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POLISH JOURNAL OF PHYSIOTHERAPY

OFICJALNE PISMO POLSKIEGO TOWARZYSTWA FIZJOTERAPII

THE OFFICIAL JOURNAL OF THE POLISH SOCIETY OF PHYSIOTHERAPY

NR 5/2023 (23) KWARTALNIK ISSN 1642-0136

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fizjoterapia polska
nr 5/2023 (23)

Assessment of control during movement, fine motor skills/handwriting, and gross motor control in children with developmental coordination disorder using the DCD-Q

Ocena kontroli podczas ruchu, umiejętności motorycznych drobnych/możliwości pisania, oraz kontroli motorycznej dużych mięśni u dzieci z zaburzeniami koordynacji rozwojowej przy użyciu DCD-Q

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Abstract

Motor coordination and control are affected by Developmental Coordination Disorder (DCD), particularly in children. As a result, they are unable to write, tie shoelaces, or participate in sports, affecting their social interactions and quality of life. Considering the poor short-term and long-term outcomes observed in children with DCD, awareness of this condition may increase, prompting more research. Among 99 children with DCD, a six-week intervention was performed in both control and intervention groups. In addition to the DCD-Q questionnaire, parents completed a fine motor/handwriting and gross motor control questionnaire. An ANOVA test was used to analyze all values as mean ± SD. The results showed that both groups improved in motor coordination and control. DCD-related motor difficulties can be addressed more effectively with early intervention in all three domains, especially fine motor control. The control group's motor control scores increased from 17.9 ± 0.6 at baseline to 21.5 ± 0.5 by the sixth week, with a statistically significant p-value of 0.009. Alternatively, the intervention group's scores improved from 19.6 ± 0.5 at baseline to 22.4 ± 0.5 at the sixth week, with a statistically significant p-value of 0.007. With regards to fine motor control, the control group's scores improved from 13.4 ± 1.08 at baseline to 16.4 ± 0.6 at the sixth week, with a statistically significant p-value of 0.01. With regards to fine motor control, the intervention group's scores improved from 14.5 ± 0.3 at baseline to 20.3 ± 1.4 at the sixth week, with a statistically significant p-value of 0.004. As for gross motor control, the control group's score increased from 16.6 ± 1.05 at baseline to 20.2 ± 1.0 at the sixth week, showing high statistical significance with a p-value of <0.0001. The intervention group's scores improved from 18.7 ± 0.5 at baseline to 21.5 ± 0.7 at the sixth week, also demonstrating statistical significance with a p-value of 0.002. Overall, this study highlights the potential benefits of tailored interventions in enhancing motor skills and overall quality of life for children with DCD.

