Physical Education

Assessment of motor competence in Brazilian children: comparison between AST-1 and TGMD-2

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Abstract - Aim: The aim of this study was to compare the results of the Athletic Skills Track-1 test (AST-1) with those of the Test of Gross Motor Development - 2nd edition (TGMD-2) in children aged 6-10. **Methods:** One-hundred and six children (50 girls and 56 boys, aged 6 -10) completed the AST-1 and the TGMD-2. Comparisons were made between the children's ages and the total time to complete AST-1 and TGMD-2 gross locomotor (LO) and object control (OC) raw scores were correlated. **Results:** In general, total time of AST-1 decreased and TGMD-2 raw scores increased with age. A moderate-relationship was observed between AST-1 total time and LO (r = -0.51) and OC (r = -0.66) TGMD-2 raw scores. When separated by gender, the coefficients between AST-1 total time and LO TGMD-2 raw score were high for boys (r = - 0.71) and low for girls (r = -0.45), and OC was also high for boys (r = -0.74) and moderate for girls (r = -0.50). These results indicate that the fundamental movement skills of children aged 6-10 can be assessed with AST-1, a quick and low-cost test, which is similar to the results obtained by TGMD-2. **Conclusion:** Considering the practicality and less time-consuming nature, the AST-1 should be considered when examining fundamental motor skill performance especially in situations with large number of children.

Keywords: measurement, motor skill, elementary school, tests evaluation.

Introduction

Regardless of all the existing knowledge about the beneficial effects of an active lifestyle, levels of moderate-to-vigorous physical activity among children and adolescents have decreased worldwide[1]. Several factors may be related to and impact the increase in sedentary lifestyles and the lack of physical activity in children and adolescents[2] and this seems to occur with motor competence all over the world[3] and also in Brazil[4]. A circular relationship has been suggested between physical activity and motor competence[5] and corroborated by the literature[6].

Studies have shown that specific physical activity programs[7] and regular physical education (PE) classes promote and increase proficiency levels in childhood[8], as well as in kindergarten[9]. Despite these promising results, motor proficiency is still lagging behind at various ages during childhood[4,9,10,11]. A possible explanation for this striking finding is that sedentary participation, low levels of physical activity[7] notably characterize PE classes, and if children do not experience structured physical activities, they are likely to be trapped in the barrier of motor proficiency[5]. In addition to regular PE classes, extra-curricular physical activity programs have been implemented with the main aim of encouraging and promoting the enrollment of children and adolescents in physical activity. In fact, there is evidence that such programs increase the level of physical activity[12,13] with the potential for subsequent enrollment in physical activities[14] and consequent improvement in the repertoire of fundamental motor skills[15] and participation in extra activity[14].

As aforementioned, one of the main issues related to the participation of children and adolescents in physical activity can be the proficiency of motor skills. However, assessing motor skills is not an easy or trivial task. Instructors and/or teachers are usually faced with the need to assess their students to check whether they are at the expected level of development or to examine the outcome of a specific intervention. Currently, there are a number of instruments for assessing fundamental motor skills and the most commonly used in early childhood are: Bayley-III, BOT-2; Movement Assessment Battery for Children (Movement-ABC, MABC-2); MAND; Peabody Development Motor Scales (PDMS and PMDS-2); NSMDA Motoriktest für Vierbis Sechjärige Kinder (MOT 4-6); the Maastrichtse Motoriek Test (MMT, Körperkoordinationstest für Kinder (KTK); the Test of Gross Motor Development (TGMD-2, TGMD-3); and the Bruininks

Motor Proficiency Test -Oseretsky (BOTMP)[16,17]. Cools[16] and Griffiths[17] observed the relevance of these different assessment instruments and concluded that, in general, both internal consistency and inter-rater reliability in some tests are high, but more studies are needed to confirm the latter proposition.

Despite their consistency, reliability and validity, the use of some of these tests to assess motor skills is not feasible in many cases, such as in PE classes, due to some important issues. Firstly, these tests usually take a long time to be performed, at least 20 min to examine each child. Secondly, special materials, space and extensive knowledge of measurement and assessment protocols are required. Therefore, although motor competence is desirable knowledge for children, assessing it is neither a trivial nor an easy task. For this reason, efforts and new alternatives are still needed to analyze and quantify fundamental motor skills, especially throughout childhood.

