College of Applied Health Sciences Ćuprija, Public Health, Ćuprija[1]
Institute for Emergency Medicine in Niš, Faculty of Medicine, Niš[2]

Original study
Originalni naučni rad
UDK 796.012.1-053.5-056.262
https://doi.org/10.2298/MPNS2402036T

ASPECTS OF MOTOR FUNCTIONING OF BLIND AND VISUALLY IMPAIRED CHILDREN – THE IMPORTANCE OF SOMATOPEDIC TREATMENT

ASPEKTI MOTORIČKOG FUNKCIONISANJA SLEPOG I SLABOVIDOG DETETA – ZNAČAJ SOMATOPEDSKOG TRETMANA

Sanja TRGOVČEVIĆ[1], Sunčica IVANOVIĆ[1], Milena CVETKOVIĆ JOVANOVIĆ[2], Suzana MILUTINOVIĆ[1], Ivana VUKOSAVLJEVIĆ[1] and Ljubica KRIVOKAPIĆ[1]

Summary
Introduction. Given that vision significantly influences motor function, particularly in the execution of voluntary movements, this study aimed to determine whether targeted somatopedic training could enhance certain motor aspects in visually impaired children. The study focuses on the following components: coordination, balance, manipulative dexterity, and walking. **Material and Methods.** The sample comprised 60 children from three schools: the Primary School for Vision Protection "Dragan Kovačević" in Belgrade, the School for Visually Impaired Children "Veljko Ramadanović" in Zemun, and the Elementary School "Djordje Krstić" in Belgrade. The experimental group included children aged 6-15 years with visual impairments, average intellectual abilities, and normal neurological and psychological status. The control group was matched by number, gender, and age, consisting of students from regular schools. We assessed motor functioning using tests for hand manipulative skills, coordination of upper and lower extremities, and body balance while walking and standing. **Results.** Statistically significant differences were observed between the experimental and control groups in all examined subtests: manipulative dexterity (p=0.006); coordination of upper extremities (p=0.029); coordination of upper and lower extremities (p=0.005); maintaining balance during walking (p=0.002); maintaining balance while standing (p=0.024), and walking (p=0.010). **Conclusion.** The results clearly indicate the importance of somatopedic treatment in improving motor functions of blind and visually impaired children.
Key words: Blindness; Visually Impaired Persons; Psychomotor Performance; Motor Skills; Postural Balance; Walking; Child Development

Sažetak
Uvod. Imajući u vidu da čulo vida u velikoj meri determiniše motoričko funkcionisanje, naročito u kontroli izvršenja voljnog pokreta, želeli smo da utvrdimo da li se ciljanim somatopedskim treningom mogu popraviti neki motorički aspekti kod dece oštećenog vida. Odabrane komponente činili su: koordinacija, ravnoteža, manipulativna spretnost i hod. **Materijal i metode.** Uzorak je obuhvatao 60 dece iz Osnovne škole za zaštitu vida „Dragan Kovačević" u Beogradu, Škole za decu oštećenog vida „Veljko Ramadanović" u Zemunu i Osnovne škole „Đorđe Krstić" u Beogradu. Eksperimentalnu grupu činila su deca uzrasta 6‒15 godina sa oštećenjem vida, prosečnim intelektualnim sposobnostima i urednim neurološkim i psihološkim statusom. Kontrolna grupa je bila ujednačena po broju, polu i uzrastu sa eksperimentalnom grupom i sastojala se od učenika iz redovne škole. Za procenu motoričkih funkcija koristili smo testove za manipulativne veštine ruku, koordinaciju pokreta gornjih i donjih ekstremiteta, kao i održavanje ravnoteže tela pri hodu i stajanju. **Rezultati**. Prisustvo statistički značajnih razlika među eksperimentalne i kontrolne grupe, utvrđeno je na svim ispitivanim suptestovima: manipulativna spretnost (p = 0,006); koordinacija pokreta gornjih ekstremiteta (p = 0,029); koordinacija pokreta gornjih i donjih ekstremiteta (p = 0,005); održavanje ravnoteže tela pri hodu (p = 0,002); održavanje ravnoteže tela pri stajanju (p = 0,024) i hoda (p = 0,010). **Zaključak.** Dobijeni rezultati nedvosmisleno ukazuju na značaj somatopedskog tretmana u poboljšanju motoričkog funkcionisanja slepe i slabovide dece.
Ključne reči: slepilo; slabovide osobe; psihomotorne performanse; motoričke sposobnosti; posturalni balans; hodanje; razvoj deteta

