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Original scientific paper

Correlation between Agility and Sprinting According to Student Age

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A B S T R A C T

The purposes of the study were to assess sprinting and agility performance characteristics and to determine the relationship between these two motor skills in elementary education students. Sprinting and agility performance were assessed in 176 children (88 boys and 88 girls) divided into three groups: Group 1 (G1, N=98; 48 boys and 50 girls), from the first year of elementary education; Group 2 (G2, N=38; 15 boys and 23 girls), from the second year of elementary education; Group 3 (G3, N=40; 25 boys and 15 girls), from the third year of elementary education. Significant differences (p<0.001) were found in agility ability among the groups and between G1-G3 and G2-G3 in the 5 and 15 m sprint. Regarding gender of the students of the same age, significant differences (p<0.001) between boys and girls in group G1 and G2 were obtained in the 5 and 15 m sprint. The correlation between agility and acceleration was significant but moderate (0.3<r<0.7) in all groups (G1, G2, and G3), in most cases. When the gender factor was included, the results were heterogeneous. Assessing this correlation according to age and gender produced heterogeneous results. For this reason, we think that both are independent qualities and that age and gender are two factors that influence the correlation results.

***Key words**: agility, gender differences, MAT, correlation, physical education*

Introduction

Many physical educators argue that physical education prepares students to adopt physically active lifestyles by fostering the appropriate acquisition of motor skills[1,3]. Furthermore, motor development specialists often suggest that not developing and refining fundamental and specialized movement skills by the end of elementary school makes it difficult for children, adolescents and even adults to enjoy recreational activities[1,3]. Therefore, it seems important to learn fundamental motor skills during early childhood[3].

Agility has been classically understood as the ability to change the direction (CODA) of the body in an efficient manner[4,5]. However, in the last few years agility has also been described as a motor skill that enables an individual to rapidly and efficiently decelerate, change direction and accelerate in an effort to react appropriately to task-relevant cues[6]. Among the different motor skills, players are required to accelerate, decelerate and change direction in many sports[4,7,8], so the ability to accelerate and change direction is an important aspect in the development of physical qualities in physical education.

Agility and sprinting abilities have been previously analyzed in many sports[4,7,8] and in school children[9,10]; T-design[7,11–15] and sprint tests not exceeding 15 m[4,7,8] have been used to determine agility and sprinting abilities, respectively. Previous studies with children aged between 6 and 9 years[16,17], analyze the CODA and the influence of different training types based on contextual interference (CI) in CODA and sprint capacity. Although there are recent studies that examine acceleration and maximal speed in 11-year-olds[18], fewer studies have been found that examine agility and sprinting in children[17].

Unfortunately, no study has analyzed agility characteristics with the T-design test and the correlation be-

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tween agility and sprinting ability in elementary school students. Since the design of school intervention programs is partly based on the results of agility and sprinting abilities in school students, it is important to assess the differences in these two motor skills depending on age and gender. Furthermore, information about the relationship between agility and sprinting abilities in elementary school students would provide some insights to help develop specific physical education programs. Findings on such an association are inconsistent as revealed by Salaj and Marković[19].

The purposes of the study were to assess sprinting and agility performance characteristics and to determine the relationship between these two motor skills according to age and gender in elementary education students. We hypothesized that in elementary education students the sprint capacity and CODA would be different depending on the age and sex.

Materials and Methods

Participants

The study analyzed a sample of 176 participants (7.6±0.8 years, 132.77±5.23 cm, 30.12±6.61 kg, 88 boys and 88 girls) (Table 1), divided into three groups depending on the school year: Group 1 (G1) (N=98; 48 boys and 50 girls), from the first year of elementary education; Group 2 (G2) (N=38; 15 boys and 23 girls), from the second year of elementary education; Group 3 (G3) (N=40; 25 boys and 15 girls), from the third year of elementary education (Table 1).

Before the beginning of the study, written informed consent was obtained from all the tutors of the children. The option was given to be able to withdraw children from the test at any time during the research. Consent was also obtained from the school council and the school's management team. The study was conducted according to the Declaration of Helsinki. The study protocol was approved by the local ethics committee – institutional board.

