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COMPARISON OF MOTOR PERFORMANCE BETWEEN CHILDREN WITH MULTIPLE DISABILITIES AND TYPICAL DEVELOPMENT

ORIGINAL ARTICLE

ABSTRACT

Purpose: Individuals with multiple disabilities have two or more disabilities at the same time, and these impairments can cause qualitatively and quantitatively insufficient motor performance. This study aimed to compare the motor performance of children with multiple disabilities to children with typical development.

Methods: This prospective study included 26 children with multiple disabilities who had visual impairment according to the International Statistical Classification of Diseases and Related Health Problems: 11th Revision, and 20 children with typical development. The Bruininks-Oseretsky Test of Motor Proficiency Second Edition Short Form was used to examine motor proficiency. A standard hand dynamometer and pinchmeter were used to assess hand and finger grip strength. The Nine-Hole Peg Test was used to evaluate performance-based hand functions.

Results: Children with multiple disabilities had lower scores for balance control ($p<0.001$), running speed agility ($p<0.001$), shoulder and arm strength ($p=0.042$), and abdominal strength ($p=0.007$). Hand grip strength scores for the dominant ($p=0.006$) and non-dominant hands ($p=0.008$) were significantly lower compared to children with typical development. Dominant hand placing ($p=0.026$) and removing ($p=0.035$) times were longer for children with multiple disabilities compared to the corresponding times for the children with typical development.

Conclusion: Data obtained from the current study reveal that children with multiple disabilities have poorer motor proficiency, grip strength, and hand functions compared to children with typical development. Inadequacy of visual input in addition to their existing disabilities may cause insufficient motor performance in children with multiple disabilities.

Key Words: Children, Hand Strength, Motor Skills, Vision Disorders

ÇOKLU ENGELE SAHİP ÇOCUKLAR İLE TİPİK GELİŞİM GÖSTEREN YAŞITLARI ARASINDA MOTOR PERFORMANSIN KARŞILAŞTIRILMASI

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çoklu engele sahip bireyler aynı anda iki ya da daha fazla engele sahiptir ve bu durum niteliksel ve niceliksel olarak yetersiz motor performansa neden olabilir. Bu çalışma, çoklu engele sahip çocukların motor performansını tipik gelişim gösteren yaşıtlarıyla karşılaştırmayı amaçlamaktadır.

Yöntem: Bu prospektif çalışmaya, Hastalıkların ve İlgili Sağlık Sorunlarının Uluslararası İstatistiksel Sınıflaması: 11. Revizyon'una göre görme bozukluğu tanısı almış çoklu engele sahip 26 çocuk ve tipik gelişim gösteren 20 çocuk dahil edilmiştir. Motor yeterliliğin değerlendirilmesinde Bruininks-Oseretsky Motor Yeterlilik Testi İkinci Versiyon Kısa Formu kullanılmıştır. El ve parmak kavrama kuvvetlerinin değerlendirilmesinde el dinamometresi ve pinçmetre kullanılmıştır. Performansa dayalı el becerilerinin değerlendirilmesi için Dokuz Delikli Peg Testi uygulanmıştır.

Sonuçlar: Çoklu engele sahip çocuklar daha düşük denge kontrolü ($p<0,001$), hareket hızı ve çeviklik ($p<0,001$), omuz ve kol kuvvet ($p=0,042$) ve abdominal kuvvet ($p=0,007$) skorlarına sahipti. Tipik gelişim gösteren çocuklar ile karşılaştırıldığında, dominant ($p=0,006$) ve non-dominant ($p=0,008$) el kavrama kuvvetleri önemli derecede daha zayıftı. Çoklu engele sahip çocukların peg testi takma ($p=0,026$) ve çıkarma ($p=0,035$) süreleri tipik gelişim gösteren çocuklara göre daha uzundu.

Tartışma: Çalışmadan elde edilen bilgiler çoklu engele sahip çocukların tipik gelişim gösteren çocuklara göre daha zayıf motor yeterlilik, kavrama kuvveti ve el fonksiyonlarına sahip olduklarını ortaya koymaktadır. Mevcut engellerine ek olarak görsel girdilerin yetersizliği, çoklu engele sahip çocuklarda yetersiz motor performansa neden olabilir.

