Validity of an Athletic Skills Track among 6- to 12-year old children

Physical Education, Child, Motor competence; Health; Pediatrics; Validity

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Abstract

The purpose of this study was to examine the feasibility and validity of an Athletic Skills Track (AST) to assess fundamental movement skills among 6- to 12-year-old children in a physical education setting. 463 Dutch children (211 girls, 252 boys) completed three tests: the Körperkoordination-Test für Kinder (KTK) and two Athletic Skills Tracks (AST-1, AST-2). The validity of AST-1 and AST-2 was examined by correlating the time (sec) needed to complete the tracks and the KTK Motor Quotient (KTK MQ).

Overall, there was a small correlation between AST-1 and the KTK MQ (r = - 0.474 (p = 0.01)) and a medium correlation between AST-2 and the KTK MQ *(*r = - 0.502 (p = 0.01)). When split up by age group the associations between the Athletic Skills Tracks and the KTK MQ were large for 12-year old children (AST-1: r = - 0.767; AST-2: r = - 0.727) and smallest for 8-year olds with a medium association (AST-1: r = - 0.501; AST-2: r = - 0.469). The results suggest that children's motor skills can be assessed with a quick, convenient, and low-cost motor competence test in a physical education setting, i.e. an Athletic Skills Track.

Keywords: *Physical Education, Child, Motor competence; Health; Pediatrics; Validity*

Introduction

Despite the well-known health effects of an active lifestyle, physical activity ratings amongst children and adolescents seem to be decreasing in many countries (Dollman, Norton, & Norton, 2005; Hallal et al., 2012; Salmon & Timperio, 2007). In the Netherlands, the percentage of children under 17 years of age who reach the public health guideline to accumulate a minimum of 60 minutes of moderate to vigorous physical activity per day is 18% (Hildebrandt, Bernaards, & Stubbe, 2013). Motor skills appear to have dropped significantly as well over the last decades among Dutch youth (Runhaar et al., 2010), a trend that is also seen among Flemish youth (Vandorpe et al., 2011).

Therefore, stimulating physical activity has become a public health priority. Physical education (PE) is suggested to be an important component in efforts to promote physical activity (Control & Prevention, 2011). The PE setting has the necessary resources and provides access to all youth (Hardy, King, Espinel, Cosgrove, & Bauman, 2013). One of the goals of PE is to increase children's movement repertoire by supporting the development of motor skills. Children's motor skills are positively correlated with physical activity (Bouffard, Watkinson, Thompson, L., & Romanow, 1996; Lubans, Morgan, Cliff, Barnett, & Okely, 2010; Okely, Booth, & Patterson, 2001; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006) and health-related physical fitness (Cantell, Crawford, & Doyle-Baker, 2008; Haga, 2008; Lubans et al., 2010; Stodden et al., 2008) in a cross-sectional research setting. There is some evidence that children's motor skills are also related to people's physical activity level on the long term. Lloyd, Saunders, Bremer, and Tremblay (2014) found a long-term relation between motor skills proficiency at age 6 and leisure time physical activity at age 26. This is in line with studies of Clark & Metcalfe and Stodden et al. (Clark & Metcalfe, 2002; Stodden et al., 2008; Stodden, Langendorfer, & Roberton, 2009). They state that Fundamental Movement Skill (FMS) competence is critical in encouraging a physically active lifestyle. However, high-quality, large-scale, longitudinal studies on this topic are currently scarce (Cliff, Okely, Smith, and McKeen (2009); Lloyd et al. (2014)). In order to increase our knowledge of the relationship between motor skills at young age and physical activity later in life valid assessment tools are needed. These tools should be able to identify children with low motor coordination as early as possible, since the foundations of FMS are laid in early childhood (Lopes, Stodden, Bianchi, Maia, & Rodrigues, 2012; Runhaar et al., 2010).

FMS can be examined with several assessment tools. The most frequently used assessment tools in early childhood are: Motoriktest für Vier- bis Sechjärige Kinder (MOT 4-6), Movement Assessment Battery for Children (Movement-ABC), Peabody Development Motor Scales (PDMS), Körperkoordination-Test für Kinder (KTK), Test of Gross Motor Development (TGMD), the Maastrichtse Motoriek Test (MMT), and the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) (Cools et al., 2009). Cools, Martelaer, Samaey, and Andries (2009) reviewed these different assessment tools and concluded that in general the internal consistency and inter-rater reliability coefficients of those tools are high. In addition, the concurrent validity of most assessment tools is moderate. However, most tests are not very feasible in a PE setting. It takes at least 20 minutes to measure one individual child. Furthermore, special test materials and extensive knowledge of the test protocols are required to be able to conduct the tests. Purchase price of the tests range between 175, - up to 1375, - euro. In summary, Cools et al. suggest that further research in measuring FMS should involve PE teachers. It seems important to screen and monitor children's FMS over time with reliable, valid and feasible assessment tools (Cools et al., 2009; Lloyd et al., 2014; Stodden et al., 2009).

