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Functional mobility and flexibility in young female swimmers

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Abstract
Introduction. **Swimming has become a very popular form of physical activity mainly due to its wholesome influence on the human body.** The aim of this study **was to determine the effects of swimming training on the functional mobility and flexibility of young female swimmers. It is believed that swimming has a beneficial impact on the basic flexibility and functional mobility parameters.** Material and Methods. **Nine young female swimmers, members of the swimming team from 5th Secondary Sport School in Bydgoszcz took part in the study. The girls' functional mobility and flexibility in were determined twice the sagittal plane with the use of the FMS test and "Eurofit" test, respectively. The bend of the torso in the frontal plane was also assessed. The differences in results were measured with Student's t-test, and the value of changes was determined using the Mollison index.** Results. **A slight increase in the final FMS test result was noted in the second examination, compared with the first one: from 16.88 ± 1.76 to 17.22 ± 2.28. In 25-35% of cases the risk of overloading muscles as well as the positive impact of training on flexibility levels in the sagittal and frontal planes (during a bend to the left) was detected: from 26.44 ± 9.73 to 29.66 ± 7.92, and from 23.33 ± 2.45 to 25.11 ± 3.18, respectively. The Mollison index revealed the most positive results in the rotational stability of the torso (1.65) and the range of the lateral bend to the left (0.73), while negative values were only found in the in-line lunge and chest mobility range (–0.42).** Conclusions. **The results of the study confirm that swimming training has a positive impact on the body of young swimmers (increased mobility and flexibility). It is of vital importance to undertake further research on the effects of swimming on the mobility of the human body.**

KEYWORDS: swimming training, preparatory period, torso bend, FMS test.

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Introduction

Swimming has been a popular pastime since antiquity. In the past, it was also a useful military tactic. Nowadays, swimming is a competitive sport, form of physical recreation, and physiotherapeutic means. The benefits of swimming are well-known, and many people practise swimming on a regular basis. In Poland, swimming is the second (after cycling) most chosen physical activity. According to data from the Polish National Research Agency, 26% of interviewees admit practising swimming, mainly due to its beneficial influence on human health, and for sheer pleasure [1].

Physical exercise in the water is a unique form of training as swimmers encounter natural water resistance and practise breathing, which in turn, enhances pulmonary capacity. Swimming improves breathing quality and control in able-bodied as well as disabled swimmers. Similar beneficial effects of swimming have been observed on the cardiovascular and skeletal systems, since the torso, head, back, and stomach muscles work together during swimming exercises. Finally, swimming is one of the few forms of physical activity, which enable the harmonious development of the whole body at a very low risk of injury [2, 3].

Considering all the aforementioned advantages, implementing swimming into the school curriculum is of key importance. Swimming is often introduced to schools as part of PE, being the first step in the future sports career of school children. Nonetheless, it must be remembered that each sports training, no matter how carefully designed, is always a real load to the body.

Material and Methods

The material was collected in the years 2014-2015. Nine young female swimmers aged 13 to 14 years, members of the swimming team from the 5th Secondary Sport School in Bydgoszcz performed the exercise tests twice: at the beginning of their preparatory training season for the National Winter Junior Championships, and after the event, during the cool-down period. The level of their functional mobility was determined using the FMS (Functional Movement Screen) test – a popular and reliable screening tool. In sports research, as well in the present study, the aim of the evaluation of functional mobility is often to decrease the risk of injury and improve the level of sports performance [4, 5]. The FMS test is used to evaluate the correctness of motion patterns and exclude any pathologies. The battery consists of a series of seven exercises: deep squat, hurdle step, in-line lunge, shoulder reach, straight leg raise, push-ups, and rotary stability [6-8]. The test results are assessed using a three-grade (3-2-1-0) scale [9, 10].

The flexibility assessment in the sagittal plane was carried out with a sit and reach test, which is a part of the Eurofit test battery. The test was performed using a box (32 × 35 × 45 cm) with an attached graduated counter. Participants were required to shift a strip on the counter while performing forward bends. The flexibility of the spine was assessed in centimeters [11].

Spinal mobility in the frontal plane was assessed with a side torso bend test developed by A. Jegier. The examination was carried out in a standing position with the participant's back against a wall. In the initial position, the examined person placed one hand on a side set scaled strip, and while performing the bend, moved the hand along the graduation. The result of the test was the difference between the baseline value at the initial position and the value recorded after the maximum bend [12].

