Original Article

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Changes in selected somatic indices in 10-12 year old girls under the influence of 3-year swimming training

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract: *Introduction:* The aim of this research is to evaluate the somatic changes of female pre-pubertal swimming athletes. The question posed was: how does three years of swimming training affect the weight, body height and BMI and biological age of pre-adolescent girls who entered swimming training without pre-selection. *Material and methods:* The study group consisted of 14 girls aged 10 years at the start of the study (body weight: 34.99 ± 2.77 kg; body height: 146.00 ± 3.05 cm) practising swimming, the control group of 14 girls aged 10 years at the start of the study (body weight: 37.93 ± 6.02 kg; body height: 145.55 ± 3.88 cm) attending physical education classes only. The study was conducted before 3 consecutive years, equally every 6 months between 8 and 12 am. Body weight and height were measured in both groups and the biological maturity shift index and body mass index were determined. *Results:* The analysis shows that female swimmers after systematic training have a lower body weight (F=10.78, p<0.01) and a lower BMI of 2.63 (F=12.23, p<0.01). No such differences are observed in body height and biological age (p>0.05). *Conclusion:* The study shows that swimming training influences changes in selected somatic indices of prepubertal girls. However, the conducted training does not affect the biological age, so it does not interfere with the natural development of the subjects. This may indicate a better assessment of the overall health of young female swimmers.

Keywords: swimming, girls, longitudinal study, somatic indices

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INTRODUCTION

Early detection and accurate diagnosis of children and young people's special developmental needs form the basis of concern for providing them with conditions conducive to a healthy life [1,2] . Therefore, monitoring children's somatic development plays a key role in assessing their health and growth. There are several reasons why we regularly monitor children's somatic development. Among other things, monitoring height, weight and Body Mass Index (BMI) allows us to assess the child's overall health [3,4]. Insufficient growth or other abnormalities in somatic development can be an early sign of health problems that require further assessment and medical intervention. Regular measurements make it possible to spot possible growth abnormalities, such as nutritional deficits, hormonal problems or the like, which may affect the child's development. Early detection of such problems may allow for quicker therapeutic intervention. Long-term monitoring of growth and weight allows developmental trends to be tracked and the results to be compared with childhood developmental norms. This makes it possible to assess whether the child is developing correctly and is within a healthy weight and height range. The monitoring of children's somatic development is therefore crucial for the early detection of health problems, the assessment of overall health and the provision of appropriate care and support for the child's proper development.

One of the basic biological needs of humans is physical activity [5-7]. Swimming is one of the most commonly recommended physical activities for people of all ages [8]. This is due to the fact that it engages multiple muscle groups simultaneously, which contributes to the development of overall muscle strength [9-11]. Exercising in water requires body stabilisation and coordination, which promotes better motor development. Water provides a low-impact environment for joints and muscles, which reduces the risk of injury. It is also worth noting that swimming is one of the few sports that can be practised safely all year round, regardless of the weather, thanks to indoor or outdoor swimming facilities.

Swimming is also a demanding sport. Following the ban on textile swimming, coaches are looking for ever newer training methods to compete at the highest level [13–15]. It is also worth emphasising that, in order to achieve success in international sports competition, swimming training should start before puberty [16]. Most swimming coaches look for children with a certain anthropometric build (high body height, long upper limb reach). According to the literature review, there is a lack of scientific studies evaluating changes in the physique of young female swimmers compared to girls not training in the sport of swimming.

Therefore, the aim of this research is to evaluate the somatic changes of female swimming athletes during the prepubertal period. Therefore, the following research question was posed: How does three years of swimming training affect the weight, body height and BMI and biological age of pre-adolescent girls who entered swimming training without pre-selection ?

MATERIAL AND METHOD

Subject

The study group consisted of 14 girls aged 10 years at the start of the study (body weight: 34.99 ± 2.77 kg; body height: 146.00 ± 3.05 cm) practising swimming in Pupils' Sports Clubs in Częstochowa (Poland), while the control group consisted of 14 girls aged 10 years at the start of the study (body weight: 37.93 ± 6.02 kg; body height: 145.55 ± 3.88 cm), attending physical education classes only. Recruitment of girls to sports clubs took place without pre-selection. At the start of the study (class IV of the Primary School), a group of girls started swimming training, with pre-existing swimming skills from attending swimming lessons twice a week.