Therefore, a new assessment tool, i.e. an Athletic Skills Track (AST), was developed by Wormhoudt, Teunissen, and Savelsbergh (2012) in cooperation with PE teachers. These teachers told the test developers how FMS occur in a PE setting and how the FMS can be translated into an exercise within a track. The new tool took into account the disadvantages of existing assessment tools (i.e. high cost, time-consuming, not suitable for a PE setting) and aimed to assess FMS among large groups of school-aged children in a PE setting. To our knowledge, no studies have assessed FMS with a skills track in a PE setting. Thus, the purpose of this study was to examine the feasibility and validity of an AST to assess FMS among 6- to 12-year-old children in a physical education setting.

Methods

First, a pilot study was performed to test if the AST offers opportunities for measuring FMS in a PE setting. Next, in the main study, the AST was refined and validated on a larger scale.

Pilot study

In the pilot study a convenience sample of 54 children (28 boys, 26 girls) aged 6- to12-year participated, all of them attending the same Dutch primary school located in the centre of Amsterdam, the Netherlands. The children completed the AST and a valid and reliable motor competence test, the KTK (Vandorpe et al., 2011). The AST consisted of several obstacles to be completed as fast as possible (e.g., barefoot crawling for five meters to the front, jumping with both feet together through five rings, throwing and catching a ball, a front roll, and climbing over a vaulting box).

The pilot study showed that the AST is a feasible test to assess FMS among children aged 6-12 years in a PE setting. The overall motor quotient scores on the KTK (KTK MQ) showed a strong correlation with AST scores (i.e. time to complete the track in seconds) corrected for age ($r = -0.645$, $p < 0.001$). Based on the pilot study, the AST was refined and validated among a larger sample of school-aged children.

Validation study

Subjects

Children aged 6- to 12-year old were recruited from 5 primary schools in the The Hague region, the Netherlands.

The schools were selected at random from a database of the The Hague University of Applied Sciences for internship schools concerning the training of PE teachers. Informed consent was obtained from the parents or guardians of 623 children after they were given written information about the purpose and nature of the study.

Measurements

Measurements included three tests: the KTK and two Athletic Skills Tracks (AST-1, AST-2). All measurements were conducted in a separate section of the gym by a team of four research assistants (PE students of the The Hague University of Applied Sciences) during regular PE lessons. The research assistants have been trained in four meetings in conducting the tests according to the protocols. Testing was spread out over a two-week

time period in May 2014. To measure all the children in this period a uniform schedule was developed: during the first week the children were measured on AST-1, during the second week on AST-2. In this two-week time period all children also completed the KTK. Before and during the testing period the children received PE lessons as planned.

Körperkoordinatinon-Test für Kinder

The KTK, developed and validated among German children (Kiphard & Schilling, 1974) was used as a criterion measure to examine the validity of AST-1 and AST-2. The KTK is divided into 4 subtests;

1) Walking backwards three times along each of three balance beams (3 m length; 6, 4.5 and 3 cm width, respectively; 5 cm height).
2) Moving across the floor in 20 seconds by stepping from one plate (25 cm x 25 cm x 5.7 cm) to the next, transferring the first plate, stepping on it, etc.
3) Jumping from one leg over an increasing pile of pillows (60 cm x 20 cm x 5 cm each) after a short run-up.
4) Jumping laterally as many times as possible over a wooden slat (60 cm x 4 cm x 2 cm) in 15 seconds.

The test protocol for the Dutch language area (Lenoir et al., 2007; Vandorpe et al., 2011) was followed. The test protocol was carried out by research assistants. It took +/- 25 minutes to complete the KTK per child.

Athletic Skills Tracks

Based on the pilot study, two tracks were designed: AST-1 and AST-2. The tracks consisted of several obstacles to be completed as fast as possible. AST-1 (see also Figure 1) consisted of the following manipulative and locomotive skills: 1) crawling for five meters to the front, 2) hopping over a bench with the hands on the bench, 3) jumping with both feet together through five rings, 4) throwing and catching a ball, 5) kicking and stopping a ball with the preferred foot, 6) a front roll, 7) a back roll, 8) walking backwards, 9) climbing over a vaulting box, and 10) jumping over a chord.