Procedure and materials

The testing trials were carried out on two separate days, during the third quarter of the school year. Prior to data collection, participants carried out the tests several times after receiving technical explanations by researchers on how to perform the agility T-test and the sprint test. On the testing day, participants performed a 7 min standardized warm-up led by researchers prior to data collection. During testing trials participants were verbally encouraged only by researchers to give maximal effort. Tests took place indoors on a synthetic pitch in the school gymnasium.

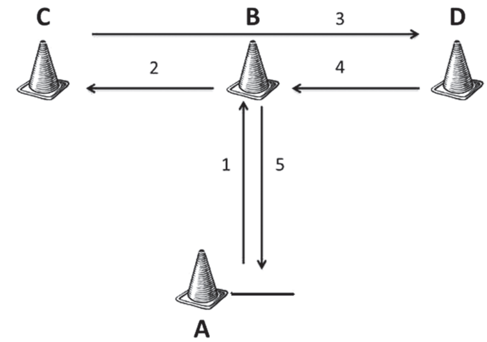


Fig. 1 Design of the course used for MAT. A-B distance = 5 m; B-C and B-D distance = 2.5 m.

During the testing sessions, the air temperature ranged from 21 to 27ºC and all test sessions were conducted in the morning (10–13 h) during school hours.

Sprinting test: This was performed on the first day and consisted of 3 repetitions of 15-m runs at maximum speed with 2-min rest periods between each repetition. Running time was recorded using photocells (Microgate Polifemo Radio Light, Italy, accuracy ±1 ms) situated 0.4 m above the ground. The starting point was set 0.5 m from the triggering photocell. Split times were recorded at 5 and 15 m[20].

Agility t-test: This was performed on the second day. The Modified Agility Test (MAT) proposed by Sassi et al.[19] was chosen for the assessment of agility. The agility test (Figure 1) was performed using the same directive protocol as the MAT[7], except that participants touched the top of the cone instead of the base. The modifications were carried out to facilitate the execution of the test for the young participants in the study. The reasons for selecting the MAT were its short duration and the variety of movements that have to be performed: moving forward, backward and sideways. Participants began with both feet behind the starting line A[15]. The spatial movements were as shown in Figure 1. A-B movements (5 m): At their own discretion, subjects sprinted forward to cone B and touched the top of it with the left hand. B-C movements (2.5 m): Facing forward and without crossing the feet, subjects moved to the right to cone C and tou-

TABLE 1
CHARACTERISTICS FOR GROUP 1 (G1), GROUP 2 (G2) AND GROUP 3 (G3) STUDENTS (VALUES ARE X±SD).

	G1	G2	G3	Total
Age (yr)	6.6±0.5	7.5±0.4	8.7±0.3	7.6±0.8
Height (cm)	123.36±4.27	135.16±4.64	139.80±4.37	132.77±5.23
Body mass (kg)	27.05±4.65	31.12±4.25	32.21±5.49	30.12±6.61
Body mass index (kg m^{-2})	17.91±0.48	17.09±0.74	16.68±0.62	17.22±0.86

ched its top with the right hand. C-D movements (5 m): Subjects moved to the left to cone D and touched its top with the left hand. D-B movements (2.5 m): Subjects moved back to the left to cone B and touched its top. B-A movements (5 m): Subjects ran backward as quickly as possible and returned to line A (Figure 1).

The total distance covered was 20 m. Any subject who crossed one foot in front of the other, failed to touch the top of the cone, and/or failed to face forward had to repeat the test. Three trials were performed and the fastest trial was used for analysis. Photocells were used to register MAT time (Microgate Polifemo Radio Light, Italy, accuracy ±1 ms). Before testing, subjects completed a 10-min warm-up, including jogging, lateral movements, dynamic stretching, and jumping. All subjects performed each test with at least 3 minutes rest between all trials to ensure adequate recovery following the indications of Sassi et al.[7].

Data analysis

Results are presented as $\overline{X}\pm$SD. All the variables were normal and satisfied the equality of variances according to the Shapiro-Wilk and Levene tests respectively. Descriptive statistics were calculated for all experimental data. Statistical significance was set at $p<0.05$. A two-way analysis of variance (ANOVA) was used for group * gender comparisons, and the Bonferroni *post-hoc* analysis was applied. Pearson product-moment correlation coefficients (r) were calculated for all groups to determine relationships between the agility T-test and the sprinting test. To interpret the results, we employed the threshold values for Pearson product-moment used by Salaj and Marković[19]: low ($r<0.3$), moderate ($0.3<r<0.7$) to high ($r>0.7$). Data analysis was performed using the Statistical Package for Social Sciences (version 19.0 for Windows, SPSS Inc, Chicago, IL, USA).

