working conditions mean that body posture and physical fitness deteriorate significantly [1]. Properly selected physical activity can be used for prevention, but also for the correction of already existing posture defects. It should be remembered, however, that regular and intensive physical effort straining the body always affects body posture, but it is not always beneficial [2].

Body posture is an individual feature that distinguishes the way each person stands and moves. Its quality is influenced by many factors, for example, practising sports. Regular training models body shape and affects the functioning of most systems and organs. However, the largest changes occur in the muscular

* Adres do korespondencji/Address for correspondence: jankowiczszymanska@gmail.com

system, in which an increase in muscle mass is observed, as well as changes in the distribution of muscle tension [3].

There is no doubt that systematic physical activity should be encouraged, especially in the case of children and youth. It is worth paying attention to swimming, which is a sport discipline most often recommended to people with body posture defects. At the same time, it is one of the most frequently undertaken forms of movement as part of so-called active rest. The availability of indoor swimming pools makes it an activity that almost anyone can do regardless of the time of year. The specific properties of the aquatic environment (minimised effect of gravity, water resistance) create favourable conditions for exercising individual muscle groups. Maintaining balance in water particularly requires control of body position and improves neuromuscular coordination. In addition, swimming improves cardiovascular and respiratory parameters [4]. There are, however, no sufficiently well documented studies that would confirm that recreational swimming, without specialised, individually selected exercises, has a positive effect on body posture.

The aim of the study was to check the impact of a 60-minute swimming training on the quality of body posture of young adults whose swimming skills are average (they swim efficiently but are not competitors). The authors assumed that the changes observed after one-time activity will indicate the direction in which systematic swimming will change body posture. Additionally, changes in load on feet and balance were assessed.

Material and methods

Study group

12 people, students of physical education at the State Higher Vocational School in Tarnów, aged 20 to 22 years old were qualified to the study group. The participants of the study comprised of volunteers who gave written consent to participate in the study and were informed in detail about its purpose and course. Everyone had access to the results obtained. The criterion for inclusion in the study was the lack of deformities, injuries and pain in the musculoskeletal system in the last three months.

Research methodology

The tests were carried out four times: before and after a 60-minute swimming training conducted under the guidance of an experienced trainer (during training, special emphasis was placed on improving the breaststroke) and (after 5 days) before and after a 60-minute lecture, during which students were in a relaxed sitting position – control examination. Since one student was not present during the second examination, and two other students felt pain that appeared in the knee and spine during swimming. In the end the results of measurements of 9 people (5 women and 4 men) were included in the analysis. All subjects had the correct BMI value.

Each time the examinations were started at 8.00, the same equipment was used and the measurement was taken by the same experienced physiotherapist.

Body posture examination

Body posture was analysed in three dimensions using the Zebris Pointer device. The following was assessed: pelvic rotation, pelvic inclination to the shoulders, distance between the right and left shoulder blades from the spine, the difference in the distance between the shoulder blades and the spine, the depth of thoracic kyphosis and lumbar lordosis, the balance of the trunk in the sagittal and coronal plane, the position of the sacrum, the difference in height of the right and left side of the pelvis and the right and left shoulder, the size of any sideways curve of the spine and the rotation of the pelvis relative to the shoulders.

For this purpose, the location of the characteristic anatomical points was indicated with a special ultrasonic indicator:

– anterior superior iliac spine, left and right, – posterior superior iliac spine, left and right, – left and right acromion, – right and left apex of the iliac disc, – point between the twelfth thoracic vertebra and first lumbar vertebra, – lower right angle and left shoulder blade.

A three-fold record of the course of the spinal axis was made, moving the pointer over the spinous processes from the seventh cervical vertebra to the sacrum. The result was averaged.

Foot load and balance test

The second part of the examinations was conducted with the use of the P-walk baroresistant platform, which evaluates the symmetry of load resulting from body weight on individual foot zones and static balance by determining the vertical projection of the centre of body pressure (*COP*). The 30-second measurement was taken in a standing habitual position without shoes with open eyes.