Anahtar Kelimeler: Çocuklar, El Kuvveti, Motor Beceriler, Görme Bozuklukları

INTRODUCTION

Motor and sensory developments are closely related processes; once peripheral sensory stimuli are perceived in the brain, the appropriate motor responses are generated. When considered from this point of view, vision plays an important role in a child's developmental process because it provides feedback to the vestibular and proprioceptive system (1) and helps to coordinate and improve movement (2). In addition, the visual ability of a child facilitates awareness of objects and motions in the environment (3) and enables the execution of voluntary goal-directed movements (4). Vision is therefore important to be able to plan and perform the child's motor skills.

Visual impairment is a general term that includes both low vision and blindness (5). According to the International Statistical Classification of Diseases and Related Health Problems: 11th Revision (ICD-11) published by the World Health Organization (WHO), those individuals whose visual acuity is equal to or better than 20/400 but worse than 20/70 can be identified as having low vision, while those with visual acuity worse than 20/400 can be identified as blind (5). The vision of children with visual impairment may be partially or completely limited owing to different factors, including pre/postnatal conditions, structural impairments, refractive errors, or cortical visual impairment (6).

Visual impairment negatively affects motor performance and leads to a delay in the development of motor skills (7). Gross motor milestones like head control, sitting, crawling, and typically emerge within the first year of a child's life (1), but visually impaired children tend to acquire motor skills later in their life compared to children with typical development (8, 9). Furthermore, visual information is required for specifying body position and maintaining balance, and the static balance of the visually impaired children is worse than it is for children without visual impairment (7). It has also been suggested that individuals with visual impairment are less proficient in performing various movements under different conditions, such as those involving variations in amplitude and orientation, or those that involve the identification of a target location (10).

To be considered person with multiple disabilities, one must have two or more disabilities at the same time; these individuals generally have a combination of various impairments, such as hearing impairment, visual impairment, mental retardation, or physical impairments (6). It has been shown that there are deficiencies in motor development as well as in all other developmental areas among children with multiple disabilities, and their motor development has been shown to be qualitatively and quantitatively different in comparison with the children with typical development (4, 11, 12). Although suitable motor skills are required for independence in terms of function, motor skills are severely limited in these children (13).

Due to the multiple impairments and poor motor skills, children with multiple disabilities limit their participation in functional motor activities, and community-based sports and physical activities (14, 15). Limited functional performance can lead to less opportunities to learn from movement experience and exploration, and hinder the development of other skills and functional activities (16). Thus, these individuals experience limitations and obstacles in daily functioning, such as unsafe movements and limited participation (2, 17). Therefore, these children are at an increased risk of progressive motor impairments, inactivity, and preventable health conditions throughout their life. By means of therapeutic interventions, these children have the potential to (a) increase competency of motor skills, (b) increase function, (c) increase self-efficacy of participating in recreational activities, and (d) decrease secondary conditions and unhealthy body compositions (13). However, to our knowledge, no study has examined the motor performance of children with multiple disabilities besides visual impairment. Therefore, the purpose of the present study was to compare the motor performance and skills of children with multiple disabilities to children with typical development by focusing specifically on motor proficiency, hand and finger grip strength, and performance-based hand dexterity.

METHODS

Participants and Recruitment

Children with multiple disabilities attending Ankara Goreneller Visually Impaired School were included in this study. Individuals with multiple disabilities between the ages of 9 and 18 years who had visual impairment according to the ICD-11 were included in this study. Information on disability status was obtained from medical reports of each child with multiple disabilities. Individuals were excluded if they had severe cardiological or pulmonary problems, were diagnosed with epilepsy, were non-ambulant, had severe communication problems that could affect study participation, or had undergone eye surgery or another important operation with general anesthesia in the last six months. In addition, children with typical development were included as a control group. Children with typical development between the ages of 9 and 18 years who volunteered to participate in this study were included.

This project was designed as a prospective study and was conducted between March 2018 and June 2018. Children with multiple disabilities were evaluated in an empty class of Ankara Göreneller Visually Impaired School. Children with typical development were evaluated in an examination room at Hacettepe University Faculty of Physical Therapy and Rehabilitation. Evaluation of each child took forty minutes and was completed on the same day. The protocol of this study was approved by Hacettepe University Non-Interventional Clinical Researches Ethics Board with GO 18/753 registration number. Informed written consent was obtained from both the children and their parents to the research and to participate in the research and to be included in the publication of the results.

