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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Feasibility and effectiveness of a balance therapy camp for children with Developmental Coordination Disorder (DCD) - a pilot study

Lotte Put
Isabelle Reymen

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij musculoskeletale aandoeningen

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Abstract

Background: Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder, characterized by clumsiness in a variety of motor skills (Cheng et al., 2019). Balance problems occur in 73-87% of children with DCD (Verbecque et al., 2021). Balance control is multisystemic (Horak, 2006). Currently, there is no balance intervention which contains all domains of balance control. Furthermore, none of these interventions were highly intensive.

Objectives: To evaluate (1) the feasibility and (2) the effectiveness of a therapy camp for children with DCD that includes all aspects of balance control in both intervention and outcome measures.

Methods: An intervention camp was organized with a total of 35 therapy hours. All domains of balance control were practiced throughout 30 different activities. A one group pretest-posttest design was used. Inclusion criteria: (1) between 5 and 12 years old, (2) a diagnosis of DCD or a clinical representation of DCD. A 1:1 ratio between children and mentors was guaranteed. Scores of the Kids-BESTest were analyzed with the Wilcoxon signed rank test.

Results: Significant improvements were seen in "Stability Limits/Verticality" (p=0.0508), "Stability in Gait" (p=0.0002) and total scores (p=0.0342). All activity categories scored between 4 (much fun) and 5 (very much fun) on the enjoyment scales. Parents reported a positive evolution in their child's self-confidence, fear of moving and motor abilities.

Conclusion: A highly intensive intervention camp is feasible and fun for children with DCD. Primary results for balance control showed some improvement, but further investigation with a greater sample size is needed to make clear conclusions.

Keywords: DCD, balance control, intervention camp, children, motor skills, highly intensive therapy

1. Introduction

Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder, characterized by clumsiness in a variety of motor skills (Cheng et al., 2019). It affects motor coordination and motor planning (Blank et al., 2019; Cheng et al., 2018). Approximately 5-6% of children worldwide are diagnosed with this condition and it is more common in boys compared to girls (Blank et al., 2019). It is important to recognize the characteristics of DCD in activities and participation because it not only affects their motor skills but also has an impact on psychosocial development (Cairney et al., 2013). Children with DCD tend to avoid physical activity due to poor self-efficacy. The gap between their own, self-reported abilities and their peers causes them to avoid participating in physical activities (Pimenta et al., 2023).

Balance problems occur in 73-87% of children with DCD (Verbecque et al., 2021). Balance control is multisystemic (Horak, 2006) and consists of six domains which include: (1) biomechanical constraints, (2) movement strategies (anticipatory and reactive postural adjustments), (3) orientation in space, (4) sensory strategies, (5) control of dynamics and (6) cognitive processing (Horak, 2006). Common balance problems seen in children with DCD include: 1) significantly poorer performance on balance subscales, 2) more difficulties in their limits of stability and anticipatory postural adjustments, 3) more difficulties to maintain a stable standing position in more complex sensory conditions, e.g. standing on a moving platform with eyes closed in comparison with their peers (Verbecque et al., 2021).

An oriented literature search investigated balance control interventions and outcome measures to evaluate and improve balance control in children with DCD. This search indicated a large heterogeneity in current available interventions with for example: strength training (Kordi et al., 2016), taekwondo training (Fong et al., 2012), trampoline intervention (Giagazoglou et al., 2015) etc. Also, different outcome measures were used to evaluate balance performance. Most common outcome measures were the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT-2), the Sensory Organization Test (SOT) and the Unilateral Stance Test. However, none of these outcome measures included all domains of the Multisystemic Framework of Balance Control. In addition, it was remarkable that the intervention and its outcome measure did not always include the same domains of balance control. Each domain of the Multisystemic Framework of Balance Control influences balance

control performance. Therefore, it is important to get full insight in each system to predict context-specific instability (Horak, 2006).

Another remark to be made is that none of the interventions were based on a highly intensive training program. However, in other pediatric populations, such as children with Cerebral Palsy (CP), highly intensive interventions have been proven to be an added value (Berrigan et al., 2021; Bleyenheuft et al., 2017; Klingels et al., 2013). A 2-week intervention camp was feasible for children between 6 and 18 years old with CP (Berrigan et al., 2021). In children around the age of 8 with CP, it has been proven that a highly intensive therapy program could be more beneficial in comparison with normal therapy (Klingels et al., 2013). No studies were found that implemented a training program for children with DCD consisting of more than 30 hours of training with a minimum frequency of 3 times per week (Jackman et al., 2020). Therefore, it is interesting to investigate the effects of a highly intensive training program on balance control in children with DCD. It is important to know if these sorts of interventions are feasible and beneficial for children with DCD.

