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ORIGINAL ARTICLE

Differences in motor abilities between blind students and students without visual impairment

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Abstract

The purpose of this study was to determine the level of motor abilities development in blind students and students without visual impairments, as well as to examine whether there are differences in motor abilities development between these two groups of participants. The research included 22 blind student (11 girls and 11 boys) and 22 students without visual impairments, aged 11-17 years. The Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) was used to assess motor abilities. The analysis of the results revealed that the motor abilities development of blind students was significantly below average, while students without visual impairments showed an average level of motor abilities development. When comparing the achievements of blind students and students without visual impairments, it was observed that blind students had poorer performance on both the overall motor test and the subtests of bilateral coordination, upper limb coordination, and balance. On the other hand, students without visual impairments achieved good results on all tested subtests.

Keywords: motor abilities · blind students · students without visual impairment

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Introduction

Through vision, the acquisition, differentiation, and automatization of motor abilities are controlled (Houwen, Visscher, Lemmink, & Hartman, 2009). Given that blind children are deprived of visual stimulation at an early age, this negatively affects the development of motor abilities (Atasavun Uysal & Duger, 2011; Bouchard & Tetreault, 2000; Levtzion-Korach, Tennenbaum, Schnitzer, & Ornoy, 2000; Rutkowska et al., 2016; Sretenovic & Nedovic, 2019). Since the significance of vision in motor development has been recognized in many studies, the most notable delays in blind children are observed in the area of motor functioning (Houwen et al., 2009; Levtzion-Korach et al., 2000).

In support of this, Haegele, Brian, and Goodway (2015) acknowledge that blind students tend to develop motor abilities later in life compared to their peers without visual impairments. Motor control problems in students with visual impairments are manifested as a lower level of development of motor abilities, including balance, speed, strength and coordination (Houwen, Hartman, & Visscher, 2010). The results of tests for assessing motor abilities suggest that students with visual impairment have more difficulties in performing motor tasks that require speed, control and accuracy (Grbovic & Jorgic, 2017; Houwen et al., 2010). Winnick (Winnick, 1985) emphasizes that in students with visual impairment, achievements on motor tests differ according to the nature of a specific motor task (Winnick, 1985, according to Grbovic & Jorgic, 2017).

One possible explanation for motor delays in blind children is the lack of physical activity, often attributed to a lack of knowledge among educators on how to appropriately modify curriculum and provide equipment for this population (Haibach, Wagner, & Lieberman, 2014; Haegele et al., 2015). However, it is believed that the absence of vision does not prevent blind children from being physically active (Wiszomirska, Kaczmarczyk, Blazkiewicz, & Wit, 2015). On the other hand, overprotective attitudes of parents can significantly limit blind children's participation in motor activities. Parents often overestimate the risks, neglecting the benefits of physical activity for their children (Bouchard & Tetreault, 2000).

Nevertheless, some authors suggest that exposure to an adequate stimulating environment can reduce motor delays, but cannot completely eliminate motor problems in blind children (Levtzion-Korach et al., 2000; Brambring, 2006; Strickling & Pogrund, 2002, according to Vucinic & Andjelkovic, 2021). Additionally, the way parents structure the environment and interact with their child can significantly influence the course of their motor ability development (Vucinic & Andjelkovic, 2021).

Analyzing the available literature, it is evident that relatively little attention has been given to a comprehensive assessment of motor abilities in blind children. Based on existing knowledge, studies indicate pronounced delays in the development of motor abilities (Atasavun Uysal, & Düger, 2011; Calık, Aslan, Aslan, & Kabul, 2019; Hadzimehmedovic, & Memisevic, 2018; Levtzion-Korach et al., 2000; Nakata, & Yabe, 2001).

The aim of the research is to investigate the level of motor abilities development and determine the differences in motor abilities between blind students and students without visual impairments.

Method

Sample of participants

The sample for our research comprised 22 blind students (11 girls and 11 boys) from specialized schools catering to visually impaired students, along with 22 students without visual impairment, aged between 11 and 17 years (AS=14.50 SD=2.01). Inclusion criteria for blind students were based on the presence of visual impairment within the range of blindness, which was determined through a review of medical documentation. Blind students with reduced cognitive abilities or additional disabilities were excluded from the sample. The selection of students without visual impairment followed the method of equivalent pairs, ensuring both groups were matched in terms of gender and age. Prior to conducting the research, we obtained approval from the institution managers, presenting them with an overview of the research process. Once their approval was granted, and with the consent of the parents, the research commenced.