ORCID NUMBER
Sanja Trgovčević - 0000-0002-8262-4313
Sunčica Ivanović - 0000-0001-8375-9298
Milena Cvetković Jovanović - 0000-0002-2535-8979
Suzana Milutinović - 0000-0003-3004-6205
Ivana Vukosavljević - 0000-0002-5000-3774
Ljubica Krivokapić - 0000-0002-4245-4807

Introduction

In the field of science, patient care, and treatment the primary principles guide us to focus on the patient rather than the diagnosis, adhering to the rule "first, do no harm" [1]. Analyzing the motor functioning of blind and visually impaired children is particularly challenging due to its critical role in their overall psychophysical development. Common misconception is that motor functioning is simple in its structure and function. However, a deeper analysis, grounded on a scientific methodology, reveals inherent complexity. Research

Corresponding Author: Dr Sunčica Ivanović, Akademija vaspitačko medicinskih strukovnih studija-Odsek medicinskih studija Ćuprija, 35000 Cuprija, Lole Ribara 1/2, E-mail: suncica.ivanovic@yahoo.com

indicates that motor function cannot be regarded as a singular ability; instead, it comprises several broad groups of specific abilities, whose boundaries are not clearly underlined.

Motor development in children involves the gradual acquisition of muscle control. This development results from the maturation of neural structures, bones, and muscles, as well as changes in body proportions. Additionally, learning opportunities enable the coordinated use of various muscle groups. The structure of motor functioning provides a fundamental basis for expanding knowledge and gaining new experiences. At the core of motor development is a hierarchy involving the maturation of innate anatomical and physiological systems.

The locomotion of a newborn is immature. The central nervous system, locomotor apparatus, sensory organs, and other body systems develop throughout childhood. During this time, a child learns and adopts new motor patterns, which become automated and more complex over time. This development follows genetically established patterns and is stimulated by environmental stimuli. Concurrently, intellectual abilities develop, collectively shaping an individual's life potential. Each system involved in this development plays a crucial role, and it is difficult to prioritize their importance. These systems are interdependent, and any inadequacy or absence of one factor can impede the harmonious development of other abilities.

Visual perception is a fundamental human cognitive function, playing a dominant and integrative role in the perception process. Approximately 90% of information from the external environment is perceived through vision. Vision helps humans understand the basic features of their surroundings, including color, size, shape, and spatial relationships such as distance, direction, and movement. Through vision, individuals learn imitation, self-awareness, and social behavior, facilitating adequate social interactions. Cognitive sensory perception relies on the interplay between various systems, forming complex dynamic connections among visual-tactile, visual-auditory, and visual-motor systems. Moreover, vision enhances the quality to other sensory information. These connections underpin the motor, emotional and intellectual functioning of an individual.

Motor development of visually impaired children

In his research, "Preschool Children with Visual Impairments", Bishop [2] asserts that developmental norms are based on observations of children with normal sight. Bishop notes that only a few studies support direct comparison between blind children and those with normal vision. Current research suggests that blind children follow their own specific laws of motor development. What might appear as a "delay" is, in fact, a normal developmental course for a blind child. The specific developmental laws for blind children are not well-defined, partially due to their relatively low population and the lack of comprehensive regional and national databases. Until these norms are established, blind children will continue to be compared to sighted children, leading to the identification of "delays".