This pilot study aimed to achieve two objectives: (1) to evaluate the feasibility of a therapy camp for children with DCD that includes all aspects of balance control in both intervention and outcome measures. The study hypothesized that such a camp would be feasible for children with DCD, but various factors such as fatigue, performance level, and experiences of success should be considered. (2) to examine the effectiveness of a therapy camp on performance of balance control of children with DCD. The total, global performance of balance control will be examined, along with improvements on every domain of the Multisystemic Framework (Horak, 2006).

The study hypothesized that a highly intensive therapy camp for children with DCD is feasible and balance control will improve after the therapy camp. These improvements could be diminished because of learning problems (Biotteau et al., 2020).

2. Methods

2.1. Study design

A one group pretest-posttest design was used in this study. All participants completed the same pre- and post-interventional assessments and underwent the same intervention. An informed consent was obtained from the parents and/or guardian as well as an assent from the participating children before the start of the study. This study was approved by the Ethics Committee of Hasselt University for medical research (B1152022000001).

2.2. Participants

2.2.1. Inclusion criteria

The study included children who met the following criteria: (1) aged between 5 and 12 years old since DCD can only be diagnosed starting from 5 years old. In children older than 12 years old, structural and behavioral changes will occur due to puberty. In addition, the severity of motor impairment may reduce, persist or change as new coping mechanisms will develop (Hands et al., 2015). (2) having an official DCD diagnosis according to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) criteria (see Table 1). (3) having a clinical representation in accordance with the DSM-5 criteria. DSM-5 describes four criteria to define DCD: (1) Execution of motor coordination tasks is more difficult when compared to typically developing children, (2) the problems present have impact on daily life activities, school, sports and games, (3) onset in early development, (4) motor skill disabilities are not attributable to another neurological condition (cognitive, visual or neurological).

In these children, the criteria were checked by the research team, criterium D was evaluated by anamnesis. If children met criteria A, B and C and had no intellectual, neurological or visual condition they were labeled as 'probable DCD' (Blank et al., 2019). Due to the high prevalence of comorbid conditions such as Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), and dyslexia, children with these conditions were also included in the study.

Table 1

Evaluation of DSM-5 Criteria

DSM-5 criteria	Evaluation
A) Motor skill acquisition and performance is at an age-inappropriate level	Movement Assessment Battery for Children, 2nd Edition (MABC-2): - Total score: at or below 16th pc - Subscale score: at or below 5th pc
B) Motor skill deficits have significant impact on daily life activities	Developmental Coordination Disorder Questionnaire (DCD-Q)
C) Onset of symptoms in early childhood	Anamnesis with parents
D) Motor skill disabilities are not attributable to another condition (e.g. medical, psychological, cognitive, visual, neurological)	Neuromotor examination performed by an acknowledged pediatrician

2.2.2. Exclusion criteria

Children were excluded from the study if DCD was not diagnosed and DSM-5 criteria were not met and/or the motor problems could be attributed to intellectual disabilities, visual/vestibular impairments or another neurological condition such as Cerebral Palsy (CP) or muscular dystrophy etc., as evidenced by anamnesis of the parents.

2.2.3. Sample size

When defining the sample size, it was important to pay attention to validity and reliability of the measurements as well as maintaining the 1:1 ratio between participants and mentors. Based on sample calculations with data from another study with children with DCD, ongoing at the university of Hasselt, calculations have been made. To provide results with 80% power and a margin of error of only 5%, a minimum of 10 children is needed.

2.3. Recruitment

Participants were recruited through a range of methods (including the distribution of flyers, phone calls, and the use of social media platforms) in physical therapy practices, schools, and specialized multidisciplinary centers located in and around Hasselt. The recruitment took place between January and March 2022.

