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Differences in Motor, Functional, and Sport-Specific Skills in Gifted Wrestlers with Different Acceleration of Biological Development

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Abstract

It is assumed that the selection of gifted children aged 13-14 years old is dominated by those with accelerated biological development. A better understanding of this problem can greatly improve the selection process for gifted children. The paper aimed to determine the differences in motor, functional, and sport-specific skills between children with different levels of biological acceleration. The study was conducted on a sample of 26 wrestlers aged 13.8±0.74 years old selected from the city of Zagreb. The participants were divided into three groups according to the acceleration of biological development (early maturers, n=9; normal, n=10; late maturers, n=7) and tested with a battery of 10 tests (6 motor, 1 functional, and 3 sport-specific). As was expected, even though there were no differences in experience and placement, the groups differed in all physical characteristics (Kruskal–Wallis ANOVA: age p=0.01; body mass, p<0.01; body height, p<0.01; sitting body height, p<0.01; body mass index, p=0.02). The groups differed significantly in two sport-specific tests and one motor test (Kruskal–Wallis ANOVA: wrestling bridge flexibility p=0.02; flipover p=0.04; medicine ball throw p<0.01). Although these were selected wrestlers, not all of them were classified as early maturers; rather, they were evenly distributed in different groups. We can assume that late maturers had technical–tactical advantages that compensated for the early maturers' advantage in explosive power. Early maturers were better in terms of explosive power, but the late maturers were better at sport-specific flexibility, as expected.

Keywords: *wrestling, biological age, talented athletes*

Introduction

Wrestling is an Olympic combat sport based on grappling and one of the few sports that was represented at the Ancient Olympic Games (Horswill, 1992). The optimal age to begin wrestling training is age 10, whereas peak performance is reached at the age of 25 (Karninčić, Baić, & Sprem, 2017). In this article we were interested in a particularly sensitive period of accelerated growth and development, i.e., older boys from 13 to 15 years old (according to international wrestling rules). This period is also called puberty and is marked by rapid changes in body size, shape, and composition (Rogol, Clark, & Roemmich, 2000). Puberty onset may occur earlier or later than expected, and in this regard, children are divided into three groups (Ostojic, 2017). Early maturers are children whose phase of accelerated growth and development began earlier, whereas late maturers are children whose biological development is delayed. The third group includes children with normal biological development that follows chronological age. The peak height velocity is an indicator of biological maturity and represents the maximum rate of natural growth during adolescence. Male adolescents generally reach it by the age of 14 (Brown, Patel, & Darmawan, 2017). The most common noninvasive method of determining a child's biological development is using a regression equation that predicts how

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far the child is from the age of peak height velocity considering the following variables: gender, date of birth, date of measurement, body height, sitting body height, and body mass (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). Children who mature earlier have an advantage in strength over those who mature later (Faigenbaum & Westcott, 2000). Children who mature later train and compete with those who mature earlier. By training and competing with bigger and stronger children, late maturers will be less successful and will give up on sports.

There are no studies of the acceleration of biological development in wrestling and its relationship with the selection of wrestlers. Most of the studies dealing with this problem in combat sports refer to the relative age effect (RAE) (Albuquerque et al., 2015; de Almeida-Neto et al.) RAE does not refer to accelerated or slowed biological development. Instead, RAE refers to athletes who are older within their age group, for example, because they were born at the beginning of the year. In a sample of judokas of different age groups, Franchini and colleagues found that hand grip strength is related more to body mass than to age (Franchini, Schwartz, & Takito, 2020). Based on hormonal status, Piskin and colleagues found that young wrestlers do not have different pubertal development from the rest of the population (Piskin, Gumus, Bayraktaroglu, Akalin, and Yamaner, 2018). Constant reductions in body mass in adolescent wrestlers did not slow down growth and development (Roemmich and Sinning, 1997).

The focus of this study is not the RAE; the focus is on the acceleration of biological development. Early maturers predominate in youth sports (Ostojic, 2017), and this phenomenon has not been investigated in a sample of wrestlers. Parents and coaches should know the implications of delayed adolescent development, and they should develop their expectations accordingly (Manna, 2014). The impact of biological development on skills, selection, or athletic performance has mainly been investigated in team sports, especially football (Burgess and Naughton, 2010; Ostojic et al., 2014). If we composed a sample from selected children who are the most successful in wrestling at that age, most of them would probably be children with accelerated biological development. This study aimed to determine the differences in biological acceleration in the most successful wrestlers from the city of Zagreb (city selection) and to determine the differences in motor, functional, and sport-specific skills between gifted wrestlers of different levels of biological acceleration.