Protocol

The study was conducted before 3 consecutive years, evenly every 6 months between 8 am and 12 am. Body weight and height were measured in both groups using a balance with a height gauge with a measurement accuracy of 0.1 kg and 0.5 cm, respectively. The following indices were determined: Biological maturity offset (MO) according to Moore [17] and body mass index (BMI) [18]. The swimmer's training macro-cycle was planned according to the British Swimming Federation guidelines for girls aged 9-12 years [19] and consisted of 4 training sessions conducted in the morning. Each training unit lasted 70 minutes where the ratio of aerobic to anaerobic tasks was 80% to 20%. The average daily distance swum by the subjects during the first year of training was about 1500 m, in the second year about 2000 m and in the third year about 2500 m.

Statistic

The normality of the data distribution was checked with the Shapiro-Wilk test, the homogeneity of variance with the Levene's test. An analysis of variance with repeated measures (ANOVA) was performed to verify the significance of differences between the compared data groups. The level of statistical significance was set at $p<0.05$. All calculations were performed using Statistica 12.0 software (Statsoft, Poland).

Ethics

In accordance with the requirements of the Declaration of Helsinki, all subjects and their parents were informed about the purpose and methodology of the study, gave written consent to participate in the study, and the protocol of the entire experiment was approved by the Research Bioethics Committee of the Jan Długosz University in Częstochowa No. KB-2/2012.

RESULTS

Figure 1 shows the changes in body weight, body height, biological age and BMI of a group of young female swimmers compared to non-training girls over the six-month measurement cycles. It can be seen that, in all cases, the variables increase with time not depending on the group studied. In the case of body weight, BMI (figure 1A, 1D), the analysis shows statistically significant differences ($p<0.01$), indicating a decrease in these variables in the group of female swimmers (table 1). No such differences are observed in body height and biological age (figure 1B, 1C), despite the slight discrepancies noted in the graphs between the subjects. Table 1 contains the results of the ANOVA for the three effects studied, i.e. group, measurement number, relationship group*measurement number. The compiled statistical values show significant differences in all studied effects only in the variables body weight and BMI ($p<0.01$). Figure 2 shows the mean change in BMI over 3 years between the study groups. Female swimming athletes have a lower BMI value of 2.63 ($F=12.236$, $p=0.0017$) after systematic training.

Table 1. ANOVA results for selected variables

Indicator	Effect	F	p
Body mass	Group	10.780	0.0029*
	Measurement number	185.179	0.0000*
	Group * Measurement number	5.107	0.0002*
Body height	Group	0.44	0.5120
	Measurement number	578.57	0.0000*
	Group * Measurement number	3.08	0.0116*
Biological age	Group	3.642	0.0674
	Measurement number	374.065	0.0000*
	Group * Measurement number	2.171	0.0611
BMI	Group	12.236	0.0017*
	Measurement number	18.146	0.0000*
	Group * Measurement number	5.335	0.0001*

