Relation Among Peak Height Velocity, Anthropometric Indices, and Motoric Abilities in Youth Swimmers

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ABSTRACT.

Introduction: The study's goal was to see if there is any significant correlation between PHV, anthropometric indices, and motoric ability tests and 25m freestyle swimming. **Methods:** The sample of participants included 15 young male swimmers. Their chronological age was 9.71±0.99 years. Used variables were age, PHV, maturity offset, body height, seating height, body mass, leg length, 25m freestyle swimming, medicine ball throw, sit-ups, and 20m sprint run. **Results:** Results showed significant differences in medicine ball throw compared to body height; taller kids threw the ball further. Sit-ups compared with body mass; kids with lower body mass did more sit-ups. 20m sprint compared by age, older kids run faster. PHV compared with age and body height, and Maturity offset compared by age and body height; if the kid is older or taller it has reached a bigger maturity offset and PHV. **Discussion:** Body height, body mass, and age are very important at a young age and can make a big difference in a young swimmer's performance. Coordination, strength, and speed at ages 8 to 11 have in progressed linear growth. Also, in swimming, there is something called "the feeling for the water" - the more time you spend consistently in the water your coordination adapts efficiently. **Conclusions:** Bigger differences in the results can be explained by sensible phases of child motor development. We didn't see a significant change in any variables connected with the 25m swim, kids start to develop motor skills on the ground and at an early age. New media such as water takes a different set of motor skills to be used/developed. This means that younger kids can have better results if they have more training experience than their older colleagues because their specific coordination, strength, and speed are used more efficiently in water.

Keywords: Children, Development, Motor skills, Water sports, PHV

INTRODUCTION

Puberty is a critical period of biological maturation, characterized by a growth spurt and the development of secondary sexual characteristics. The onset and progression of puberty vary among individuals, with differences in timing (the age at which certain pubertal milestones are reached), velocity (the rate of progression through puberty), and duration (the period between the onset and completion of puberty or between specific stages). These parameters exhibit significant individual variability (Gluckman & Hanson, 2006). During adolescence, the peak height velocity (PHV) represents a phase of rapid growth in height. This period is particularly crucial for young athletes as monitoring PHV can help optimize training programs and minimize injury risks. Ignoring the effects of PHV and critical developmental phases can jeopardize an athlete's health. Moreover, understanding PHV can provide valuable insights for sports selection, as physical characteristics significantly influence performance levels. Research indicates that height can play a crucial role in an athlete's success, offering natural advantages in certain sports. The increasing focus on the relationship between anthropometric and motor characteristics has led to new demands in sports anthropometric research (Szabo et al., 2020). Motor abilities (MA), which encompass everyday skills and sports performance movements, are vital for athletic performance. Well-developed motor abilities enable athletes to expend less energy and move more quickly. Knowledge of motor skills in young schoolchildren is directly related to the effects of physical education and the development of specific motor skills. During the early school years, the dynamics of development are slow compared to the preschool years. The general mobility factor present in preschoolers begins to vary in the first few years of elementary school, a period marked by rapid motor skill development (Nikolic et al., 2015). In swimming, motor skills differ from those used on land, requiring specific coordination and skill sets to achieve optimal results. Children's life experiences and stimulation form the foundation for acquiring critical motor skills for various sports activities (Clark & Metcalfe, 2002). Strength development during adolescence follows a linear growth pattern, which is also of great importance. Although strength has traditionally been measured through isometric and isokinetic tests, recent studies have focused on exercises commonly found in dryland strength training programs as predictors of swimming performance (Pérez-Olea et al., 2018). This research aims to explore how these factors affect swimming performance in adolescent athletes. There is a notable lack of studies addressing this subject in competitive adolescent swimming.

METHODS

Participant

The sample of participants included 15 male swimmers. Their chronological age was 9.71±0.99 years. Participants did not have any illness or medical condition that may have prevented them from performing tests. Their parents were informed about the procedures and purpose of the study and signed informed consent before the investigation began. The study was conducted following the declaration of Helsinki, and the Ethical Board of the Faculty of Kinesiology, University of Split, Croatia (Ethical board number 2181-205-02-05-22-035).