Bishop highlights that the most noticeable delays in visually impaired children are in motor development. Vision serves as a primary motivator for many motor activities (e.g., head control, upright posture, reaching, and locomotion), which may be absent in blind children. However, early interventions can often minimize these delays. Additionally, hearing is not as strong motivator for initiating movements such as catching and grabbing. "Catching by sound" is not equivalent to "catching by visual stimulus", so delay in locomotion due to auditory cues cannot be fully compensated, as auditory development does not offer the same adaptive advantages as visual development. When vision is substituted with hearing or touch as stimuli, it is important to remember that touch and hearing are sequential, not continuously like vision. Key developmental milestones, such as head control, independent sitting, arm and hand use, crawling, standing, and walking, are delayed without additional stimulation, typically by several months.

Udo and Fils [3] found significant delays in the use of hands in blind children, even though their arms and hands are primary organs of perception.. At five months, a blind child might keep closed fists at a shoulders level. There will be no touching of fingers of both hands, and they will not be active in the medial line. In this age, a sighted child is already practicing coordinated movements and moving an object from one hand to the other. This delay impacts both gross and fine motor skills, as the absence of vision prevents the natural coordination of hands and eyes. Instead, blind children must rely on ear–hand coordination, which requires more experience and develops later than eye–hand coordination. Without attempting to reach for sound sources by around 12 months, blind children will not explore their environment through crawling or walking.

The inability to perceive and imitate movement, combined with the lack of self-confidence and inhibition, affect walking development in blind children. Motor visual imitation is crucial for learning to walk, expressing vocal movements, engaging in various games, and performing daily activities. Without visual imitation, blind children's locomotion is significantly poorer. They rely on tactile-kinesthetic imitation, learning through passive tactile guidance [4].

Walking is a source of enjoyment for both blind and sighted children. While sighted children learn to balance after a few weeks, blind children require more time. Once they achieve an upright position and balance, further development can occur. Understanding body control (a child's perception of their capabilities and awareness that others have similar abilities) and space recognition (realizing that there is space "right outside") involves cognitive abilities. When this understanding is reached, coordinated and purposeful movements within the environment can occur, facilitating interactions and orientation within their world [2]. Blind children's walking has certain characteristics: a nearly motionless upper body, limited arm swinging, a forward-inclined head, and widely spread feet in a fan-shaped form [4].

Fine motor skills also develop more slowly in visually impaired children. Vision aids in controlling, imitating and refining these movements. Blind children find it challenging to acquire grasping movements (e.g., the use of accessories, crayons…) and "academic skills" like stacking cubes, coloring, coating, and using scissors [5].

Jablan [6] found that in a sample of 95 blind and practically blind primary school children, 55.8% showed harmonious motor development. Minimal difficulties were noted in praxis activities, oral motor functions, and differentiation of motor functions of fingers and hands. However, tasks requiring physical integrity experience and kinetic movements were moderately challenging. The least developed motor function was motor preservation. The research results indicate slower motor functions development in blind children due to the lack of visual experience, sensory and motor deficits, and poor experiential foundations.

In the study "Motor skill performance of school-age children with visual impairments" [7] researchers explored different motor achievements in visually impaired children aged 7–10 years using the MABC test battery. The analysis showed that children with visual impairments performed slower in hand usage tests compared to sighted children, regardless of compensatory skills (reducing the distance and using proprioceptive information) or regardless of severity of visual impairment. Significant difficulties were observed in eye-hand coordination tasks, with the greatest difference found in bimanual coordination test. No statistically significant difference was found in dynamic balance, but there was a difference in static balance. The authors concluded that the poorer results in the experimental group were solely due to visual impairments.

Jablan, Vučinić, and Gligorović [8] investigated motor function development, spatial orientation, and the relationship between these aspects in blind primary school children. They found motor function difficulties in 44.2% of participants, with motor abilities improving with age. A positive correlation was also found between intellectual abilities, motor functions, and school achievement.