Wormhoudt, Teunissen and Savelsbergh, in collaboration with PE teachers, proposed a new screening tool for fundamental motor skills called the Athletic Skills Track (AST). The test AST based on existing theories of children's movement development and its result based on the time taken to complete a specific skill track[18]. The ease of obtaining a parameter, namely the time to complete the track, which can be used to indicate the performance of fundamental motor skills, is an important advantage compared to the existing instruments, making it unique for examining the motor performance of fundamental motor skills, especially when this assessment involves a large group of children. The AST considered the disadvantages of existing assessment tools (i.e. high cost, time consuming, not suitable for a PE setting) and aimed to assess general motor competence among large groups of schoolchildren in a PE setting[18]. Ideally, the new tool can be used for (1) screening: from identifying individuals at risk to identifying talents; (2) monitoring: monitoring the motor development of individuals and monitoring trends in motor skills at (sub)group and school level over a longer period; (3) benchmarking: comparing groups and schools in children's motor skills; and (4) evaluation: the assessment of interventions (methods, programs, products) to improve children's motor skills[18].

Although the AST-1 seems to provide a unique opportunity for examining fundamental motor skills, there is still much to investigate regarding its application. As mentioned by the authors when it was first proposed, further studies are needed to better assess reliability, discriminative capacity and validity across ages. We complement this by adding that it is necessary to compare the AST-1 with the results of other fundamental motor skills assessment instruments. In this context, the aim of this study was to compare the results of the AST-1 with the results of the TGMD-2 tests in children aged 6 to 10. The main justification for this objective is that the TGMD-2 is a well-established test of fundamental motor skills proficiency and, as such, a possible standard reference to be used.

Methods

Participants

The study enrolled 106 children aged between 6 and 10 from three public elementary schools in the city of Estância Hidromineral de Poá, located in the metropolitan region of São Paulo-SP, Brazil. Based upon a questionnaire from the Associação Brasileira de Empresas e Pesquisas (ABEP), children's response indicated that they belonged to B1 and C2 social classes. The schools were chosen at random from a list of previously contacted schools that agreed to take part in the study. Written consent was obtained from all the children's parents or legal guardians after they had received written information about the aim and procedures of the study. Finally, the institution's Research Ethics Committee approved by n. 6.555.976 the Project sent CAAE: 74988123.9.0000.5465 all the procedures and the consent form signed by the parents or legal guardians.

Procedures

The children were assessed at their own school settings. First, each child's height and weight were obtained. Then, the children performed the AST-1, following the established protocol[18]. The AST-1 track consists of a series of fundamental motor tasks, specifically organized and distributed in a circuit format, to be completed as quickly as possible. The AST-1 track is made up of locomotor, handling and stability skills, totaling 10 skills, as follows: (1) alligator crawl; (2) rabbit hop; (3) traveling hop; (4) throw and catch a ball; (5) kick and stop a ball; (6) roll forward; (7) roll backward; (8) run backward; (9) climb; and (10) jump (for a more detailed description, see Hoeboer et al.[8]).

Initially, the children received information and watched an instructional video before performing three trials on the track. The first trial was a familiarization trial, and the following trials were the actual test trials. During the three trials, the children received feedback and instructions from the assessor if necessary. As established in the test protocol, the time to complete each trial was taken by the assessor using a stopwatch. After finishing an attempt, the children rested for 4 to 5 min before performing the next attempt. The shortest time obtained between the two attempts was used as the AST-1 performance.

Three weeks following this first assessment, the children performed the locomotion and object control subtests of the TGMD-2. In this case, the performance of each subtest followed the protocol and organization of the TGMD-2 for each skill. Before each test, an assessor instructed and demonstrated each skill and, if the child did

not understand the task, further demonstrations and instructions were given. Each child made at least three attempts, one for practice and the other two for later analysis. The attempts were recorded on video with a properly positioned camera. After data collection, three previously trained evaluators analyzed the skill performance videos. In this analysis, the two attempts made by the children were inspected and scored according to the TGMD-2 performance criteria and the raw scores for the locomotor and object control subtests were obtained.