AST-2 (see Figure 2) only consisted of locomotive skills, i.e.: 1) crawling for five meters to the front, 2) balancing on a bench, 3) jumping through five rings, 4) a front roll, 5) a back roll,

6) hopping over a vaulting box, 7) a longitudinal roll, 8) a tumble over on the rings, 9) a hopscotch around two cones, and 10) a stretch jump in the trampoline.

All children were shown an instruction movie before they performed three try-out trials per track and two trials per track, which were measured in time (seconds) by a research assistant using a stopwatch.

**** Figure 1 near here****

**** Figure 2 near here****

Data analysis

Of the 623 children who were allowed by their parents or guardians to participate in the study, 463 children met the inclusion criteria (age: between 6 and 12 years; all three tests completed).

First of all, the raw test scores on the KTK were converted into age- and gender-specific motor quotients (KTK MQ) using the test protocol for the Dutch language area (Lenoir et al., 2007). Participants were then classified into the five KTK motor skill categories: High Motor Giftedness (HMG), Good Motor Giftedness (GMG), Normal Motor Giftedness (NMG), Moderate Motor Disorder (MMD), and Serious Motor Disorder (SMD).

Second, descriptive statistics were performed to characterize the sample. To analyse a normal distribution of the outcome parameters, histograms were plotted and the kurtosis and skewness values for each of the outcome parameters were assessed. Differences between boys and girls were tested using an Independent Samples T-test. To analyse the test-retest reliability of the Athletic Skills Tracks the intraclass correlation coefficient (ICC) was calculated between the first and second trials of AST-1 and AST-2 with a Two Way Random model. In order to check for a learning effect between both trials, the scores on separate trials were also compared using a Paired Samples T-test. To examine the criterion validity of the Athletic Skills Tracks, KTK MQ and AST-1 and AST-2 scores were correlated with a Pearson's correlation test. Effect sizes (r) for main effects were calculated as outlined by Cohen (1992).

To analyse the distinctiveness of the Athletic Skills Tracks to identify children with low or high motor skills a one-way ANOVA was performed comparing the scores on AST-1 and AST-2 between the five groups based on the KTK MQ. All statistical analyses were

performed using IBM SPSS 22.0 64-bit edition. Values were considered statistically significant at $p < 0.05$.

Results

In total, 463 children (252 boys and 211 girls) with a mean age of 9 ± 2 years completed all three tests. Data was normally distributed. The anthropometric characteristics of the children and the KTK MQ and Athletic Skills Tracks scores are shown in Table 1. Boys had an average KTK MQ of 102 ± 14 and girls had an average KTK MQ of 106 ± 13. On average, it took about 44 to 45 seconds to complete the athletic skills tracks per child. When looking into AST-1/KTK level in Table 1 it shows that 69,5% of the children were normal motor gifted and completed AST-1 in 52 seconds ± 14. These children completed AST-2 in less time, i.e. 45 seconds ± 10.

Table 2 shows the results on the KTK, AST-1 and AST-2 per age group. An independent-samples t-test showed that girls had a significantly higher KTK MQ than boys (106 ± 13.3 versus 102 ± 14.2; T (461) = -3.242, p = 0.01.). On the other hand boys were significantly faster on AST-1 than girls (42 ± 9.5 sec versus 46 ± 11.5 sec; T (460) = -3.823, p < 0.01).

**** Table 1 near here****

**** Table 2 near here****

Test-retest reliability athletic skills tracks

Both athletic skills tracks were measured twice. The intraclass correlation coefficient between the first and second trial was 0.875 (95% CI [0.852-0.895]) for AST-1 and 0.891 (95% CI [0.870-0.908]) for AST-2 indicating a high degree of test-retest reliability (Shrout & Fleiss, 1979) However, a paired sample t-test showed a small, but significant learning effect between the two trials. On average, children completed the second trial two seconds faster than the first trial (AST-1 trial 1: 45 sec ± 11, versus trial 2: 44 sec ± 11; T=6.026, p < 0.05; AST-2 trial 1: 47 sec ± 12 versus trial 2: 45 sec ± 12; T=8.226, p < 0.05). Because of the small difference between the two trails it was decided to continue with the data of the second trial of AST-1 and AST-2 to examine their relationship with the KTK.

Criterion validity athletic skills tracks

Overall, there was a small correlation coefficient between AST-1 and the KTK (r = - 0.474, p = 0.01), and a medium correlation coefficient between AST-2 and the KTK *(r = - 0.502, p =* 0.01) (see Table 3). The correlations were higher when split up for gender; accept the correlation between AST-2 and the KTK for girls (*r = - 0.448, p* = 0.01*)*. In general,

correlations were also higher when examined per age group. The association between the tracks and the KTK was largest for 12-year old children (AST-1: r = - 0.767, p = 0.01; AST-2: r = - 0.727, p = 0.01) and smallest for 8-year olds with a medium association (AST-1: r = - 0.501, p = 0.01; AST-2: r = - 0.469, p = 0.01). There was no significant correlation between AST-2 and the KTK for 6-year old children (see Appendix 1).

