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AGILITY IN PRIMARY EDUCATION STUDENTS: DIFFERENCES BY AGE AND GENDER

LA AGILIDAD EN ALUMNOS DE EDUCACIÓN PRIMARIA: DIFERENCIAS POR EDAD Y SEXO

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ABSTRACT

Agility was assessed in 110 children (63 boys and 47 girls) divided into two groups: (a) Group 1 (G_1) (n=53): first year student in primary education (age: 6.3±0.6 years) and (b) Group 2 (G_2) (n=57): fourth year students in primary education (age: 9.5±0.4 years). A modified version of MAT [(28)] was used to determine agility: MAT_2. The purposes of the study were to assess the agility level of the two groups, verify the influence of age and gender in agility performance at an early age and determine the reliability and reproducibility of MAT_2. Good reliability values were found in MAT_2. Significant differences ($p<0.05$) were found between general results of G_1 (9.76±0.90 s) and G_2 (8.29±0.80 s). No significant results were found according to gender in G_1 but if in G_2 ($p<0.05$).

KEY WORDS: agility, test, MAT, physical education, gender differences.

RESUMEN

Se evaluó la agilidad en 110 niños (63 chicos y 47 chicas) divididos en dos grupos de alumnos de educación primaria: (a) Grupo 1 (G_1) (n=53): alumnos de 1º curso (6.3±0.6 años), y (2) Grupo 2 (G_2) (n=57): alumnos de 4º curso (9.5±0.4 años). Se utilizó una modificación respecto al MAT [28] para la valoración de la agilidad: el MAT_2. Los propósitos del estudio fueron cuantificar el nivel de agilidad de los dos grupos, comprobar la influencia de las variables edad y sexo en la agilidad en edades tempranas y determinar la fiabilidad y reproducibilidad del test MAT_2 en niños de 6 y 9 años. Se han obtenido diferencias significativas ($p<0.05$) entre los resultados generales obtenidos por el G_1 (9.76±0.90 s) y el G_2 (8.29±0.80 s). En el análisis realizado en cada grupo no se han encontrado diferencias significativas atendiendo al sexo en el G_1 pero si en el G_2. Se han obtenido buenos valores de fiabilidad en el test MAT_2.

PALABRAS CLAVE: agilidad, test, MAT, educación física, diferencia de género

INTRODUCTION

One of the main objectives of physical education teachers is to develop in an effectively and efficiently form the abilities and motor skills needed to participate in physical activities and sports and recreational activities with their students. Motor development studies have been one of the main objectives of physical education programs [20]. It depends of different factors like age, strength, neuromuscular maturation and body composition. Motor abilities are in part determined by subject genotype and are greatly influenced by transformational kinesiologic processes [11]. In this sense, the physical education professionals need to know the characteristics of the motor development stage of the students according to age in order to influence in a positive way to improve its motor abilities.

Agility is an important and necessary component in physical sports and recreational activities [15, 17, 26]. Traditional definitions of agility have simply identified speed in directional changes as the defining component [6, 30, 34]. Other studies claim that agility requires not only speed in directional changes because cognitive factors are also necessary. So agility was recognized as a complex quality [29, 34]. Agility is also defined as a physical skill that enables individuals to rapidly and efficiently decelerate, change direction, and accelerate in an effort to react appropriately to task-relevant cues [10, 28].

Most research has applied the term ''agility'' to describe any dynamic sporting action that involves change in body position or change of direction speed [10, 28]. More recently, agility has been identified as a rapid whole body movement with change of velocity or direction in response to a stimulus [5]. This definition recognises the inclusion of cognitive skills in determining agility performance and it's applied to open skills only [16].

Several studies evaluated agility in different disciplines such as football [30], netball [12], rugby [9, 21], hockey [18] or soccer [22, 27]. However, very few studies evaluated this ability in primary school students.

Nowadays it would be required continuous assessment of motor abilities of school children to verify what different studies exposed. These studies showed that life style change that implies a decrease in daily physical activity have contributed to a delayed of the motor develop of school children [19]. This decline can only be confirmed with a continuous and regular evaluation of school children being the physical education classes the ideal environment to check it.

The purposes of the study were: (1) to assess the agility level of primary education students, (2) verify the influence of age and gender in agility performance at an early age and (3) determine the reliability and reproducibility of a modifies ability test with 6 and 9 years old children.