Statistical analysis

Normality and homogeneity of variance were first tested and, once these assumptions were met, the following analyses were carried out. A multivariate analysis of variance (MANOVA) was carried out, with age (6, 7, 8, 9 and 10 years) and gender (male, female) as factors, and body mass, height and body mass index as dependent variables. Three analyses of variance (ANOVAs) were also carried out, with age and gender as factors, with the total AST-1 time, the locomotor TGMD-2 and the gross object control score. Person correlation tests were then carried out between TGMD-2 locomotor time and AST-1 total time and object control and AST-1 total time. Person tests were carried out with all participants (men and women) and also with subgroups of men and women. Correlation coefficients were interpreted as insignificant (< 0.3), low (between 0.3 and 0.5), moderate (between 0.5 and 0.7), high (between 0.7 and 0.9) and very high (between 0.9 and 1.0). When necessary, follow-up univariate analyses and HSD Tukey post hoc tests were used. All procedures were carried out using SPSS software (SPSS for Windows, version 19.0), and the significance level was kept at 0.05.

Results

All the children completed the AST-1 and TGMD-2 tests. Table 1 shows the anthropometric information for girls and boys in each age group. MANOVA revealed an age effect for all variables (body mass, $F(4,96) = 25.64$, $p < 0.001$; height, $F(4,96) = 73.99$, $p < 0.001$, and BMI, $F(4,96) = 5.90$, $p < 0.001$). No differences were observed for gender or the interaction between gender and age group.

Figure 1 shows the AST-1 screening time for boys and girls in each age group. ANOVA revealed an effect of age, $F(4.96) = 20.55$, $p < 0.001$, sex $F(1.96) = 39.27$, $p < 0.001$, and the interaction of age and gender, $F(4.96) = 4.49$, $p < 0.005$. The post hoc tests showed a longer time for the 6-year-old than that observed for the 8-, 9- and 10-year-olds. The post hoc also showed a longer time for the 7-year-old than the one observed for the 9- and 10-year-olds and a longer time for the 8-year-old in comparison with the one observed for the 10-year-olds. However, due to the interaction between group and gender, these post hoc results should be interpreted with caution. The post hoc for the interaction indicated shorter times only for the 9 and 10 year old boys when compared to the 9 and 10 year-old girls.

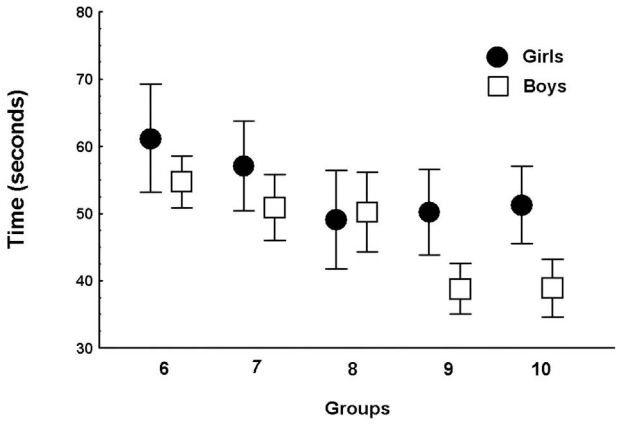

Figure 1 - Mean and standard deviation of the AST-1 time for boys and girls for each age group.

Table 1 - Mean (standard deviation) of chronological age, body mass, height, body mass index (BMI) for boys and girls in each age group.

Age group (year)	Sex	N	Chronological age (years)	Body mass (kg)	Height (m)	BMI (kg/m^2)
6	Male	12	6.5(0.3)	23(3.6)	1.20(0.1)	16(1.8)
	Female	08	6.5(0.3)	22(4.4)	1.18(0.1)	15(2.2)
7	Male	10	7.5(0.3)	26(6.1)	1.20(0.1)	16(2.8)
	Female	11	7.6(0.3)	27(5.2)	1.26(0.1)	17(2.6)
8	Male	10	8.3(0.3)	33(8.9)	1.28(0.1)	19(4.0)
	Female	10	8.5(0.3)	30(5.5)	1.27(0.1)	19(3.8)
9	Male	10	9.7(0.2)	42(4.4)	1.46(0.1)	19(2.3)
	Female	11	9.5(0.3)	38(8.5)	1.41(0.1)	18(2.9)
10	Male	14	10.5(0.3)	36(6.9)	1.41(0.1)	18(2.9)
	Female	10	10.3(0.3)	36(6.5)	1.41(0.1)	18(3.0)