Procedure

Demographic information of the children was obtained from the participants or their parents. The Bruininks-Oseretsky Test of Motor Proficiency Second Edition Short Form (BOT-2 SF) was used for evaluating motor proficiency, and a standard hand dynamometer (Jamar® Plus + Digital Hand Dynamometer from Patterson Medical by Sammons Preston, Bolingbrook, USA) and a pinchmeter (Jamar® Pinch Gauge, TEC, Clifton, New Jersey, USA) were used for measuring hand grip strength and pinch grip strength, respectively. The Nine-Hole Peg Test for evaluating performance-based hand functions was also used.

The BOT-2 SF is a common measurement tool used for evaluating motor proficiency. The short form of the longer test consists of 14 items chosen from the 53 items of the complete form. This measurement tool is suitable to use in children between the ages of 4 and 21 years (18, 19). The "Balance," "Running Speed Agility," and "Strength" subtests were used in the present study. The duration of standing on one leg on a balance beam was measured for the balance subtest, the number of one-legged stationary hops over 15 seconds was measured for the running speed agility subtest, and the number of knee push-ups and sit-ups over 20 seconds was measured for the strength subtest.

The Jamar hydraulic hand dynamometer was used to measure hand grip strength by following the guidelines of the American Society of Hand Therapists (ASHT) (20). The Jamar hydraulic pinch gauge was used to measure pinch grip strength. Each measurement was repeated three times, and the children rested for approximately one minute between each measurement. The test was repeated for the other hand in the same way.

The Nine-Hole Peg Test (9-HPT) was used to evaluate performance-based hand functions and finger dexterity. Before starting, information about the test was given to the children by the researchers. The peg board was centered in front of the child, and nine pegs were placed near the board on the same side as the hand being tested. The children who are blind used tactile sense when they were placing the pegs into the holes and removing them. The test was repeated for the other hand in the same way.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistical Software (IBM Corporation, Armonk, New York) version 23. Measured outcomes were tested for normality. Descriptive statistics were given as median and interquartile range for the non-parametric data. The Mann–Whitney U

Test was used to compare two non-parametric data sets. The significance level was set at 0.05. When describing the level of evidence-based on the size of a p-value, the preferred terminology is as follows: a p-value around 0.05 shows "weak evidence", while a p-value less than 0.01 shows "strong evidence" and a p-value less than 0.001 shows "very strong evidence". The power of study was calculated according to dominant hand grip results. As a result of power analysis, the power of the study was calculated as 0.97 with alpha of 0.05 (21).

RESULTS

In the present study, 59 individuals with multiple disabilities were assessed, and 33 children who did not meet the criteria were excluded. In total, 26 children with multiple disabilities (mean age: 13.96±3.14 years) were included in the study. In addition, 20 children with typical development (mean age: 12.90±2.79 years) were included in the control group. The study flowchart was shown in Figure 1. There was no significant difference in terms of age between the groups (p=0.293). None of the children

Table 1. Comparison of the BOT2-SF, Grip Strength, and 9-HPT Results between the Groups

	Children with Multiple Disabilities (n=26)	Children with Typical Development (n=20)	p
BOT-2 SF Scores			
Balance (0-4 points)			
Standing on One Leg on a Balance Beam – Eyes Open	0 (0-0)	4 (3-4)	<0.001*
Running Speed Agility (0-10 points)			
One-legged Stationary Hop	0 (0-0)	8 (8-8)	<0.001*
Strength (0-9 points)			
Knee Push-Ups	2 (0-2)	2 (2-2)	0.042*
Sit-Ups	2 (0-2)	2 (2-2)	0.007*
Hand and Finger Grip Strength (Kilogram-Force)			
Dominant Hand			
Hand Grip	12.39 (8.66-14.84)	17.78 (12.33-21.49)	0.006*
Palmar Grip	3.33 (2.00-3.50)	3.33 (2.62-4.33)	0.169
Pinch Grip	1.83 (1.16-2.75)	2.13 (1.83-2.46)	0.317
Lateral Grip	3.88 (2.75-5.25)	4.29 (3.66-5.75)	0.166
Non-Dominant Hand			
Hand Grip	10.77 (7.18-14.46)	16.63 (11.18-18.32)	0.008*
Palmar Grip	2.75 (2.00-4.10)	3.38 (2.33-3.92)	0.471
Pinch Grip	1.66 (1.00-2.16)	1.67 (1.00-2.58)	0.748
Lateral Grip	3.00 (2.16-5.00)	3.80 (3.42-4.33)	0.074
9-HPT (Second)			
Dominant Hand			
Placing Time	33.22 (0-62.00)	14.26 (12.70-16.15)	0.026*
Removing Time	11.11 (0-19.00)	7.14 (6.10-8.00)	0.035*
Non-Dominant Hand			
Placing Time	36.32 (0-70.72)	14.45 (12.9-18.11)	0.196
Removing Time	10.95 (0-14.00)	6.98 (6.40-8.72)	0.201