Keywords

developmental coordination disorder, DCD-Q, motor control, cerebellum

Streszczenie

Koordynacja motoryczna i kontrola są zaburzone przez zaburzenia koordynacji rozwojowej (DCD), szczególnie u dzieci. W rezultacie nie są one w stanie pisać, wiązać sznurowadła ani uczestniczyć w sporcie, co wpływa na ich interakcje społeczne i jakość życia. Biorąc pod uwagę słabe wyniki krótko- i długoterminowe obserwowane u dzieci z DCD, świadomość tego stanu może wzrosnąć, co skłoni do dalszych badań. Wśród 99 dzieci z DCD przeprowadzono sześciotygodniową interwencję w grupach kontrolnych i interwencyjnych. Oprócz kwestionariusza DCD-Q, rodzice wypełnili kwestionariusz dotyczący umiejętności motorycznych drobnych/możliwości pisania i kontroli motorycznej dużych mięśni. Do analizy wszystkich wartości użyto testu ANOVA jako średniej ± SD. Wyniki wykazały, że obie grupy poprawiły koordynację motoryczną i kontrolę. Trudności motoryczne związane z DCD mogą być skuteczniej adresowane poprzez wczesną interwencję we wszystkich trzech dziedzinach, zwłaszcza w kontroli motorycznej drobnych mięśni. Wyniki kontroli motorycznej grupy kontrolnej wzrosły z 17,9 ± 0,6 na początku do 21,5 ± 0,5 w szóstym tygodniu, z istotnym statystycznie p-wartością 0,009. Natomiast wyniki grupy interwencyjnej poprawiły się z 19,6 ± 0,5 na początku do 22,4 ± 0,5 w szóstym tygodniu, z istotną statystycznie p-wartością 0,007. W odniesieniu do kontroli motorycznej drobnych mięśni, wyniki grupy kontrolnej poprawiły się z 13,4 ± 1,08 na początku do 16,4 ± 0,6 w szóstym tygodniu, z istotną statystycznie p-wartością 0,01. W odniesieniu do kontroli motorycznej drobnych mięśni, wyniki grupy interwencyjnej poprawiły się z 14,5 ± 0,3 na początku do 20,3 ± 1,4 w szóstym tygodniu, z istotną statystycznie p-wartością 0,004. Jeśli chodzi o kontrolę motoryczną dużych mięśni, wynik grupy kontrolnej wzrósł z 16,6 ± 1,05 na początku do 20,2 ± 1,0 w szóstym tygodniu, wykazując wysoką istotność statystyczną z p-wartością <0,0001. Wyniki grupy interwencyjnej poprawiły się z 18,7 ± 0,5 na początku do 21,5 ± 0,7 w szóstym tygodniu, również wykazując istotność statystyczną z p-wartością 0,002. Ogólnie rzecz biorąc, to badanie podkreśla potencjalne korzyści dostosowanych interwencji w zakresie poprawy umiejętności motorycznych i ogólnej jakości życia dzieci z DCD.

Słowa kluczowe

zaburzenia koordynacji rozwojowej, DCD-Q, kontrola motoryczna, móżdżek

doi.org/10.56984/8ZG20B0LR

Introduction

Approximately 2 to 7% of children suffer from Developmental Coordination Disorder (DCD). Children with DCD often struggle with activities that require coordination, such as tying shoelaces, using utensils, or participating in sports [1]. The balance problems of these children are common in about sixty to seventy percent of them [2]. They may also have difficulty with tasks that involve fine motor skills, such as writing, drawing, or cutting with scissors. These challenges can not only affect a child's physical abilities but also their social and emotional well-being. Based on a systematic review of children aged 2 to 6 years who were engaged in any type of physical activity, only 54% of studies reported that children were engaging in physical activity at least 60 minutes of structured and 60 minutes of unstructured activity each day, according to the National Association of Sport and Physical Education. Recreational and leisure activities that challenge and motivate children and youth are considered essential for their development [3, 4]. Also, children and youth suffering from disabilities (such as cerebral palsy, spina bifida, or traumatic brain injury) are at risk. There are two forms of motor learning, vestibular–ocular reflex (VOR) and oculomotor learning (OML). This form of learning is known to occur in the cerebellum, which is the most common brain structure associated with this process. The cerebellum plays a crucial role in coordinating and fine-tuning movements, ensuring their accuracy and efficiency. There are approximately 150 million neurons within the cerebellum, which constitutes approximately 15% of the brain's mass and contains more than half the entire brain's neurons [5]. One of the main factors that determine how well a child will function in daily life and at school is their motor performance. Rehabilitative service delivery models for children and adults emphasize community participation and meaningful, rewarding activities [6]. According to the dictionary, posture refers to a body's position relative to a reference frame. An upright posture involves aligning the body with the environment, as well as positioning it upright. To ensure healthy postural development, parents, educators, and healthcare professionals should understand this predictable pattern. Individuals during this critical period benefit from physical activity, proper ergonomics, and awareness of good posture [7]. School-age children and youth, however, have well-established health benefits from physical activity [8]. Globally, more than 42 million children younger than 5 years of age are overweight, according to the WHO. It is, therefore, essential that physical activity be undertaken during the early years in order to benefit from its health benefits. Maintaining and improving physical fitness requires regular physical activity and exercise. Withdrawal from participation may cause individuals to miss out on opportunities for fitness activities. As a result, their overall fitness levels may be affected. In most children with DCD, the cerebellum appears to be diminished in its ability to provide feed forward control input prior to movement, which results in the use of feedback-based strategies that take longer to respond, have poorer timing, and have large within-child variability.