Instrument used in the research

Motor Proficiency, Second Edition-BOT-2 shorter form (Bruininks & Bruininks, 2005). This assessment tool is designed for children and adolescents aged four to 21 years. The shortened version of the BOT-2 serves as a screening tool to identify children with motor deficits. It provides reliable results for the students' overall motor abilities in a short period of time. The assessment focuses on four areas of motor development: 1. Fine motor precision, 2. Hand coordination, 3. Body coordination, and 4. Movement speed and strength (Christodoulou, 2016). The test consists of 14 tasks divided into 8 subtests.

Within the Bilateral Coordination subtest, the following tasks were included: a) synchronized arm and leg jumps in place (on the same side of the body), and b) tapping the foot on the floor and the index finger on the table in synchronization (arm and leg on the same side of the body). The Balance subtest required tasks such as: a) walking in a straight line, and b) balancing on one leg on a beam with eyes open. The upper limb coordination subtest involved tasks where the child was required to: a) bounce a tennis ball off the ground and catch it with both hands, and b) bounce the tennis ball off the ground alternately with both hands.

The testing was conducted in a gymnasium. Blind students had the opportunity to familiarize themselves with the materials through tactile analysis, receive detailed verbal instructions for each task (including positioning), and take breaks. Once the tasks were understood, the testing proceeded according to the instructions outlined in the test. The testing was carried out individually. Due to the specificities of blind children, as well as the additional time required to complete certain tasks, the testing lasted longer (1 hour) than the anticipated duration (15-20 minutes).

For the purpose of this study, we will focus on the analysis of blind students' performance in the coordination and balance subtests, which are particularly relevant for engaging in physical activities. Accordingly, specific accommodations were made in these subtests for blind children. In the Coordination of the upper limbs subtest, where manipulation of a ball was required, a volleyball ball with a bell inside was used to provide a sound stimulus and feedback about the ball's movement. In the Balance subtest, where blind students had to walk in a straight line, accommodations included placing a rope along the line and having the students wear socks to enhance their perception of the line and facilitate easier following. Additionally, a caller was present to audibly indicate the direction of movement, providing assistance to the blind students.

Statistical data analysis

The data analysis was performed using the statistical software package SPSS 20. The achievements on the subtests are presented numerically (N) and in percentages (%). The Mann-Whitney test was used to examine differences in motor abilities between blind students and students without visual impairments.

Results

The results of the Kolmogorov Smirnov test showed values less than 0.05, which means that the assumption of normality of distribution is rejected, which indicates the use of non-parametric statistics for testing our hypotheses (Table 1).

Table 1. The normality of the distribution of results on the BOT-2 test

Variable	Mean±SD	Median	Variance	Skewness	Kurtosis	KS-test	df	p
BOT-2	35.14±7.89	34.00	62.26	0.137	-1.219	0.107	44	0.48

The reliability of the BOT-2 test used in this study was assessed using Cronbach's alpha coefficient, and the obtained value was 0.914, indicating high internal reliability (Table 2).

Table 2. Verification of the measurement instrument-Cronbach's alpha coefficient

Variable	N of Items	Cronbach's ά
BOT-2	14	0.914

Table 3 presents the scores of blind students and students without visual impairment on the subtests. In the bilateral coordination skill requirement task of jumping in place, blind students had lower scores. Sixteen students received one or zero points, while only six students scored two or three points. However, blind students performed exceptionally well in tasks involving tapping their index finger on a table and tapping their foot on the floor, with all students achieving the maximum of four points. When it came to maintaining a balanced position while walking along a straight line, 16 students (72.80%) were able to take up to five correct steps. However, the blind students struggled with the task of maintaining balance and standing on one leg on the beam, as 19 students (86.40%) were unable to participate in the activity for even one second. Catching the ball with both hands posed a difficulty for the majority of blind students, with 15 students (68.20%) exhibiting poor performance. In the dribbling task, blind students had the lowest average scores, with 16 students (72.80%) receiving only one point out of a maximum of seven points. In contrast, students without visual impairment achieved the best average scores in the bilateral coordination, balance, and upper limb coordination subtests, with nearly all of them receiving the maximum points (Table 3).