Figure 2 shows the total raw score of the locomotor TGMD-2 for boys and girls at each age. The ANOVA revealed an effect of age, $F(4,96) = 11.32$, $p < 0.001$, but not of gender, $F(1,96) = 0.25$, $p > 0.05$, and of the interaction of age and gender, $F(4,96) = 0.69$, $p > 0.05$. The post hoc tests showed a lower raw score for the 6-year-old than that observed in the 8-, 9- and 10-year-olds, and a lower raw score for the 7-year-old when compared to the 9- and 10-year-olds.

Figure 3 shows the total raw score of the TGMD-2 object control for boys and girls at each age. The ANOVA revealed an effect of age, $F(4,96) = 14.71$, $p < 0.001$, and gender, $F(1,96) = 10.26$, $p < 0.005$, but no interaction between age and gender, $F(4,96) = 2.03$, $p > 0.05$. The post hoc tests revealed a lower raw score for the 6-year-old when compared to the 8-, 9- and 10-year-olds and a lower raw score for the 7-year-old the 8-, 9- and 10-year-olds. Finally, the raw scores were lower for girls in comparison to those observed for boys.

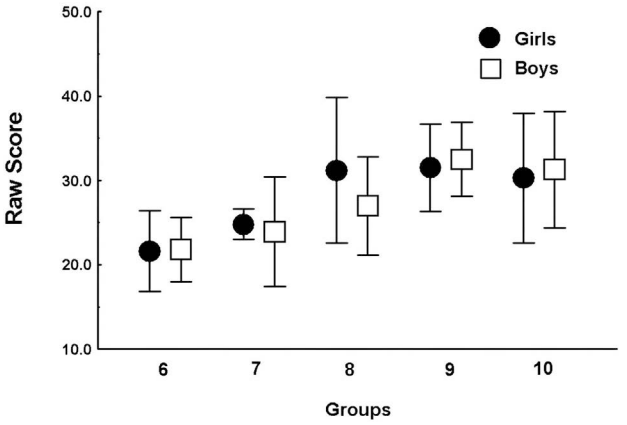

Figure 2 - Mean and standard deviation of the TGMD-2 locomotor raw score for boys and girls for each age group.

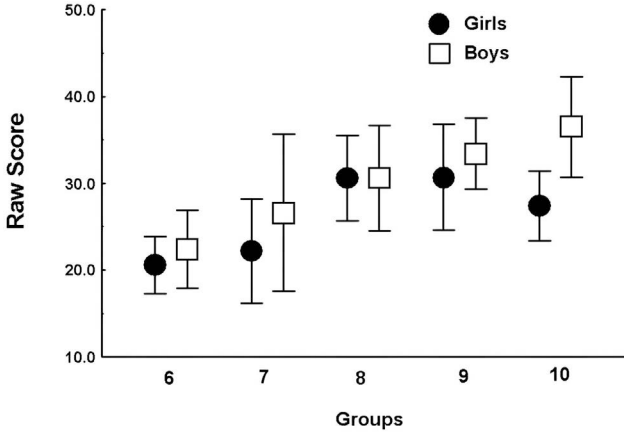

Figure 3 - Mean and standard deviation of the TGMD-2 object control raw score for boys and girls for each age group.

Relation between AST-1 and TGMD-2

Figure 4 presents scatter plots showing the relationship between AST-1 track time and TGMD-2 locomotion and object control raw scores. In general, Pearson's coefficients indicated a moderate negative relationship between AST-1 track time and the TGMD-2 locomotor, $r = -0.51$, $p < 0.001$, and object control raw scores, $r = -0.66$, $p < 0.001$.

Regarding the relationship between AST-1 track time and the TGMD-2 gross locomotor and object control score, independently for boys and girls, the coefficients indicated some differences. The coefficients for AST-1 track time and the TGMD-2 gross locomotor score showed a high negative relationship for boys, $r = -0.71$, $p < 0.001$, and a low negative relationship for girls, $r = -0.45$, $p < 0.005$. The coefficients for the AST-1 travel time and the TGMD-2 gross object control score indicated a high negative relationship for boys, $r = -0.74$, $p < 0.001$, and a moderate negative relationship for girls, $r = -0.50$, $p < 0.001$.