The differences in the results were measured with Student's t-test, and the value of changes was determined using the Mollison index. The level of statistical significance was set at 0.05.

Table 1. Comparison of the FMS test results

Test	No	Exam (n = 9)	min.-max	mean ± SD	D	t
Deep squat	1	I	1-3	2.00 ± 0.50	0.22	0.80
		II	2-3	2.22 ± 0.67		
Hurdle step	2	I	2-3	2.66 ± 0.50	0.22	1.00
		II	2-3	2.88 ± 0.33		
In-line lunge	3	I	2-3	2.44 ± 0.53	–0.22	–0.80
		II	1-3	2.22 ± 0.67		
Shoulder reach	4	I	2-3	2.55 ± 0.53	–0.22	–1.03
		II	1-3	2.33 ± 0.71		
Straight leg raise	5	I	2-3	2.55 ± 0.53	0.11	0.42
		II	1-3	2.66 ± 0.71		
Push-ups – arms stretch	6	I	0-3	2.55 ± 1.01	–0.33	–0.69
		II	0-3	2.22 ± 0.97		
Rotary stability	7	I	2-3	2.11 ± 0.33	0.55	2.27
		II	1-3	2.66 ± 0.50		
Total value	8	I	14-19	16.88 ± 1.76	0.33	0.43
		II	15-20	17.22 ± 2.28		

Results

Table 1 shows the mean and total FMS test results determining the level of functional mobility. Figure 1 represents the estimated changes of analysed variables. The data show that all variables measured during the second examination, as well as the final results, were higher; however, the difference was statistically non-significant.

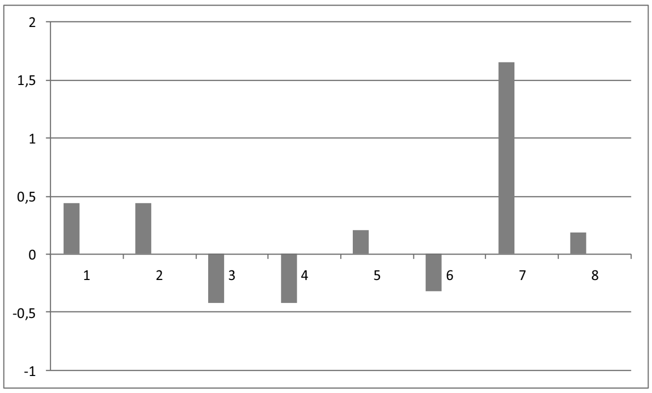

Figure 1. Mean values of the FMS test estimated with the Mollison index

Figure 1 shows that the highest positive change occurred in the rotation stability of the torso, while negative changes were observed in in-line lunge, shoulder reach range, and arms stretch during push-ups.

Table 2 shows a comparison of the mean and total values of the forward torso bend in the sagittal and frontal planes. Figure 2 shows the estimated changes of the studied variables.

The above results show that all the mean ranges of bend results during were greater in the second examination than in the first examination, and all the differences, but for the bend to the right, were statistically significant.

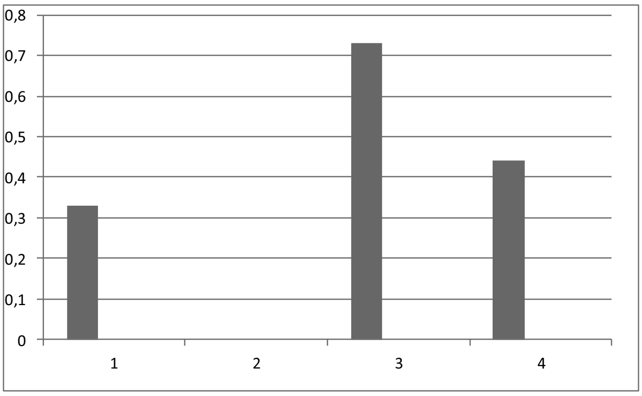

Figure 2. Mean values of flexibility range estimated using the Mollison index

Figure 2 shows that the greatest change in the flexibility range, measured with the Mollison index, was noted for the bend to the left, while no changes were observed in the bend to the right results.

