Grip strength and pen pressure are not key contributors to handwriting difficulties in children with developmental coordination disorder in Indian context

Abstract

Handwriting difficulties were predominant among children with developmental coordination disorder. Poor muscle strength and pressure exerted by pen were factors assessed by the clinicians and they play a role in determining the handwriting efficiency. There is no empirical evidence on the handwriting efficiency and the factors associated with it for Indian children with developmental coordination disorder. The study aims in evaluating the grip strength and pen pressure in handwriting performance among children with developmental coordination disorder. Ten children of age group 5-10 years with developmental coordination disorder were compared with typically developing children. Hand dynamometers were used in evaluating the palmar and tripod grip strength. Handwriting task was compared between the typically developing children and DCD children and the results of the study assured that there was no significant difference documented in the hand dynamometer measures of grip strength. DCD children exhibit less pressure on writing surface as compared to typically developing peer group children. There was no correlation between grip strength and pen pressure over handwriting efficiency in children with developmental coordination disorder. Clinicians should create awareness on the importance of enhancing handwriting skill among children with developmental coordination disorder.

Keywords: DCD, Handwriting performance, pen pressure, grip strength, academic performance

Introduction

Efficient academic performance among school aged children demands a good Handwriting skill and it is a key for progression in academics. Children with poor handwriting skill exhibits poor participation in academic activities and have poor self esteem[1]. Children with developmental coordination disorder experiences poor participation in academic tasks that demands motor coordination. They experience failure in academics due to poor handwriting skill[2]. Children learning outcome is evaluated through the written examination and with deficits in handwriting skills, they experience poor grading in examination as well as failures. Handwriting skill is imperative for success in academics[3]. Group of children who exhibits difficulty in handwriting inspite of having higher intelligence is children with developmental coordination disorder.

The term DCD represents children who exhibits motor coordination difficulties without the presence of medical conditions and neurological defects[4]. Previous researchers have documented that 89% of children

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with developmental coordination disorder experiences handwriting difficulty and this is established by American psychiatric association in their diagnostic criteria. Over the past 10 years researchers were evaluating the child's writing skill using tablets and by using other diagnostic tools to evaluate the handwriting speed as well as legibility[5]. In our previous research we have concluded that children with developmental coordination disorder exhibits poor writing speed as compared to the typically developing peer group children and they produce few words per minute as well as few legible words when compared to children with typical development[6].

The slowness in producing letters in handwriting process is linked to poor academic task execution capability. The literature search has confirmed that there is excessive pausing in writing task and that is the reason for slowness in producing efficient writing[7]. In 2014, Prunty et al concluded that children with DCD will pause for longer period of time in between letters as well as between words as compared to children with typical development[8]. Researchers often describe the difficulties described by children with developmental coordination disorder without examining the underlying factors that influences the child. However the underlying mechanisms remain unknown and poorly understood.

Occupational therapist who executes assessment and design intervention for children with developmental coordination disorder must examine the factors which restrict the child from executing it. Failed to understand the cause and effects will lead to insufficient evidence generation about developmental coordination disorder children[9]. Clinicians fail to understand the assumptions and treatment options available in managing children with developmental coordination disorder. There are assumptions about the child's handwriting difficulty and there is insufficient evidence left regarding the grip strength and pressure. For an efficient writing task, there is a need for in hand manipulation skill, the ability of the child to manipulate the object held in hands[10].

Efficient manipulation of thumb and fingers with effective control of force over the pen or pencil shaft to produce the letters and shapes demands in hand manipulation skill and grip strength. Smits-Engelmann et al concluded in their research finding that there is a need for force production with intrinsic muscles and that should be applied downwards on to the paper[11].

Methodology

The current study was approved by institutional ethical committee of SRM Medical College hospital and research institute. Parents were explained about the study design and procedure to be conducted and they were provided with the information sheet, after our primary researcher explained the work, parents were

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asked to sign consent form and they were allowed to withdraw from the study at any time. Then the children with developmental coordination disorder were included and recruited for the study from the community with the help of primary school teachers, support groups and research group.

