Journal of Exercise Physiologyonline

JUNE 2020
Volume 23 Number 3

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Stability of Motor Talent in Young Brazilian Students

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ABSTRACT

Miranda L, Werneck FZ, Coelho EF, Novaes JS, Figueiredo AJ, Ferreira RM, Lima JRP, Vianna JM. Stability of Motor Talent in Young Brazilian Students. **JEPonline** 2020;23(3):89-100. This study evaluated the evolution and stability of motor talent diagnosis in young students of a military college, as well as the biological maturation effect on the range of variation of anthropometric and motor indicators. A total of 299 students of both sexes (11 to 17 yrs old) participated in a battery of tests to assess body size, flexibility, isometric strength, explosive strength, speed, endurance, and somatic maturation. Schoolchildren with scores above the 98th percentile (P98) were classified as motor-talented. Anthropometric and motor indicators showed high stability after 9 months. However, motor talent diagnosis showed low stability. The range of variation of the indicators was higher in late-maturing schoolchildren, but only for body mass and height (boys), and handgrip strength (girls). It was concluded that there is a high stability of motor talent indicators but low stability of motor talent diagnosis, considering P98 and that the range of variation observed was partially dependent on maturation.

Key Words: Biological Maturation, Stability, Talent, Tracking

INTRODUCTION

Sports talent identification is an important step in the scientific approach used to find young subjects with the potential to become elite athletes (13). This process has been performed predominantly by motor diagnosis with the application of test batteries (11,12,16). Studies have verified that the results obtained in test batteries can predict sports success in young athletes (4,22). The quality of evidence that anthropometric and motor factors contribute to the development of elite athletes is high (25).

At school, performance-related physical fitness assessment allows teachers to detect motor talent for sports, that is, young students who score well above average on one or more traits such as strength, speed, and endurance (7). Motor talent is considered a prerequisite for sports talent (12). In Brazil, studies carried out by Projeto Esporte Brasil (PROESP-BR) in schoolchildren found a prevalence of motor talent around 5.0% (17). However, in addition to high performance of subjects, motor talent must show stability over time.

Tracking (or stability) of a trait can be defined as maintaining a relative position within a group, requiring longitudinal observation of the same individuals at least twice over time (19). In short periods of time, the stability of anthropometric and motor traits tends to be moderate to high (19,3,6). Notwithstanding, there is still a lack of studies on stability of motor talent diagnosis, particularly in Brazilian schoolchildren.

It should be noted that biological maturation is an important intervening variable in body size and motor performance of young subjects (24). During adolescence, biological maturation varies considerably between individuals with the same chronological age, and the effects on motor performance vary with sex (1). Some studies have quantified the relative gain in anthropometric and motor traits in young athletes over time (8,9,10,27), verifying that the observed changes are dependent on maturational stage (18,28,29) and may vary considerably among individuals (2,27).

Longitudinal monitoring of motor talent indicators allows for observing the development of anthropometric and motor traits over time. This helps in the decision making of coaches in the process of identification, development, and selection of talents to help avoid mistaken judgments about the sports potential of the athletes. Thus, this study evaluated the evolution and stability of motor talent diagnosis in young students of a military college after 9 months, as well as the effect of biological maturation on the range of variation of anthropometric and motor indicators.

METHODS

Subjects

Participants in this longitudinal study were 299 primary and secondary school students of the Military College of Juiz de Fora (CMJF), Minas Gerais State, Brazil. Of these, 184 were boys (age: 14.0 ± 1.6 yrs; height: 165.0 ± 11.3 cm; weight: 57.2 ± 15.0 kg; BMI: 20.8 ± 3.9 $kg \cdot m^{-2}$, VO_2 peak: 47.9 ± 5.2 $mL \cdot kg^{-1} \cdot min^{-1}$) and 115 were girls (13.7 ± 1.4 yrs; 157.7 ± 6.5 cm; 51.1 ± 10.8 kg; 20.4 ± 3.5 $kg \cdot m^{-2}$, 43.4 ± 4.5 $mL \cdot kg^{-1} \cdot min^{-1}$). Students were assessed in September 2016 and June 2017. The consent of legal guardians and the assent of schoolchildren were obtained prior to study participation. This study is an integral part of the “Gold Athletes

Project: Multidimensional and Longitudinal Evaluation of Young Athletes' Sports Potential", approved by the Research Ethics Committee of the Federal University of Ouro Preto (CAAE: 32959814.4.1001.5150).