Abbreviation: BOT-2 SF: The Bruininks-Oseretsky Test of Motor Proficiency Second Edition Short Form, 9-HPT: The Nine-Hole Peg Test. Data were expressed as median (interquartile range). Mann-Whitney U test, *p <0.05

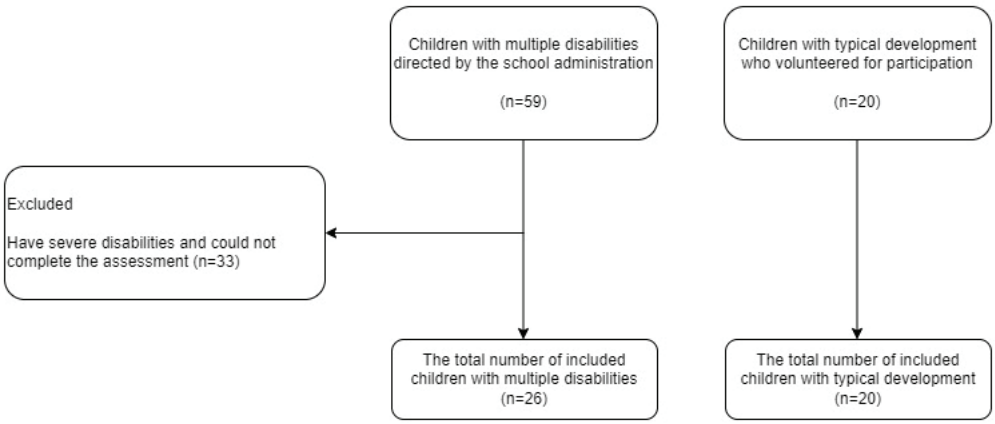

Figure 1. Flowchart of the Study Sample

had any difficulty during the motor performance measurements. The measured outcomes are shown in Table 1 in terms of medians and interquartile ranges.

Analysis of the motor proficiency indicated that there was very strong evidence of lower balance and running speed agility scores ($p<0.001$); strong evidence of lower abdominal strength scores ($p=0.007$); and weak evidence of lower shoulder and arm strength scores ($p=0.042$) for the children with multiple disabilities in comparison with the scores of children with typical development.

According to the results of the hand and finger grip strength tests, there was strong evidence that the children with multiple disabilities had lower hand grip strength scores for both the dominant ($p=0.006$) and non-dominant hand ($p=0.008$) when compared to the corresponding scores of the children with typical development. There was no evidence of any significant differences with respect to dominant palmar grip ($p=0.169$), pinch grip ($p=0.317$), and lateral grip ($p=0.166$) as well as non-dominant palmar grip ($p=0.471$), pinch grip ($p=0.748$), and lateral grip strength ($p=0.074$) scores for the children with multiple disabilities in comparison with those of the children with typical development.

When comparing the 9-HPT durations of the groups, there was weak evidence that the dominant hand placing ($p=0.026$) and removing times ($p=0.035$) were longer for the individuals with multiple disabilities. There was no evidence indicative of longer placing ($p=0.196$) and removing times ($p=0.201$) for the non-dominant hand.

DISCUSSION

This study aimed to exhibit the motor performance of the children with multiple disabilities who had visual impairment and compare with children with typical development in different areas. To our knowledge, this is the first study comparing the motor performance of children with multiple disabilities who have visual impairment to children with typical development. In this study, motor performance was assessed with respect to various movements, such as motor proficiency, grip strength, and performance-based hand functions. The results confirmed that children with multiple disabilities had poorer motor performance, including decreased motor proficiency, hand and finger grip strength, and performance-based hand dexterity, in comparison with the corresponding performance of children with typical development.

Visually impaired children face difficulties in performing various activities in their daily lives because of their motor and sensorial impairments (22, 23). Previous studies have indicated that there are specific differences in motor performance and sensorimotor control between children with visual impairment and children with typical development (7-10); visually impaired children have also been found to exhibit delayed motor development (6, 22). These limitations, which have been observed in children with visual impairment, are similar to those demonstrated by children with multiple dis-

abilities who had visual impairment in the present study. The present study showed that the individuals with multiple disabilities had lower scores on activities assessed for balance, running speed agility, shoulder and arm strength, and abdominal strength compared to individuals with typical development.