During the analysis the following was taken into account: load on the right and left foot resulting from body weight, and the Arch Index (AI) of the longitudinal arch, the average position of the vertical projection of the centre of gravity on the X and Y axes, the length of the path that the centre of gravity covered during the test, the average speed of the centre of gravity and the Length Surface Fraction (LFS).

Statistica v10 was used to develop the results. The average, median, minimum, maximum and standard deviation were calculated. The non-parametric Friedman ANOVA test and Kendall test were used. Differences were considered significant when $p < 0.05$.

Results

A significant change in the position of the pelvis in the transverse plane was noted after 60-minute swimming training. There was a significant increase in pelvic rotation ($p = 0.02$). A tendency was also found in the frontal plane in which the position of the

spine deteriorates. One-time swimming training did not change the depth of the physiological curves of the spine. It also did not affect the position of the shoulder blades.

Being in a relaxed sitting position for an hour did not change the shape of the physiological curves of the spine. However, it had a slight effect on reducing pelvic rotation and aligning the sideways curves of the spine.

There was a growth tendency in the symmetry of load on feet resulting from body weight due to swimming activity. A free sitting position predisposed to the transfer of body weight towards the right foot. Neither intensive swimming training, nor relieving the sitting position, did not change the arch of the subjects' feet.

Table 1.

Comparison of selected posture characteristics of the subjects before and after swimming training as well as before and after 60 minutes spent in a sitting position

	Control examination					Variable	Swimming					p
	Avg.	Mdn	Min.	Max.	SD		Avg.	Mdn	Min.	Max.	SD	
Measurement 1	4.41	5.20	0.60	7.50	2.48	**Pelvic rotation [o]**	7.48	4.85	1.40	19.30	6.28	ns
Measurement 2	**3.41**	**3.30**	**0.80**	**6.10**	**2.01**		**17.35**	**10.65**	**0.70**	**60.00**	**17.76**	**<0.05**
			ns						ns			
Measurement 1	2.98	1.80	0.50	7.00	2.64	**Pelvic inclination in relation to the shoulders [o]**	4.39	4.45	0.80	7.30	2.49	ns
Measurement 2	3.10	2.40	0.80	7.60	2.20		3.01	2.30	0.40	7.10	2.28	ns
			ns						ns			
Measurement 1	48.33	46.0	32.00	59.00	9.15	**The distance of the right shoulder blade from the spine [mm]**	44.60	42.00	32.00	62.00	9.75	ns
Measurement 2	48.00	43.0	27.00	65.00	14.09		47.20	50.00	30.00	61.00	11.84	ns
			ns									
Measurement 1	40.22	48.0	20.00	53.00	12.62	**The distance of the left shoulder blade from the spine [mm]**	35.60	37.00	-1.00	56.00	19.32	ns
Measurement 2	45.89	51.0	28.00	60.00	11.94		39.70	39.00	14.00	62.00	14.94	ns
			ns						ns			
Measurement 1	8.67	10.0	1.00	14.00	4.61	**Difference between the distances between the shoulder blades and the spine [mm]**	15.40	14.00	2.00	42.00	11.40	ns
Measurement 2	4.22	6.00	0.00	9.00	4.09		12.20	9.00	0.00	46.00	13.75	ns
			ns						ns			
Measurement 1	34.28	34.6	18.20	48.30	9.83	**Depth of thoracic kyphosis [o]**	36.30	34.55	20.00	49.30	8.04	ns
Measurement 2	36.72	36.6	26.20	50.20	7.83		37.01	38.85	23.00	47.30	6.93	ns
			ns						ns			
Measurement 1	26.41	26.4	9.00	43.70	10.28	**Depth of lumbar lordosis [o]**	26.79	26.50	10.70	44.40	11.67	ns
Measurement 2	24.51	23.3	11.00	39.30	9.85		26.84	27.15	10.10	48.30	12.55	ns
			ns						ns			
Measurement 1	2.20	2.30	0.10	3.90	1.21	**Torso balance in the sagittal plane [o]**	1.42	1.30	0.20	2.80	1.09	ns
Measurement 2	2.39	1.80	0.30	5.30	1.80		2.13	1.70	0.20	4.30	1.40	ns
			ns						ns			
Measurement 1	20.09	18.1	9.50	36.40	8.02	**Position of the sacrum [o]**	18.38	16.80	2.80	37.30	10.78	ns
Measurement 2	17.74	17.0	7.70	32.20	8.16		20.21	18.50	6.20	40.00	10.16	ns
			ns						ns			
Measurement 1	12.70	11.8	1.60	30.00	9.00	**Difference in position of the right and left side of the pelvis [mm]**	17.93	14.75	0.30	40.70	14.15	ns
Measurement 2	10.33	8.30	0.20	19.30	6.59		13.10	14.35	0.60	28.50	8.91	ns
			ns						ns			
Measurement 1	7.92	6.50	2.20	15.20	4.77	**Difference in position of the right and left shoulder [mm]**	7.79	5.25	0.30	19.20	7.29	ns
Measurement 2	10.13	6.80	1.50	23.60	7.62		11.83	10.15	1.90	26.70	7.77	ns
			ns						ns			
Measurement 1	1.01	0.60	0.10	3.20	0.99	**Torso balance in the coronal plane [o]**	1.32	1.20	0.70	2.00	0.47	ns
Measurement 2	1.04	1.00	0.10	2.60	0.76		1.36	1.10	0.10	3.30	0.94	ns
			ns						ns			
Measurement 1	0.93	0.00	0.00	8.40	2.80	**Sideways curve of the spine [o]**	0.97	0.00	0.00	5.40	2.06	ns
Measurement 2	**0.50**	**0.00**	**0.00**	**4.50**	**1.50**		**2.36**	**0.00**	**0.00**	**13.40**	**5.03**	ns
			ns						ns			
Measurement 1	3.29	3.00	0.40	10.90	3.49	**Pelvic rotation in relation to the shoulders [o]**	4.86	2.90	0.10	16.30	5.20	ns
Measurement 2	4.03	3.30	0.70	11.20	3.61		2.80	3.15	0.20	6.40	2.03	ns
			ns						ns			