Procedures

The battery of tests was applied during the Physical Education (PE) lessons of each class that lasted for approximately 90 min in 3 different days. Data were collected from Monday to Friday between 9:00 a.m. and 12:00 p.m. Decimal chronological age of students was determined having the date of data collection as a reference. Verbal explanation and test demonstration were performed. The evaluation was done by properly trained professionals. The classification of students regarding motor talent (yes or no) was based on the following indicators: height, wingspan, flexibility, maximum isometric force, upper limb explosive strength, lower limb explosive strength, speed, and endurance. To be considered as motor-talented, the schoolchild should have a score greater than or equal to the 98th percentile in at least one of these indicators, with the respective cutoff points for age group and sex being adopted (20).

Body mass, height, wingspan, and seated height were measured according to the procedures used by Norton and Olds (32). To measure body mass, a digital anthropometric scale, graduated from 0 to 200 kg with an accuracy of .05 kg was used. Height was measured by a tape measure fixed to the wall, graduated from 0 to 200 cm, with an accuracy of .20 cm. The body mass index (BMI) was calculated using the equation: body mass (kg)/squared height (m^2). Lower limbs length was estimated from the difference between height and seated height. During these measurements, schoolchildren were barefoot and wearing PE clothes.

Hamstring and lumbar spine flexibility were measured by the sit-and-reach test using the Wells bench (Sany, Brazil) with feet supported at the 23-cm mark. The procedures of Gaya and Gaya (7) were adopted, with three attempts, considering the highest value reached. Lower limb muscle power (explosive strength) was evaluated by vertical jump with countermovement (CMJ), using a contact mat (Multi-Sprint Full® Kit, Hidrofit, Brazil), adopting the procedures described by Rodrigues and Marins (26). The hands were positioned on the hips, with the participant being asked to perform a quick squat and then a vertical jump from the standing position. Three jumps were performed with the best result being considered.

To evaluate upper limb explosive strength, the medicine ball throw test was performed, using a 2 kg ball and adopting the procedures of Gaya and Gaya (7). Each participant made two attempts, the best result was recorded. To evaluate maximum isometric force, the handgrip strength test was performed, using a hand dynamometer (Jamar®), following the procedures described by Fernandes and Marins (5). Three attempts were made with the dominant hand, the best result was recorded. Linear speed was evaluated by a 20-m speed run test measured by photoelectric cells (Multi-Sprint Full® Kit, Hidrofit, Brazil), following the procedures of Gaya and Gaya (7). The participant made two attempts, the best time was considered.

Aerobic endurance was assessed by a 20-m multistage fitness test (15), in which the running pace was established by a beep. The test starts at a speed of 8.5 $km \cdot hr^{-1}$, adding 0.5 $km \cdot hr^{-1}$ at each 1-min interval. The test ends when the participant stops due to fatigue or when he/she cannot reach the line at the same time of the beep on two consecutive occasions. Biological maturation was evaluated through somatic maturation indicators: percentage of predicted adult stature attained at the time of observation (%PAS), estimated using the Khamis and Roche method (14); and predicted age at peak height velocity (PHV), calculated from the maturity offset (MO) and estimated by the method of Mirwald et al. (21). For the classification of maturational stage, %PAS was expressed as z-score, being stratified in tertiles (P33 and P66) based on the sample values. Schoolchildren were then classified as late (<P33), normomature (≥P33 and ≤P66), and early-maturing (>P66). Parent height was obtained by self-report (mother height: ICC = .98 (.98 - .99); father height: ICC = .98 (.98 - .99)).

Statistical Analyses

Data were described by mean ± standard deviation (quantitative variables) and percentages (qualitative variables). Student's *t*-test for paired samples was used to test differences between pre- and post-tests. Analyses of variance (ANOVA) were used to analyze differences in percentage change (Δ%) in anthropometric and motor indicators between maturational stages, with *post-hoc* Tukey test. Stability was assessed by the intraclass correlation coefficient (ICC), McNemar test, and Kappa coefficient. The effect size (ES) was calculated with Cohen's d. Analyses were performed on IBM SPSS software, version 24.0 (IBM Corp., Armonk, NY, USA). The value of P≤0.05 was adopted for statistical significance.

RESULTS

Table 1 shows the variation of the predictors evaluated in 2016 and 2017. In boys, significant differences were observed in all anthropometric and motor variables, except for vertical jump. In girls, there was no change in speed and endurance. After 9 months, both boys and girls presented bigger body size and were more flexible and stronger, with boys being also faster and more resistant. From the practical point of view, according to the ES, changes were of small to moderate magnitude. The stability of anthropometric and motor indicators was high, ICC ranging from .73 to .97 (Table 1).

Table 1. Change in Anthropometric and Motor Indicators in Female (n=115) and Male (n=184) Students of the Military College of Juiz de Fora (CMJF) After Nine Months.