Methods

Sample

The sample of participants included 26 male wrestlers aged 13.8±0.74 years who train in wrestling and compete at national championships in the age category of younger or older schoolboys. The sample is a selection of the best wrestlers from 12 clubs in the Croatian capital, Zagreb. A detailed description of the sample is presented in Table 1. For the age of peak height velocity (PHV) prediction, an online calculator was used (Prediction of Age of Peak Height Velocity—College of Kinesiology | University of Saskatchewan). The calculator uses the Mirwald et al. method from 2002, and the required variables are gender, age, body height, body mass, and sitting height. The age from PHV estimates how many years the subject is from his age at PHV (Milić, 2014; Rađa, Erceg, & Milić, 2016; Baxter-Jones et al., 2020). The variable individual deviation from the average value (APHV) was obtained, and the respondents were divided into three groups: early maturers (APHV <-0.51); normal maturers (n = 10) (APHV range -0.50 to 0.50); and late maturers (n = 7) (APHV >0.51).

The study protocol followed the guidelines stated in the Declaration of Helsinki. The study is part of the Fitness Profiles of Wrestlers and Construction and Validation of Sport-Specific Tests project and was approved by the Ethics committee of the Faculty of Kinesiology of the University of Split (no 2181-205-02-05-22-0012).

Variables

The variable sample included anthropometric variables: age, body mass, body height, sitting body height, and body mass index; variables assessing motor skills: sit-and-reach, medicine ball throw, flexed arm hang test, sit-up test, push-ups, and bench press 1RM; a variable assessing functional skills: running 1500 m; and variables assessing sport-specific motor skills: wrestling bridge flexibility, flipover, and dummy throwing, with the addition of the variable placement at the national championship.

All variables for the assessment of motor abilities, functional characteristics, and sport-specific tests are part of the standard battery for the selection of the best wrestlers in the city of Zagreb. Since the boys had significantly different physical characteristics, a relative result was calculated for the following three variables: medicine ball throw, flexed arm hang test, and bench press 1 RM. All sport-specific tests have already been used in the wrestling literature: wrestling bridge flexibility: In this test, the distance between the forehead and heels is measured when the wrestler is in the position of the wrestling bridge (Kuleš & Marić, 2001; Said Abdel-Hakim, 2015); wrestling bridge turnover or flipover: the wrestler must switch over his head as many times as possible in one minute from the position of the back bridge to the front bridge and back (Kuleš & Marić, 2001); SWFT: the wrestler throws two opponents alternately (shoulder throw) for three periods of 30 seconds, maximally fast—heart frequency is measured immediately after throwing and after 1 minute of rest. The SJFT index is calculated according to the formula HR1+HR2/maximum number of throws (Emerson et al., 1998; Işik, Doğan, Cİcİoğlu, & Yildirim, 2017; Marković et al., 2021).

Data-processing methods

The data were analyzed using Statistics 13 (Statsoft, USA, 2013). The normality of distribution was tested by the Shapiro–Wilk test due to the small number of participants in the subsamples. Due to significant deviations from the normal distribution (Shapiro–Wilk test), differences between the groups were examined using a nonparametric Kruskal–Wallis ANOVA test. Even though the results indicated the need for nonparametric statistics rather than descriptive statistics for better results readability, the following parameters were calculated: arithmetic mean, standard deviation, and the minimum and maximum result. The level of significance was set at $p<0.05$.

Results

It can be seen in Table 1 that there is a statistically significant difference between the groups in the following variables: age, body mass, body height, sitting body height, and body

Table 1. Descriptive statistical parameters (arithmetic mean and standard deviation - mean±SD and minimum and maximum result - min/max) for all the variables describing the sample and differences between the groups (Kruskal-Wallis ANOVA).

	All groups (n=26)		Late maturers (n=7)	
	Mean±SD	Min/Max	Mean±SD	Min/Max
Age	13.8±0.74*	12.00/14.00	12.43±0.53*	12.00/13.00
Experience	4.31±1.54	2.00/7.00	4.93±1.97	3.00/7.00
Body mass (kg)	58.30±12.17*	37.70/85.60	46.37±6.35*	37.00/53.00
Body height (cm)	166,25±10 48*	144.00/187.00	152.93±6.44*	144.00/159.50
Siting body height (cm)	85.98±8.00*	56.40/95.80	80.61±3.84*	73.00/83.00
Body mass index (BMI)	20.86±2.45*	17.59/25.79	19.78±2.00*	18.06/23.60
Placement	5.25±4.80	1.00/24.00	8.13±7.96	1.50/24.00
	Early maturers (n=9)		Normal (n=10)	
	Mean±SD	Min/Max	Mean±SD	Min/Max
Age	13.56±0.53*	13.00/14.00	13.10±0.74*	12.00/14.00
Experience	4.61±1.58	2.50/7.00	3.60±0.94	2.00/5.00
Body mass (kg)	70.43±9.96*	56.10/85.60	55.74±4.29*	50.00/67.20
Body height (cm)	175.56±6.91*	161.30/187.00	167.19±3.08*	163.30/171.40
Siting body height (cm)	92.16±2.61*	88.50/95.80	84.18±9.88*	56.40/90.30
Body mass index (BMI)	22.81±2.54*	17.77/25.79	19.94±1.62*	17.59/22.87
Placement	3.31±1.45	1.67/5.50	4.97±3.07	1.00/9.00