Discussion

The present-day level of sport performance and sports results achieved even by the youngest athletes show that victory in sport is often determined by a tenth of a second. This can also be noted in young swimmers, whose training programs are carefully designed and implemented from the very beginning of their career. The aim of these programs is to increase body efficiency, energy production, and exercise tolerance in order to achieve better sport results. Individualization of training programs and their adjustment to one's abilities (gradual increase of the load) is of particular importance [13]. Young swimmers' training programs also include general exercises designed to develop their overall fitness and multiple mobility in a harmonious way. Therefore, in order to prevent injuries due to over-

Table 2. Comparison of results of flexibility tests

Test	No	Exam (n = 9)	min.-max	mean ± SD	D	t
Forward bend	1	I	7-40	26.44 ± 9.73	3.22	3.30*
		II	16-41	29.66 ± 7.92		
Bend to the right	2	I	29-21	24.22 ± 2.44	0.00	0.00
		II	18-32	24.22 ± 3.80		
Bend to the left	3	I	20-27	23.33 ± 2.45	1.78	3.12*
		II	21-30	25.11 ± 3.18		
Total value	4	I	48-89	74.00 ± 11.55	5.11	2.40*
		II	64-95	79.11 ± 9.78		

* p > 0.05

training, constant monitoring of young swimmers' health and fitness are necessary [14].

One of the most strenuous periods in an athlete's career is the pre-competition preparatory period, when the highest level of performance is to be achieved [14]. The young swimmers who participated in our study were tested for the first time during their training (preparatory) period, before the National Winter Junior Championships. The second examination was performed during the cool-down period, after the championships. This way, we were able to evaluate the influence of each type of training, and the workload in particular, on the girls' functional mobility and flexibility. The increased flexibility and relatively stabilised functional mobility, at the estimated 25-35% of the over-load injury risk, was determined. Therefore, our assumptions of the increase in functional mobility, evaluated during the second examination with the FMS test, were confirmed. Even though, the final values of both tests were not statistically significant, the mean results achieved during the second examination was much higher and close to the values characteristic of low risks of injury occurrence. Most FMS test results, i.e. deep squat, hurdle step, straight leg raise, and rotary stability were higher (improved) during the second examination. Lower results were attained only in in-line lunge, shoulder reach range, and arms stretch in push-ups. Thus, our hypothesis that functional mobility increases thanks to swimming training was only partly confirmed.

It seems that the preparation period before the championships has a negative impact on the mobility of the shoulder girdle, due to the constant need for intense muscle work in this body area and also in the arms. Other authors also confirm the impact of swimming training on the mobility of the shoulder girdle. Jansson et al. [15] showed that young competitive swimmers are characterized by smaller ranges of rotary motion of the shoulder joint in comparison with their non-training peers. It can be assumed that swimming training in children negatively affects the mobility of the shoulder joint as it focuses on improving the strength of the upper limbs and the swimming technique. Contrary conclusions were drawn by Radlińska and Berwecki [16] who observed a better mobility level of the joints of the upper limb between groups of competitive swimmers and non-training subjects. The discrepancies in the results of these studies can point to both a high laxity of this feature and, generally, to a good range of mobility among non-training children. However, it is confirmed that there is a need for sports training in order to maintain the flexibility of the joints in adulthood. However, the results of the study (both partial and total) confirm the assumption that swimming training significantly improves the body's general flexibility. The differences in the attained values between the first and second examinations of the bends to the front and to the left turned out to be statistically significant. It is worth pointing out that the arithmetical mean value of the bend to the right did not increase, as it is the right side that most swimmers declared as stronger. The training program improved the flexibility of the bend to the left, nearly reaching the value of the other, stronger side. Thus, it can be concluded that the swimming training program has a beneficial influence on spinal flexibility in the sagittal and frontal planes.

Kyung-Hun et al. [17] also revealed a positive effect of swimming training on the flexibility of the spine. They evaluated the effects of 12-week combined linear and nonlinear periodic training on physical fitness and competition times in finswimmers. The results of the study showed an improvement of the forward torso bend result, and the difference found was statistically significant. Jorgowić et al. [18] attempted to assess the influence of flexibility on 50 m swimming results in crawl, backstroke, and breaststroke performed by students of sport and physical education. They showed a positive correlation between flexibility and achieved results; however, they found no statistically significant differences in the observed changes, which was associated with the low level of swimming techniques of examined students.

The results of the Mollison index evaluating the changes in the studied variables, indicated the highest increase in the rotary stability of the torso. Yet, positive results were also achieved in the deep-squat, hurdle-step, and straight-leg raise tests as well as in total value. The remaining components of the FMS test showed negative marker values, therefore, it can be concluded that their results were far worse. The flexibility tests revealed a significant improvement in the forward bend and bend to the left, while the value of the bend to the right (0) did not change.