Indicators	Sex	Pre	Post	P	*d*	ICC
Height (cm)	Female	157.7 ± 6.5	158.4 ± 5.7	<.001*	.12	.97
	Male	165.0 ± 11.3	167.6 ± 9.7	<.001*	.26	.96
Wingspan (cm)	Female	160.4 ± 7.7	161.8 ± 7.1	<.001*	.19	.97
	Male	168.7 ± 12.3	172.2 ± 11.1	<.001*	.31	.96
Sit and Reach (cm)	Female	26.7 ± 8.2	31.8 ± 7.6	<.001*	.67	.83
	Male	22.3 ± 8.0	26.3 ± 8.0	<.001*	.50	.86
Handgrip Strength (kgf)	Female	25.7 ± 5.0	28.0 ± 3.8	<.001*	.60	.73
	Male	33.2 ± 10.2	37.4 ± 8.3	<.001*	.50	.88

Medicine Ball Throw (m)	Female	3.12 ± 0.47	3.50 ± 0.46	<.001*	.82	.69
	Male	4.13 ± 0.90	4.75 ± 0.95	<.001*	.65	.83
CMJ (cm)	Female	22.9 ± 4.2	22.1 ± 4.4	.01*	.18	.87
	Male	28.5 ± 6.6	28.9 ± 6.3	.13	.06	.89
20-m Speed Run (s)	Female	3.89 ± 0.31	3.85 ± 0.33	.08	.12	.85
	Male	3.54 ± 0.32	3.48 ± 0.30	<.001*	.20	.89
20 m MSFT (m)	Female	802.0 ± 278.6	801.1 ± 292.2	.96	.001	.89
	Male	1174.6 ± 424.3	1269.3 ± 446.8	<.001*	.21	.97

CMJ = Countermovement Jump; **MSFT** = Multistage Fitness Test; *Statistical significant difference, P<0.05; *d* = Effect Size; **ICC** = Intraclass Correlation Coefficient

After 9 months, the following percentage variation (Δ%) was observed in anthropometric and motor indicators in boys and girls, respectively: height (1.7% vs. 0.4%), wingspan (2.1% vs. 0.9%), flexibility (24.3% vs. 24.3%), handgrip strength (15.7% vs. 11.1%), medicine ball throw (16.0% vs. 13.1), vertical jump (2.7% vs. -2.8%), 20-m speed (-1.7% vs. -0.9%), and distance traveled (11.6% vs. 2.5%).

Somatic maturation indicators showed high stability. The predicted adult stature for boys and girls was 179.3 ± 6.2 cm vs. 163.6 ± 4.2 cm, respectively (ICC = 0.96). The %PAS was 92.3 ± 5.5% vs. 96.2 ± 3.3% for boys and girls, respectively (ICC = 0.95). The predicted age at PHV was 13.8 ± 0.6 yrs for boys (ICC = 0.96) and 12.3 ± 0.6 yrs for girls (ICC = 0.99).

The range of variation of these indicators was shown to be partially dependent on biological maturation (Table 2). In boys, changes in height and wingspan were higher in late-maturing boys. In girls, only the change in handgrip strength was associated with maturation, with a higher gain at 9 months in late-maturing girls.

Table 2. Differences in Percentage Change (Δ%) in Anthropometric and Motor Indicators in Female (n=115) and Male (n=184) Students of the Military College of Juiz de Fora (CMJF) After Nine Months by Maturational Status.

Indicators	Maturational Status				P	*Post hoc*
	Sex	Late (1)	Normomature (2)	Early (3)		
Height (cm)	Female	0.3 ± 1.4	0.6 ± 1.4	0.4 ± 0.8	.59	-
	Male	2.1 ± 2.6	1.0 ± 1.8	1.6 ± 1.6	.02*	1>2
Wingspan (cm)	Female	1.2 ± 1.5	0.8 ± 1.3	0.6 ± 1.2	.17	-
	Male	2.6 ± 2.0	1.6 ± 1.5	2.0 ± 2.2	.03*	1>2