2.4. Intervention

Five consecutive days, with a total of 35 therapy hours, were filled with activities which, all together, covered all domains of the Multisystemic Framework of Balance Control. The therapy camp included 30 activities in total, which were grouped into six categories: running, jumping, Virtual Reality (VR), cognitive tasks, circus, and group activities with focus on social interaction. Table 2 provides an overview of the activities within each category. Activities in the category 'Virtual Reality' were performed on the Gait Real-Time Analysis Interactive Lab (GRAIL) and Hololens 2. The GRAIL system is an innovative, interactive dual belt treadmill where VR is added to a motion capture system. The Hololens 2 from Microsoft was used and was provided by the Expertise center for Digital Media (EDM) of Hasselt University. The Hololens 2 provided Mixed reality (MR), in which items are virtually added to the real world. In MR no controllers were needed to interfere with the system. Because of this, only natural movements were used. Using VR and MR, it is possible to create a fun and effective intervention to train balance control. The activities could be performed in individual sessions, in pairs or in groups. When organizing the activities, it was important to alternate high load activities with low load activities, to maintain an achievable load throughout the day. If a child refused to participate in an activity, an alternative activity within the same category was provided. The theme of the therapy camp was "circus".

A one-on-one ratio between therapists and participants was provided so therapy could be adapted individually. Children were matched to mentors based on personal factors and clinical representation. Therapy was provided by 1st master students who received an 8-hour theoretical and practical training in preparation of the camp.

Table 2

Overview of Activities within each Category

Category	Activities
Running	– Parcours in bouncy castle – Relay with/without dual task – Group games
Sitting balance	– Parachute – Balance bikes (x3) – Sack race – Decorating cupcakes + fruit satay – Crafting juggling balls
Virtual Reality (VR)	– GRAIL (x3) – Holomoves
Circus	– Circus class (x4)
Jumping	– Trampoline (x2) – Jumping exercises on bouncy castle – Airtrack – Rope skipping – Olympic games
Group activities with focus on social interaction	– Quartet/4 in a row/gambling – Parcours – Playing memory tag

2.5. Outcome measures

Several tests and questionnaires were taken before and after the intervention. Assessments were focused on motor development, balance control and socio-emotional wellbeing. Questionnaires were administered online or by phone calls with the parents and the child. The pre-intervention tests took place within 14 days before the intervention camp. The post-intervention tests were administered within 14 days following the completion of the camp. Pre- and post-interventional tests and questionnaires were the following:

2.5.1. General Questionnaire

The general questionnaire was designed to gather information from parents about various aspects related to their child's health and development. It covered topics such as the child's medical history, motor performance, and any relevant pregnancy-related factors. The questionnaire also provided parents with the opportunity to ask questions and voice any concerns or doubts they may have had.

2.5.2. Movement Assessment Battery for Children - second edition (MABC-2)

The MABC-2 was used to test the children's motor performance (Smits-Engelsman et al., 2008). The test contains three age bands ranging from three to six years, seven to ten and eleven to sixteen years (Smits-Engelsman et al., 2008). The MABC-2 consists of eight motor skill items divided over three different domains: Manual Dexterity (three items), Aiming and Catching (two items) and Balance (three items). Raw scores are converted into standard scores and can be summed up and recorded into a Total Standard Score or a percentile score. The MABC-2 is known for good inter-rater reliability and criterion validity (Smits-Engelsman et al., 2008; Wuang et al., 2012). The MABC-2 is a norm-referenced test for Dutch children aged from 3 to 16 years old (Schoemaker et al., 2012).

2.5.3. Balance Evaluation Systems Test for children (Kids-BESTest)

The Kids-BESTest contains 36 items that identify and classify postural control deficits across six domains or systems: Biomechanical Constraints, Stability Limits/Verticality, Transitions - Anticipatory Postural Adjustment, Reactive Postural Response, Sensory Orientation and Stability in Gait. Items in each domain are scored on a 4-point ordinal scale and domain scores are calculated (Dewar et al., 2017; Horak et al., 2009). Research with typically developing children shows that the full version of the Kids-BESTest has excellent reliability. It is also applicable to distinguish between different stages in postural control development (Dewar et al., 2017). The Kids-BESTest was administered in a standardized manner by 1st degree masters students to ensure consistency and minimize discrepancies in the results.

2.5.4. Enjoyment scales

A five-point Likert scale was used to assess enjoyment. Smileys ranging from very unhappy with the description ‘not fun’ (1 point) to very happy with the description ‘very much fun’ (5 points). Children were asked to report their experience after every intervention and give a total enjoyment score at the end of the camp.

2.5.5. Qualitative interview with parents and child

At the end of the intervention camp, both children and their parents were interviewed to gather their feedback about the program. Children were asked three open-ended questions to share their experience, while parents were interviewed over the phone within two weeks after the intervention. Following questions were asked to the parents: (1) “Have you observed any changes in your child's motor behavior since participating in the therapy camp?”, (2) “Have you noticed any social or affective changes in your child following the therapy camp?” and (3) “Do you have any suggestions for practical or content-related changes that could be made to enhance the therapy camp in the future?”.

