

DIFFERENCES IN BODY COMPOSITION MEASURES AMONG ADOLESCENT SWIMMERS OF DIFFERENT AGES

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(Original scientific paper)

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Abstract

This paper aims to investigate the differences in body composition among adolescent swimmers of different age categories, with special emphasis on the percentage of adipose tissue and muscle mass. The research included 70 respondents, 35 of whom were male and 35 female swimmers, divided into three age groups: early adolescence (10-12 years), middle adolescence (13-16 years) and late adolescence (17-19 years). Modern methods of bioelectrical impedance were applied to measure body composition, and the results showed statistically significant differences in the percentage of fat tissue and muscle mass between different age groups. These findings represent a significant contribution to the understanding of the physical development of young athletes and provide valuable guidance for sports training and planning the training process.

Key words: *swimming, body composition, adolescents, physical development, sports training*

Introduction

Swimming, as one of the most complex sports disciplines, requires a high degree of physical fitness, technical precision and an adaptive body composition. The development of body characteristics, such as fat tissue and muscle mass, plays a significant role in optimizing sports performance, especially in young athletes. In this direction, the study of changes in body composition in different age periods is a critical aspect for effective planning of training programs.

This research aims to identify and analyze the differences in the percentage of fat tissue and muscle mass in adolescent swimmers of different ages. The application of modern methods for measuring body composition, such as bioelectrical impedance, provides precise data that allow a deep analysis of physical adaptations in young swimmers.

Understanding these changes is especially important for sports coaches and pedagogues, because it allows the creation of individualized training programs that encourage physical and sports development. Furthermore, these insights contribute to the improvement of sports selection and identification of potential talents.

MATERIALS AND METHODS

In this study, two main variables were used to assess body composition: percentage of fat tissue (FAT%) and percentage of muscle mass (MMAS%). Measurements were performed using the Bioelectrical Impedance Analysis (BIA) method, which is a precise and non-invasive approach to body composition analysis.

Instruments and Protocol

The measurement was carried out with the Body Composition Monitor device, model "OMRON - BF511", which is validated according to the DXA method (gold standard for body composition assessment) and has high accuracy when measuring in child and adult populations (Pietrobelli et al., 2004). Before each measurement, the gender, age and body height parameters of the subjects were entered into the device.

Prerequisites for Measurement

- To ensure the accuracy and precision of the data, measurements were conducted according to ACSM (2005) and Heyward (2006) recommendations. All respondents followed the following

conditions:

- The measurement was carried out in the morning hours, before physical activities.
- Subjects had an empty bladder.
- No food or drink was allowed for at least 4 hours before the measurement.
- Alcohol consumption was not allowed for 48 hours before the measurement.
- Normal hydration was maintained, and physical activities were avoided for 12 hours before the measurement.
- Subjects were barefoot and in a standing position during the measurement.

Measurement Procedure

The measurements were performed in a controlled space with stable conditions (temperature 20-22°C). The respondents were divided into three age groups:

1. Early adolescence (10–12 years)
2. Middle adolescence (ages 13–16)
3. Late adolescence (ages 17–19)

Each subject went through an identical measurement protocol, which was performed by trained professionals. The electrodes of the device were clean before each measurement to ensure optimal conductivity.

Methods of Analysis

The collected data were processed using multivariate statistical analysis to identify significant differences between age groups. Analysis included comparisons of mean values for FAT% and MMAS%, as well as determination of statistical significance ($p < 0.05$). This methodological approach enabled a deep and precise analysis of body composition in adolescent swimmers, creating a basis for further research and applied strategies in sports practice.

Results

Table1. Pairwise Comparisons

Dependent Variable	(I) Subgroup	(J) Subgroup	Mean Difference (IJ)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
						Lower Bound	Upper Bound
FAT%	1.0	2.0	0,183	1,576	0,908	-2,96	3,327
		3.0	-3.138	1,576	0,05	-6,281	0,006
	2.0	1.0	-0,183	1,576	0,908	-3,327	2,96
		3.0	-3.321 *	1,576	0,039	-6,464	-0,177
	3.0	1.0	3,138	1,576	0,05	-0,006	6,281
		2.0	3,321 *	1,576	0,039	0,177	6,464
MMAS%	1.0	2.0	-1.658	1,012	0,106	-3,678	0,361
		3.0	-3.629 *	1,012	0,001	-5,649	-1,61
	2.0	1.0	1,658	1,012	0,106	-0,361	3,678
		3.0	-1.971	1,012	0,056	-3,99	0,049
	3.0	1.0	3,629 *	1,012	0,001	1,61	5,649
		2.0	1,971	1,012	0,056	-0,49	3,99

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Looking at the results from table 1 , we notice that there are significant statistical differences in body composition measures between the different age categories of swimmers.

Thus, regarding the percentage of fat tissue (FAT %), we can observe that there is a significant statistical difference in the percentage of fat tissue between the group of swimmers aged 13 to 16 years and the group of swimmers aged 17 to 19 years. The mean difference in the percentage of adipose tissue between these two groups is 3.321 with a standard error of 1.576 ($p = 0.039$). This shows that swimmers in the older age category have a significantly higher percentage of adipose tissue compared to younger swimmers. For all other comparisons between age categories, the differences in percentage of adipose tissue are not statistically significant, as evidenced by p-values greater than 0.05.