Brambring [9] describes three theoretical interpretations of delayed motor development in blind children. One theory links delays directly to the primary deficit, i.e., the lack of vision, which prevents or restricts a blind child to gain adequate experience in a social environment that can be reached by motor activities under physiological conditions. Another theory attributes delays to a non-stimulating social environment and low expectations. The third theory suggests that delays are due to various adaptive compensation mechanisms, where different effective alternative strategies can help blind children compensate for their primary deficit to varying degrees.

In the previous discussion, we established that children with visual impairment face significant challenges in motor functioning, impacting their daily lives. Our study specifically aimed to investigate whether targeted somatopedic training could improve certain motor aspects in visually impaired children. The selected components included manipulative dexterity, coordination, balance, and walking, which served as the dependent variables in our study. The independent variables included the level of visual impairment, gender, age, and the treatment applied. By examining these variables, we aimed to determine the effectiveness of somatopedic training in enhancing the motor functions of visually impaired children.

Material and Methods

The study sample consisted of 60 children selected from three schools: the Primary School for Vision Protection "Dragan Kovačević" in Belgrade, School for Visually Impaired Children "Veljko Ramadanović" in Zemun, and Primary School "Djordje Krstić" in Belgrade. The inclusion criteria were as follows: visual impairment defined according to the World Health Organization standards, age of the participants ranging from 6-15 years, encompassing both younger and older primary school students, children with average intellectual abilities as determined by their inclusion in regular curriculum classes during school enrollment, and normal neurological and psychological statuses to avoid the confounding effect on motor abilities. The sample was divided into two groups: Experimental Group (E), consisting of 30 children (15 blind and 15 visually impaired) who received targeted somatopedic treatment, and Control Group (K), consisting of 30 children (15 blind and 15 visually impaired) who did not receive somatopedic treatment.

The somatopedic treatment was conducted by special education and rehabilitation teacher, based on individualized and group somatopedic programs. The research lasted for twelve weeks, during which the Group E children underwent somatopedic treatment.

To gather the required data and achieve the study's objectives, we employed the following methods and instruments: analysis of school ophthalmological documentation, analysis of school pedagogical-psychological documentation, analysis of medical records, and special education and rehabilitation tests. By examining the school ophthalmological documentation, we obtained information on the level and type of visual impairment. Visual acuity, whether at the low vision level or at the blindness level, was assessed according to the World Health Organization's definition. Given the upper limit of low vision provides some flexibility in terms of visual acuity, it was essential for the information to be documented by the Commission for Classification and Categorization of the Republic of Serbia. Data on the participants' gender, school age, and academic performance were gathered from the school pedagogical-psychological documentation. We obtained information on birth date, presence of other illnesses, the age at which the child began walking, early childhood motor development, and medical interventions related to vision from the medical records of school health records. Children with neurological impairments and children whose intellectual abilities indicated developmental delays were excluded from the research. Consequently, we used the following special education and rehabilitation tests: Test for assessing manipulative dexterity of the hand (Task I according to Lafaye) [9]; Test for assessing movement coordination of the upper extremities [11]; Test for assessing movement coordination of the upper and lower extremities [10]; Test for assessing balance maintenance during walking [12]; Test for assessing balance maintenance when standing [12]; Test for assessing gait [11].

Descriptive statistical methods were used to process the collected data, including percentages, means, and standard deviations, while ANOVA model, correlation analysis and t-test were employed to determine the correlation between dependent and independent variables.

Results

The assessment of participants' achievements and performance was conducted before and after treatment, as detailed below (**Table 1**).

Initially, both the E and K groups showed similar levels of performance based on the number of strung beads, as illustrated in the combined table above. However, following treatment, a notable increase in the number of "very successful" participants was observed in the E group compared to the K group. Specifically, the proportion of "very successful" participants in the E group increased from 21 (63.6%) to 9 (30%), while in the K group, it increased from 12 (40%) to 21 (63.6%).

Furthermore, after treatment, no participants in the E group were classified as "unsuccessful", whereas in the K group, this proportion increased from 0% to 13.3%. The number of participants classified as "successful" decreased in both groups, with 14 (46.7%) in the K group and 9 (30%) in the E group, as more participants transitioned to the "very successful" category after treatment.