2.6. Data analysis

Because of the small sample size, non-parametric statistics were used.

(1) First, the age, gender and MABC-2 scores were documented. Descriptive statistics such as the median and interquartile range (IQR) were used to give an overview of the characteristics of the participants.

(2) Secondly, the pre- and post-interventional values of the Kids-BESTest were statistically tested with the Wilcoxon signed rank test. Data were analyzed per domain, as well as the total score. Scores were marked as significant when p-values < 0.05.

(3) The third stage involved analyzing the enjoyment scales completed by the children to determine which categories of activities were most and least enjoyable. This analysis helped to identify which activities were preferred by the majority of the children and which activities might need to be improved or modified. The results of this analysis were presented through a descriptive table with median scores and IQR as well as boxplots.

(4) In the final stage of analysis, qualitative data were collected through pre-intervention general questionnaires and post-intervention interviews with parents and children. These data were organized and presented in a tabular format, providing a clear and concise summary of the responses. This allowed a quick and efficient identification of common themes and patterns related to the experiences of the participants in the intervention.

3. Results

3.1. Descriptive information of the participants and their corresponding MABC-2 scores

Table 3 presents the age and gender distribution of the 12 children (9 boys, 3 girls) diagnosed with DCD (10 children) or 'probable DCD' (2 children) and their corresponding MABC-2 scores. The age range of the children in the study was between five to twelve years old, with a median age of 10 and an IQR of 4.5. Among the scores, there is a notable outlier within the 'balance' domain, with one child scoring percentile 75. Additionally, it should be noted that there are missing scores for child 9 due to illness on the day of the test administration.

Table 3

Descriptive Information of the Participants and their Corresponding MABC-2 Scores

Descriptive information			MABC-2 scores			
Children	Age (years)	Gender	Manual dexterity	Aim and catch	Balance	Total
1	11	F	0.1	0.5	1	0.1
2	11	M	5	25	75	16
3	9	F	0.1	0.1	0.1	0.1
4	12	F	0.5	5	0.1	0.1
5	12	M	1	1	9	0.5
6	5	M	16	0.1	1	0.5
7	7	M	5	0.5	9	2
8	10	M	0.5	0.5	9	0.5
9	11	M	/	/	1	/
10	10	M	2	5	5	1
11	10	M	0.1	0.2	0.1	0.1
12	6	M	5	2	9	2
Median	10		1	0.5	3	0.5
IQR (P25-P75)	4,5 (6,75;11,25)		4.9 (0.1;5)	4.5 (0.5;5)	8.68 (0.33;9)	1.9 (0.1;5)

Note. (i) Gender: female (F) and male (M), (ii) IQR = interquartile range with percentile 25 (P25) with percentile 25 (P25) and percentile 75 (P75).

3.2. Kids-BESTest

Table 4 shows the statistical analysis of the Kids-BESTest. Comparing total scores before and after the intervention, a significant improvement can be perceived (p=0.034). Median scores ameliorate from 73% to 78%. Analyzing each domain, no significant difference was found in domain 1 “Biomechanical Constraints”. However, median scores improved from 90% to 93%. In domain 2 “Stability limits/Verticality'', a significant improvement of median scores from 67% to 72% was observed (p=0.039). Median scores of domain 3 “Anticipatory Postural Adjustments”, were borderline significantly better with an improvement from 61% to 67% (p=0.051). Domain 4 “Postural Responses”, was the only domain with a deterioration of median score after intervention. Nevertheless, the decline was not significant with median scores from 75% to 72%. In domain 5 “Sensory Orientation”, median scores remained unchanged with a mean score of 93%. Mean scores of domain 6 “Stability in Gait” improved very significantly going from 55% to 67% (p=0.0002).