Variables and procedure

Used variables were age, PHV, maturity offset (MO), body height (BH), seating body height (SBH), body mass (BM), leg length (LL), 25m freestyle, medicine ball throw (MBT), sit-ups (SU), training age (TA) and 20m sprint run.MO was calculated by the formula: Maturity offset (years) = - 8.128741 + (0.0070346 × (age × sitting height)); (Moore et al.,2015). All anthropometric indices were measured by strict protocol (Ross WD et al.,1991). BH, SBH, and LL were measured using measuring tape.BM was calculated on a digital scale. MBT was measured lying down on the back, participants had three attempts and the best throw was recorded as a result. SU were measured by max repetition in one minute. The 25m freestyle was the best-recorded result in the competition that our athletes had until that moment. TA was estimated by the time passed from entering the sport and the time until we did measurements. The 20m sprint run was measured with a stopwatch, athletes had three attempts, and the best attempt was recorded as a result. A formula calculates PHV and the following variables are required: gender, date of birth, date of measurement, height, sitting height, and weight. (Mirwald et al.,2002).

Statistics

Descriptive statistics parameters were calculated: arithmetic mean and standard deviation, minimal and maximal results. Kolmogorov-Smirnov test was calculated to estimate the normality of distribution in each variable. Pearson's correlation was calculated for analysing relations among variables. All statistical analysis was done in Statistica v13.00 software.

RESULTS

The results of descriptive statistics are presented in Table 1. According to the Kolmogorov-Smirnov test calculation, it can be seen that all variables have a normal distribution and are therefore suitable for parametric statistical methods (p>0.20).

Table 1. Descriptive parameters of measured variables, on the total sample of participants (N=15)

Variable	*Mean*	*Minimum*	*Maximum*	*SD*	*max D*	*K-S (p)*
Age (years)	*9.71*	*8.00*	*11.00*	*0.99*	*0.26*	*p > .20*
PHV	*-0.77*	*-2.06*	*0.35*	*0.83*	*0.18*	*p > .20*
Maturity offset	*-3.00*	*-3.80*	*-2.17*	*0.58*	*0.15*	*p > .20*
Body height (cm)	*145.38*	*135.00*	*159.80*	*7.05*	*0.11*	*p > .20*
Seating height (cm)	*75.11*	*64.00*	*82.00*	*4.51*	*0.16*	*p > .20*
Body mass (kg)	*40.19*	*29.60*	*51.10*	*7.19*	*0.16*	*p > .20*
Leg length (cm)	*70.27*	*58.00*	*78.00*	*5.72*	*0.18*	*p > .20*
25m sprint (s)	*26.59*	*19.69*	*36.43*	*5.00*	*0.15*	*p > .20*
Medicine ball throw (cm)	*283.21*	*108.00*	*415.00*	*88.98*	*0.14*	*p > .20*
Sit-ups	*19.21*	*11.00*	*30.00*	*6.33*	*0.15*	*p > .20*
20-meter sprint (s)	*4.50*	*3.97*	*6.09*	*0.61*	*0.25*	*p > .20*
Training age	*15.08*	*6.00*	*41.00*	*12.34*	*0.35*	*p > .20*

Legend: PHV- peak high velocity.

Table 2 demonstrates a correlation between anthropometric indices with speed (25 and 20m sprint) and strength tests (Medicine ball throw and Sit-ups). It can be noted that a significant correlation occurs between medicine ball throw and body height (r=0.58). On the other hand, Sit-ups correlate negatively with body mass (-0.65). Other variables do not correlate significantly (r= -0.46 – 0.54). Additionally, correlations between chronological parameters and tests showed significant results only between age and 20m sprint (r=-0.77) (see Table 3).