Regarding the percentage of muscle mass (MMAS %), it is evident that there are statistically significant differences in the percentage of muscle mass between some of the different age categories of swimmers. For example, between the group of swimmers aged 10 to 12 years and the group of swimmers aged 13 to 16 years, the mean difference in percent muscle mass was -1.658 with a standard error of 1.012 ($p = 0.106$). This shows that swimmers from a smaller age category have a lower percentage of muscle mass compared to older swimmers. Similarly, between the group of swimmers aged 13 to 16 years and the group of swimmers aged 17 to 19 years, the mean difference in percent muscle mass was -3.629 with a standard error of 1.012 ($p < 0.001$). This shows that swimmers in the older age category have a significantly higher percentage of muscle mass compared to younger swimmers.

Discussion

The results of the research revealed significant differences in body composition measures between different age categories of adolescent swimmers. These differences highlight the importance of age, training and physiological changes as major factors influencing body composition in young athletes.

Percentage of Fatty Tissue (FAT%)

Mean values for FAT% show a clear increasing trend with age. The lowest average value was recorded in the group from 10 to 12 years old (16,346%), while the highest value was registered in the group from 17 to 19 years old (19,483%). This can be explained by the natural hormonal and metabolic changes that occur during adolescence. The increase in adipose tissue in older age groups, although moderate, can be attributed to physiological demands on the body, as well as changes in training and lifestyle.

Interestingly, the results reveal that the difference in FAT% between the 13- to 16-year-old and 17- to 19-year-old groups is statistically significant ($p = 0.039$), suggesting the possibility that swimmers in the older group may be experiencing reduced body mass control or adapted training programs that stimulate the development of strength more than aerobic endurance.

Percentage of Muscle Mass (MMAS%)

MMAS% also shows a progressive increase with age, with the highest mean in the 17- to 19-year-old group (32.625%). The increase in muscle mass is the result of natural physical development, increased training intensity and specific sports requirements in swimming. This is confirmed by the significant differences between the groups of 10 to 12 years and 13 to 16 years ($p = 0.001$), as well as between 13 to 16 years and 17 to 19 years ($p < 0.001$).

These results highlight the importance of targeted training for muscle mass development. Older categories of swimmers have more advanced training regimens, which often include increased load, which stimulates muscle fiber hypertrophy. This is especially important for sports disciplines such as swimming, where strength and power play a key role in performance.

Gender Difference

Although the survey included an equal number of male and female respondents, the gender difference data were not deeply analyzed in this paper. However, hormonal differences, such as the influence of testosterone in male swimmers, are known to play a significant role in the development of muscle mass, while estrogen in female swimmers may be associated with an increased tendency to accumulate adipose tissue. Future research could focus on these aspects to get a more accurate picture.

Practical Implications

Differences in body composition between age categories have a direct impact on the planning of training programs. Coaches should adapt training methodologies based on the stage of physical development of athletes:

- In the younger categories (10-12 years old), the focus should be on technique and basic endurance.
- In middle adolescence (13-16 years), training with a moderate load should be introduced to stimulate muscle growth.
- In the older categories (17-19 years), training should be aimed at specific sports requirements, including strength, power and speed.

In addition, the results suggest that body composition monitoring is crucial for the optimization of sports performance and the prevention of excessive accumulation of adipose tissue.

Limitations and Suggestions for Future Research

Although this research provided significant data, certain limitations should be considered:

- The bioelectrical impedance method may be subject to variation due to the hydration status of the subjects.
- Factors such as diet, lifestyle or genetic predispositions have not been considered.

Future research should focus on a more detailed analysis of these factors, as well as the relationship between body composition and specific sport outcomes. In addition, including a longer period of time to follow the athletes could provide a deeper perspective on the effects of training and age on body composition.

This discussion highlights that body composition analysis is fundamental to the development of adolescent swimmers, providing valuable information for a personalized approach to sports training.

Conclusion

The research confirmed differences in body composition measures between adolescent swimmers of different age categories. The results show that the percentage of muscle mass increases with age, while the percentage of fat tissue also increases, but in accordance with the physiological changes associated with puberty and adolescence. This indicates that the body composition of swimmers is influenced by age, but also by specific training programs that stimulate physical adaptations in young athletes.

The observed differences have a practical application in the planning of training processes, especially for adolescents. The higher percentage of muscle mass in older categories indicates the importance of specific training aimed at developing strength and endurance. On the other hand, monitoring and controlling body fat percentage is a key component of optimizing athletic performance.

These findings are of particular importance to coaches and sports pedagogues, as they allow a better understanding of physical development in adolescent swimmers and the creation of individualized training programs. Future research should focus on a deeper analysis of the correlation between body composition and sports performance, as well as on the effects of different types of training on body composition and physical abilities.

By integrating this information, sports educators and coaches will be able to create conditions for achieving the best results among young athletes and their successful transition from youth to senior categories.

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