

Evaluation of cardio respiratory and Neuromotor fitness in Indian children with developmental coordination disorder

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Abstract

Children with developmental coordination disorder exhibit decreased participation in sports and in other physical activity sessions and the situation has enhanced negative concerns on aerobic capacity and lung functions. The current study examines the cardio respiratory and Neuromotor capability among children with developmental coordination disorder in Indian context using field based test like six minute walk test and snider match test. Twenty children of age group 5-10 years participated in the study and they were initially screened using movement assessment battery for children (MABC-2), Developmental coordination disorder questionnaire (DCDQ). Children with developmental coordination disorder had poorer performance on both six minute walk distance and snider match test when compared to age matched typically developing children ($p < 0.01$). There is a significant correlation between snider match test and 6 minute walk distance ($r = 0.510$, $p < .001$) for all children. Moreover, the reduction in aerobic capacity was related to decrease in lung function and reduced peripheral muscle conditioning was the underlying factor that limits the aerobic capacity evaluated through six minute walk test distance.

Keywords: DCD, DCDQ, MABC-2, Aerobic capacity, snider match test.

Introduction

Developmental coordination disorder (DCD) is characterized with the difficulties in executing the functional tasks such as writing and manipulating small objects as well as executing physical activity like cycle riding. DCD is characterized by impairments in motor coordination and it influences the participation in physical activity. The difficulties faced by children with DCD were not related to neurological impairment or other medical conditions. DCD is the chronic impairment that persists into adulthood and few considers DCD will outgrow on its own and there is no need to intervene on the child's routine. Literature search focused on motor coordination difficulties experienced by children with developmental coordination disorder but there are no remarkable findings and documentation on the factors underlying the impairments. However the terms used in describing the children with DCD were clumsy, awkward and movement impaired.

The variation in terminology used initiated difficulty in identifying children with DCD and the prevalence rate documented in the literature search varies based on the terminology used and assessment tool used. In Indian context there is no standard assessment tool to identify the children with motor coordination difficulty. Few children with difficulty in fine motor skill, gross motor coordination and balance were considered to have developmental coordination disorder without the gold standard diagnostic methods. There are innumerable domains where the child needs assessment and intervention as well as further exploration. In 1937, children were diagnosed and termed as clumsy, awkward and dyspraxia if they presents with mild motor problems. Geuze et al documented that children with motor coordination difficulty also have difficulty in reaching age appropriate milestone. When the child exhibits difficulty in acquisition of skills he or she requires movement coordination assistance.

Developmental coordination disorder is characterized by defect in executing the skills that demands coordination of motor skills. Diagnosis is based on the performance of activities of daily living skills. The child with DCD inspite of having IQ greater than 80% finds it hard to execute the task that demands coordination of bilateral upper limbs¹. When compared to typically developing peer group children, these children diagnosed with DCD finds it difficult to wear the shirt and button up the shirt. At school and in play ground these children were found to be isolated and avoid participation in sports. Ball throwing and catching task that is considered as simple by the typically developing children requires repeated practice and learning for children with developmental coordination disorder². However they find it hard to execute the ball catching and throwing task after repeated practice sessions. Based on these negative experiences in play ground, these children tend to avoid physical activity sessions and tend to feel isolated and avoid peer group children. Later these children develop negative perception of their abilities and have other psychosocial impairments if not adequately managed and rehabilitated at the early stage.

Early diagnosis plays an important role in rehabilitating children with developmental coordination disorder. Based on the early diagnosis, the children with developmental coordination disorder can be allocated for rehabilitation sessions³. But failed and false positive results in diagnosis can further delay the intervention process and the child with developmental coordination disorder exhibits peripheral muscle deconditioning and cardiovascular conditioning. The results were poor cardio respiratory and neuromuscular fitness. American psychiatric association and world health organization have inclusion and exclusion criteria in their diagnostic process and the child is considered as having DCD if he/she has difficulty in executing the motor skills which were considered appropriate for the Childs chronological age and intelligence⁴. Poor participation in physical activities was considered to be the risk factor for poor cardio respiratory fitness. Failed in participation in sports and other academic activities makes the child less mobile and in due course of time, the child acclimatizes and bound to home. Decreased participation in physical activities will isolate the child and bind him to home and he or she will lose contact with the peer group children. Majority of the parents in Indian contexts wants their children to get academic success by scoring higher grades on examination but fails to evaluate the child's physical activity levels as well as fitness level.