Table 2. Pearson correlation test between anthropometric indices and speed and strength tests

Variable	*25m sprint (s)*	*Medicine ball throw (cm)*	*Sit-ups*	*20m sprint (s)*
Body height (cm)	*-0.15*	*0.58**	*-0.25*	*-0.20*
Seating height (cm)	*0.02*	*0.21*	*-0.44*	*0.25*
Body mass (kg)	*0.12*	*0.15*	*-0.65**	*0.49*
Leg length (cm)	*-0.21*	*0.54*	*0.07*	*-0.46*

Legend: *-significant correlations

Table 3. Pearson correlation test between chronological parameters and speed and strength tests

Variable	*25m sprint (s)*	*Medicine ball throw (cm)*	*Sit-ups*	*20m sprint (s)*
Age (years)	*-0.46*	*0.28*	*0.34*	*-0.77**
PHV	*-0.39*	*0.48*	*-0.04*	*-0.52*
Maturity offset	*-0.43*	*0.39*	*0.05*	*-0.57*
Training age	*0.09*			

Legend: PHV- peak high velocity; *-significant correlations

The correlation between PHV, Maturity offset, age, and anthropometric indices is shown in Table 4. The results show a significance between age with PHV (r=0.81) and maturity offset (r=0.83). Also, a significant correlation can be seen between body height with PHV (r=0.72) and maturity offset (r=0.58). Seating height and body mass do not reach a significant correlation with PHV and maturity offset.

Table 4. Pearson correlation test between PHV, Maturity offset, and age and anthropometric indices

Variable	*Age (years)*	*Body height (cm)*	*Seating height (cm)*	*Body mass (kg)*
PHV	*0.81**	*0.72**	*0.43*	*0.28*
Maturity offset	*0.83**	*0.58**	*0.44*	*0.16*

Legend: PHV- peak high velocity; *-significant correlation

DISCUSSION

The results indicated several significant differences. One finding was that taller children performed better in the medicine ball throw, which was conducted while lying down. This advantage is likely due to longer arm length, resulting in greater swing force production. These results are consistent with a 2008 study showing positive correlations between medicine ball throw scores and both height (r = 0.34) and weight (r = 0.34) (Davis et al., 2008). For sit-ups, children with lower body mass performed more repetitions. These results may be explained by a rapid gain in weight in adolescence period of life. This explanation is consistent with the study by Park et al. 1994 based on 6580 students from grade 4 to senior high from Seoul, district town, and countryside were evaluated for sexual maturity using Tanner staging, weight, height and body mass index and compared for growth. There was an increase of 5.5 kg in weight for boys at the same age as for growth in height, that is between 11 and 14 years of age. In girls, an average weight gain of 5.1 kg occurred between 11 and 13 years of age, slightly later than that of growth in height. Rapid gain in weight occurred during Tanner stages 2~3 for girls. A total gain of 20.70 kg for boys occurred during the whole sexual maturation period while girls gained a total of 19.73 kg (Park et al., 1994). This result can be attributed to the fact that lighter children often have less body fat, giving them an endurance advantage in this test. While body mass alone does not provide a complete picture of body composition, the similarity in age and grouping of the participants allowed for meaningful comparisons. In another study from 2008 higher waist circumference and subcutaneous skinfolds at the thigh, abdomen, and subscapular sites were associated with poorer performance in these exercises. Therefore, targeted conditioning to reduce body fat at these sites could improve performance (Esco et al., 2008). In the 20m sprint, older children ran faster than their younger counterparts, highlighting that motor development progresses with age. This finding aligns with a study on Spanish preschoolers, which showed that sprint times decreased as children aged, providing reference values for running speed in this age group (Latorre-Román et al., 2017). However, similar correlations were not observed in water-based activities. Comparisons of peak height velocity (PHV) and maturity offset with age and height revealed that older and taller children had reached higher maturity levels and PHV. This is expected, as taller and older children generally mature faster, both physically and in terms of bone structure. An interesting but non-significant observation was the relationship between training age and 25m swim performance. Due to the small sample size, the study was limited in its ability to detect significant correlations. Nonetheless, it is generally understood that longer training in any sport improves proficiency. Swimming, emphasizes the importance of developing a buoyancy and sense of fluid movement. Unlike land-based activities where older children typically outperform younger ones, swimming performance can be superior in younger children if they have more experience and better technique. Technique and experience are not the only factors that are important. Height, body fat, motor abilities, and many factors play a role in swimming performance. In other words, it is hard to point out a few things that are the most influential. Height can give an advantage in swimming but doesn't necessarily mean that you will be a better swimmer if you are taller. For example in the study from 1964 swimming results had no significant correlation with height and weight although results didn't have significant correlations there were still connections to the results which could change to significant if the author took a different sample (Stroup, F. 1964). This suggests that swimming requires a unique set of motor skills and emphasizes the importance of specialized training in water.