Table 3. Achievements of blind students and students without visual impairment on subtests of the BOT-2 test

Tasks		Blind students					Students without visual impairment
		Subtest 4		Bilateral		Coordination	
Jumping in place same sides synchronized	Jumps	0	1	(2-4)	5		5
	Points	0	1	2	3		3
	N	4	12	2	4		22
	%	18.20	54.50	9.10	18.20		100.00
Tapping feet and fingers- same sides synchronized	Taps	10					10
	Points	4					4
	N	22					22
	%	100.00					100.00
		Subtest 5		Balance			
Walking forward on a line	Steps	(3-4)	(5)	(6)			6
	Points	2	3	4			4
	N	8	8	6			22
	%	36.40	36.40	27.20			100.00
Standing on one leg on balance beam-eyes open	Seconds	(0-0.9)		(1.0-2.9)		(6.0-9.9)	10
	Points	0		1		3	4
	N	19		3		2	20
	%	86.40		13.60		9.10	90.90
		Subtest 7		Upper-limb		Coordination	
Dropping and catching a ball bath hand	Catches	2	3	4	5		5
	Points	2	3	4	5		5
	N	6	9	5	2		22
	%	27.20	40.90	22.70	9.10		100.00
Dribbling a ball alternating hand	Dribbles	1		2		(8-9)	10
	Points	1		2		6	7
	N	16		6		1	21
	%	72.80		27.20		4.50	95.50

The results from Table 4 indicate that the level of motor abilities development among blind students is significantly below average.

Table 4. Level of development of motor skills in blind students and students without visual impairment

Level of development		Blind students	Students without visual impairment
Well below average	N	21	0
	%	95.50	0
Below average	N	1	0
	%	4.50	0
Average	N	0	22
	%	0	100.00

Conversely, all respondents in the group of students without visual impairment showed an average level of motor abilities development. A comparison of the results between the two groups on the BOT-2 test reveals a statistically significant difference (U=0.000; Z=-5.703; p=0.000). The scores of blind students were significantly lower compared to those of students without visual impairment (Table 5).

Table 5. Determining achievement differences between blind and students without visual impairment on the BOT-2

Variable	Blind students (N = 22)	Students without visual impairment (N = 22)	Mann-Whitney U test	Wilcoxon rang test	Z	p
	Median	Median				
BOT-2 test	26.50	44.00	0.00	253.00	-5.703	0.000

Table 6 demonstrates a statistically significant difference in the achievements of these two groups on the subtests.

Table 6. Determining achievement differences blind and students without visual impairment on subtests of the BOT-2 test

Variable	Blind students (N = 22)	Students without visual impairment (N = 22)	Mann-Whitney U test	Wilcoxon rang test	Z	p
	Median	Median				
Subtest 4: Bilateral coordination	6.00	7.00	44.00	297.00	-5.286	0.000
Subtest 5: Balance	4.00	8.00	0.00	253.00	-6.008	0.000
Subtest 7: Upper-limb Coordination	4.00	12.00	0.00	253.00	-6.039	0.000

Specifically, it was determined that students without visual impairment achieved better results in bilateral coordination (U=44.000; Z=-5.286; p=0.000), upper limb coordination (U=0.000; Z=-6.039; p=0.000), and balance (U=0.000; Z=-6.008; p=0.000). Overall, the results indicate that blind students have lower motor abilities development compared to students without visual impairment, particularly in tasks requiring bilateral coordination, balance, and upper limb coordination.

Discussion

The aim of our study was to determine the level of motor abilities development among blind students and students without visual impairment. Upon examining the obtained results, it can be concluded that the level of motor ablities development among blind students is significantly below average, while most students without visual impairment exhibit an average level of development. These findings are supported by the results of Atasavun Uysal and Düger (2011), which indicate a significantly lower level of motor abilities development among blind students compared to their peers without visual impairment. Christodoulou et al. (2019) also confirm that the development of motor abilities in visually impaired students falls under the “below average” category, unlike typically developing students who fall under the “above average” category. Similar conclusions have been reached by other studies (Alibegović & Jablan, 2009; Sretenović & Nedović, 2019).