Statistical analysis revealed a significant difference in performances between the E and K groups after treatment (p=0.006, r=0.350), indicating the effectiveness of the treatment intervention.

Regarding the evaluation results from the Lafaye test, participants were categorized based on the number of adverse movements during both measurements. Notably, after the first measurement, there was no statistically significant difference between the E and K groups. However, after treatment, the E group demonstrated significantly fewer adverse movements during task execution compared to the K group (p=0.015; r=0.314).

Overall, these findings underscore the effectiveness of the treatment intervention, particularly in enhancing performance and reducing adverse movements within the E group relative to the K group.

Table 2 presents a comparative analysis of successful task performance between groups E and K before and after treatment intervention.

Before treatment, both groups exhibited similar levels of successful task completion, with the majority of participants in the "task completed successfully" category. Specifically, 55% of participants in both groups successfully completed the task during the initial assessment, while none were categorized as "unsuccessful". However, noticeable differences emerged after the second assessment.

In group E, the proportion of participants in the "task completed successfully" category increased substantially to 80%, accompanied by a decrease in the proportion categorized as having "problems in task performance" (B category). Conversely, in group K, although there was a slight increase in successful task completion (53.3% from 55%), the change was minimal compared to group E. Statistical analysis revealed a significant difference between the two groups after the treatment intervention (p=0.029, r=0.283).

Before treatment, both groups demonstrated comparable levels of successful task performance, with no statistically significant difference between them (p>0.05). The distribution of participants across categories ("unsuccessful", "problem in task performance", and "task completed successfully") was fairly equal,

Table 1. Achievements of participants in relation to performance/number of stringing beads and number of adverse movements on Lafaye test

Tabela 1. *Postignuća ispitanika u odnosu na uspešnost/broj nizanja perli i nuskretnji na Lafaj testu*

Group *Grupa*	I Measurement/*Merenja*			II Measurement/*Merenja*				
	*A	*B	*V	*A	*B	*V	*GI	*GII
E	2 (6.7%)	15 (50%)	13 (43.3%)	0	9 (30%)	21 (63.6%)		
E	1 (3.3%)	1 (3.3%)	15 (50%)	0	1 (3.3)	9 (30%)	13 (43.3%)	20 (66.7%)
K	5 (16.7%)	15 (50%)	10 (33.3%)	4 (13.3%)	14 (46.7%)	12 (40%)		
K	1 (3.3%)	3 (10%)	18 (60%)	1 (3.3%)	3 (10%)	15 (50%)	8 (26.7%)	11 (36.7%)
Total/*Ukupno*	7 (11.7%)	30 (50%)	23 (38.3%)	4 (6.7%)	23 (38.3%)	33 (55%)		
Total/*Ukupno*	2 (3.3%)	4 (6.7%)	33 (55%)	1 (1.7%)	4 (6.7%)	24 (40%)	21 (35%)	31 (51.7%)

Legend: *A – unsuccessful; *B – successful; *V – very successful
Legend: *A – unsuccessful; *B – 3 to 5 mistakes; *V – 1 to 2 mistakes; *G – no mistakes
*Legenda: *A – neuspešni; *B – uspešni; *V – veoma uspešni*
*Legenda: *A – neuspešni; *B – 3 do 5 grešaka; *V – 1 do 2 greške; *G – bez greške*

Table 2. Achievements of participants in relation to coordination of upper extremities and of upper and lower extremities
Tabela 2*. Postignuća ispitanika u odnosu na koordinaciju gornjih ekstremiteta i gornjih i donjih ekstremiteta*