Avg. – average; Mdn – median; Min – minimum value; Max – maximum value; SD – standard deviation; COP – Centre of Pressure

One-hour swimming training significantly reduced the path length that the general centre of gravity covered during the 30-second static balance test on the balance platform (p = 0.007). Under the influence of swimming, the average speed also decreased (p = 0.007). Sitting in a relaxed position had a negative effect on both parameters. There was a statistically significant increase in path length (p = 0.01) and an increase in average speed (p = 0.01).

Discussion

In the presented work, changes in body posture, foot load, body weight and balance occurring under the influence of a 60-minute swimming training and after spending 60 minutes in a relaxed sitting position were compared. It has been reported that swimming training for non-competitors changes the position of the pelvis in the transverse plane and affects the position of the spine in the coronal plane. The level of balance improved due to swimming activity and deteriorated after an hour spent in a relaxed sitting position.

Swimming is one of the most popular forms of physical activity. It is widely believed that it has a beneficial effect on shaping the habit of correct posture and even reduces postural defects. It is difficult to disagree with the opinion about its beneficial effect on the body. Swimming engages almost all muscles, helping to strengthen them. The aquatic environment relieves the joints and spine while creating resistance for working muscles. It also helps to increase chest mobility and strengthen respira-

Table 2.

Comparison of selected features describing the load on the feet of the subjects before and after swimming training as well as before and after 60 minutes spent in a sitting position