Discussion

This study compared the results of the AST-1 and TGMD-2 tests in children aged between 6 and 10. The results showed that the assessment of children based on the AST-1 resembles the assessment based on the TGMD-2, revealing the same differences between age groups and also between boys and girls. In addition, the correlation coefficients showed a moderate to high relationship between the children's performance on the two tests. Based on these results, it is suggested that although the AST-1 and TGMD-2 use different procedures, focusing on different performance issues, the results of both tests are at least moderately comparable. These issues are discussed, indicating the advantages and disadvantages and possible applications in screening the development of children's skills in middle childhood.

Both the AST-1 and the TGMD-2 showed that 6-year-olds performed less well than 8-, 9- and 10-year-olds and that 7-year-olds performed less well than 9- and 10-year-olds. The only difference in relation to the age comparison was that the TGMD-2, for object control, indicated that 8-year-olds performed better than 7-year-olds, a difference that was not seen in the AST-1. Therefore, both tests indicated essentially similar results between the age groups included in this study. With regard to comparisons between boys and girls, the AST-1 showed that boys performed better than girls only at the ages of 9 and 10. In contrast, the TGMD-2 showed no difference between boys and girls for locomotor skills and that boys performed better than girls at all ages for object control skills.

These similar results are relevant for a few reasons. Firstly, according to Cools and colleagues[16], the TGMD-2 is a very important and reliable assessment tool and, as the AST-1 showed very similar results, this importance can

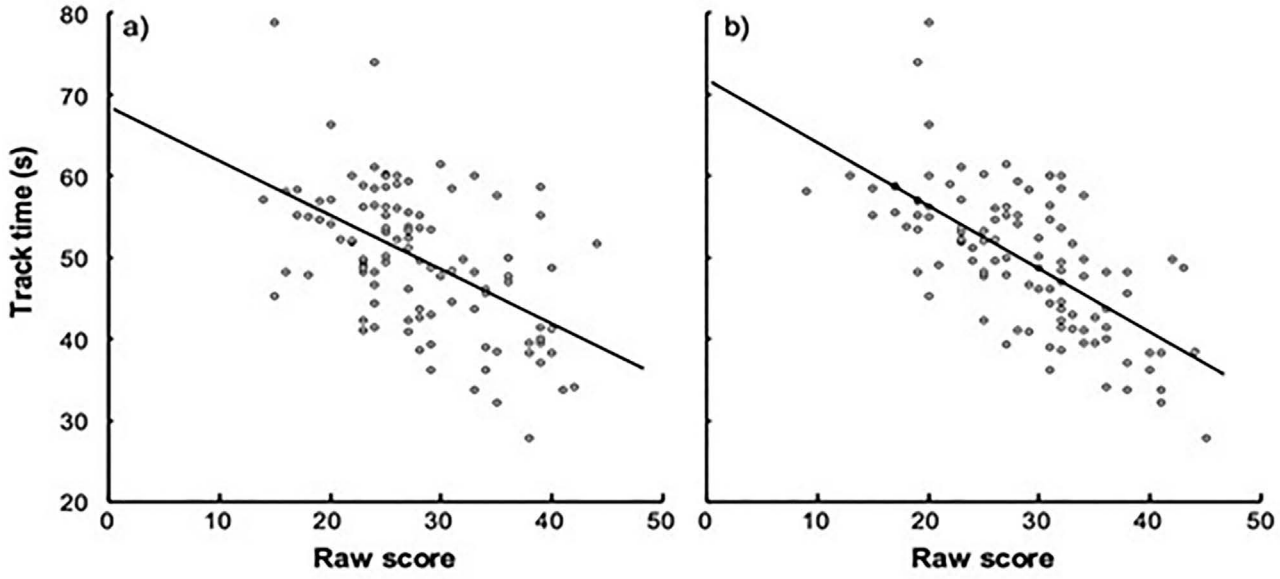

Figure 4 - Scatter plots between the AST-1 track time and the TGMD-2 locomotor (a) and object control (b) raw scores for all the children.

also be extended to this test. This applies especially to the age assessment, although some discrepancy in results was observed between the age comparisons. Despite this difference, considering that the AST is more feasible in a PE context than the most commonly used instruments[18], including and especially the TGMD-2, the use of the AST-1 should be considered. The quantitative assessment of a child, based on the AST-1, takes around a minute or two minutes, whereas the time taken to assess the TGMD-2 is much longer (around 20 min). Therefore, using the AST-1 as a tool to assess a large number of children and/or students, even during regular physical education classes, is much more appropriate and easier.