	I Measurement/*Merenja*			II Measurement/*Merenja*		
Group/*Grupa*	*A	*B	*V	*A	*B	*V
E	0	12 (40%)	18 (60%)	0	6 (20%)	24 (80%)
E	2 (6.7%)	13 (43.3%)	15 (50%)	0	6 (20%)	24 (80%)
K	0	15 (50%)	15 (50%)	0	14 (46.7%)	16 (53.3%)
K	4 (13.3%)	14 (46.7%)	12 (40%)	2 (6.7%)	14 (46.7%)	14 (46.7%)
Total/*Ukupno*	0	27 (45%)	33 (55%)	0	20 (33.3%)	40 (66.7%)
Total/*Ukupno*	6 (10%)	27 (45%)	27 (45%)	2 (3.3)	20 (33.3%)	38 (63.3%)

Legend: *A – unsuccessful; *B – problem in task performance; *V – task completed successfully
*Legenda: *A – neuspešni; *B – problem u izvođenju zadatka; *V – uspešno izveden zadatak*

Table 3. Achievements of participants in relation to dynamic balance and static balance
Tabela 3. *Postignuća ispitanika u odnosu na dinamičku ravnotežu i na statičku ravnotežu*

	I Measurement/*Merenja*			II Measurement/*Merenja*		
Group/*Grupa*	*A	*B	*V	*A	*B	*V
E	6 (20%)	13 (43.3%)	11 (36.7)	2 (6.7%)	5 (16.7%)	23 (76.7%)
E	5 (16.7%)	22 (73.7%)	3 (10%)	2 (6.7%)	10 (33.3%)	18 (60%)
K	5 (16.7%)	18 (60%)	7 (23.3%)	3 (10%)	18 (60%)	9 (30%)
K	8 (26.7%)	19 (63.3%)	3 (10%)	3 (10%)	19 (63.3%)	8 (26.7%)
Total/*Ukupno*	11 18.3%)	31 (51.7%)	18 (30%)	5 (8.3%)	23 (38.3%)	32 (53.3%)
Total/*Ukupno*	13 21.7%)	41 (68.3%)	6 (10%)	5 (8.3%)	29 (48.3%)	26 (43.3%)

Legend: *A – unsuccessful; *B – problem in task performance; *V – task completed successfully
Legend: *A – unsuccessful; *B – with certain problems; *V – in accordance with the requirement
*Legenda: *A – neuspešni; *B − problem u izvođenju zadatka; *V – uspešno izveden zadatak*
*Legenda: *A − neuspešni; *B − uz određeni problem; *V − u skladu sa zahtevom*

with the lowest percentage in the "unsuccessful" category (10%). However, notable variations were observed after treatment.

In group E, there were no participants classified as "unsuccessful" after treatment, with a substantial increase to 80% of participants successfully completing the task. In contrast, in group K, although there was a marginal increase in successful task completion (46.7% from 45%), the number of participants facing "problems in task performance" remained unchanged. Statistical analysis indicated a significant difference between the two groups after treatment intervention (p=0.005, r=0.361).

Overall, the results highlight the effectiveness of the somatopedic treatment, particularly evident in group E, where a higher proportion of participants achieved successful task completion following intervention compared to group K.

Table 3 presents a comparative assessment of task performance between groups E and K before and after treatment intervention.

Initially, both groups demonstrated similar levels of task execution, with the majority of participants falling into the "problem in task performance" category (B category). Specifically, 51.7% of participants from both groups encountered some difficulties in task execution, while a smaller proportion was categorized as "unsuccessful" (20% in E group and 16.7% in K group).

Following the treatment intervention, significant improvements were observed in group E. A substantial 76.7% of participants from group E successfully completed the task (V category), compared to only 30% in group K. Conversely, in group K, the majority of participants (60%) remained in the "problem in task performance" category, with only 16.7% achieving successful task completion. This shift in performance led to a statistically significant difference between the two groups post-treatment (p=0.002, r=0.388).

Additionally, before treatment, both groups exhibited comparable distributions across task performance categories, primarily in the "problem in task performance" category (68.3% in each group). However, a slightly higher percentage of participants in group K were unsuccessful in task execution (26.7%). Subsequent to treatment, marked improvements were evident in group E, with 60% of participants achieving successful task completion, compared to 26.7% in group K. The majority of participants in group K (63.3%) continued to face challenges in task execution, remaining in the "problem in task performance" category. This disparity in performance post-treatment resulted in a statistically significant difference between the groups (p=0.024, r=0.292).