Children were reassessed to confirm their diagnosis with developmental coordination disorder. DSM-V criteria of diagnosis were followed and DCDQ was used to screen the children with DCD. In accordance with the DSM-V diagnostic criteria A of DCD, children should possess significant difficulties in motor skill and the performance in motor skill should be less than 5th percentile. Movement assessment battery for children includes three motor competencies like manual dexterity, aiming and catching, balance. According to DSM-V criterion B, the motor difficulties experienced by children should have significant impact over the children's activities of daily living and the difficulties were documented and reported by parents and to evaluate the criterion C as well as D, educational qualification and mental history were taken into consideration.

To confirm the presence of DCD in accordance with the criterion D, The British Picture Vocabulary Scale 2nd edition was used. Each participant was evaluated using DSM-V criteria of DCD, Movement assessment battery for children, DCDQ. Without the gold standard assessment tool, researchers use more than one tool to confirm the diagnosis. The children included in the study should have IQ score above 80 and that confirms the absence of intellectual defect. Control group children were recruited from the primary and secondary schools in and around Chennai.

Teachers were contacted through emails and they were informed about the details of the study and if willing they can recruit the children to participate in the study. Teachers as they spend majority of their time with students, they can use their professional judgment to identify the children with developmental coordination disorder. Teachers identify the children with the absence of motor, intellectual and reading difficulties. To evaluate the children motor skills there is a need to incorporate any standardized assessment tool that finds the difficulties of Indian children with DCD. They can use their personal skills and judgment to evaluate the child's difficulties.

The referred children were evaluated personally by the therapist. Children found to have any difficulty in dyslexia, ADHD were excluded from the study. Language skill and attention skill were considered as confounding factors when evaluating the handwriting skill among children. Detailed Assessment of speed of handwriting- DASH was used and copy fast task was used in the current study. DASH was commonly used to measure the handwriting speed and accuracy. Words that are illegible and legible were documented. Speed of execution is evaluated by total distance covered by pen and which s divided by writing time.

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Previous research found no difference in speed of execution among children with and without DCD. The time percentage is measured by pausing during writing and the task of lifting the pen or pencil off the page is used to document the in air pause of writing. Previous researchers documented those children with developmental coordination disorder exhibits greater pause while writing than typically developing children with DCD. In previous research work, it is documented that higher percentage of typically developing children have DCD and without gold standard assessment tool, there are misdiagnosis and faulty rehabilitation methods.

There is a lack of automaticity in writing task and these children experience delay in copying task from board when compared to other typically developing peer group children. Pausing while writing was used to examine the relationship between grip strength and pressure exerted by pen over the paper. In the current study three evaluations of grip strength was calculated. Palmar grip, pinch grip and tripod grip was used to evaluate the level of strength in the extrinsic muscles of the hand in the forearm. Palmar strength was measured using hand dynamometer. In the present study, American society of hand therapists –ASHT guidelines was used and the participants was instructed to hold the dynamometer with their elbow flexed to 90 degrees and shoulders abducted with medial rotation of forearm.

The dynamometer was placed in the dominant hand first and instructed to squeeze the dynamometer for 3- seconds. The instructions were delivered to the child to squeeze the with as dynamometer for 3 seconds and the child is instructed to squeeze as much as possible with maximum strength. Dominant and non dominant hand was tested at the same time and three trials were allowed for every child and the maximum value is documented. 3 seconds were allowed to squeeze the dynamometer as during the time period the child is allowed to recruit the muscles to produce force. Peolsson et al recommended in his research study that jamar dynamometer was most reliable to use in clinical setting. Pinch grip of thumb and index finger and tripod grasp of thumb, index and middle finger was used in handwriting and a practice trial was allowed for each participant to execute the grip strength. The mean strength is calculated for all the dependent variable in each grip pattern observed while writing. After grip strength evaluation, handwriting assessment was implemented for 60 minutes. To evaluate the difference between typically developing children and children with developmental coordination disorder, descriptive statistics was examined for dependent variables.

