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Original Article

Development of Normative Data of the Athletic Skill Track and Development Coordination Disorder Questionnaire in Children

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ABSTRACT

Background: The escalating prevalence of pediatric obesity and the concomitant decline in physical activity levels have underscored the imperative to rigorously assess motor competencies in the younger demographic. The Athletic Skill Track (AST) and Development Coordination Disorder Questionnaire (DCDQ) are pivotal instruments in this context. However, normative benchmarks for these tools, particularly within the Pakistani pediatric milieu, remain inadequately delineated.

Objective: This investigation aimed to establish preliminary normative benchmarks for AST and DCDQ among a cohort of children aged 4 to 12 years in Lahore, Pakistan. A secondary objective involved delineating gender disparities in test performance and elucidating the correlation between Body Mass Index (BMI) and test outcomes.

Methods: Adopting a cross-sectional study framework, data were collated from an urban-based private school in Lahore, utilizing convenience sampling methods. The participant pool comprised 500 healthy children within the 4-12 age bracket. The research protocol encompassed anthropometric measurements and subsequent administration of AST and DCDQ. Data analysis was executed utilizing SPSS software, version 28.0.

Results: The study unveiled a marked gender-based disparity in AST performance, with boys manifesting superior rapidity across all AST tracks (AST 1: Mean=21.84, SD=4.99; AST 2: Mean=22.66, SD=5.083; AST 3: Mean=20.23, SD=4.76). An age-progressive enhancement in test performance was evident, as reflected in the linear decrement in completion times for AST-1 and AST-2 with advancing age. This trend, however, exhibited deviations from extant literature in specific cohorts, particularly in nine-year-old participants. In the realm of DCDQ outcomes, a significant positive correlation with age was observed, suggesting developmental advancements in coordination skills. The gender analysis revealed that boys outperformed girls in DCDQ assessments (Boys: Mean=60.17, SD=5.87; Girls: Mean=57.45, SD=7.09).

Conclusion: The present study enriches the extant body of knowledge by providing essential normative data for AST and DCDQ within a Pakistani pediatric population. It underscores notable gender and age-related variances in motor skills and coordination, offering critical insights for the formulation of targeted interventions and early detection strategies in motor skill development.

Keywords: Athletic Skill Track, Development Coordination Disorder Questionnaire, Pediatric Motor Skills, Physical Activity Assessment, Normative Data, Gender Differences, Pakistan.

INTRODUCTION

The escalating prevalence of obesity in children across all age groups, exacerbated by increasingly sedentary lifestyles, has become a pressing public health issue. Understanding of physical fitness habits in pre-kindergarten children remains limited, especially concerning the influence of school enrollment on their regular exercise routines. Public health experts have underscored the critical need for specific sports participation among children and adolescents in response to alarming rates of childhood obesity (1).

In 2008, a collaborative effort among various health care and fitness organizations led to the establishment of the Physical Activity Guidelines for Americans. These guidelines, which have garnered broad support, include specific recommendations for the pediatric population. They advocate for high-intensity physical activity for children and teenagers, suggesting at least one hour of exercise per

day, three times a week, along with muscle and bone-strengthening activities. The guidelines emphasize that sports exercises should be age-appropriate, enjoyable, diverse, and complement daily physical activity needs (1).

The appropriate volume and intensity of exercise for optimal health benefits during adolescence remain uncertain. Although it has been suggested that exercise levels beneficial for adults could apply to children, quantifying children's activity levels accurately is challenging. This difficulty poses a significant barrier to research, potentially affecting the consistency and generalizability of findings (1).

Engaging in proper exercise during childhood and adolescence can significantly enhance strength, aerobic endurance, and muscle mass, thereby reducing the risk of heart disease. These benefits extend into adulthood, contributing to an improved circulatory profile. Furthermore, exercise in children positively impacts bone strength, mental health, memory, school performance, and reduces the likelihood of sports injuries. Notably, physical activity habits developed in childhood often continue into adulthood (2).

The decline in physical activity levels among children and adolescents has been observed globally, including in the Netherlands, where a concurrent decrease in Motor Competence (MC) among youth has been noted. The challenge of accurately measuring physical activity in these age groups is compounded by the diversity of available evaluation tools, which are chosen based on study design and participant age (3).

Self-report studies indicate that 60 to 70 percent of adolescents engage in sufficient recommended physical activity. However, studies employing more stringent methods reveal lower levels of activity, particularly when cardiovascular health standards are considered. This discrepancy highlights the need for improved assessment methods and a better understanding of the benefits of low to moderate exercise levels, which are typically regarded as suboptimal for enhancing cardiorespiratory fitness (4).