CONCLUSIONS

This study revealed several intriguing findings about the unique nature of swimming compared to land-based sports. Unlike on land, swimming requires time for individuals to feel relaxed and understand their body movements in the water. As a result, proficient swimmers may not necessarily be the best athletes on land due to the distinct demands of swimming. Immersing oneself in swimming is a remarkable experience for both children and adults. With increased time spent in the pool or sea, one's body becomes more adept at gliding through the water efficiently. Swimmers begin to control their movements better and achieve fluidity. The study demonstrated that younger or smaller children could outperform their taller, stronger, or older peers. However, a limitation of this study is the small sample size. Despite this, the study likely emphasizes the importance of monitoring peak height velocity (PHV), motor abilities, and anthropometric indices when working with adolescent athletes. Tracking these variables is likely crucial for helping adolescent athletes reach their potential. These tests serve the purpose of monitoring athletes' physical condition and give us a better understanding of athletes' anatomical structure and performance abilities and therefore are beneficial and should be performed.

REFERENCES

Gluckman, P. D., & Hanson, M. A. (2006). Evolution, development and timing of puberty. *Trends in Endocrinology & Metabolism*, *17*(1), 7-12.

Szabo, D. A., Neagu, N., Gliga, A. C., & Sopa, I. S. (2020). Analyzing and comparing anthropometric indices as contributory factors of influence in sports performance. *Analele Universitatii din Oradea-Fascicula Educatie Fizica si Sport*, *30*(2020), 3-16.

Nikolic, D. S., Kocic, M. R., Beric, D. I., Cvetkovic, N. T., & Krzalic, A. S. (2015). Motor abilities of children in urban and rural areas. *Facta Universitatis, Series: Physical Education and Sport*, 127-138.

Clark, J. E., & Metcalfe, J. S. (2002). The mountain of motor development: A metaphor. In J. E. Clark& J. H. Humphrey (Eds.), Motor development: Research and Reviews, (volume 2, pp. 163-190). Reston, VA: National Association for Sport and Physical Education.

Pérez-Olea, J. I., Valenzuela, P. L., Aponte, C., & Izquierdo, M. (2018). Relationship between dryland strength and swimming performance: pull-up mechanics as a predictor of swimming speed. *The Journal of Strength & Conditioning Research*, *32*(6), 1637-1642., Moore, S. A., McKay, H. A., Macdonald, H., Nettlefold, L., Baxter-Jones, A. D., Cameron, N., & Brasher, P. M. (2015). Enhancing a somatic maturity prediction model. *Medicine & Science in Sports & Exercise*, *47*(8), 1755-1764.

Davis, K. L., Kang, M., Boswell, B. B., DuBose, K. D., Altman, S. R., & Binkley, H. M. (2008). Validity and reliability of the medicine ball throw for kindergarten children. *The Journal of Strength & Conditioning Research*, *22*(6), 1958-1963.

Esco, M. R., Olson, M. S., & Williford, H. (2008). Relationship of push-ups and sit-ups tests to selected anthropometric variables and performance results: A multiple regression study. *The Journal of Strength & Conditioning Research*, *22*(6), 1862-1868.

Latorre-Román, P. Á., Mora-López, D., Martínez-Redondo, M., & García-Pinillos, F. (2017). Reference values for running sprint field tests in preschool children: A population-based study. *Gait & Posture*, *54*, 76-79.

Mirwald, R.L., Baxter-Jones, A.D.G., Bailey, D.A., Beunen G.P. An assessment of maturity from anthropometric measurements. Medicine and Science in Sports and Exercise 2002: 34(4); 689-694.

Ross WD, Marfell-Jones MJ. Kinanthropometry. In MacDougall JD, Wenger HA, Green HJ, eds. *Physiological Testing of the High-Performance Athlete*, pp 223-308. Champaign, Illinois: Human Kinetics Books, 1991.

PARK, H. G., HONG, C. H., & KIM, D. H. (1994). Physical gowth according to sexual maturation of Korean adolescents. *Journal of the Korean Pediatric Society*, 1187-1195.

Stroup, F. (1964). Height, weight and swimming time. *Physical Educator*, *21*(1), 19.