BMI - body mass index, p - statistical significance, * p<0.01

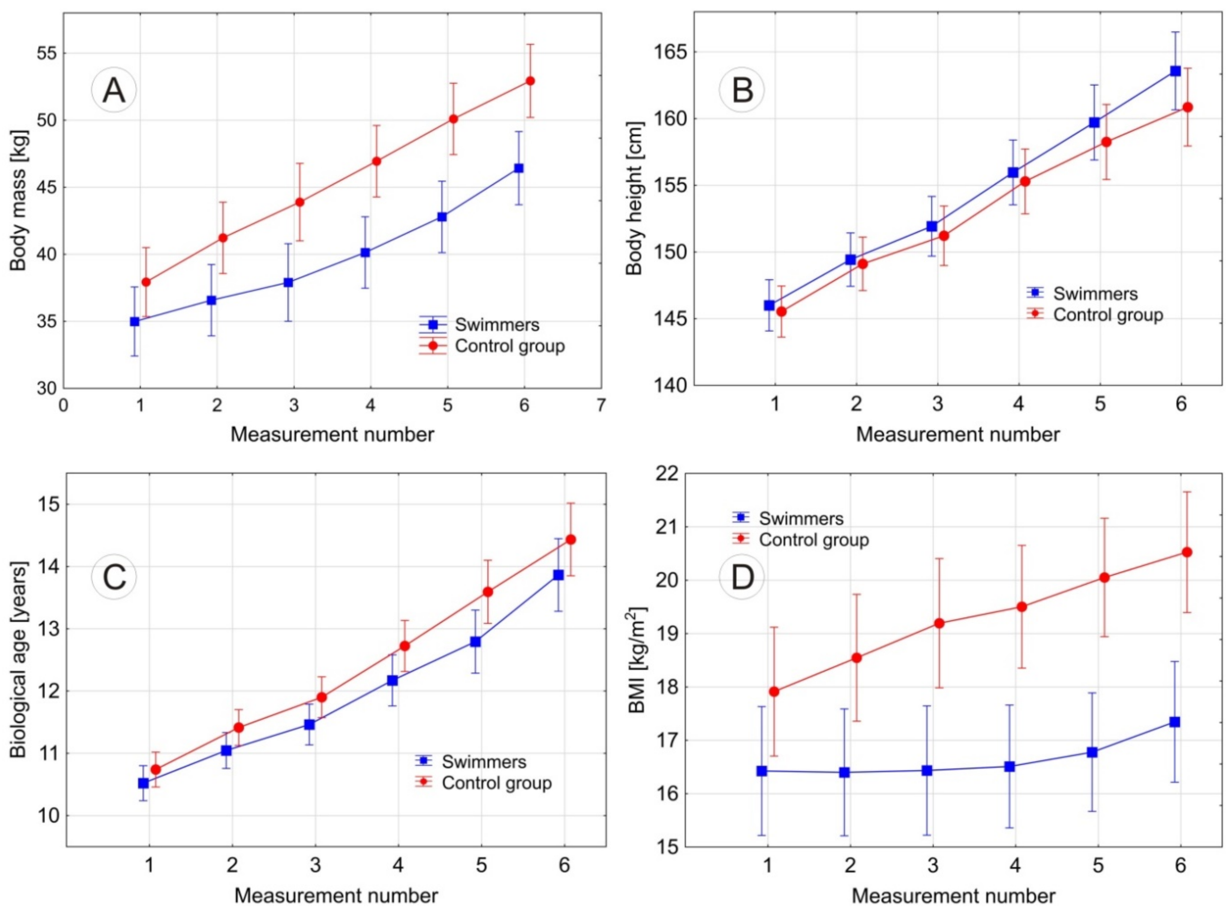

Figure 1. Changes in selected somatic variables in the swimmer and control groups over the course of the study.

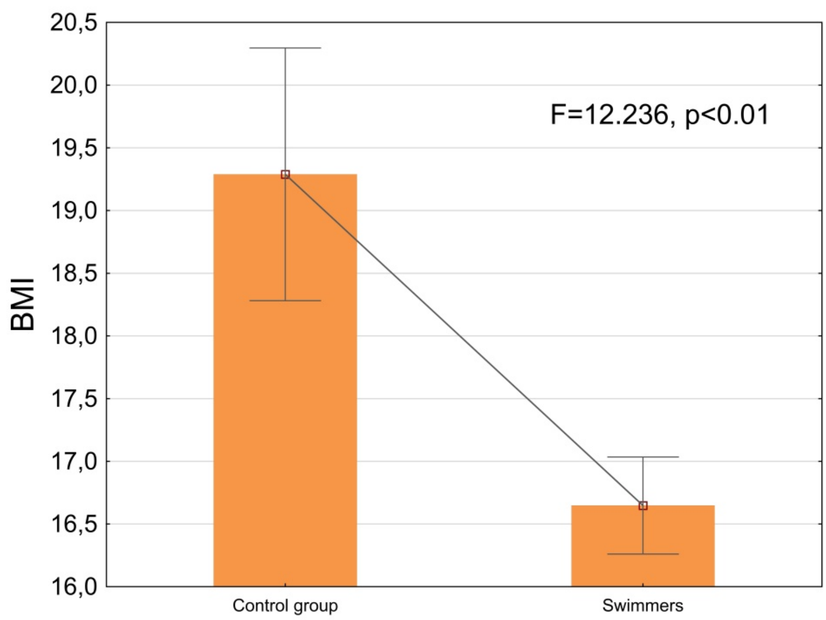

Figure 2. Change in BMI in the female swimmers and control group after three years of swimming training.