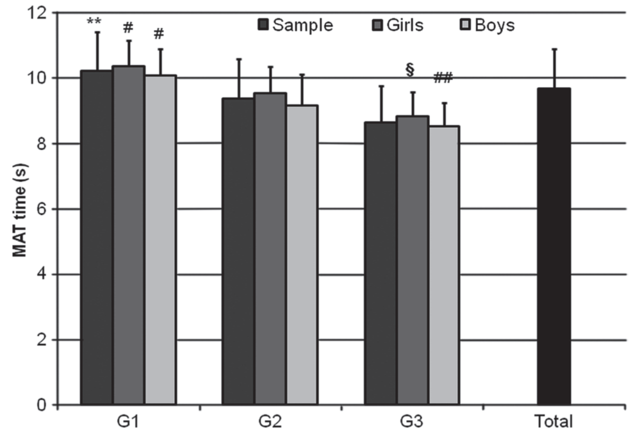
Results

Figures 2, 3 and 4 shows the MAT and sprint test results for each group considering the age and gender of the subjects.MAT showed significant differences among all the school year groups ($F(2) = 34.89$, $p<0.01$). The shortest time was observed in G3 (8.62±0.81) and the longest time in G1 (10.21±1.19).

The sprint test also showed significant differences at 5 m ($F(2) = 16.11$) and 15 m ($F(2) = 20.47$), between G1 and G3 ($p<0.01$) and between G2 and G3 ($p<0.01$).

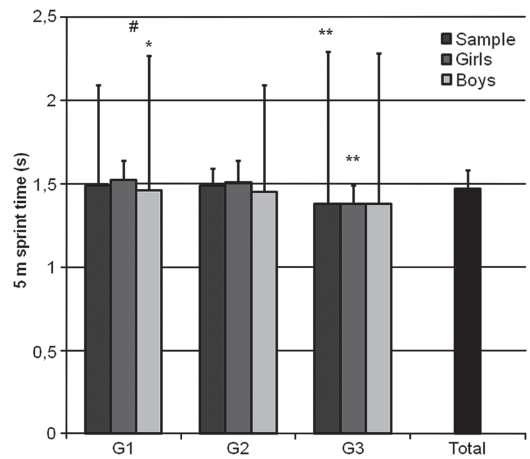
No significant differences were found within the same age group between boys and girls in any of the three groups in MAT and the 15 m sprint test. However, in the 5 m sprint test significant differences in G1 ($p<0.05$) were found between boys and girls (Figure 3).

Considering the gender factor, significant differences were found in MAT between G1-G2 ($p<0.05$), G1-G3 ($p<0.01$), and G2-G3 ($p<0.01$) with respect to the boys and between G1-G2 ($p<0.05$) and G1-G3 ($p<0.01$) with respect to the girls. In the sprint time test, significant



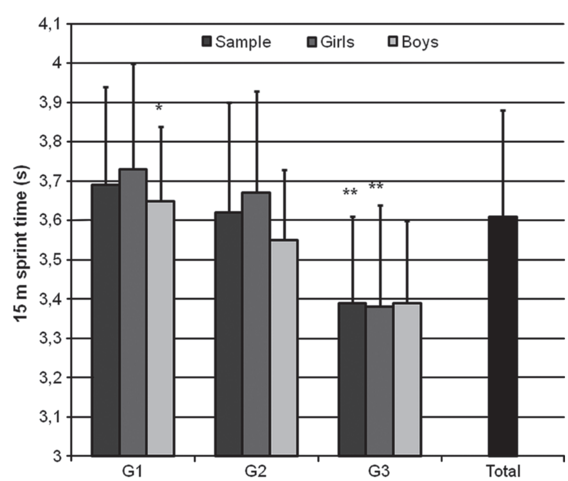
** p < 0.01 significant differences between all groups (G1, G2 and G3),
# p < 0.05 significant differences with G2 group, ## p < 0.01 significant differences with G1 and G2 groups,
§ p < 0.01 significant differences with G1.