It has been indicated that children with visual impairment have lower balance scores (3, 24). In the present study, children with multiple disabilities had poorer balance performance compared to children with typical development. Thus, inadequacy or absence of visual input in addition to their existing disabilities may cause decreased balance performance in children with multiple disabilities.

Agility is one of the most important performance-based physical fitness parameters and affects the quality and efficiency of motor performance; it also requires a combination of parameters such as balance, coordination, speed, reflexes, strength, and endurance (25). It has been found that children who are blind have performed worse on agility performance tests than children with typical development (3). In a similar manner, the present study has shown that the children with multiple disabilities had lower scores for agility performance.

As with the previous parameters, children with visual impairment had poorer muscle strength compared to children with typical development (3, 7). Both children with low vision and children who are blind had lower strength scores when tested for hip and knee extension compared with the scores of children with typical development, and individuals who are blind had the lowest strength scores among these three groups (26). In this study, the results have shown that the individuals with multiple disabilities had lower strength scores for the shoulder, arm, and abdominal muscles in comparison with children with typical development.

In the present study, the hand grip strength scores of the children with multiple disabilities were lower than children with typical development for both the dominant and non-dominant hands. A study that compared the grip strength of judokas with and without visual impairment indicated that the individuals with visual impairment had lower hand grip strength scores (27). This difference between the groups may be due to the individuals with visual impairment were not being able to use their hands for active exploration and manipulation because of decreased or inexistent visual knowledge (28).

Fine motor skills require more effort and time for children with multiple disabilities, and there are generally performance differences between the dominant and non-dominant sides (4). In the present study, it was found that both placing and removing times were longer for the dominant hand, but there was no evidence of longer times for the non-dominant hand. Previous studies have indicated that upper extremity speed and dexterity were decreased for children with visual impairment in comparison with the performance of children with typical development (4, 28). It has been demonstrated that inadequate eye-hand coordination, decreased visual perception, and compensatory mechanisms such as increased tactile stimuli and reduced distance of vision influence activity performance (10, 28).

Implications for Practice

The results of the study make it clear that children with multiple disabilities besides visual impairment had poorer motor performance when compared to children with typical development. In addition, another main purpose of the authors was to draw the attention of politicians and authorities to the development of health policies and practices for supporting children with multiple disabilities. There is a specific need to develop health policies that will increase the number of healthcare professionals and physiotherapists working with these children (29-31). Because all children with multiple disabilities have different abilities, disabilities, and therapeutic goals, there is a specific need for the therapist's experience of the child's motor abilities (29). Besides, the success of this process depends on knowledge about limiting factors affecting the participation of each child in order that intervention to change limiting factors should be guided appropriately (29, 31). By means of training programs conducted by physiotherapists, the motor proficiency of children with multiple disabilities can increase. Although the lack of internal motivation of children with multiple disabilities, stimulation of motor abilities will help

them to participate in daily life activities and provide control over their own life (15). In light of the results of this study, the authors recommend that the treatment program of children should include vestibular stimulation training, upper extremity muscle strengthening, functional fine motor activities to improve motor skills. Besides, group aquatic aerobic exercise programs can help these children to improve cardiorespiratory endurance (14). It is expected that the findings of the present study will contribute to the development of clinical approaches for children with multiple disabilities who have visual impairment.

Study Limitations and Future Perspective

The present study had some limitations to be taken into account. The "multiple disabilities" is an umbrella term used for individuals who have a combination of various impairments at the same time. However, it should be considered that the participant heterogeneity in this study makes the findings generalizable for individuals with multiple disabilities. Besides, this study cannot give information about the developmental and/or cognitive stages, sex norms, and reference to age. Because the measurement tools which were used in this study do not contain norm values for children with multiple disabilities.

Another issue was the lack of reliable measurement tools for students with multiple disabilities. Reliability and validity studies of the used measurement tools have not been conducted for children with multiple disabilities. The measurement tools used in this study have been designed and standardized for individuals with typical development. However, The BOT-2 SF and a hand dynamometer have been used in previous studies in individuals with visual impairment (27, 32). Due to the lack of reliable measurement tools, it is necessary to develop and use specific test batteries for children with multiple disabilities.

It should also be noted that sensory integration problems and decreased physical activity might also affect the motor skill performance of these children, but these factors were not examined in this study. Future studies are needed to investigate the relationship between sensory integration, physical activity level, and motor performance in children with multiple disabilities.

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