Methodology

Study site

A randomized experimental study was carried out in different sites such as Government high school in Vridhachalam district, Sri Aurobindo Vidyalaya, Neyveli.

Study approval

The study was enrolled with the Institutional review board, SRM MCH & RC, SRM IST and procured approval. The study was also registered with The Clinical Trials Registry- India. Informed consent was obtained from the parent or the guardian (in case parent unavailable) of the selected subjects, prior to their enrolment in the study.

Protocol

This experimental study was carried out for a period of six weeks with a sample size of 99 and grouped into A and B. The subjects were selected based on the inclusion and exclusion criteria. The selected subjects were screened and randomized into control and test groups by computer randomization. Group A was labeled as the control group and the subjects in the control group received conventional gross motor training for six weeks. The training consists of activities that enhanced the core strength and mobility. Group B was labeled as the interventional group and the participants allocated to the interventional group. The program was used to enhance and assess. The gross motor training was provided in the control group for core stability, strengthening exercises, balance, and coordination exercises. The motor skills of the subjects were assessed and analyzed using the DCD-Q which contains 15 items categorized as three domains: control during movement, fine motor/ handwriting and gross motor/ planning and general coordination. The follow-up visits were conducted at 2, 4- and 6-weeks Motor skill analysis using DCD-Q was done at baseline and at 6 weeks.

Inclusion criteria

- Age: 8-11 years.
- Gender: Both male and female.
- DCD questionnaire score: 15-57.

Exclusion criteria

- Patients Diagnosed neurological or other movement disorders.
- Patients with Congenital, musculoskeletal or cardiopulmonary disorder that could affect motor performance.
- Patients diagnosed with visual impairment.
- Patients with sensory impairment.
- Patients with cognitive impairment.
- Epilepsy.
- Patients who are undergoing physiotherapy management.
- Patients with Hearing impairment.

DCD-Q (Developmental Coordination Disorder Questionnaire):

The questionnaire is to be filled by parents on monitoring the children. The questionnaire contains 15 items that focus on determining the coordinating functions in the child. It is constructed as three domains namely:

- Control during movement
- Fine motor/ handwriting
- Gross Motor Control

doi.org/10.56984/8ZG20B0LR

The items are assessed and scores are given for each item from 1-5. The items are scored and totalled for 75 [9]. The total score of each individual is obtained by adding the scores for all three factors. The inference we obtained from the scores are, for children aging between 5 years to 7 years, 11 months, if the score ranges between 15-46, they are indicated or suspected for DCD and if the score ranges between 47-75, they are considered to probably not have DCD. If the child ages from 8 years to 9 years, 11 months, and the score exists between 15 to 55, the child is suspected of DCD and if the score exists between 56-75, the child is considered to probably not be affected with DCD. If the age of the child lies between 10 years and 15 years, and the score lies between 15-57, the child is suspected for DCD and if the score lies between 58-75, then the child is assumed to probably be unaffected with DCD [10].

Statistical analysis

All the values are expressed as mean ± SD. All the tests were analyzed using ANOVA test. Comparison of results within the groups and between the groups were estimated and interpreted. The values were considered to be statistically significant if the p value was < 0.05.

Results

Table 1. DCD-Q assessment scores for control during movement expressed as Mean ± SD

Domain	Grou					
Control during movement	Control	17.9 ± 0.6	18.7 ± 0.5	20.3 ± 0.5	21.5 ± 0.5	0.009
	Intervention	19.6 ± 0.5	20.6 ± 0.5	21.5 ± 0.5	22.4 ± 0.5	0.007