Sit and Reach (cm)	Female	21.8 ± 27.2	28.1 ± 26.4	21.1 ± 22.1	.45	-
	Male	21.1 ± 31.1	27.3 ± 31.6	22.3 ± 34.0	.56	-
Handgrip Strength (kgf)	Female	14.3 ± 16.7	12.0 ± 16.6	5.1 ± 13.9	.04*	1>3
	Male	15.0 ± 19.5	13.8 ± 16.5	16.5 ± 18.2	.73	-
Medicine Ball Throw (m)	Female	18.1 ± 14.3	12.3 ± 11.3	9.6 ± 12.7	.02*	
	Male	17.4 ± 15.6	15.2 ± 12.6	14.7 ± 9.2	.50	-
CMJ (cm)	Female	5.1 ± 12.3	-3.0 ± 11.6	-0.1 ± 15.4	.27	-
	Male	0.1 ± 12.7	2.4 ± 13.6	5.7 ± 15.4	.11	-
20-m Speed Run (s)	Female	-2.4 ± 6.9	-1.0 ± 4.9	0.7 ± 5.1	.08	-
	Male	-2.0 ± 5.3	-1.6 ± 4.5	-1.4 ± 4.9	.81	-
20 m MSFT (m)	Female	7.3 ± 21.4	4.3 ± 36.9	-3.2 ± 19.9	.39	-
	Male	9.6 ± 21.6	17.3 ± 45.9	5.1 ± 17.8	.12	-

CMJ = Countermovement Jump; **MSFT** = Multistage Fitness Test; *Statistical significant difference, P<0.05

Stability of motor talent diagnosis is shown in Table 3. The overall agreement in motor talent diagnosis was 88.6% in boys and 81.7% in girls. In boys, there was no significant difference in motor talent diagnosis from 2016 to 2017 (12.5% vs. 8.7%, respectively, P=0.19). Notwithstanding, there was low agreement (stability) in motor talent diagnosis in the same period (r=.40). Of the 23 boys classified as motor-talented in 2016, only 39% (n=9) maintained the classification in 2017. Among those classified as motor-talented in 2017, 43.7% were not motor-talented in 2016. In girls, there was a significant increase in motor talent diagnosis from 2016 to 2017 (8.7% vs. 18.3%, respectively, P=0.03). Diagnosis stability was even lower in girls (r=.23). Only half of girls classified as motor-talented in 2016 (50%) repeated the result in 2017. Of the 21 girls classified as motor-talented in 2017, 76.2% (n=16) were not motor-talented in 2016.

Table 3. Stability of Motor Talent Diagnosis in Students of the Military College of Juiz de Fora (CMJF) After Nine Months.

Male						
		Motor Talent 2017				
		No	**Yes**	**Total**	**P**	***Kappa***
Motor Talent 2016	**No**	154 (83.7%)	7 (3.8%)	161 (87.5%)		
	Yes	14 (7.6%)	9 (4.9%)	23 (12.5%)	.19	0,40
	Total	168 (91.3%)	16 (8.7%)	184 (100.0%)		

Female						
		Motor Talent 2017				
		No	**Yes**	**Total**	**P**	***Kappa***
Motor Talent 2016	**No**	89 (77.4%)	16 (13.9%)	105 (91.3%)	.03*	0,23
	Yes	5 (4.3%)	5 (4.3%)	10 (8.7%)		
	Total	94 (81.7%)	21 (18.3%)	115 (100.0%)		

*Statistical significant difference, P<0.05

DISCUSSION

The present study evaluated the alteration of anthropometric and motor indicators and the stability of motor talent in students of the Military College of Juiz de Fora (CMJF) after 9 months, comparing possible effects of biological maturation on the range of variation of these indicators. The main results are as follows: (a) significant differences were found in most anthropometric and motor variables in both boys and girls after nine months; (b) stability of anthropometric and motor indicators was high, suggesting that the individuals varied little in relation to the group average, and, in general, maintained the same relative position from 2016 to 2017; (c) the range of variation of motor talent predictors was only partially dependent on biological maturation; and (d) motor talent diagnosis presented low stability, especially in girls, suggesting that the probability of schoolchildren remaining above the 98th percentile is low.

The range of variation of anthropometric and motor indicators was from 0.4% to 24.3%, agreeing with the values obtained in previous studies (9,18,30). During puberty, boys may show increases of up to 20% in height and agility, and 40% in body mass, in addition to a 50% decrease in fat percentage and gains of up to 50% in anaerobic power and 70% in VO_2 peak (1,24). In under-14 and under-16 rugby players, the average gain in vertical jump after a season was 7.9% and 9.2%, respectively; and the increase in aerobic endurance was 0.0% and 9.6%, respectively (29). These changes occur predominantly between 14 and 16 years, being mediated by hormones (24) and influenced by physical training (9,10). In young soccer players, the progression of starting players throughout the season was found to be higher than that of reserve players, and was associated with a different degree of growth and maturation (8).