In summary, the findings underscore the efficacy of the treatment intervention, particularly in enhancing task performance among participants in group E compared to group K.

In Table 4, initial testing revealed that both E and K groups had 60% of participants in the "problem in

Table 4. Achievements of participants in relation to walking assessment
Tabela 4. *Postignuća ispitanika u odnosu na procenu hoda*

	I Measurement/*Merenja*			II Measurement/*Merenja*		
Group/*Grupa*	*A	*B	*V	*A	*B	*V
E	1 (3.3%)	18 (60%)	11 (36.7%)	0	12 (40%)	18 (60%)
K	3 (10%)	18 (60%)	9 (30%)	2 (6.7%)	19 (63.3%)	9 (30%)
Total/*Ukupno*	4 (6.7%)	36 (60%)	20 (33.3%)	2 (3.3%)	31 (51.7%)	27 (45%)

Legend: *A – 5 and more poor walking characteristics *B – 2 to 4 poor walking characteristics *V – walks well
*Legenda: *A – 5 i više loših karakteristika hoda *B – 2 do 4 loše karakteristike hoda *V – dobro hoda*

Table 5. Analysis of the results of the E group using a t-test after the first and second testing of dependent variables
Tabela 5. *Analiza dobijenih rezultata E grupe nakon prvog i drugog testiranja zavisnih varijabli primenom t-testa*

Testing 1 and 2/*Proba 1 i 2*	t	df	Sig
Lafaye 1 testing 1/*Lafaye 1 proba 1*	-3.07	29	.005
Lafaye 1 testing 2/*Lafaye 1 proba 2*	-3.53	29	.001
Coordination of upper extremities testing 1/*Koordinacija gornjih ekstremiteta proba 1* Coordination of upper extremities testing 2/*Koordinacija gornjih ekstremiteta proba 2*	-2.69	29	.012
Coordination of *U and*L extremities testing 1/*Koordinacija *G i *D ekstremiteta proba 1* Coordination of *U and*L extremities testing 2/*Koordinacija *G i *D ekstremiteta proba 2*	-4.09	29	.000
Dynamic balance testing 1/*Dinamička ravnoteža proba 1* Dynamic balance testing 2/*Dinamička ravnoteža proba 2*	-5.76	29	.000
Static balance testing 1/*Statička ravnoteža proba 1* Static balance testing 2/*Statička ravnoteža proba 2*	-6.59	29	.000
Walk testing 1/*Hod broba 1* Walk testing 2/*Hod proba 2*	-3.25	29	.003

Legend: *U – upper extremities; *L – lower extremities
*Legenda: *G – gornji ekstremiteti; *D – donji ekstremiteti*

task performing" (B) category, with E group showing slightly better walking proficiency (36.7%). No significant difference existed between the groups initially. After treatment, significant improvements were observed in the E group, with no participants in the "unsuccessful" (A) category and 60% in the "walks well" (V) category. In comparison, the K group had only 30% of participants in the "walks well" (V) category, with one participant shifting. A statistically significant difference emerged during the second testing (p=0.010, r=0.329), indicating varied treatment impact on task performance between groups. **Table 5** confirms that the quality of performance significantly improved following somatopedic treatment.

Discussion

Manipulative dexterity begins developing in infancy, becoming most prominent during preschool years but continuing throughout childhood. This skill is crucial for everyday tasks, from basic physiological activities to more complex tasks like writing and drawing, which are essential for social functioning. For children with impaired vision, particularly blind children, manipulative dexterity is even more vital. They heavily rely on their hands for gathering information, reading, and writing, providing invaluable sensory input that cannot be obtained through other means. Thus, our research aimed to assess manipulative dexterity in children with impaired vision and evaluate the effectiveness of targeted somatopedic treatment.