Results

Table 1: Mean Values of selected measures of both group A and B

Measures	DCD Group	Typically developing children group	p

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Age in years	9.54	9.87	.65
Total score MABC-2	1.45	0.00	-
Manual dexterity	5.34	52.03	<.001
British pictorial vocabulary scale	092.12	0. 00	-

Table 2: A Comparison of the handwriting performance, grip strength and pen pressure for group A and B

Measures	Developmental coordination disorder children	Typically developing children	p
Words per minute	16.45	20.00	.213
Illegible words	3.12	0.00	.001
Grip strength – palmer	10.12	13.98	.121
Pinch grip	2.65	2.45	.632
Tripod	3.24	3.88	.412
Copy fast task	4.21	6.45	.023

Discussion

Children with handwriting difficulties need assessment in both force control and speed. Further detailed evaluation need to be done on amount of pressure exerted and handwriting speed while writing a free task and copying. In clinical practice it is made clear that children with developmental coordination disorder hold the pencil tightly while writing and those results in fatigue as well as pain over fingers. The underlying factors for the fatigue and painful symptoms were lack of strength and endurance were assumed to be the reasons for poor handwriting legibility[12].

However the reduced strength in shoulder complex will have an impact on force production and writing speed. Force production will have a significant effect on the handwriting legibility. Relationship between force production as well as strength and handwriting difficulties was not properly examined and without detailed evaluation there are no specific interventions to enhance the strength and force control. Till now there are no specific interventions to address the difficulties faced by children with developmental coordination disorder in producing letters. Occupational therapy interventions were designed to enhance the intrinsic muscle strength. Activities like manipulating writing utensils and therapeutic will enhance the hand strength[13].

Intervention process that specifically focuses on enhancing the speed and legibility were delivered for children with developmental coordination disorder in occupational therapy classes. To enhance the handwriting skill acquisition, there is a need to orient the task that regulates force in upper limb. The aim

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of that intervention should be designed to free the potentially stiff arms and to strengthen the shoulder girdle. Majority of the therapist provide adaptive equipments like angled board and the board with inclination specifically promotes pressure control over wrist. These approaches used by occupational therapist were common in clinical practice and through systematic evaluation of Childs handwriting skill the therapeutic interventions were documented[14].

Raynor et al documented those children with developmental coordination disorder experiences difficulty in providing strength and force control. van der Hoek et al in 2012 evaluated that children with DCD had abridged strength in the vastus lateralis and biceps femoris. The muscle group of lower limb will deteriorate on themselves as a result of deconditioning process. Physical inactivity is the reason for deterioration in muscle strength. However the deterioration in peripheral muscle strength was not evaluated by other researchers in 2006, hands and larkin conducted a research trial and they suggested that similar pattern of peripheral weakness was observed in children with DCD[15].

Majority of the researchers documented that prerequisite for efficient handwriting production is grip strength. It is made clear that children exhibits difficulty in manipulating small objects in hand they fails to exhibit sufficient grip strength and pressure on pen and pencil. They experience innumerous difficulties when the grip strength is poor, the children with DCD exhibits difficulty in holding pen and exerting pressure over the writing utensils. Lot of studies focused on drawing and the children were asked to copy as well as repeat the writing task. Even repetition of single character is allowed[16]. When compared to typically developing children, DCD children exerts too much pressure over the notebook and they took a long time to complete the writing task as compared to age matched typically developing children. However in alphabet tasks children with developmental coordination disorder exhibits less pressure in pages as compared to peer group children. As there are biomechanical differences in producing handwriting across languages, to understand the details of biomechanical issues across languages further research in Tamil language is needed[17]. There is a distinct lack in clinical practice when examining the strength and pen pressure. No studies have examined the strength and endurance. Still it is unclear about the role of pressure exerted over the pen and pencil among children with developmental coordination disorder. There is a need to explore the relationship between pen pressure and speed of writing, this will further support the decisions made by therapist in deciding the treatment programmes. There is a need to evaluate the grip strength and pressure exerted on paper while writing in children with and without developmental coordination disorder. There is a need to evaluate the relationship between handwriting performance, speed, legibility and pausing during writing.

Conclusion

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Future research might scrutinize more directly the differences in letter production and grip strength variation with various letters. It is mandatory to examine in detail the lack of force control and within word pausing in children with developmental coordination disorder. Without a gold standard assessment tool to document the handwriting difficulty, there is a need of a assessment tool for Indian children with developmental coordination disorder.

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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.

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

References

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