METHODS

Participants.

On-hundred and ten (n = 110) primary education students of a public school took part in this study (63 boys and 47 girls). Study sample was divided into Group 1 (G_1) (n=53; first year primary education students) and Group 2 (G_2) (n=57; fourth year primary education students). The Mean ± SD of age, height, body mass, and body mass index (BMI) are presented in Table 1.

Table 1. Physical characteristics for Group1 and Group 2 students (Values are Mean±SD).

	Group 1 (G_1)			**Group 2 (G_2)**		
	TOTAL(n=53)	♂ **(n=31)**	♀ **(n=22)**	**TOTAL (n=57)**	♂ **(n=32)**	♀ **(n=25)**
Age (year)	6.3±0.6	6.2±0.5	6.3±0.3	9.5±0.4	9.3±.6	9.7±0.3
Heigth (cm)	121.49±4.98	121.69±5.02	121.23±5.24	142.8±5.27	139.5±4.33	144.8±5.02
Body mass (kg)	25.64±4.06	25.73±3.67	25.52±3.98	33.46±5.32	32.21±5.12	34.43±4.67
BMI (Kg. m^{-2})	17.51±1.85	17.57±1.93	17.43±1.37	16.41 ±1.73	16.67±1.28	16.63±1.75

SD =estándar deviation, G1 = first year primary education students, G2 = fourth year primary education students, BMI = body mass index

Written informed consents were obtained after the explanation of the nature of the research from all subjects before beginning the study. At any time during the research option was given to retire children from the test. Also consents were obtained from the school council and the school's management team. The study was conducted *according to* the Declaration of *Helsinki* (1964). The study *protocol* was approved by the local Ethics Committee-Institutional Board.

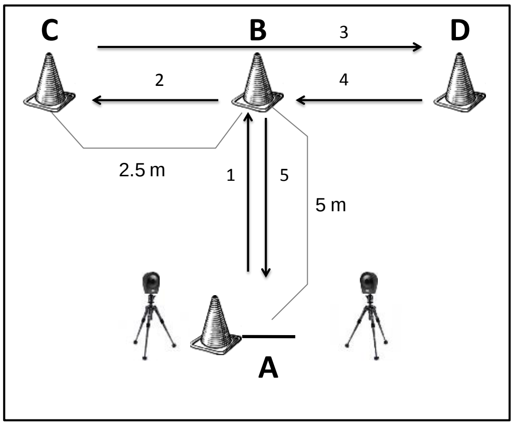
Procedure and materials

A modified version of MAT (*Modified Agility Test*) [28] proposed by Sassi et al. (2009) was chosen for assessment of agility: MAT_2. The MAT_2 (Figure 1) was performed using the same directives protocol of the MAT [28], except that subject must touch the top of the cone instead of the base. The modifications were carried out to facilitate the execution of the test to the young participants of the study. The reasons for selecting the MAT_2 were its short duration and the variety of movements to perform: forward, back and side displacements.

The protocol used in this study consisted of performing 3 repetitions of described by cones A, B, C and D (Figure 1) in the short time possible, with a rest of 4 minutes between each runs [28]. The output from the starting point, starting from late position 0.5 m compared to cone A, was performed when the performer considers it appropriate. The starting position was standing with one front leg over the other. It should perform the following movements:

- A-B displacement (5 m): At his or her own discretion, each subject sprinted forward to cone B and touch the top of it with the right hand.
- B-C displacement (2.5 m): Facing forward and without crossing feet, they shuffled to the left to cone C and touch its top with the left hand.
- C-D displacement (5 m): Subjects then shuffled to the right to cone D and touch its top with the right hand.
- D-B displacement (2.5 m): They shuffled back to the left to cone B and touch its top.
- B-A displacement (5 m): Finally, subjects ran backward as quickly as possible and return to line A.

Figure 1. Test MAT_2.



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 throughout had to repeat the test. Three trials were performed and the best time was used for analysis. Tests were performed indoors on a synthetic pitch at the school gymnasium. Before testing, subjects completed a 10 minute warm-up, including jogging, lateral displacements, dynamic stretching, and jumping. All subjects performed each test with at least 3 minutes of rest between all trials to ensure adequate recovery following the indications by Sassi et al. (2009) [28]. All tests were conducted at a random order and on a single day for each test subject.