**** Table 3 near here****

Discriminative ability athletic skills tracks

A one-way ANOVA revealed that both Athletic Skills Tracks were able to categorize children's FMS into high, good or normal motor giftedness or moderate or serious motor disorder as indicated by the KTK. The time score on AST-1 and AST-2 were significantly different between the five KTK categories (AST-1: Welch's F (4,21.011) = 22.968, p < 0.05; AST-2: Welch's F (4,20.366) = 27.746, p < 0.05)). On average, children with a higher motor giftedness completed the Athletic Skills Tracks significantly faster than children with lower levels of FMS (see also Table 1). Tukey HSD post-hoc analysis revealed that the differences between the KTK categories were all significant (p < 0.05) for AST-1 and AST-2 except for the difference between NMG – HMG and GMG – HMG.

Discussion

The purpose of this study was to examine the feasibility and validity of an AST to assess FMS levels among 6- to 12-year-old children in a physical education setting. The results show that an AST is a feasible test in a PE setting. The track measures a broad range of FMS using sports equipment and materials that are available in every gym in The Netherlands. On average, it took less than 1 minute per child to complete one of the tests (AST-1 or AST-2). A complete class (25-30 children) can be measured in one regular PE lesson of 50 minutes. Although a learning effect was found between the first and second trials (after three try-out trials), the test-retest reliability of both AST-1 and AST-2 was high. Furthermore, both AST-1 and AST-2 seem to be able to measure FMS in children aged 6-to12-year as the correlation coefficient between the time to complete the tracks and the KTK MQ was small and medium for AST-1 and AST-2, respectively.

Correlations were higher when split up by age group, except for 6- and 8-year old children on AST-2. In addition, the results showed that the tracks are able to distinguish between different motor skill categories (SMD, MMG, NMG, GMG, and HMG).

When comparing the results in this study with those presented in the review of Cools et al. (2009), it can be concluded that the validity of both tests (AST-1 and AST-2) is in the same range as the most frequently used assessment tools (range *r:* 0.43 - 0.87). However, the Athletic Skills Tracks are more feasible in a PE setting than the MOT 4-6, Movement-ABC, PDMS, BOTMP, TGMD, MMT, and the KTK. In other words, the AST seems to be a valuable alternative for the current motor competence tests to assess children's FMS in a PE setting. In order to increase its value, it is recommended to develop age-specific Athletic Skills Tracks in future studies since the current tracks were less distinct for the more gifted children. If the AST is capable to distinguish between different motor skill categories, the track could also be used by sports coaches to recognize potential athletes in different sports. The KTK is already tested for talent identification in female gymnastics (Vandorpe et al., 2012). Vandorpe et al. (2012) concluded that a non-sports-specific motor competence test could contribute positively in the process of talent identification. In addition, a motor competence test could also be helpful for insight into talent development (Faber, Nijhuis-Van Der Sanden, Elferink-Gemser, & Oosterveld, 2014). The AST might also be used by PE teachers and physiotherapists to identify the less motor gifted children. It is estimated that 5-10% of children are diagnosed with a Developmental Coordination Disorder (Kirby & Sugden, 2007).

Since FMS are founded in early childhood, and FMS are a predictor of people's physical activity level later in life (Lloyd et al., 2014), it is important to identify children with low motor coordination as early as possible (Lopes et al., 2012; Runhaar et al., 2010).

This study had several limitations. First, in this study, only time to complete the track was measured as an indicator of a child's motor skill level. Although this is a very feasible measure in a PE setting, other indicators, such as the quality of the movement, may be an even better predictor of motor competence. Secondly, no information was gathered on children's sports participation or physical activity level. Children who perform certain sports, such as soccer or basketball might have been at an advantage since AST-1 consisted partly of manipulative skills. In future studies, preferably, objective assessment methods should be employed to measure children's physical activity level as well as their motor skill level. Thirdly, this study did not focus on longitudinal effects of FMS on an active lifestyle. This could be a focus in future studies.

In conclusion, an Athletic Skills Track is a feasible motor competence test that can be used in a PE setting to measure FMS of children aged 6- to12-year. The tracks showed small to medium validity compared to a frequently used but time-consuming motor competence test and provided an indication of children's motor skills level. The challenge in future research is to differentiate the tracks for age and gender.

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