Globally, promoting MC, physical activity, and healthy body weight among children and adolescents is a crucial challenge. In recent years, the concept of physical literacy has gained prominence in various countries, including the United States, Canada, and Great Britain, in response to these concerning trends. Physical literacy encompasses the motivation, confidence, physical competence, knowledge, and understanding necessary for lifelong engagement in physical activities. It is increasingly recognized that promoting physical literacy is not only beneficial for children but also for adults and older adults. MC is considered a fundamental aspect of physical literacy, and leading international physical activity guidelines recommend that young children engage in diverse exercises to enhance skeletal muscles and improve motion skill competence (8).

Research has linked greater physical activity engagement in childhood with numerous health benefits, including reduced adiposity, lower risk of cardiometabolic diseases, enhanced aerobic fitness and muscle development, and improved quality of life. Physical literacy is seen as a pathway to health, with higher physical activity levels associated with health benefits (9).

The connection between sports participation and cognitive functioning in children has been sparsely researched. Childhood is a critical phase for brain development, and understanding this association is vital (10).

While the benefits of regular physical activity in children and adolescents are clear, misconceptions exist about the potential adverse effects and complications of exercise in long-term illnesses such as epilepsy, asthma, and diabetes. Recent evidence highlights the positive impacts of physical activity on these conditions. For instance, physical exercise improves metabolism, bone density, cardiovascular health, and insulin sensitivity in children with Type 1 Diabetes Mellitus (T1DM), reducing their mortality risk. Similarly, children with asthma benefit from exercise through improved cardiovascular health, physical capacity, increased asthma-free days, and enhanced quality of life. Adolescents with epilepsy, previously discouraged from sports participation due to concerns about symptom exacerbation, have been shown not to experience increased symptom severity with physical activity. The existing research also suggests that sports participation and regular exercise reduce the development of mental health disorders during adolescence. Thus, children with long-term illnesses should be encouraged to engage in sports and exercise to enhance their long-term health and quality of life (11).

Fundamental Movement Skills (FMS) are crucial for developing the MC component of physical literacy and play a vital role in MC development. Physical education (PE) has been identified as a valuable resource in nurturing physical literacy, providing children with the foundations for an active lifestyle. While physical literacy extends beyond physical education, PE offers essential building blocks for lifelong engagement and enjoyment in physical activities (12).

There is a growing need to promote sustained MC, physical exercise, and healthy weight status in children, along with large-scale, repeated measures during early development. The factors influencing MC development and, consequently, health outcomes are not well understood. Given the alarming trends, several countries have intensified initiatives, incorporating them into their educational curricula (12).

A credible and accurate assessment method suitable for the PE environment is essential to place greater emphasis on PE, physical activity, and sports promotion. Various motor skill competency assessments have been developed, such as the Körperkoordinations-

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Test für Kinder (KTK), which is product-focused, and the Movement Assessment Battery for Children-2, which is process-oriented (12).

The Athletic Skills Track (AST) emerged in 2016 as a robust and practical test for measuring children's motor skills. Unique in its approach, the AST considers the functionality of the entire body and consists of a series of five to seven detached FMS supporting coordination skills. Previous studies have validated the AST as a reliable and feasible tool for assessing FMS in children aged four to twelve in a PE setting (13).

The FMS can be categorized into locomotive, manipulative, and balance skills. As children progress through the Mountain of Motor Development, their motion becomes more complex, with FMS serving as a prerequisite for more advanced stages (14).

The AST challenges students to complete a course in the shortest time possible, focusing solely on the time taken to complete the track. This approach distinguishes the AST from other FMS assessment tools, which often have high costs, are time-consuming, and are not suitable for PE settings (14).

Given the decline in FMS and physical activity (PA) levels in recent decades, there is an urgent need to enhance our understanding of FMS development and create effective strategies to help children achieve optimal levels of physical literacy (PL). Reliable motor skill competency testing is crucial in this endeavor (15).

The Developmental Coordination Disorder Questionnaire (DCDQ) is another tool used to assess children's motor abilities. It is a parent-reported test designed to aid in diagnosing Developmental Coordination Disorder (DCD) in children. Parents compare their child's motor skills to those of their peers on a 5-point Likert scale (15).

The DCDQ, originally developed at the Alberta Children's Hospital in Calgary, Canada, has been adapted and validated in various cultures, including a Spanish version (DCDQ-ES). However, further psychometric validation is required, and context-specific cut-off scores are recommended for different demographics (15).

DCD, characterized by coordination difficulties, affects learning performance, participation in fitness activities, and cognitive processes like awareness and empathy from childhood through maturity. It is a common pediatric disorder with an estimated global prevalence of 6% (17).