The evaluations sessions were carried out during physical educations classes. Previously 4 sessions were planning where all subjects could practice the test protocol. All subjects received appropriate explanations of the correct way of perform MAT_2 by researchers. All times the same warm up was performed. Participants were instructed that they should perform the test at maximum intensity.

In all repetitions students were motivated at starting point to ensure maximum intensity performance; this was controlled by consistency to avoid differential between-subjects effect.

For MAT_2 one pair of the electronic timing system sensors (DSD Laser System) mounted on tripods was set approximately 0.40 m above the floor and was positioned 2 m apart facing each other on either side of the starting line. Time measurement begins and ends when the subject crosses the line between the tripods. The calculated margin of error was ±0.001 ms. To collect the MAT_2 results it was designed a specific recording sheet. All time results from all repetitions were collected.

Another recording sheet was designed to collect information about the physical activity level of the participants. This was filled out by the participants with his or her parents. The questionnaire collected aspects related to the number of hours of formal and non formal physical activity.

Data Analysis

The intraclass correlation coefficient (ICC) [33] was used to asses MAT_2 reproducibility (scale option of SPSS 17.0) and two different coefficient of variation (CV): (SD/Mean)*100 [3] and ((SD*1.96)/Mean)*100 [3, 4]). Both for the CV and for ICC were performed about the three repetitions and the last two, second and third repetition. Data were analyzed with SPPS (Version 17.0). The $p<0.05$ level of statistical significance was selected. Descriptive statistics were *calculated* for all experimental data. The normal distribution of results for the variables applied was tested by using the Kolmogorov-Smirnov test. We conducted a 2 x 2 ANOVA for the factors age (G_1 vs. G_2) and gender (Boys vs. Girls), reporting the values of effect size estimation through Partial Eta Squared (ηp^2). *One-way ANOVA* was used to *test* for differences in agility performance by gender in each group. The Pearson correlation test, with two-tailed test of significance, was used to study relations between the MAT_2 results and the physical activity level of the subjects. Also a linear regression analysis to test the predictive value of the physical activity level on agility performance in the agility test was calculated.

RESULTS

MAT_2 test showed good reproducibility values (Table 2). Except the CV2 results calculated with the three repetitions of G_1 (9.60%) all results were below 5.80%. The ICC minimum result was 0.774 and the maximal was 0.913 (Table 2)

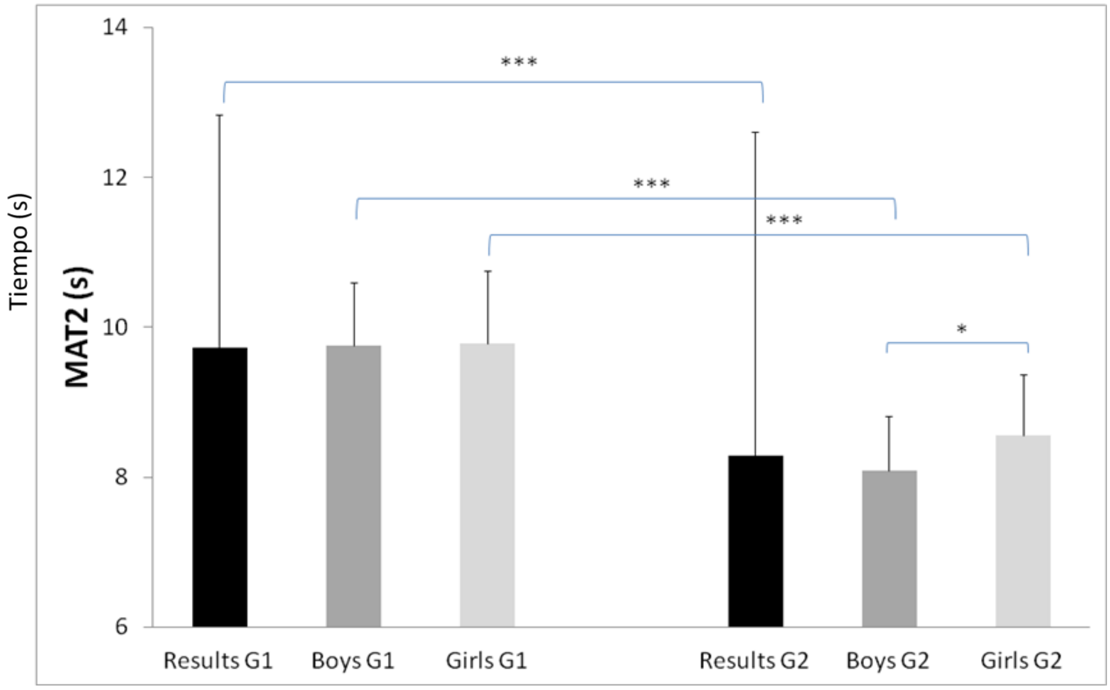
Table 2. Reproducibility results of MAT_2.