Table 4

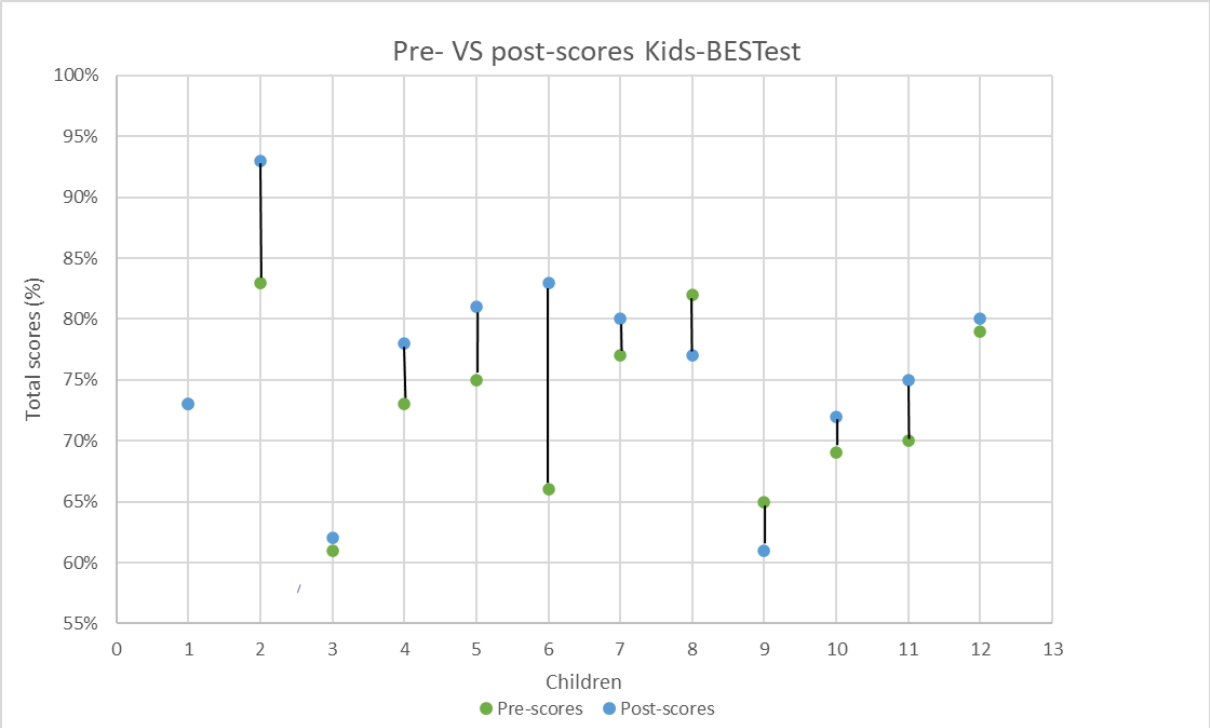
Statistical Analysis of the Kids-BESTest: Pre- and Post-intervention Scores and P-values

	Pre-intervention		Post-intervention		P-value
Domain	Median	IQR	Median	IQR	
I. Biomechanical Constraints	90%	6	93%	11	0.328
II. Stability Limits/Verticality	67%	13	72%	17	0.039*
III. Anticipatory Postural Adjustments	61%	19	67%	16	0.051
IV. Postural Responses	75%	11	72%	27	0.415
V. Sensory Orientation	93%	18	93%	33	0.906
VI. Stability in Gait	55%	11	67%	13	0.0002*
Total	73%	12	78%	9	0.034*

Note. (i) IQR = interquartile range, (ii), p-values derived from one-sided Wilcoxon Signed Rank Test (iii) significant values are indicated with (*).