The results of high stability of anthropometric, motor, and maturational indicators also corroborate the available literature (3,10,19). In soccer players aged 11 to 16, the best performers of the aerobic fitness test continued to be the best after 4 years of follow-up (3). This result suggests that the indicators that present high stability offer greater reliability in predictive models of future performance. There is evidence that speed, agility, endurance, and ability of repeated sprints are good predictors of future performance, especially in the early stages of sports training and within a period of 1 to 3 years (22). The longer the follow-up time, the smaller the ability to predict the young athlete's potential. It is recommended that motor talent predictors should be systematically assessed over time, emphasizing individual development and comparison with reference values (3).

Due to the greater biological variability observed in adolescence, and considering the range of variation of anthropometric and motor indicators observed in this period, caution is recommended in the early selection of talents, under the risk of losing potential talents. In this sense, the current height of a young subject, for example, should not be used as a predictor of sports talent because of the great variation in growth potential during puberty. On the other hand, the prediction of adult height is desirable in the identification of talents (24). The present study showed high stability of predicted adult height in schoolchildren. Likewise, the linear velocity of displacement is less sensitive to variations due to growth and maturation processes and training, and can also be used as an index of talent identification (10).

In the present study, maturational status only partially influenced changes in anthropometric and motor indicators, corroborating, in part, the results of previous studies (18,28). Different methods of classification of maturational status may explain the divergence in results. It is known that growth and maturation processes are related and both influence anthropometric traits and motor performance (1). Late-maturing and/or chronologically younger subjects generally present lower body size and lower performance (8), affecting the selection and training of young athletes. Monitoring biological maturation in the developmental process of schoolchildren is of paramount importance in assessing the sports potential of young subjects. Research has shown that, through the catch-up phenomenon, late-maturing schoolchildren can reach and even surpass those who previously had advantages for being more biologically advanced (28).

To the best of our knowledge, this is the first Brazilian study to investigate the stability of motor talent diagnosis in schoolchildren, which was shown to be low using the 98th percentile. In German football, young subjects performing above the 99th percentile in physical tests are 12 times more likely to become national soccer team players. On the other hand, this high cutoff point leads to loss of future talent (11). Different cutoff points have been suggested for the classification of high motor performance, such as P66 (3), P70 (11), and P98 (7). Our results corroborate the premise that, in addition to high motor performance, stability is needed for the identification of sports talents. In Switzerland, for example, a recent longitudinal study with young soccer players aged 12 to 15 found that the most promising subjects are not necessarily the best, but rather those who consistently present above average performance in motor and skill tests over the years, emphasizing a holistic (person-oriented) perspective in talent selection (32).

Motor talent diagnosis must be performed to observe the virtues and weaknesses of young athletes, but it should not replace the subjectivity of the coach in decision making for the identification and development of promising young subjects, multidimensional approaches being necessary for this purpose. Franzen et al. (6) add that in talent identification models, before PHV, priority must be given to motor skills (coordination), while physical fitness (strength, agility, speed, and endurance) should be prioritized after PHV. According to these authors, the development of motor competence and physical fitness does not occur linearly, and there is a change point for each trait evaluated (6).

The study design adopted does not allow us to state whether the observed changes were due to the training effect, which may be considered a study limitation. In addition, it is known that there are periods of greater gain in motor performance (31); in this study, no such analysis was performed. Further studies should consider looking at these issues.

Anthropometric and motor traits are important for the identification and development of potential sports talents. The results of the present study showed the percentage of change of these characteristics in a period of 9 months. This information should be used by coaches to assist in monitoring the progression and development of athletes. The interindividual variability observed in the changes in motor talent predictors over time suggests that the development of the athlete should be done in a longitudinal and individual way. Based on the results found, it is recommended that coaches avoid selecting young athletes only for physical attributes, given the low stability of motor talent. Finally, we do not recommend the use of P98 to motor talent diagnosis criteria. It is recommended to test new criteria for the diagnosis of motor talent, such as the use of P90, and to perform prognostic studies with the purpose of validating the adopted criteria. Moreover, talent development programs should prioritize the participation and maintenance of selected and unselected subjects, offering new development opportunities to all young people.

CONCLUSIONS

The findings indicate that there is high stability of anthropometric and motor indicators in schoolchildren within a period of 9 months, and that the range of variation of these indicators is partially dependent on somatic maturation. On the other hand, motor talent diagnosis considering the 98th percentile shows low stability.

ACKNOWLEDGMENTS

The authors would like to thank the Higher Education Person Improvement Coordination (CAPES), Postgraduate Program in Physical Education, Faculty of Physical Education and Sports (FAEFID), the financial support by Federal University of Ouro Preto. The authors also would like to thanks the teachers of Physical Education Section (SEF-CMJF) and the students for volunteering for the study.

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