Further evidence of the similarity between the results of the AST-1 and the TGMD-2 was shown by the correlational coefficients. In general, the coefficients indicated a moderate relationship (coefficients varying between r = -0.5 and r = -0.6, for locomotor and control object, respectively); when gender was taken into account, the relationship increased for boys (r = -0.7 for locomotor and control object) and decreased for girls (r = -0.4 and r = 0.5 for locomotor and control object). This difference between girls and boys in the assessment results between the AST-1 and the TGMD-2 is interesting and may highlight some characteristics of these tests. While the TGMD-2 is oriented towards skill standards, the AST-1 results may be influenced by some physical abilities that may even begin to emerge in late childhood. These possible differences may have been accommodated by the differences in raw scores observed between boys and girls[4,19], although there is a feeling that these differences would not appear until the age of eleven or later[16].

It is undeniable that having a tool that covers the greatest number of competences possible and is a practical enough to be applied in a classroom is fundamental. In this way, teachers/coaches will be able to promote the equitable development of individuals. When delays are not adjusted to reduce or equalize these differences between the genders they can have serious consequences. Such differences can be seen in the performance of daily physical activities, as demonstrated in the literature[12,13,20]. This is alarming because it will have consequences for the lack of physical activity. Many tests to assess FMS in children are somewhat deficient in some aspects, for example: they are used in a specific population with different contexts and cultures, and need to be adapted and validated to be applied in a specific country or population[16,17]. The following criteria should be followed when using the available tests: purpose of the assessment, age and suitability of the test, simplicity of the test (instruction and demonstration should be short and simple), ease of training for examiners and observers, cultural similarity between norm and test group[11,16,17,19]. This will help ensure the quality of the results of the instruments, including those validated and used in a different country, culture, population, gender and age.

Despite providing relevant data, this study had several limitations. Firstly, only the time taken to complete the track was measured to assess the child's level of motor skill. Although this is a viable measure for evaluations in Physical Education classes, it is not yet known whether only the time taken to complete the track can assess the quality of the fundamental motor skills performed. To address this problem, a professional/evaluator accompanied the individual during the course to check that the

movements were in line with those found in the video of the original study, which could help to refine the quality of the results. Secondly, the capabilities of the AST-1 during walking showed more locomotion capabilities than object control, which may explain why the relationship with the TGMD-2 did not show stronger results than those obtained. Thirdly, the AST-1 test has not yet been standardized for the Brazilian population. Fourthly, both tests used in this study have new versions, therefore the results could be different if these new versions had been used

In spite of these limitations, further research is needed to ensure that easy and reliable tools are available to assess the development of children's skills, and our results have shown that the AST-1 can be an important test to use for this purpose. However, due to the complexity and many influencing factors, motor competence is not an easy and trivial task. It may be necessary and important to use multiple assessments to obtain a complete picture of motor competence, as suggested previously[11,19], or to use different tools to obtain specific information. In this case, due to its feasibility and speed, the AST-1 could be used to obtain a general and "global" view of children's motor competence, especially when it involves a large number of them. If a child's performance stands out, other assessments should be used to better understand that performance. Another possibility would be to use the AST-1 more frequently to obtain general information and, at specific ages and/or episodes, use another test (i.e. the TGMD-2) to obtain a more accurate assessment of the individual's motor status.

Conclusion

In conclusion, this study demonstrated that the results of the AST-1 and the TGMD-2 are similar and have a moderate relationship. This similarity indicates that the AST-1 can be used to assess children's motor performance, which is related to the development of basic skills. Furthermore, considering the practicality and less time-consuming nature of its application, the AST-1 should be considered when examining fundamental motor skill performance especially in situations with large number of children where the TGMD-2 would be less likely to been used.

Acknowledgments

The authors are grateful to the parents for their consent and to the children for their participation.

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Manuscript received on June 10, 2024
Manuscript accepted on September 1, 2025