Figure 1

Pre- vs. Post-Scores Kids-BESTest

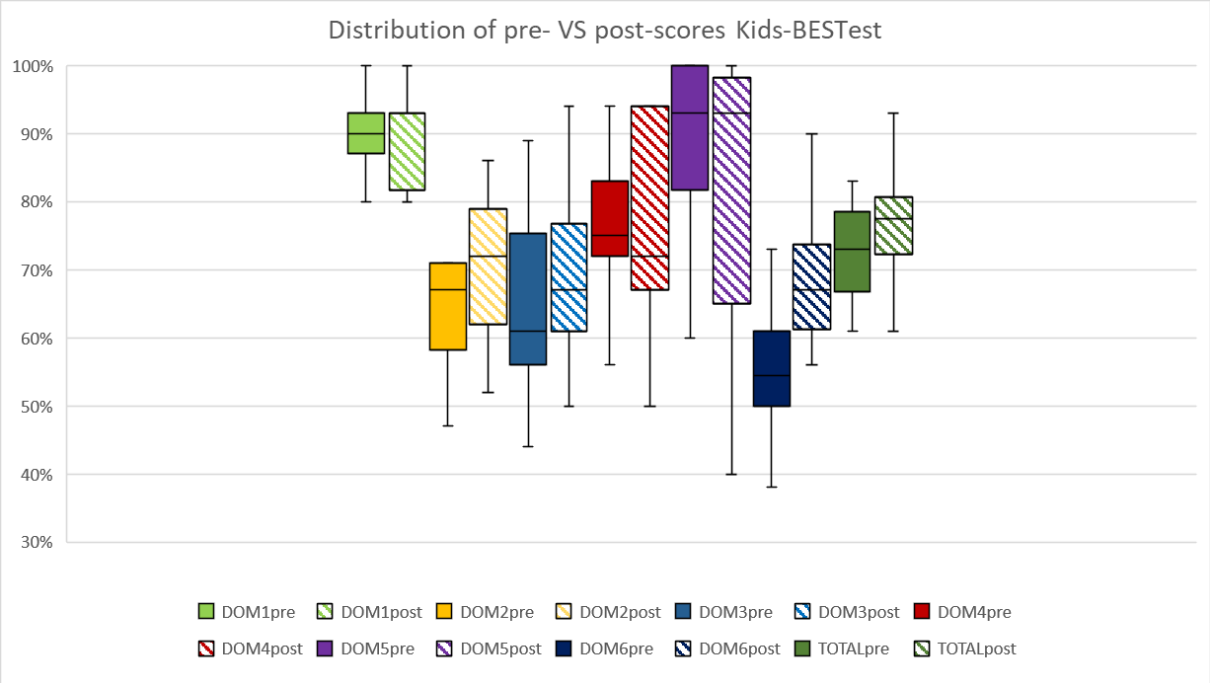


Note. Statistics: min., Q1, med., Q3, max., $\propto = 0.05$

Figure 1 shows the individual interventional change. The degree of progress varies considerably among the participants. Nevertheless, it can be inferred that all children demonstrated better Kids-BESTest scores after the intervention camp. One child obtained the same score as before the intervention.

Figure 2

Distribution of Pre- vs Post-scores Kids-BESTest



Note. Statistics: min., Q1, med., Q3, max., $\propto = 0.05$

Figure 2 shows the distribution of pre- and post-intervention scores for each domain of the Kids-BESTest. It visualizes the heterogeneity scores, even after the intervention camp. This figure makes it clear that, in general, the median scores were higher after the intervention.

3.3. Enjoyment scales

Table 5 presents the median scores and interquartile range of each activity category. It is remarkable that all categories got scores between 4 (much fun) and 5 (very much fun). The “Sitting balance” and “Virtual Reality” categories were rated as the most enjoyable, with a median score of 5. According to the children’s feedback, VR games were a popular choice due to the widespread appeal of gaming among children. They particularly enjoyed the games when they were able to win. However, the "circus" category scored lower with a median score of 4. Children who provided lower scores expressed that this activity was particularly difficult and they did not get much experiences of success.