	Control examination					Variable	Swimming					p
	Avg.	Mdn	Min.	Max.	SD		Avg.	Mdn	Min.	Max.	SD	
Measurement 1	48.40	48.60	41.60	57.50	5.028		47.58	47.65	42.90	53.20	3.73	ns
Measurement 2	47.42	48.30	41.70	51.90	2.97	**Load on the left foot [%]**	49.35	48.85	44.30	56.30	3.19	ns
			ns						ns			
Measurement 1	51.60	51.40	42.50	58.40	5.028		52.42	52.35	46.80	57.10	3.73	ns
Measurement 2	52.58	51.70	48.10	58.30	2.97	**Load on the right foot [%]**	50.65	51.15	43.70	55.70	3.19	ns
			ns						ns			
Measurement 1	22.77	24.03	12.54	31.18	5.874	**Arch index for the left foot [%]**	23.44	25.02	9.22	34.04	8.59	ns
Measurement 2	23.67	24.69	14.55	34.36	5.98		23.55	24.86	13.14	31.80	6.84	ns
			ns						ns			
Measurement 1	21.77	25.17	6.84	31.77	7.516	**Arch index for the right foot [%]**	22.82	24.60	6.23	31.97	8.00	ns
Measurement 2	22.99	24.89	5.28	30.85	7.09		23.39	24.93	6.04	30.75	7.00	ns
			ns									

Avg. – average; Mdn – median; Min – minimum value; Max – maximum value; SD – standard deviation

Table 3.

Comparison of selected features describing the balance of the subjects before and after swimming training as well as before and after 60 minutes spent in a sitting position

	Control examination					Variable	Swimming					p
	Avg.	Mdn	Min.	Max.	SD		Avg.	Mdn	Min.	Max.	SD	
Measurement 1	1.10	0.80	0.40	2.70	0.80	**Average position COP X-axis**	0.84	0.90	-0.70	2.40	0.78	ns
Measurement 2	0.53	0.50	0.10	1.20	0.41		0.55	0.40	0.20	1.30	0.37	ns
			ns						ns			
Measurement 1	1.18	1.40	0.10	1.80	0.51	Average position COP Y-axis	1.11	1.20	-1.80	2.40	1.19	ns
Measurement 2	1.86	1.40	0.10	8.80	2.67		1.17	1.30	0.20	1.80	0.60	ns
			ns						ns			
Measurement 1	**209.28**	**209.40**	**179.80**	**248.30**	**22.08**		**304.63**	**315.90**	**249.80**	**336.10**	**30.64**	**<0.05**
Measurement 2	**274.93**	**274.00**	**220.60**	**339.60**	**42.46**	**COP path length**	**229.23**	**219.10**	**186.40**	**276.80**	**29.77**	ns
			<0.05						**0<0.05**			
Measurement 1	**6.97**	**7.00**	**6.00**	**8.30**	**0.74**		**10.15**	**10.50**	**8.30**	**11.20**	**1.01**	**<0.05**
Measurement 2	**9.17**	**9.10**	**7.40**	**11.30**	**1.41**	Average speed	**7.64**	**7.30**	**6.20**	**9.20**	**1.00**	**<0.05**
			<0.05						**<0.05**			
Measurement 1	9.32	7.20	2.50	21.40	6.35	**Fraction surface length (LSF)**	14.50	10.05	2.80	43.50	12.27	ns
Measurement 2	10.56	9.80	2.70	21.20	6.18		7.99	6.50	2.60	24.00	6.41	ns
			ns									

Avg. – average; Mdn – median; Min – minimum value; Max – maximum value; SD – standard deviation; COP – Centre of Pressure

tory muscles. Systematic swimming improves metabolism and helps maintain normal body weight [5].

In the literature you may find many reports on the quality of body posture of people practising swimming at the competitive level. Łubkowska et al. [6], by examining 91 girls practising swimming, noticed an increase in the angle of inclination of the upper thoracic spine with a simultaneous decrease in the angle of inclination of the lumbar section. In studies conducted among 85 girls with competitive classes, it was found that competitive swimming changes the position of the spine and can be used as posture corrective exercises. It is recommended that people with flat back defects swim in symmetrical strokes on their chests, i.e. breaststroke and butterfly stroke. However, backstroke swimming corrects round and concave backs [7]. Studies show that the incidence of scoliosis among girls training synchronised swimming (from 4–5 years) is 19% lower compared to the control group. Swimmers also have less frequent pelvic rotations and shoulder asymmetries [8 Barczyk Pawelec conducted a 5-month, carefully selected program of exercises in water on a group of 36 children diagnosed with Ist degree scoliosis. At the end of the exercise period, she noted, in addition to increasing chest mobility, a positive change within the anteroposterior curves of the spine [9].