Fig. 2 Modified agility test (MAT) results in the group 1 (G1), group 2 (G2) and group 3 (G3), considering sample, age and gender.



* p < 0.05 significant differences with G3 , ** p < 0.01 significant differences with G1 and G2,
# p < 0.05 significant differences between boys and girls in the same group,.

Fig. 3 Sprint 5 m test results in the group 1 (G1), group 2 (G2) and group 3 (G3), considering sample, age and gender.



* p < 0.05 significant differences with G3 , ** p < 0.01 significant differences with G1 and G2,

Fig. 4 Sprint 15 m test results in the group 1 (G1), group 2 (G2) and group 3 (G3), considering sample, age and gender.

TABLE 2
RELATIONSHIPS BETWEEN MAT AND SPRINT TEST ACCORDING TO AGE

Variables	G1	G2	G3	Total
MAT – 5 m	0.450**	0.502**	0.406*	0.531**
MAT – 15 m	0.577**	0.693**	0.654**	0.531**
5 m – 15 m	0.748**	0.791**	0.668**	0.788**

MAT = modified agility test, G1 = group 1, G2 = group 2, G3 = group 3. * Significant correlation for $p<0.05$; ** Significant correlation for $p<0.01$

TABLE 3
RELATIONSHIPS BETWEEN MAT AND SPRINT TEST ACCORDING TO AGE AND GENDER

Variables	G1 $_{girls}$	G1 $_{boys}$	G2 $_{girls}$	G2 $_{boys}$	G3 $_{girls}$	G3 $_{boys}$
MAT – 5 m	0.464**	0.404**	0.592**	0.235	0.360	0.478*
MAT – 15 m	0.532**	0.626**	0.757**	0.534*	0.814**	0.608**
5 m – 15 m	0.814**	0.633**	0.754**	0.826**	0.468	0.736**

MAT=modified agility test, G1 = group 1, G2 = group 2, G3 = group 3. * Significant correlation for $p<0.05$; ** Significant correlation for $p<0.01$

differences were only found between G1-G3 ($p<0.05$) in boys and between G1-G3 ($p<0.01$) and G2-G3 ($p<0.01$) in girls.

Bivariate correlation analysis showed a significant correlation between MAT and sprint tests at 5 and 15 m (Table 2) in all groups (G1, G2 and G3) and taking into account all subjects, although the correlation was moderate ($0.3<r<0.7$). Similarly, there was a significant and good correlation ($r>0.7$) between the sprint test at 5 and 15 m for G1 and G2 groups and total students, but moderate for the G3 group.

Bivariate correlation analysis differentiated by gender and age showed disparate values (Table 3). With respect to the correlation between MAT and the 5 m test a moderate significant relationship was found for the boys and girls in G1, in G2 for the girls and in G3 for the boys. It was also found a moderate significant relationship in the MAT and the 15 m test for the boys and girls in G1, and in G2 and G3 only for the boys. No significant correlation was shown for the girls in G3 for the 5 and 15 m sprint tests.

Discussion

Agility performance depending on age

Based on the results of the MAT test, significant differences ($p<0.01$) were obtained in the ability to change direction between G1-G2, G1-G3 and G2-G3 groups (Figure 2). The results of the present research are consistent with the finding of a previous study where age was also observed to be a differentiating parameter in agility[21]. Furthermore, boys from North India have shown different agility abilities depending on age[22]. The results of our study reinforce the hypothesis that age can be a differentiating factor in the agility of elementary education students. Because agility is a motor skill that can be improved through proper progressive practice[23–25], it would be interesting to analyze whether this ability, in different age groups, can be modified with different types of intervention protocols (i.e. straight line sprint or CODA training).

Agility performance depending on gender

No significant differences were observed between boys and girls in any of the first three course years of elementary education students. Similarly, McKenzie et al.[10] obtained no significant differences between 5 and 6 year-old students in the agility test[10]. It appears that the gender differences in terms of CODA are manifested as time passes[10] and may be attributed to biological maturation.