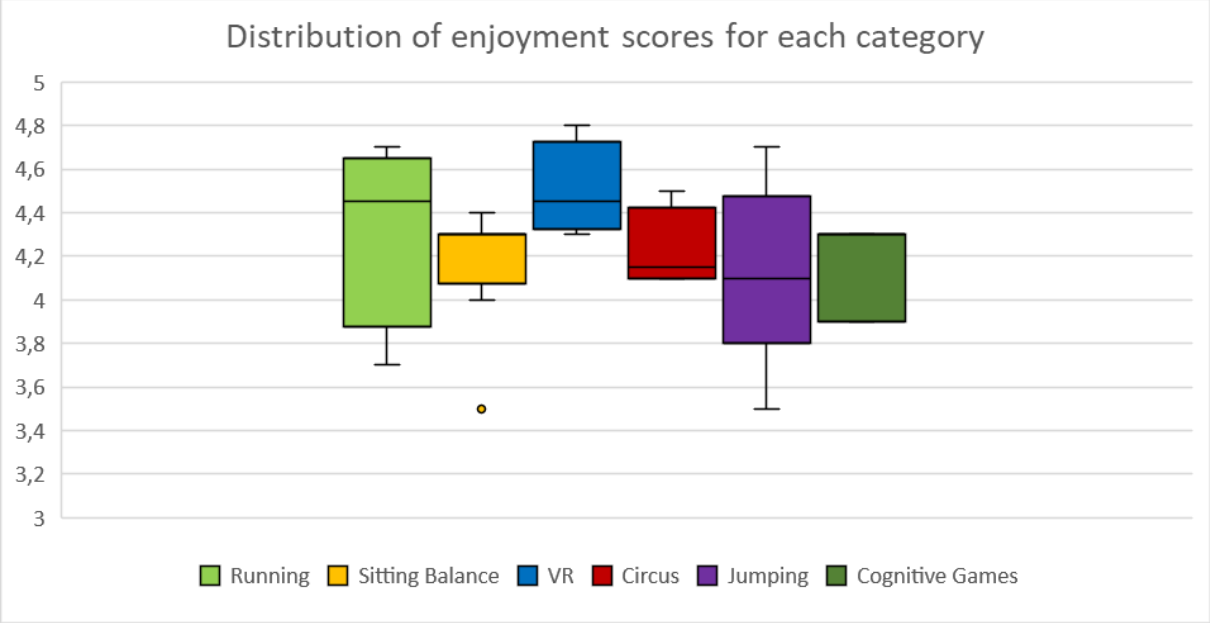
Table 5

Results of the Statistical Analysis of the Enjoyment Scales

Category	Median score	IQR
Running	4.8	0.88
Sitting balance	5.0	0.50
Virtual Reality (VR)	5.0	0.38
Circus	4.0	0.75
Jumping	4.5	1.13
Cognitive games (group activities)	4.5	0.50

Figure 3

Boxplots of the Enjoyment Scores across different Activity Categories



Note. Statistics: min., Q1, med., Q3, max., $\propto = 0.05$

Figure 3 displays a boxplot of enjoyment scores across various activity categories. It is remarkable that there is a lot of variability in scores of the category “jumping” with scores between 1 and 5. Some activities were very tiring and some children fell during the activity. Other children liked the games and the challenging activities.

3.4. Qualitative interview with parents and child

The overall impression of the camp was positive. All parents reported that the therapy camp had a positive impact on their children's self-confidence, as they appeared more self-confident after the intervention. Seven out of twelve parents noticed a positive evolution in their child's motor abilities, others did not observe any difference. The positive changes in motor behavior were most evident in the domains of balance, endurance, cycling, and fine motor skills. Nonetheless, a few parents reported that the camp was tiring for their child. The parents of one child provided feedback that suggested reducing the number of activities in future camps in order to avoid fatigue among the children. On the other hand, the parents of one child recommended narrowing the age range between participants, which could help the children make friends more easily with others their own age.

The children's responses in the enjoyment scales showed many individual differences compared to the qualitative interview of the parents. Out of the 12 children, 10 rated the camp with a score of 5, which means "super nice," while the remaining two children rated it with a score of 3, meaning "nice." Out of the 12 children, 8 reported that they would not change anything about the intervention camp. The other 3 children had some suggestions for improvement, such as having the bouncy castle available every day, removing the activity of mat surfing, or extending the duration of the camp. One child did not answer this question.

4. Discussion

This study aimed to achieve two objectives: (1) to evaluate the feasibility of a therapy camp for children with DCD that includes all aspects of balance control in both intervention and outcome measures and (2) to examine the effectiveness of the therapy camp in improving the balance control of children with DCD using both intervention and outcome measures.

Regarding feasibility, the qualitative interviews conducted with both children and parents indicated that the camp was feasible, but identified potential concerns related to participant fatigue and appropriate age ranges that should be addressed in future camps. The enjoyment scales showed that all activities were generally enjoyable, with median scores ranging from 4 to 5. The "Sitting balance" and "Virtual Reality" (VR) categories received the highest enjoyment scores, with a median score of 5. VR games were particularly favored due to their

widespread appeal among children. Interestingly, recent research demonstrated that the use of active video games leads to moderate to large improvement on balance tasks (Blank et al., 2019). This finding further supports the positive impact and potential effectiveness of incorporating VR games in interventions targeting balance skills. However, the "circus" category received a lower median score of 4, as some children found it challenging and not well-aligned with the exercises. It is important to interpret enjoyment scale scores with caution due to potential factors influencing the scores, such as motivational or personal factors. Further adjustments or modifications may be needed to enhance the experience of the "circus" category. Possible adjustments or modifications could include: (1) simplifying or breaking down complex circus skills into smaller, more manageable steps, (2) providing additional demonstrations or visual aids to help children understand and perform circus activities, (3) offering more opportunities for practice and repetition to build confidence etc.

