Journal of Science and Medicine in Sport xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

The Athletic Skills Track: Age- and gender-related normative values of a motor skills test for 4- to 12-year-old children

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ARTICLE INFO

Article history:
Received 16 November 2017
Received in revised form 21 January 2018
Accepted 26 January 2018
Available online xxx

Keywords:
Physical education
Child
Motor skills
Physical activity
Motor competence test

ABSTRACT

Objectives: The aim of the presented study is to provide age- and gender-related normative values and MQ values for a motor skills test, the Athletic Skills Track, among 4- to 12-year-old children.
Design: Cross-sectional.
Methods: In 2016, a total of 7977 Dutch children, 4036 boys (mean age 8.6 years, SD 2.1) and 3941 girls (mean age 8.6 years, SD 2.1), performed an age-related version of the Athletic Skills Track (AST). The AST is a track consisting of 5–7 fundamental movement skill tasks that should be completed as fast as possible. The children performed the test during a regular physical education (PE) lesson under the supervision of their own PE teacher. For each version of the AST (AST-1: n = 917; AST-2: n = 3947; AST-3: n = 3213) age- and gender-related reference centiles were derived from the gathered data using the Lambda, Mu, Sigma (LMS) method.
Results: All children completed the AST within 60 s (mean 29.6 s, SD 7.7). An independent samples t-test showed that boys were significantly faster in completing the track than girls, except for the 4-year-old boys. Therefore, age- and gender-related reference centiles were derived. The reference curves demonstrate an almost linear decrease in time to complete AST-1 and AST-2 with increasing age.
Conclusions: The present study provides age- and gender-related normative values and MQ values for the AST among 4- to 12-year-old Dutch children. With these normative values PE teachers can interpret children's performance on the AST.

1. Introduction

Physical literacy (PL) is gaining more and more attention in physical education (PE), physical activity (PA) and sports promotion worldwide. PL is the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life.[1] PE is an important resource to develop PL during childhood.[2,3] A high level of motor skill competence in youth is associated with several health related parameters such as lower body mass index,[4,5] better cardiorespiratory fitness,[6] and higher PA levels in cross-sectional[7–9] and longitudinal studies.[10] Motor skill competence is constrained by the level of fundamental movement skills (FMS) performance.[11] FMS are associated with increased cognitive development,[12,13] social development and language skills.[14] Furthermore, good FMS performance is positively associated with self-esteem[15] and reduced levels of anxiety.[16]

The crucial development of FMS is inbedded in the development of motor skill competence as shown in the mountain of motor development.[17] Although motor skill development is a nonlinear, self-organizing process that is driven by task, environment and organism,[18] this metaphor of motor development shows six periods of development that characterizes most typically developing individuals.[17]

Since children's FMS and PA levels seem to have decreased in the last decades,[19] there is an urgency to increase our understanding of the development of FMS and to develop effective strategies to support children in obtaining an optimal level of PL. Therefore, we

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https://doi.org/10.1016/j.jsams.2018.01.014
1440-2440/

need valid motor skill competence tests. The urgency to increase our understanding of motor skill development is also recognised by PE teachers who are willing to monitor motor skill competence of children more objectively.[20]

In 2016, researchers[21] have developed a robust and feasible motor skill competence test, the Athletic Skills Track (AST) that PE teachers can use to assess children's FMS in an objective way. The AST is fundamentally different than conventional motor competence tests. The AST is a track that consists of a series of 5–7 detached, rather than isolated, FMS based on coordinative abilities[22] (e.g. coupling, spatial orientation, and balance ability).[23,24] Previous studies have shown that the AST is a reliable, valid and feasible assessment tool to assess FMS among children from 4 to 12 years old in the PE setting.[21,25] In the first study, it was shown that it was possible to measure one class of approximately 24 children in a one hour lesson. All children completed the track within 60 s. The concurrent validity of the AST was moderate to high; i.e., the correlation coefficient between the time to complete the AST and age- and gender-specific motor quotients of the Körperkoordination-Test für Kinder (KTK) ranged between $r = -0.469$ and $r = -0.767$ ($p < 0.05$).[21] In the second study three age-related versions of AST have been developed. AST-1 has been developed for 4- to 6-year-old children, AST-2 for 6- to 9-year-old children and AST-3 for 9- to 12-year-old children. The test-retest reliability of the AST proved to be high (AST-1: ICC = 0.881, AST-2: ICC = 0.802, AST-3: ICC = 0.800). The internal consistency was above the acceptable level of Cronbach's $\alpha > 0.70$ (AST-1 = 0.764, AST-2 = 0.700, AST-3 = 0.763). The concurrent validity between the AST and the KTK were even higher than in the first study (AST-1: $r = -0.747$, $p = 0.01$; AST-2: $r = -0.646$, $p = 0.01$; and AST-3: $r = -0.602$, $p = 0.01$).[25]

Although the AST appears to be a promising objective tool to assess children's motor skill competence in the PE setting, the lack of normative values limits the ability to interpret children's performance on the AST. Producing reference norms and Motor Quotient (MQ) outcomes generates a scoring system that describes individuals global motor competence in meaningful categories, and allows comparison with results from other schools, region, countries and studies.[26] Therefore, the objective of the presented cross-sectional study was to provide age- and gender-related normative values and MQ values for the AST for Dutch children from 4 to 12 years old.