	G_1	G_2
1,2,3a CV1c	4.90%	2.60%
1,2,3a CV2d	9.60%	5.00%
1,2,3a ICC	0.774 (0.674-0.852)	0.913 (0.869-0.944)
2,3b CV1c	3.00%	2.30%
2,3b CV2d	5.80%	4.40%
2,3b ICC	0.885 (0.797-0.934)	0.909 (0.851-0.945)

CV = coefficient of variation, ICC = intraclass coefficient correlation, G1 = first year primary education students, G2 = fourth year primary education students
a 3 repetitions results
b 2º & 3º repetition results.
c CV=(DS/Mean)*100
d CV=((DS*1.96)/Mean)*100

Figure 2 shows the MAT_2 results for each group taking into account the age and gender.

Figure 2. MAT_2 results according to sex and gender (Mean±SD) (*: p<0.05; ***: p<0.001).



The intergroup analysis showed statistically significant differences between G_1 (9.76±0.90 s) and G_2 (8.29±0.80 s) ($p<0.001$; $F_{1,106}= 80.17$; $\eta p^2 = 0.43$) in relation to age. This difference remains if we include the gender factor. Thus we found significant differences ($p<0.001$) between boys in G_1 (9.72±0.86 s) and G_2 (8.08±0.73 s), and between girls in G_1 (9.82±0.97 s) and G_2 (8.56±0.81 s).

The G_1 within-group analysis showed no statistically significant differences (Boys: 9.72±0.86 s; Girls: 9.82±0.97 s) in relation to gender. G_2 boys showed a mean value of 8.08±0.73 s compared with G_2 girls who reached a men result of 8.56±0.81 s. In this case the within-group analysis showed statistically significant differences ($p<0.05$; $F_{1,56} = 5.57$).

Bivariate correlation analysis showed a negative correlation (cor. = -.588**) between MAT_2 results and weekly time expended in extracurricular organized sport and physical activity. The intergroup segmented by age analysis showed that this correlation is true for G_1 boys (cor. = -.480**; 62.9±62.1 h) and G2 girls (cor. = -.525**; 106.8±75.5 h), but not in the case of G_1 girls (34.1±50.9 h) and G_2 Boys (62.9±62.1 h).

To analyze the predictive value of the average weekly time spent in sport and physical activity for the agility test result, linear regression analysis showed a significant prediction ($p<0.001$) when analyzed for all students as a whole, with a percentage of variance explained of 34.5% ($\Delta R^2 = 0.345$).

The analysis by groups revealed the same tendency showed by the correlation analysis (G_1 boys: $\Delta R^2 = 0.230$ ($p<0.01$); G_1 girls: $\Delta R^2 = 0.275$ ($p<0.01$)).

DISCUSSION

Similarly, like other T-designed tests (8, 28), MAT_2 showed good reproducibility values. MAT_2 reproducibility could be considered as good (7,13) because it has yielded a value greater than 0.70. The fact of not exceed the values of CV in all cases except one (G1 (2,3b CV2d): 5.80 %) showed an optimal assessment of reproducibility, because values bellow 10% have been positive evaluated (3). In other agility test reproducibility studies similar values were obtained (1, 14, 23, 31). Similarly, the ICC yields good values for the group G_1 being above 0.70 and excellent for the group G_2 to exceed 0.90 (7, 13) allowing its use in training programs (5). Although these results should independently in subsequent studies with a larger sample size, the positive results of MAT_2 reproducibility agreed with other T-design agility tests (8, 26, 28) although the subjects were adults.