The effectiveness of the intervention camp was assessed by evaluating the results of the Kids-BESTest. A significant improvement was observed in the total score of the participants when analyzed at the group level. Additionally, significant improvements were found in domain 2 (Stability Limits/Verticality) and domain 6 (Stability in Gait). Children with DCD commonly struggle with activities such as maintaining a coordinated gait, dressing independently, riding a bike etc. (Biotteau et al., 2020). To achieve these activities, it is necessary to have a great sense of verticality and a good stability in gait. An improvement in these domains could be very useful for these children. However, the extent of progress varied among the participants, with some children demonstrating greater improvement than others. Possible confounding factors, such as comorbidities like Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD), may contribute to the variation in outcomes. Children with ASD scored significantly lower on all domains of the MABC-2, including balance control (Craig et al., 2021). ADHD alone does not necessarily lead to motor impairments. Although cognitive disturbances could lead to difficulties with learning processes (Lewis et al., 2008). Additionally, it is important to consider that engagement in sports activities during leisure time, which was not examined in this study, could act as a confounding factor in evaluating the effectiveness of the intervention.

Based on the results, the predefined hypotheses can be confirmed. The balance camp is feasible for children with DCD or probable DCD, but factors such as fatigue, performance level, and experiences of success should be considered. It is important to note that the observation of fatigue leading to a decline in performance was only made by the parents of one participant. Nonetheless, the potential impact of fatigue on performance should be considered in future camps. Success experiences provided a boost to their self-confidence, which also reflected in their daily life activities. The second hypothesis regarding the effectiveness of the balance camp can also be confirmed with significant improvement in total Kids-BESTest scores.

Our study had several limitations that should be acknowledged. Firstly, the sample size was small, consisting of only 12 participants. This limited sample size makes it challenging to generalize the findings to the broader population of children with DCD, and it weakens the external validity of the study. The small sample may also limit the statistical power of the analyses and increase the risk of Type II errors, potentially affecting the reliability of the results. Type II errors occur when the null hypothesis is not rejected, even though it should have been rejected. This means that you conclude there is no effect when there actually is an effect. However, this study was a pilot study, which allowed for certain adjustments to be made to the final protocol. Based on the findings and insights gained from this pilot study, a larger study can be designed and conducted. This larger study can incorporate the necessary modifications and improvements to further investigate the research questions with a more robust sample size and enhanced statistical power.

Furthermore, time-on-task was lower than expected due to factors such as providing explanations, engaging in discussions, adaptations in exercises etc. Time-on-task can be defined as the amount of time you spend being actively involved in the learning process; acquiring new skills, knowledge, values, and attitudes. It can be evaluated through various methods such as direct observation (timers or stop-watched based measurements), self-report (diaries, logs or structured questionnaires), technological monitoring (software applications or online platforms) etc. Lower time-on-task can have several potential consequences such as reduced learning time, decreased skill development and lower retention and transfer to new contexts. These aspects are challenging to plan in advance, but they can be considered as areas for improvement in the future.

Additionally, the absence of a control group is a limitation of the study. Without a control group, it is challenging to determine the specific impact of the intervention on the participants' outcomes and to establish a direct causal relationship. However, the study was conducted using a robust research design and incorporated various outcome measures, which increases the reliability of the findings. Although the lack of a control group limits the ability to draw definitive conclusions, the results still offer valuable insights for future research.

Lastly, there was no follow-up period in our study. Therefore, long-term effects or sustainability of the intervention could not be evaluated. Future studies could consider longer-term follow-up assessments to gain a better understanding of the intervention's lasting effects.

Overall, while our study provides valuable insights into the feasibility and effectiveness of the intervention camp for children with DCD, the limitations should be considered when interpreting the results and further research is needed to address these limitations.

5. Conclusion

Children with Developmental Coordination Disorder (DCD) experience limitations in their motor skills, such as motor coordination and motor planning. Balance problems are prevalent in the majority of these children. It is important to recognize the characteristics of DCD in activities and participation because it not only affects their motor skills but also has an impact on their psychosocial development. Due to poor self-efficacy, children with DCD tend to avoid engaging in physical activities. Overall, there is a need for a suitable intervention for these children.

In response, an intervention camp with focus on balance control was organized for children with DCD that incorporated all aspects of balance control. Results showed that such a highly intensive intervention camp is feasible and experienced as fun. All parents reported improvements in the socio-affective domain and also the primary results for balance control showed significant improvements. These results are promising, but further research with a greater sample size is needed to make clear conclusions.

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