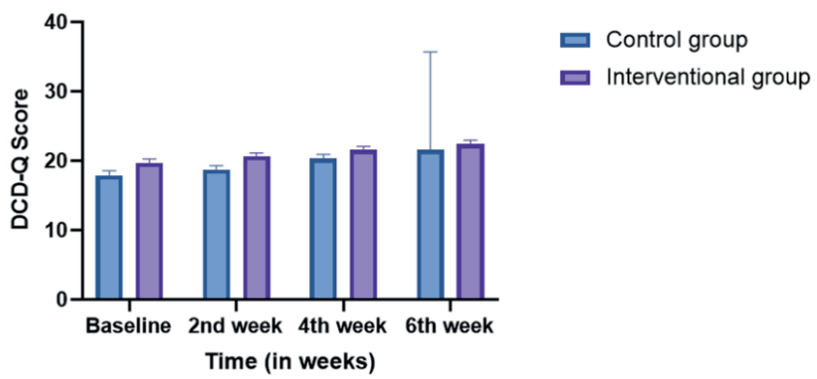

Figure 1. DCD-Q assessment showing scores for movement control between control and interventional groups at baseline, 2nd, 4th, and 6th weeks

Table 2. DCD-Q assessment scores for fine motor control expressed as Mean ± SD

Domain	Group	Baseline	2nd week	4th week	6th week	p value
Fine motor	Control	13.4 ± 1.08	14.4 ± 0.9	15.4 ± 0.8	16.4 ± 0.6	0.01
	Intervention	14.5 ± 0.3	15.4 ± 0.4	16.2 ± 0.5	20.3 ± 1.4	0.004

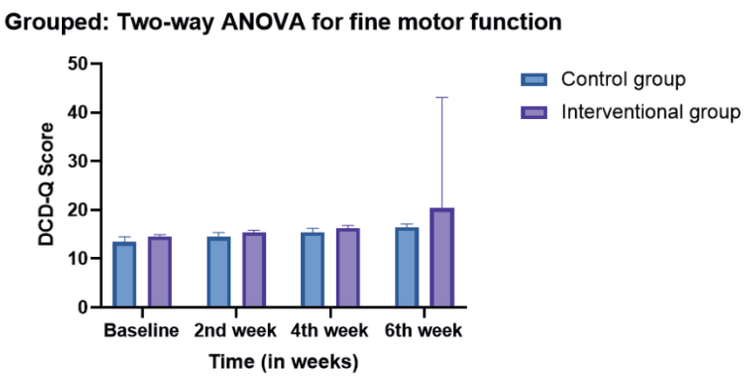

Figure 2. DCD-Q assessment showing scores for fine motor control between control and interventional groups at baseline, 2nd, 4th, and 6th weeks

doi.org/10.56984/8ZG20B0LR

Table 3. DCD-Q assessment scores for gross motor control expressed as Mean ± SD

Domain	Group	Baseline	2nd week	4th week	6th week	p value
Gross motor	Control	16.6 ± 1.05	17.8 ± 1.04	18.9 ± 1.04	20.2 ± 1.0	< 0.0001
	Intervention	18.7 ± 0.5	19.6 ± 0.6	20.4 ± 0.9	21.5 ± 0.7	0.002

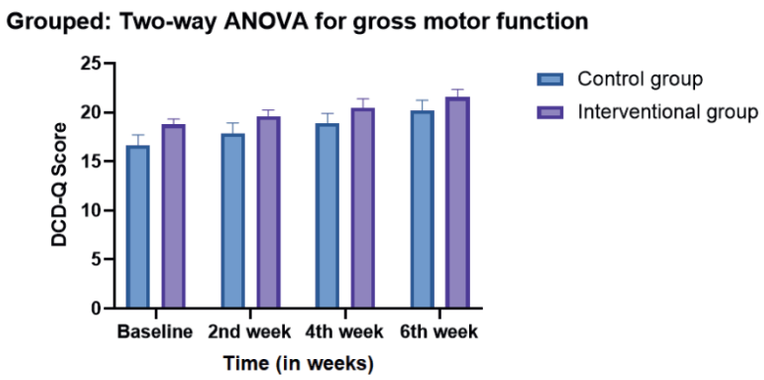

Figure 3. DCD-Q assessment showing scores for gross motor control between control and interventional groups at baseline, 2nd, 4th, and 6th weeks