DISCUSSION

The study shows that three years of swimming training influences changes in selected somatic variables of prepubertal girls. Obviously, with the biological development of 10-12 year old children, not depending on training, their body mass increases, which is confirmed by our results. However, the body mass of female swimmers is statistically lower, moreover, it can be assumed that it includes more muscles [9] than in non-swimmers. In our study, there was no change in body height, which is also confirmed by other researchers working on this topic [18-20]. Other studies have reported higher body height values in swimming-trained boys in relation to non-swimmers [23,24]. Other scientific reports also confirm that in the accepted age range (10-12 years), body height in boys who practice swimming is not significantly greater compared to peers who do not practice swimming [21]. However, it should be noted that most of the research work concerns boys previously selected for the sport of swimming.

Although there was no noticeable change in body height in the study groups in these studies, the change in BMI is clear. Although research suggests that swimming may increase appetite and energy intake [25]. This may indicate a better assessment of overall health and a reduction in obesity in young female swimmers [3,4,26]. BMI is considered a marker of obesity [25-27]. Swimming is an effective anti-obesity measure in adolescents for the prevention and treatment of overweight [30,31]. Our results are consistent with those of other researchers [32], who showed that a 36-week swimming programme resulted in a decrease in body fat and BMI in a sample of adolescents. It was concluded that this type of sport could be recommended to adolescents as a recreational or rehabilitative activity due to its potential to develop balance [33]. However, there is a limitation related to the fear of water. It can be presumed that people who are shorter and of lower body weight, characterised by low body fat, will have more reason to be apprehensive, even in the shallow water zone [34]. Low body weight and the associated lower body fat is another barrier due to inferior buoyancy of the body, making it more difficult to perform buoyancy familiarisation exercises in water and causing more rapid hypothermia, which discourages exercise in water.

Our research also shows that the training provided does not affect biological age, which in our opinion is a positive sign. This means that it does not affect the natural development of the girls. This is confirmed by the correct selection of a training plan for a period of three years, which is designed to increase the girls' endurance capacity without interfering with their natural development. Scientific reports on the biological development in children involved in swimming compared to peers who did not do any additional physical activity are inconclusive [35,36]. It has been shown that there is a higher degree of biological development in children who practice swimming compared to peers who did not practice swimming [36]. However, it should be emphasised that this may have been due to earlier selection for the sport of swimming. Other cross-sectional studies of girls aged 11-12 years showed no significant differences in biological development compared to female peers [37], who did not do any additional physical activity, which confirms our scientific reports.

Controlled studies involving the use of supervised extra-curricular exercise over a long period of time in children are difficult to conduct and therefore rare. The results of these studies are a prelude to more in-depth analyses. They can serve as a reference point for other researchers and can pave the way for further research.

Conflict of interests: The material for this article is a collection of unused and previously unpublished data collected in 2012-2015 by Dr Mariusz Kuberski, an employee of Jan Długosz University in Częstochowa. This collection of data was collected by Dr M. Kuberski during the period when he was preparing his doctoral thesis, whose supervisor was Dr hab. Ryszard Zarzeczny prof. UJK. This data is a separate collection - this material was not used in the dissertation. The data collected by Dr M. Kuberski and forming the material for this article were obtained during the research he conducted at the Jan

Długosz University in Częstochowa, using the University's equipment. The research material consisted of the results of people from sports clubs cooperating with Dr Mariusz Kuberski, as a result of his personal relations and during his work in one of them as a swimming coach. The article was written in connection with the authors' work for the Jan Długosz University in Częstochowa.

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