For children with developmental coordination disorder the simple activity of throwing the ball towards the target is

difficult and they need repeated practice attempts to master the skill. Other age matched typically developing children learn the task easily without any practice and learning effort. Reduced participation in green land play will further reduces the child's aerobic fitness and lung function. In our previous research we have concluded that children with DCD have low levels of vitamin D deficiency and this will deteriorate the health and well being of the child. For aerobic fitness, the child should engage in the physical activity sessions for at least 4 times per week. Children with DCD were reported to have poor aerobic fitness level compared to their peer group children and they previous researchers have documented that using laboratory tests. But research in field based test for children with developmental coordination disorder were in scarce and there are less documentation in Indian children with developmental coordination disorder⁵. Till date there is no documentation on 6MWT, FVC, FEV1 values were verified for children with DCD in Indian context using field based tests. This purpose of the current study is to examine the cardio respiratory and Neuromotor fitness using field based test and bed side evaluation.

Methodology

Participants were recruited from 5 primary schools in and around Chennai and the participants underwent screening for developmental coordination disorder using DCDQ and MABC- Movement ABC test (Henderson & Sugden, 1992). Both typically developing children and children with developmental coordination disorder participated in the study and they were assigned into two groups. Group A was assigned with DCD children and Group B is with typically developing children. Every child included in the study underwent six minute walk test and match blowing test. The test was conducted in the physical education rooms at the schools and prior approval was obtained from the school principal. All children with DCD were asked to participate in the field test and they were explained about the test and instructed to walk at their own pace and if they have difficulty in proceeding further steps.

They were allowed to stop at any time and the total distance covered and minutes completed were documented as well as the reason for termination of the test were also documented for reference purpose. During the initial screening process, 2 children were excluded as they have intellectual difficulty and 1 child is not interested to attend the field test and he left the study. Finally 10 children with DCD were completed the field test and 10 children without DCD were also completed the test. Before experimenting the protocol, the test was explained in detail to the parents and the child. Information sheet was distributed to the parents and they were asked to rectify their doubts at any point from the study initiation to end. Written informed consent form was signed by all the parents. At the baseline the participants were examined for the presence of any illness.

Clinical interviews were also conducted with the parents to confirm the diagnosis. As there is no gold standard assessment tool for the diagnosis of children with DCD in Indian context, to confirm the diagnostic methods, questionnaire and interviews were used. Inclusion criteria for the study are children should not receive any intervention during the past 3 months and they should not have any emotional and neurological disorder. Any history of learning disorders and behavioral disorders were excluded. The current study aimed to evaluate the cardio respiratory fitness and hence the presence of any cardio respiratory

diseases like cystic fibrosis and asthma as well as respiratory infection before 1 month was excluded. Typically developing children were included in the study on volunteer basis. Initially socio-demographic data was collected and children completed the field test on consecutive sessions on a single day. Participants were allowed to complete the 6MWT test.

Snider match test was conducted to evaluate the FEV1 values and the children were asked to blow the match stick held at the distance of 1 meter from mouth and the child should blow out the fire. Height and weight were documented in the physical education room and the demographic questionnaire includes child's health status and medications. 6 minute walk test was performed in a flat surface with 30 meter hallway and the distance is marked every 2 meters. In accordance with the American thoracic society the test was conducted twice and the best value is documented as final value. Initially, all the children included in the study were allowed to undertake a practice test. Participant was allowed to cover the long distance as possible. They can stop and resume the activity after a break. Pulmonary function test was replaced with the bed side assessment which is performed using snider match test.

Results

Table 1: Comparison of demographic data for children with and without DCD

Demographic profile	DCD Group	Typically developing Group	t	p
Age	8.12	8.23	0.812	0.412
Height	132.2	135.2	-1.111	0.231
Weight	31.2	29.8	-1.345	0.12
BMI	15.4	16.5	-1.52	0.14
IQ	100	102	0.812	0.327

Table 2: Comparison of pulmonary function, Cardiorespiratory parameters, 6MWD and MABC scores of children with and without DCD

Parameters	DCD children	Typical children	t	p
HR Max	172.25	178.34	0.334	0.623
FEV1	100.65	128.6	3.123	0.005
6MWD	500.23	723.1	3.912	0.001
MABC Scores	17.82	3.8	9.215	0.0001

Discussion

Children with DCD were perceived as having lower fitness levels, however it has been documented by the previous researchers that these children perceive themselves as incapable and not eligible to execute any activities of daily living task that demands effort. Simple task of activities which is executed in daily life by other children of same age

requires repeated practice and effort from a child with developmental coordination disorder. They experience trouble in executing walking, running and jumping. Due to the difficulties in task, these children are less physically active and more likely to be sedentary than children without developmental coordination disorder⁶.