The results of the study need further verification due to the small number of the examined swimmers. Nevertheless, they confirm the authors' assumption that swimming has a beneficial impact on the functional mobility and flexibility of the human body. It is an issue rarely discussed in literature, and therefore we find further studies on the subject essential and crucial for proper evaluation of health implications of swimming.

References

1. Omyła-Rudzka M. Physical activity of Poles. Warsaw: The Communication Research Centre for Public Opinion Research [Aktywność fizyczna Polaków. Warszawa: Komunikat z badań Centrum Badania Opinii Publicznej]; 2013.
2. Weber-Nowakowska K, Żyżniewska-Banaszk E, Gębska M. New methods in physiotherapy. The Halliwick Concept as a form of rehabilitation in water [Nowe metody fizjoterapii. Koncepcja Halliwick jako forma usprawniania w środowisku wodnym]. Ann Acad Med Stetin. 2011; 57(2): 43-45.
3. Radzimińska A, Kos A, Bułatowicz I, et al. Swimming as a form of active rehabilitation for patients with spinal cord injury at the C7 level [Pływanie jako forma aktywnej rehabilitacji osób z urazem rdzenia kręgowego na wysokości C7]. J Health Sci. 2013; 3(11): 233-242.
4. Aptowicz J, Lemiesz G, Ciesiun P, Biernat R, Mrozowska A. The application of the FMS (Functional Movement Screen) for evaluation of functional movement: the case of Olympic taekwondo practitioners [Zastosowanie FMS (Functional Movement Screen) do oceny ruchomości funkcjonalnej na przykładzie zawodników uprawiających taekwondo olimpijskie]. Szkice Humanistyczne. 2010; 10/4(23): 265-276.
5. Butler R, Contreras M, Burton L, et al. Modifiable risk factors predict injuries in firefighters during training academies. Work. 2013; 46: 11-17.
6. O'Connor F, Deuster P, Davis J, et al. Functional Movement screening: predicting injuries in officer candidates. Med Sci Sports Exerc. 2011; 43: 2224-2230.
7. Lemiesz G, Iwańczyk K, Biernat R, et al. Use of a functional evaluation test in practice [Zastosowanie testu funkcjonalnej oceny w praktyce]. Prakt Fizjoter Rehabil. 2013; 39: 4-11.
8. Grygorowicz M, Głowacka A, Wiernicka M, et al. Complex physiotherapeutic assessment as the foundation of primary prevention of sport injury [Kompleksowa ocena fizjoterapeutyczna podstawą profilaktyki pierwotnej urazów sportowych]. Now Lek. 2010; 79(3): 240-244.
9. Cook G, Burton L, Kiesel K, et al. The functional movement screen, upper and lower quarter applications. March 14-15, Sioux Falls, South Dakota 1999.
10. McGill S, Frost D, Andersen J, et al. Movement quality and links to measures of fitness in firefighters. Work. 2012; 43: 357-366.
11. Committee of experts as sports research. Eurofit – European test of physical fitness. Rome; 1988.
12. Jegier A, Nazar K, Dziak A. Medycyna Sportowa. Warszawa: Wydawnictwo Lekarskie PZWL, 2013.
13. Siewierski M. The volume and structure of training loads of top swimmers during the pre-competition preparation phase [Wielkość i struktura obciążeń treningowych pływaków najwyższej klasy w bezpośrednim przygotowaniu startowym do zawodów głównych]. Pol J Sport Tourism. 2010; 18: 227-238.
14. Oprychał C, Karpiński R, Sachnowski K. The long-term process of training high-class swimmers [Proces wieloletniego szkolenia pływaków wysokiej klasy]. Sport Wyczynowy. 2005; 9-10: 57-67.
15. Jansson A, Saartok T, Werner S, Renstrom P. Evaluation of general joint laxity, shoulder laxity and mobility in competitive swimmers during growth and in normal controls. Scan J Med. Sci Sports. 2005; 15: 169-176.
16. Radlińska N, Berwecki A. The assessment of range of motion in selected joints in competitive swimmers. J Kinesiol Exerc Sci. 2015; 70(25): 53-62.
17. Kyung-Hun Y, Min-Hwa S, Shin-Woo K, et al. Effects of combined linear and nonlinear periodic training on physical fitness and competition times in finswimmers. J Exerc Rehabil. 2014; 10(5): 306-312.
18. Jorgić B, Aleksandrović M, Okičić T, et al. Influence of flexibility on swimming results in students of sport and physical education. Sport Sci. 3 2010; 1: 37-41.