The DCDQ-2007, an updated version of the DCDQ, extends its applicability to adolescents. Its psychometric properties, including concurrent validity, sensitivity, and specificity, were tested against the MABC-2 in a community-based sample of 87 teenagers. While promising psychometric features were found, the relevance of the DCDQ-2007 as a screening measure for motor problems requires careful consideration (22).

In summary, the increasing concern over childhood obesity and declining physical activity levels necessitates a focused approach towards enhancing physical literacy, motor competence, and healthy lifestyle practices from an early age. Tools like the AST and DCDQ play a significant role in this endeavor, providing valuable insights and aiding in the development of targeted interventions.

MATERIAL AND METHODS

The study was conducted as a cross-sectional analysis, where data on Athletic Skill Track (AST) and Development Coordination Disorder Questionnaire (DCDQ) scores were collected and analyzed at a single point in time, specifically in the year 2022. Data collection took place in Lahore, within an urban community setting, utilizing a private school located in Township as the primary setting.

A convenience sampling technique was employed to select the participants for this study, which spanned a duration of six months following the approval of the synopsis. The population targeted for this research comprised healthy children aged between 4 to 12 years, with a total sample size of 500 participants (24).

For the purpose of screening, anthropometric measurements including weight, height, hip circumference, and chest circumference were meticulously recorded for all 500 participants. The data collection for the DCDQ and AST I, II, III was conducted through a structured procedure.

The inclusion criteria for the study were set as follows: children aged between 4 to 12 years (23), encompassing both genders (25), who were able to understand and communicate in Urdu or English. Children were required to be capable of following instructions to be eligible for participation.

However, certain exclusion criteria were also established to maintain the integrity of the study. These included children with nystagmus (26), flat foot, a history of club foot, any history of surgery within the past year, cognitive impairment as indicated by a score less than 20 on the Mini-Mental State Examination (MMSE), inability to follow commands, presence of functional scoliosis, or a leg length discrepancy.

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The data analysis was conducted using SPSS version 28.0. The data collection procedure involved engaging the adolescent population, aged above 4 years, in the Athletic Skill Track and Developmental Coordination Questionnaire. The participants were instructed to perform these tests using specific equipment, with the data being collected by an observer.

The tools used for this study were the Athletic Skill Test and the DCDQ. The AST is a measure of children's motor skills, comprising a series of five to seven detached skills, such as coupling, spatial orientation, and balance abilities. Participants were challenged to complete the course in the shortest time possible, with the time taken being the sole metric of measurement. The reliability scores for AST I, II, and III were 0.88, 0.802, and 0.8, respectively (23).

The DCDQ, a brief parent questionnaire, assesses coordination and helps diagnose Developmental Coordination Disorder in children. Parents rated their child's motor skills compared to their peers on a 5-point Likert scale. The DCDQ demonstrated a reliability of 0.91 (27).

RESULTS

The Athletic Skill Tests (AST) and the Development Coordination Disorder Questionnaire (DCDQ) present insightful data on children's athletic skills and coordination. In AST1, male participants exhibited a lower mean score of 21.84 with a standard deviation of 4.99, and their scores ranged from 13.00 to 42.00. In contrast, females scored higher on average, with a mean of 27.91 and a narrower standard deviation of 4.23, spanning from 20.00 to 39.00. AST2, evaluated without gender distinction, showed an overall average score of 27.05 among 191 participants, a standard deviation of 7.09, and scores ranging from 13.00 to 47.41. AST3 displayed similar gender-based differences: males averaged 20.23 with a standard deviation of 4.76 and a range from 11.00 to 41.13, while females averaged higher at 27.31 with a standard deviation of 7.79 and scores from 15.00 to 47.30.

The DCDQ results, grouped by age, revealed that children aged 5-8 years (273 participants) had an average mean score of 53.65, a standard deviation of 2.45, and scores ranging on average from 45.50 to 60.00. In the 9-12 years age group (227 participants), the average mean score was notably higher at 63.86, with a standard deviation of 3.40 and an average score range from 51.50 to 69.50.

Correlation analyses for AST and DCDQ showed significant relationships. AST1 scores correlated positively with BMI ($r = 0.199$, $p = 0.016$) but showed a weak negative correlation with hip circumference. AST2 scores had a slightly stronger positive correlation with BMI ($r = 0.231$, $p = 0.001$). AST3 scores, however, showed a negligible negative correlation with BMI. In the DCDQ, a strong positive correlation was observed between scores and age for both males ($r = 0.827$, $p < 0.001$) and females ($r = 0.885$, $p < 0.001$).