In the literature search further terminology like developmental apraxia and minimal brain dysfunction were also documented. American psychiatric association introduced the term developmental coordination disorder and the term gained popularity in literature. At Ontario, research community was agreed to use the term developmental coordination disorder to help researchers identify the children with developmental coordination disorder and to develop treatment approaches. Identifying children with DCD at the earlier stage will further prevent the secondary complications and in research setting in Indian context heterogeneity of the disorder needs consideration. The heterogeneity of DCD is further creating complications in the identification of children with developmental coordination disorder. However identifying the children who exhibits motor coordination difficulty at the earlier stage by their parents or teacher is considered as a challenge and majority fails in identifying the children with DCD. It is a real challenge for teachers and parents to correctly identify the child's difficulty and needs. Due to the presence of various assessment tools, researchers often confuse between various tools used and for the diagnosis of children in Indian context researchers used multiple tools at single time and ends with false positive and false negative results as well as diagnosis. The most commonly used tools for Indian children with DCD includes Bruininks Oseretsky Test of Motor Proficiency (BOTMP), Movement Assessment Battery for Children (MABC), Developmental Coordination Disorder Questionnaire (DCDQ). However for Indian children none of the tools produce a consistent findings and there are innumerable inconsistency between the assessment tool used, BOTMP identify the child with DCD however the same child is identified in non-DCD category with MABC. Thus there is no consistency between the tools used.

Rivlis et al in 2011 documented those children with developmental coordination disorder exhibits poor health related physical fitness in addition to their motor problems. Majority of the researchers examined the difference between typically developing children and children with DCD in non-clinical settings. Till date, there is no clear data and documentation on the level of physical fitness of children who were diagnosed with developmental coordination disorder in Indian context⁷. There is unclear statements exists on the performance of Indian children on different components of physical fitness. One of the main components of poor physical fitness is aerobic power and it is lower in children with developmental coordination disorder⁸.

The gold standard method for evaluating the aerobic capacity is cardiopulmonary exercise test. The CPET is performed in field based test or laboratory based test. Faught et al in 2010 documented that developmental coordination disorder is identified as a chronic health condition and it is associated with decrease in cardio respiratory function⁹. Van der hoek in 2012 documented that there is an alteration in peripheral muscle response in children with DCD due to inactivity. Field based six minute walk test is the safe and efficient way for assessing the functional status among children with developmental coordination disorder. In monitoring the effectiveness of

the treatment, six minute walk test is most commonly used and it is safe for children with DCD when compared to laboratory based tests¹⁰.

Walking tests like 6MWT is the sub-maximal test used and its normative data with its extended applicability was documented by lie et al in 2005. The walk test is most commonly used exercise test in clinical settings and it has a good reliability and validity data for Indian children. The 6-min walking test (6MWT) has emerged as a clinically relevant test as it incorporates the common activities of daily living and it closely resembles the most commonly executed physical activities like walking and the instructions delivered to the children were quite simple as they were instructed to walk at their own pace and the test is used to estimate cardiopulmonary fitness in healthy children and in children with developmental coordination disorder¹¹. Children with developmental coordination disorder were found to have difficulty in coordination of their motor skills and they demands perfect motor coordination for treadmill walking to estimate their sub maximal test¹². Thus the field based test is the most reasonable alternative for children with developmental coordination disorder¹³.

As children with DCD have balance problem, there is a need for supervised testing sessions and monitoring their exercise capability along with supervision plays an imperative role¹⁴. Executing the cycle ergometer test and performing the shuttle run tests were also difficult for children with developmental coordination disorder. As the shuttle run test demands the coordination of bilateral limbs, balance, pivoting the line with foot contacts. Thus walking is easier for children with developmental coordination disorder¹⁵. Eisenmann et al concluded that lung function is predicted through cardiopulmonary fitness and they have documented that children and adults who engages in regular physical activities have good lung function. Estimating the lung function of children with DCD is safe way to examine their aerobic fitness¹⁶.

Conclusion

The results of the study add to the documentation that children with developmental coordination disorder experiences exercise intolerance and they have poor cardio respiratory function and Neuromotor fitness. Further longitudinal studies were in need to evaluate the findings of changes in pulmonary function.

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Availability of data and other materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Please mail and reach us in monisha_ravikumar@srmuniv.edu.in

Ethics approval and consent to participation

The study was approved by the Institutional Ethics Committee (Human Studies) of the SRM Institute of Science and Technology, Kattankulathur with Approval No. 1755/IEC/2019. Written informed consent for interviews was obtained from all participants. The privacy and confidentiality of all the participants was strictly maintained.

Competing interests

Authors declare no conflict of interest

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