According to Ercerg et al. (2008) age, motor development and maturation are factors that affect agility in children (11). MAT_2 results revealed significant differences ($p<0.001$) between G_1 and G_2, where age is the differentiating factor between groups. Our study results confirm that age could be a differentiating factor in the agility of both boys and girls in primary education stage. So during primary education teachers must take into account the age of the students because it could influence their agility performance. During this development stage there is a significant improvement of the agility performance that should be taken into account when designing exercises of increasing difficulty and intensity throughout the educational process of students.

On the other hand another factor that is exposed as influential in agility in primary students is gender. No significant differences related to agility performance were found among students of G_1 (6.3±0.6 years) but in the G_2 (9.5±0.4 years) related to the gender (Figure 2). Thus, it seems that at early ages (6-7 years) the difference in the agility level between boys and girls is nonexistent but when children grow up during primary education level (9-10 years) differences related to gender show up significantly. Both genders showed an improvement in the agility level according to age. This improvement was much greater in the case of boys. Our results are consistent with those obtained by Amusa et al. (2010) in a study of South African children. In this study no significant differences in agility relating to gender were found in children from the first years of the education system (1-5 grades) but in grade 6 [(2)].

In this sense it would be necessary to analyze which aspects influence the lower agility improvement of girls at this age. Aspects such as the quantity and quality of motor practice, maturation and motor development and the context in which they operate, cited by Thomas et al. (1985), can explain the differences in motor skills at early ages [(32)].

Contrary to our results, Lam and Schiller (2001), in a study of 5 to 6 years old children in Hong Kong found significant differences in both agility and other parameters according to gender [(19)]. They concluded that boys presented higher results than girls both in running speed and agility. Perhaps this difference in the results of our study respect to Lam and Schiller (2001) research may be due to the different tests used to assess agility. Lam and Schiller (2001) used the BOTMP (*Bruininks-Oseretsky Test of Motor Proficiency*) [(24)]. The BOTMP evaluate agility in a composite item, which include strength and agility, against MAT_2 that specifically assess the agility of the subject.

Many agility studies with primary school students were made by using diverse tests and methodologies, making it difficult to compare the obtained data. It would be interesting to carry out further studies with a similar methodology to obtain clear conclusions respect to agility level according to age and gender in children during school age. In this sense we think that MAT_2, using photocells, could be a useful and reliable test to be generalized as a method for evaluating agility in young children.

Consistent with our results, McKenzie et al. (2002) found no significant differences in agility results according to gender of 5 to 6 years old students applying different motor tests [(16)]. These authors suggested that in many cases the gender differences in terms of motor ability increase as time passes, as we observed in our study. McKenzie et al. (2002) analyzed agility differences in 6 to 12 years old Anglo American and Mexican American adolescents [(20)]. Since both the used test as socio-cultural characteristics are very different it is difficult to compare the results of the studies.

Oxyzoglou et al. (2009) found significant differences in agility between a children group (13.6±0.9 yr, 163.39±10.13 cm, 57.34±11.13 Kg) who perform specific handball training with respect to a group that carried out only physical education sessions [(25)].

We found a significant correlation between the MAT_2 results and hours of physical activity and organized after-school sports if we analyze the values of the whole group. Thus, the greater number of after-school sports hours the better agility results. However, if we analyze data for each group, the results are diverse, showing a correlation in G_1 boys and in G_2 girls, but not for G_1 girls or G_2 boys. Thus, we cannot find a logical explanation.

It is possible that the quantity and quality of motor experiences outside the school context can greatly influence the motor skills of school children. In the same way, it might be interesting to include specific agility programs in physical education sessions, given its multilateral nature.

In future research it would be necessary to perform studies aimed at trying to determine the impact of agility intervention programs for students between 6 and 10 years old, trying to design the most appropriate methods based on different ages.

CONCLUSION

First, the proposal agility test (MAT_2) showed good reproducibility values.
Agility improves on both boys and girls in the age between 6 and 9 years. We found significant differences ($p<0.05$) in agility between primary education students of 1st year (G1: 6.3±0.6 years) and 4th year (G2: 9.5±0.4 years).
No significant differences were found in the G_1 but in G_2 ($p<0.05$) according to gender. Agility improves in function of age in the early stages of schooling. This improvement is greater in boys compared to girls.
Girls achieved less agility improvement during the age from 6 to 9 years. It´s necessary to clarify whether it is due to the quantity and quality of motor practice, to specific maturation aspects and motor development or the context in which they develop.

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