2. Method

The research design was set up to reach a large group of children. Children aged 4- to 12-years were recruited from 86 primary schools in The Hague region, the Netherlands. Informed consent was obtained from the parents or guardians of the children after they were given written information about the purpose and nature of the study. After the informed consent was obtained, 8,458 children completed an age-specific version of the Athletic Skills Track (AST-1, AST-2 or AST-3) under the supervision of their own PE teacher.

The age-specific versions of the AST consist of a series of fundamental movement skill tasks (AST-1: n = 5, AST-2: n = 7, and AST-3: n = 7) to be completed as fast as possible (see Supplementary material — Maps of AST-1, AST-2 and AST-3).[20] The only outcome measurement is time to complete the track. In all three tracks the same FMS are tested, with the difficulty of the tasks ascending from AST-1 over AST-2 to AST-3. The AST was completed during a regular PE lesson between March and April 2016. In this lesson the measurement was conducted in a gymnasium that was separated into three sections (see Supplementary material — Map of the gymnasium into three sections). In two sections the children received an autonomous assignment from their PE teacher. In the third part the AST was conducted. The PE teacher performed the track once after which the children performed three try-out trials. After having received feedback from the PE teacher during the three try-out trials the children performed one measurement trial independently. The PE teacher measured the time to complete the track using a stopwatch and registered it in Excel.

All 86 PE teachers who participated in this study were trained according to the AST protocol by the principal investigator of this study. The protocol provides guidelines about the AST to be used per age group. It also provides guidelines about how to deal with adverse events, such as falling or cheating. The study protocol was approved by the Ethical Committee of the Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands (ECB 2015–31).

Data analysis was performed with the Statistical Package for the Social Sciences (SPSS version 24.0, 64-bits edition, SPSS Inc, Chicago, Illinois). Of the 8458 children who were allowed by their parents or guardians to participate in the study, 7977 children met the inclusion criteria for data analysis (age: between 4 and 12 years; all data complete: Age, Gender, AST-track number and AST-time).

All data were expressed as Mean, Standard Deviation (SD), and range. The normality of the data was investigated by analysing the normal distribution in relation to the medians. In addition, histograms were plotted. Differences between boys and girls were examined per track with independent samples t-tests and with a one-way ANOVA it was investigated if the tracks were able to distinguish between age groups within the track.

Age- and gender-related reference centiles were derived per track using the Lambda, Mu, Sigma (LMS) method as introduced by Cole[27] using R GAMLSS packages.

Based on the reference centiles of the AST, MQ values were calculated following the example of the Körperkoordination-Test für Kinder (KTK).[28] The MQ (mean = 100; SD = ±15) gives an indication of children's level of motor giftedness, ranging from "gifted children" to "children with motor dysfunctions".[28] The norms for the MQ of the KTK are based on the performance of 1228 normally developing German children (1974). The MQ score is standardized by age and gender. As stated by Kiphard and Schilling[28] in a normal population, a MQ score below 85 represents a motor performance level that is considered as problematic. The normalised value was scaled with 100 as the average value based on the 50th percentile. The other cut-off points are based on the 10th, 25th, 75th, 90th percentiles using the following formula: MQ = (50th percentile AST-x/time AST-x) × 100.

3. Results

The final sample consisted of 7977 4- to 12-year old children (4036 boys and 3941 girls). The mean age of the boys was 8.6 years (SD 2.1) and the mean age of the girls was 8.6 years (SD 2.1). The Supplementary material — Descriptive statistics of respondents' characteristics, provides descriptive statistics of the final sample as well as the Dutch population (Central Dutch Foundation for Statistics [CBS]).[29] In our sample, the ratio of boys to girls was approximately equal, which does not significantly deviate from the Dutch youth population. Considering age, the sample does not fully reflect the Dutch population in the lower age group. This is because not all primary schools in The Netherlands provide PE lessons for children at the ages of 4 and 5 years. Hence, we consider the sample to be representative for Dutch children attaining PE lessons in terms of gender and age.

As shown in Table 1 all children completed the AST within 60 s. On average, boys completed AST-1 in 25.3 s ± 7.1, AST-2 in 30.6 s ± 7.3, and AST-3 in 27.0 s ± 6.9. Girls completed AST-1 in 27.4 ± 7.9 s, AST-2 in 33.0 s ± 7.9, and AST-3 in 29.1 s ± 6.8.

Please cite this article in press as: Hoeboer JJAAM, et al. The Athletic Skills Track: Age- and gender-related normative values of a motor skills test for 4- to 12-year-old children. *J Sci Med Sport* (2018), https://doi.org/10.1016/j.jsams.2018.01.014