However, not all studies have so clear results. In the work of Mucha et al. in children training for 3 years, adverse changes in the position of the spine in the coronal plane and a tendency to deepened thoracic kyphosis were observed [1]. In other studies, Mucha et al. examined Polish representatives specialising in breaststroke (12 years of swimming experience). They noted that the left side curvature of the thoracolumbar spine in the frontal plane is characteristic of these competitors. It was also found that long-term swimming training contributes to the occurrence of hypermobility of the spine in the sagittal plane [10]. Łubkowska and Tarnowski conducted a study among 212 primary school children practising swimming. Training loads were selected by age category. Accelerated physical development of children swimming relative to the control group was noted, however, the quality of spinal curvatures varied [11]. Kuczyński et al. [12] also analysed how the balance changes after one-time training in a swimming pool. The measurements were carried out among students of the University of Physical Education in Wrocław using the AMTI Accu Sway platform. Deterioration of balance was observed.

To sum up, the results of the conducted tests encourage us to exercise caution when recommending swimming, as a replacement for corrective gymnastics in the case of people who are simply perfecting their swimming technique. Although there was an improvement in the level of balance under the influence of one-time swimming training, at the same time adverse changes in the position of the pelvis and spine were found. Probably intense effort revealed small body posture abnormalities in the subjects. Perhaps it was related to errors in the technique of swimming. The observations made are thought-provoking and should be confirmed in a larger study group.

Conclusions

Despite many positive benefits, swimming should not be recommended as a replacement for corrective gymnastics.

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Streszczenie

Wstęp: Nieprawidłowości postawy ciała są powszechne w każdej grupie wiekowej. Często wiążą się z uczuciem dyskomfortu lub bólem. Niestety specjalistycznymi ćwiczeniami korygującymi postawę ciała objęte są niemal wyłącznie dzieci w wieku przedszkolnym i szkolnym. Panuje powszechne przekonanie o dobroczynnym wpływie pływania na postawę ciała. Niektórzy uważają nawet, że pływanie może zastąpić ćwiczenia korekcyjne. Za cel pracy przyjęto ocenę zmian jakości postawy ciała i poziomu równowagi pod wpływem 60-minutowego intensywnego treningu pływackiego u osób w wieku 20-22 lat, których poziom umiejętności pływackich określono jako przeciętny.

Materiał i metody: Badanie przeprowadzono na grupie 9 osób, studentów PWSZ w Tarnowie. Do trójpłaszczyznowej oceny postawy ciała użyto ultradźwiękowego urządzenia Zebris Pointer. Analizowano ułożenie obręczy barkowej i biodrowej, ukształtowanie kręgosłupa, nachylenie kości krzyżowej oraz zrównoważenie ciała w płaszczyźnie strzałkowej i czołowej. Badanie powtórzono przed i po godzinnym wykładzie oraz przed i po godzinnych, intensywnych zajęciach na pływalni. Wyniki opracowano w programie Statistika v10. Zastosowano statystyki opisowe, nieparametryczny test Friedmana i test post-hoc Kruskala. Przyjęto poziom istotności $\alpha=0,05$.

Wyniki: Zanotowano istotne statystycznie zwiększenie rotacji miednicy pod wpływem treningu pływackiego. Obserwowano także nieznaczne pogorszenie ustawienia kręgosłupa w płaszczyźnie czołowej. Ćwiczenia doskonalące styl klasyczny nie wpłynęły na głębokość kifozy piersiowej i lordozy lędźwiowej. Po 60 minutach spędzonych w swobodnej pozycji siedzącej obserwowano pogłębienie kifozy piersiowej. Zmiana ta nie była jednak statystycznie istotna.

Wnioski: Nie zaleca się traktowania pływania jako zamiennika gimnastyki korekcyjnej. Intensywny trening pływacki może nasilić istniejące błędy postawy ciała u osób, które dopiero doskonalą technikę pływania.

Słowa kluczowe: postawa ciała, równowaga, pływanie, środowisko wodne