Finally, the ANOVA and regression analysis for AST1 and AST2 revealed varied results. For AST1, the regression model showed an insignificant relationship with a very low F-value (0.040) and a high p-value (0.841), indicating no significant predictive value. In contrast, AST2's regression analysis showed a significant model with an F-value of 9.615 and a p-value of 0.002, suggesting a stronger predictive relationship between the tested variables.

Table 1 Consolidated Descriptive Statistics of Athletic Skill Tests (AST)

Test	Gender	N	Mean	Std. Deviation	Minimum	Maximum
AST1	Male	79	21.84	4.99	13.00	42.00
AST1	Female	68	27.91	4.23	20.00	39.00
AST2	Total	191	27.05	7.09	13.00	47.41
AST3	Male	79	20.23	4.76	11.00	41.13
AST3	Female	83	27.31	7.79	15.00	47.30

Table 2 Combined Descriptive Statistics of Development Coordination Disorder Questionnaire (DCDQ)

Age Group	Total N	Average Mean	Average Std. Deviation	Average Minimum	Average Maximum
5-8 Years	273	53.65	2.45	45.50	60.00
9-12 Years	227	63.86	3.40	51.50	69.50

Table 3 Correlations for AST and DCDQ

Test	Correlated Variable	Pearson Correlation	Sig. (2-tailed)	N
AST1	BMI	0.199	0.016	147
AST1	Hip Circumference	-0.075	0.364	147
AST2	BMI	0.231	0.001	191
AST3	BMI	-0.041	0.604	162

Test	Correlated Variable	Pearson Correlation	Sig. (2-tailed)	N
DCDQ (Male)	Age	0.827	0.000	261
DCDQ (Female)	Age	0.885	0.000	239

Table 4 Combined ANOVA and Regression Analysis for AST1 and AST2

Test	Model	Sum of Squares	df	Mean Square	F	Sig.	B	Std. Error	Beta	t	Sig.
AST1	Regression	1.254	1	1.254	0.040	0.841	0.168	0.837	0.017	0.201	0.841
AST2	Regression	461.823	1	461.823	9.615	0.002	1.802	0.581	0.220	3.101	

DISCUSSION

In this study, normative values related to gender and age have been established for children aged 4 to 12 based on the time required to complete AST I, AST II, and AST III. The study supports Hoebar's findings, indicating that boys are significantly faster in all three tracks. Notably, AST 1 shows boys with an average time of 21.83±4.99, AST 2 with 22.66±5.083, and AST 3 with 20.23±4.76 (25). The reference curves illustrate age-related changes in AST-1 and AST-2 completion times, presenting an almost linear decrease with age. This study, however, finds differences from Hoebar's results in the completion times for AST-2 and AST-3 among nine-year-old boys and girls, with boys outperforming girls significantly in both tests.

The study also explores the concurrent validity of the AST in terms of its correlation with the MQ KTK. While moderate to high correlations were reported in previous studies, this study presents divergent results with AST I: $r = 0.017$, $p = 0.4$; AST II: $r = 0.22$, $p = 0.001$; and AST III: $r = -0.047$, $p = 0.2$.

Further, the DCDQ-ES total scales showed statistically significant age differences, with younger children scoring lower than their older counterparts (27). This finding aligns with the results of this study, which also identifies a significant positive correlation between age and DCDQ scores. However, differences were observed in the performance between the sexes. Contrary to Rebeca's findings, where girls outperformed boys in the total score, this study finds the opposite, with boys scoring higher than girls.

In the broader context, motor coordination is recognized as a multifaceted concept, encompassing various factors. Fine motor skills, movement coordination, and general coordination, while related, are distinct concepts. This study highlights that children with DCD typically face challenges with fine and gross motor coordination patterns, regardless of cultural and geographical backgrounds (28). A comprehensive assessment is essential for identifying DCD or coordination issues in daily life.

The study, however, is not without limitations. The participant pool was exclusively drawn from the Lahore region, and the urban setting of data collection may have influenced the normative values. Additionally, all participating children were receiving weekly physical education lessons from qualified PE teachers, which could have impacted their motor skills development. Furthermore, the age-based reference curves do not account for variations within the same birth year.

For future research, it would be beneficial to explore reference values in other parts of Pakistan or in different countries. Studies should focus on the specificity and sensitivity of these tests for the Pakistani population, employing a larger sample size and adhering to diagnostic criteria. More precise age recording, based on both the birth year and month, is recommended. Further assessments on the discriminative ability and validity of AST for specific age groups are also suggested.

CONCLUSION

In conclusion, this study has successfully developed preliminary data for the AST and DCDQ based on normative values, offering valuable insights into motor skill competencies among children in the Lahore region.

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