*statistically significant difference between groups in variables: Age (H=9.85, p=0.01); Body mass (H=17.80, p<0.01); Body height (H=19.20, p<0.01); Siting body height (H=18.92, p<0.01); Body mass index (H=7.50, p=0.02).

mass index.

It can be seen in Table 2 that the groups differ significantly in the following variables: wrestling bridge flexibility, medical ball throw (relative), and flipover.

Table 2. Descriptive statistical parameters (arithmetic mean and standard deviation - mean±SD and minimum and maximum result - min/max) for all the analyzed variables and differences between the groups (Kruskal-Wallis ANOVA).

	All groups (n=26)		Late maturers (n=7)	
	Mean±SD	Min/Max	Mean±SD	Min/Max
Sit-and-reach (cm)	52.13±9.07	34.00/71.00	54.29±9.95	40.00/67.00
Wrestling bridge flexibility (cm)	32.52±12.07*	13.50/62.00	25.80±5.70*	16.30/32.10
Medicine ball throw (cm)	380.38±105.15	76.00/554.00	298.43±32.05	259.00/334.00
Medicine ball throw (relative)	58.30±12.07*	37.70/85.60	6.51±0.84*	5.07/7.70
Flexed arm hang test (sec)	41.81±19.63	1.00/78.00	40.71±25.49	6.00/78.00
Flexed arm hang test (relative)	0.77±0.44	0.02/1.93	0.92±0.63	0.11/1.93
Sit-up test (1 min)	41.08±6.20	31.00/52.00	40.00±6.63	32.00/49.00
Push-ups	35.27±14.54	14.00/72.00	28.00±9.92	14.00/40.00
Bench press 1RM	49.27±18.20	21.00/90.00	34.29±7.87	30.00/50.00
Bench press 1RM (relative)	0.86±0.23	49.27/12.07	0.75±0.20	0.56/1.20
Running 1500 m	429.76±65.36	362.00/522.00	449.00±58.18	362.00/515.00
Flip-over (1 min)	20.73±7.56*	0.00/31.00	23.71±3.97*	14.00/23.00
Dummy throwing (3×30sec)	19.48±3.75	14.00/27.00	17.29±2.87	14.00/23.00
	Early maturers (n=9)		Normal (n=10)	
	Mean±SD	Min/Max	Mean±SD	Min/Max
Sit-and-reach (cm)	53.17±5.41	45.00/58.50	49.70±11.20	34.00/71.00
Wrestling bridge flexibility (cm)	41.26±13.92*	23.50/62.00	29.36.00±9.38*	13.50/38.20
Medicine ball throw (cm)	455.89±77.85	332.00/554.00	369.80±116.50	76.00/523.00
Medicine ball throw (relative)	6.48±0.70*	5.48/7.51	7.28±0.67*	5.78/8.14
Flexed arm hang test (sec)	43.67±14.36	26.00/68.00	40.90±21.17	1.00/74.00

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Table 2. Descriptive statistical parameters (arithmetic mean and standard deviation - mean±SD and minimum and maximum result - min/max) for all the analyzed variables and differences between the groups (Kruskal-Wallis ANOVA).

	Early maturers (n=9)		Normal (n=10)	
	Mean±SD	Min/Max	Mean±SD	Min/Max
Flexed arm hang test (relative)	0.63±0.27	0.35/1.21	0.79±0.41	0.02/1.30
Sit-up test (1 min)	41.00±6.24	31.00/49.00	41.90±6.42	33.00/52.00
Push-ups	40.67±18.41	20.00/72.00	35.50±12.26	21.00/50.00
Bench press 1RM	63.89±16.35	40.00/90.00	46.60±15.64	21.00/65.00
Bench press 1RM (relative)	0.92±0.24	0.54/1.22	0.90±0.22	0.51/1.23
Running 1500 m	411.50±41.87	362.00/475.00	432.00±70.24	370.00/522.00
Flip-over (1 min)	15.11±9.51*	0.00/25.00	23.70±4.45*	16.00/31.00
Dummy throwing (3×30sec)	20.63±3.50	16.00/25.00	20.10±4.15	15.00/27.00

*statistically significant difference between groups in variables wrestling bridge flexibility (H=07.50 p=0.02, flip-over (H=065, p=0.04), and medicine ball throw (H=17.80, p<0.01).