Sprint performance depending on age

The acceleration ability observed at 5 and 15 m showed significant differences according to age between G1-G3 and G2-G3. On the contrary, in a previous study no significant differences were observed in the acceleration ability of children from 9 to 13 years[22]. The results indicate that the differences between ages in acceleration and CODA are not manifested equally; therefore we think that these two abilities are specific and dependent on biological maturation processes[26].

Sprint performance depending on gender

The significant differences observed between boys and girls in the G1 group coincide with the results of Lam and Schiller[9] conducted with Hong Kong children of 5 and 6 years; in both studies boys showed higher sprint performance values than girls at early ages[9]. However, even though, Amusa, Goon, and Amey[27] did not observe significant differences in sprint performance ability between South African boys and girls from lower grades in the educational system (1–5 grade), significant differences were observed between the 6th and 7th grade[27]. The different tests used in each study may explain the differences between studies. It would be interesting for further studies to analyze the influence of gender and age on agility and sprinting performance at this stage of schooling in more depth.

Correlations

Even though the relationships between sprinting and agility abilities have been examined[28–33], this is the first study that has systematically examined the controversy of specificity of typical rapid movement performance qualities (acceleration and agility) in elementary school students. In our research, a significant moderate relationship was observed between the agility performance and the sprint time at 5 and 15 m in G1, G2 and G3. These results are consistent with the relationships observed by Little and Williams[31] in professional footballers, where a significant moderate correlation ($p<0.05$, $r=0.346$) was found between the 10 m test and the zigzag agility test. Similarly, Salaj and Marković[19] did not obtain a high correlation between different agility tests (lateral stepping, 20-yd shuttle run, and figure-of eight run) and acceleration ability (5, 10 and 20 m). No significant correlation was found between a 20 m sprint test and a 20 m sprint test with four changes of direction[28]. Thus, the issue of the relations among the sprinting and CODA abilities in elementary school students remains unresolved.

Considering the correlations by gender, we also obtained disparate values and in some cases no significant correlations were found. Sassi et al.[7], observed in physical education students (22.5±1.5 years) a significant correlation ($p<0.05$, $r=0.34$) between MAT and a 10 m acceleration test in girls but not in boys[7].

The conflicting results may be attributed to age and gender. Further studies are required to determine the correlation between speed and acceleration in primary school children.

Conclusion

As it was hypothesized, the ability to change direction (MAT) and sprinting ability (5 and 15 m) were manifested in different ways as a function of age and gender in the elementary school students. Therefore, the physical education teacher should consider these differences when choosing the programming at each of these ages.

The association between agility and acceleration has yielded a moderate correlation. Assessing this correlation according to age and gender has shown heterogeneous results. For this reason, we think that both are independent qualities and that age and gender are two factors that influence correlation results. In future research it would be interesting to observe the effect of different training programs both the agility and the sprinting ability in primary school children's.

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KORELACIJA IZMEĐU AGILNOSTI I SPRINTA PREMA DOBI UČENIKA

S A Ž E T A K

Svrha istraživanja bila je procijeniti sprint i agilnost izvedbenih karakteristika, kao i procjeniti odnos između navedene dvije motoričke sposobnosti kod učenika osnovnih škola. Sprint i agilnost perfomanse su ocijenjeni kod 176 djece (88 dječaka i 88 djevojčica) podijeljenih u tri grupe: Grupa 1 (G1, N= 98; 48 dječaka i 50 djevojčica) uz prve godine osnovnoškolske edukacije; Grupa 2 (G2, N=38; 15 dječaka i 23 djevojčice) iz druge godine osnovnoškolske edukacije i Grupa 3 (G3, N=40; 25 dječaka i 15 djevojčica) uz treće godine osnovnoškolske edukacije. Kod spola učenika istih godina, nađene su značajne razlike ($p<0,001$) između dječaka i djevojčica kod grupe G1 i G2 pri sprintu na 5 i 15 metara. Korelacija između agilnosti i ubrzanja, u većini slučajeva, je značajna ali i umjerana ($0.3<r\leq 0,7$) u svim skupinama (G1, G2, i G3). Kada je isključen spolni faktor, rezultati su se pokazali heterogeni. Ocjenjivanje takve korelacije prema godini i spolu je proizvelo heterogene rezultate. Iz tog razloga, smatramo kako su oba faktora neovisnih kvaliteta i kako su godina i spol dva faktora koji utječu na rezultat korelacije.