Discussion

According to a previous narrative review, children aged 2 to 5 years are not likely to benefit from physical activity due to a lack of evidence. Based on the scientific evidence available at the time, it was concluded that the amount of physical activity that age group should be engaged in was too weak to determine [11]. Poor postural control is one of the main characteristics of children with DCD [12, 13]. Because they react more slowly to balance disturbances than their peers, these children are less capable of controlling their balance during variable circumstances. The selected studies were studied for all the parameters that were assessed for motor performance analysis and also other functions like emotional and cognitive status. However, a review could not conclude that virtual reality as a standalone had a high and firm positive effect on the motor functions of children with DCD as the results of the studies were variable. In general, children with DCD tend to have a lower performance in aspects of physical, emotional, and cognitive functions when compared with normal children [14]. One study conducted by J. Hammond et al., 2012, was included in this review and the study made use of Wii Fit and it was found that the tool was beneficial in enhancing the motor proficiency of the children who had taken up the assessment. Study results in 2001 showed a high level of internal consistency and discriminant power for the Developmental Coordination Disorder Questionnaire (DCDQ). Developmental Coordination Disorder (DCD) cannot, however, be diagnosed solely based on the DCDQ. Tests and reports should be used to make a diagnosis. Parents may feel less concerned about a medical condition being diagnosed by using the Coordination Questionnaire. For an accurate diagnosis of DCD and for guiding appropriate interventions, comprehensive assessments and information integration are essential. Despite the inclusion of younger children in a study, the Developmental Coordination Disorder Questionnaire (DCD-Q) proved to be a reliable instrument. Based on the data obtained by Wilson et al. [15], the DCD-Q was found to have similar internal consistency. The DCD-Q measures the construct consistently across age groups, indicating its reliability across different age groups. It demonstrates the DCD-Q's usefulness as a reliable tool for evaluating developmental coordination difficulties in children, regardless of their age. Several motor factors have been found to be robust in children aged 4 to 8 years old in the study conducted by Wilson et al. This age group emerged as a single factor for factors 3 and 4, which are general coordination and gross motor control. Glascoe [16] found that parents' concerns regarding their child's motor performance led to more over-referrals to daycare centers than pediatric settings. The results suggest that parents may have a difficult time accurately assessing their child's motor performance in an area with few deviant motors. Milder cases of DCD within the general population are difficult to identify and assess accurately [17]. Researchers and healthcare professionals should take into account the limitations of population-based screenings and explore alternative strategies for early detection and intervention, such as targeted assessments or increasing awareness among parents and educators regarding DCD's signs and symptoms. Both a population-based sample (88.6%) and a combined clinic-referred/control sample (84%) found the Developmental Coordination Disorder Questionnaire (DCD-Q) to be slightly below its preferred standard. As a result of these findings, approximately 84% to 89% of parents will agree with their opinion if they do not express concerns about their child's motor functioning based on the DCD-Q. Crawford et al. [18] highlighted the utility of the DCD-Q for identifying children without DCD in their conclusions. A significant correlation was found between DCD-Q score and motor skills test results (MABC) and visual-motor

doi.org/10.56984/8ZG20B0LR

integration test results (VMI). The Developmental Coordination Disorder Questionnaire (DCDQ) is highly sensitive, exceeding 84%. Although the specificity is lower at 71%, it is still considered acceptable for a screening tool that targets a particular developmental condition. According to Chambers & Sugden, 2002 [19]; Faught et al., 2008 [20]; Schoemaker et al., 2008 [21]; Schoemaker et al., 2003 [22], other DCD measures report specificity values ranging from 62% to 66%. The DCDQ aligns with these values.

Conclusion

Study participants with Developmental Coordination Disorder (DCD) were evaluated on their ability to control movement, fine motor skills, handwriting skills, and gross motor skills. All three domains showed improvement in both groups, with the intervention group performing better in all three areas, especially fine motor control. This study highlights the potential for

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doi.org/10.56984/8ZG20B0LR