Furthermore, our research aimed to examine whether there are differences in the motor abilities development between blind and students without visual impairment. Through the analysis of the results, it is evident that students without visual impairment have more developed motor abilities and achieve better results both in the overall motor test and the subtests. In terms of bilateral coordination, blind students displayed uncoordinated movements, undefined laterality, rotational movements, and difficulty understanding instructions during tasks such as jumping in place with synchronized arm and leg movements. This aligns with the findings of Rutkowska et al. (2016), who assessed bilateral coordination in blind children and adolescents and found that their performance was below or significantly below average. The jumping in place with synchronized opposite-side movements proved to be the most challenging task for visually impaired students, as their ball manipulation was hindered, resulting in limited success before the ball dropped. Additionally, some students struggled with catching the ball with both hands, relying on their entire body to grasp it. These findings are consistent with studies by Houwen, Hartman, Jonker, and Visscher (2010) and Wagner, Haibach, and Lieberman (2013) regarding deficits in dribbling and ball-catching skills. Similar conclusions have been drawn by Houwen, Visscher, Lemmink, and Hartman (2008), who observed that visually impaired students performed the poorest in terms of coordination compared to their peers without visual impairment. Ilić-Stošović and Nikolić (2012) focused on examining coordination in students with sensory impairments and found that 65.07% of visually impaired students exhibited coordination disorders, while 34.93% displayed good coordination skills.

When walking along a line, a certain number of blind students showed deviations from the line and hand lowering. However, they did not experience significant difficulties on this task, which may be explained by their previous participation in physical education classes involving this activity. On the other hand, blind students demonstrated the poorest performance when standing on one leg on a beam, as they exhibited fear, discomfort, a tendency to fall, and a need for support. Comparing the ability to maintain balance and perform tasks related to static or dynamic balance between blind and typically developing students, as observed by Nakata and Yabe (2001), it is evident that typically developing students perform better than blind students, which aligns with the findings of our study. Schmid, Nardone, De Nunzio, Schmid, and Schieppati (2007) emphasize that students without visual information often exhibit poor static and dynamic balance and an increased risk of falling. Tasks such as standing on one leg, walking along a line, jumping in place with both feet, walking on tiptoes, which require the ability to maintain balance in dynamic conditions, have been found to show significant differences between blind and non-impaired peers, indicating a delayed acquisition of balance abilities in blind students, sometimes up to 10-20 months later compared to their sighted peers (Rutkowska et al., 2015). Furthermore, tasks involving maintaining balance during free walking and significantly reducing support also posed difficulties for these students, resulting in lower scores (Rutkowska et al., 2015). Standing on one leg on a beam was identified as the most challenging task in terms of balance assessment for blind students, which is consistent with our results. Similarly, Uzunović et al. (2015) highlight that maintaining balance on a supporting surface narrower than their foot surface is a specific problem for students with visual impairments. Analyzing the obtained results, Grbović and Jorgić (2017) conclude that students without visual impairments achieve better results in balance maintenance tasks compared to students with moderate or severe visual impairments. Bouchard and Tetreault (2000) found that the most significant difference occurs in the balance subtest, with balance being the most affected and students without visual impairments achieving 3 to 5 times better results. Similar findings were reported by Houwen et al. (2008). Ilić-Stošović and Nikolić (2012) also identified a weaker development of balance ability, with 28.90% of visually impaired students and 22.90% of visually impaired students showing difficulties in maintaining balance. Considering research on the impact of visual impairments on balance ability, it is concluded that visual information is a crucial factor for maintaining balance (Ćosić, Kasum, Radovanović, & Koprivica, 2014). Therefore, the lack of balance is considered one of the most profound problems for blind students. Numerous studies have confirmed the difficulties blind students face in maintaining a balanced position (Calık et al., 2019; Romanov, Koretić, & Garunović, 2017). In order to improve balance in blind students, interventions have been implemented with positive effects on balance, as demonstrated by Koutsokosta and Fotiadou (2010, according to Christodoulou, Mousouli, Spyridon-Georgios, Christopoulou, & Christopoulos, 2017) and Atasavun Uysal and Düger (2011).

Conclusion

As limitations of the small number of conducted studies, methodological aspects are mentioned. Namely, the lack of adequate and reliable instruments specifically designed for this population, as well as the absence of a justified sample size, hinders the generalization of conclusions from the conducted research (Bakke, Cavalcante, Oliveira, Sarinho, & Cattuzzo, 2019).

Therefore, recommendations for future research should focus on increasing the sample size of participants and assessing motor abilities at an earlier age in order to identify motor deficits and timely intervention when children are at an optimal age for learning motor abilities (Houwen, Hartman, & Visscher, 2010). Ultimately, considering the comprehensive perspective, the examination of motor functioning in blind children is considered a basis for program conceptualization, environmental adaptation, and physical activities, which contribute to improving motor abilities.

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