Discussion

It should be noted that the groups differed significantly by age; therefore, differences between the groups may have occurred due to age differences and not biological acceleration. This requires a revision of the methodology for monitoring biological acceleration and the entire theoretical framework exploring biological acceleration rates. In 2000 and 2010, Malina found that children with accelerated biological development were selected for teams because they were recognized as having talent. In our study, the selected best young wrestlers from Zagreb were classified in all three categories of biological age (Malina et al., 2010; Malina et al., 2000). We assumed that most of these wrestlers would be in the group of accelerated biological development (early maturers). However, most of the wrestlers are in the normal biological acceleration group (ten participants), nine wrestlers are in the early maturers group, and seven wrestlers are in the late maturers group. Similar results were obtained by Piskin and colleagues when they determined that wrestlers do not differ from the rest of the population in terms of growth during puberty (Piskin et al., 2018). It can be assumed that not all of them can be classified as early maturers due to the complex technical and tactical structure of wrestling. The most successful wrestlers in the city who belong to the late maturers group do not dominate in terms of physical abilities but are technically and tactically superior to their opponents. Earlier studies also found that early maturers often rely on physical superiority and not on technique and tactics (Curby, 2013). Soccer players of different biological acceleration rates were compared in the technical aspects of soccer, and the research showed that there were no statistically significant differences in most of the analyzed variables (precision, passing, dribbling) (Thomas, Oliver, Kelly, and Knapman, 2017). Wrestlers who mature faster physically do not mature faster mentally; this means they are not necessarily mentally ready for greater challenges (Mirzaei, 2021). This may be the reason why, among the selected participants, there were also those who matured late. The advantage of early biological acceleration does not have to be reflected in the technical structure, but it should be reflected in motor skills. Another study on soccer players showed that early maturers are significantly better than late maturers in all motor skills (Rađa et al., 2016). In this study, early maturers were significantly better than others only in explosive arm power (medicine ball throw, H = 17.80; p <0.01).

Interestingly, no differences were found in maximum strength, repetitive strength, or strength endurance. Moderate correlations between strength variables and PHV were found in judokas, but the sample was not a selection of the best judokas (Detanico, Kons, Fukuda, and Teixeira, 2020). Early maturers had significantly lower results in specific flexibility (wrestling bridge flexibility, H = 07.50; p = 0.02), which was expected since other studies have confirmed this (Nikolaïdis, 2012). In previous studies on judokas, sport specific tests were associated with PHV (Detanico et al., 2020). There was also a significant difference in the sport-specific flipover test (H = 065; p = 0.04). This test is heavily influenced by flexibility (Starosta, Fostiak, and Zurek, 2017), and specific flexibility has proven to be significant in the wrestling bridge flexibility test. In the other sport-specific test (dummy throwing), there were no statistically significant differences between the groups. In this sport-specific test, both explosive power and flexibility played an important role. Since early maturers have superior explosive power and inferior flexibility, it is logical that there are no significant differences in this test.

Limitations

Very few studies have dealt with research on the accelerated biological development of wrestlers. Research on wrestlers using Mirvald's methodology (the assessment of maturity from anthropometric measurement) does not exist. Thus, it is impossible to compare the results of this paper to a similar sample in wrestling. No data were collected on the reduction of body mass in the subjects (which is a common behavior of wrestlers), but the reduction of body mass can affect the acceleration of biological development.

Conclusion

Early maturers did not dominate in the selected group of wrestlers as hypothesized before the test. Accelerated biological development is not related to the technical or tactical aspects of the sport. Wrestlers with slower biological development acceleration can compensate for the lag in motor skills with better technical and tactical preparation. In the sample of the selected group of wrestlers, the early maturers were superior only in explosive power and inferior in flexibil-

ity. The two sport-specific tests did not show an advantage in early maturers because both are more influenced by flexibility, in which late maturers are superior. If a sample includes the most successful wrestlers of this age, children classified as early maturers are not dominant in either motor skills or sport-specific tests. Future research should exclude the influence of age on the results when investigating biological age acceleration.

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Conflict of Interest
The author declares that there is no conflict of interest.

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