We assessed manipulative dexterity using the Lafaye test, evaluating participants' ability to string beads. We categorized participants based on the number of beads strung: those who strung between 9-25 beads were deemed "successful", those who strung more than 25 beads were categorized as "very successful", and those who strung fewer than 9 beads were labeled "unsuccessful". The results are presented in **Table 1.**

Initially, most participants from both E and K groups fell into the "successful" category (50%), followed by "very successful" (38.3%), with the fewest classified as "unsuccessful" (11.7%). There was no significant difference between the E and K groups during the first measurement. However, post-treatment, significant differences emerged. In the E group, there were no "unsuccessful" participants, with the number of "successful" participants decreasing to 30% and "very successful" increasing to 63.6%. This disparity between group performances was statistically significant during the second measurement (p=0.006, r=0.350), indicating that somatopedic treatment effectively improved manipulative dexterity.

Researchers investigating the coordination abilities of visually impaired children noted difficulties in expressing these motor skills. Zemcova [13] observed that children with low vision often exhibit deficits in coordination, while Nikolic et al. [14] found that coordination issues were prevalent in 54.4% of such children, among other signs of developmental delay.

In our study, as shown in **Table 2**, none of the participants in either the E group or the K group failed the task during the initial measurement. The percentage of participants encountering difficulty in task execution was 45%, with 55% successfully completing it. There was no statistically significant difference between the groups at this stage.

During the second measurement, we observed that there were still no unsuccessful participants. However, the percentage of successful task completion increased to 80% in the E group and 53.3% in the K group. Statistical analysis revealed a significant difference between these two groups after treatment application, with a p-value of 0.029 and a correlation coefficient of r=0.283.

It's noteworthy that there were no unsuccessful participants in either measurement. This suggests that the task may have been relatively easy for participants at this level of coordination ability testing.

Upon reviewing **Table 2,** we observed that 50% of participants in the E group successfully completed the task during the initial measurement, while 43.3% encountered difficulties, and only 6.7% were unsuccessful. In contrast, in the K group, 13.3% were unsuccessful, 40% succeeded, and 46.7% faced challenges in task performance. Following the second testing, no participants in the E group were unsuccessful, with 80% successfully completing the task. Subsequent to treatment, the E group exhibited significantly improved results, with a statistically significant difference noted (p=0.005, r=0.361).

Balance constitutes a fundamental motor skill, serving as the basis for various motor functions alongside coordination. Its full development is crucial for sitting, walking, and other motor activities. While genetic factors play a role in its development, sensory stimuli are also essential, particularly for children with impaired vision. **Table 3** illustrates the distribution of participants from both groups concerning dynamic balance, specifically walking. Initially, 20% of E group participants were unsuccessful, 43.3% encountered difficulties, and 36.7% succeeded. In the K group, 16.7% were unsuccessful, 23.3% succeeded, and 60% faced challenges. Initially, both groups showed similar achievements without statistical significance. Post-treatment, 76.7% of E group participants succeeded, with only 6.7% unsuccessful, while K group participants showed slight improvement, resulting in a statistically significant difference (p=0.002, r=0.388). This underscores the substantial impact of somatopedic treatment on enhancing dynamic balance, emphasizing its susceptibility to practice.

Table 3 illustrates the distribution of participants from both the E and K groups during the initial and subsequent measurements concerning static balance when standing. In the E group, 16.7% were unsuccessful, 73.7% completed the task with some difficulty, and only 10% completed it as requested. Similarly, in the K group, only 10% completed the task as requested, while 26.7% were unsuccessful. Initially, both groups showed similar achievements, with no statistically significant difference noted.

Following treatment in the E group, the percentage of participants completing the task as requested increased to 60%, with 6.7% being unsuccessful. The percentage of participants encountering specific difficulties remained unchanged (63.3%), while the percentage of unsuccessful attempts decreased to 10% in the K group. Although a statistically significant difference was found between the achievements of participants from the E and K groups during the second measurement (p=0.024, r=0.292), it is evident that better outcomes were attained through normal biological maturation and development in the K group.

Walking is a fundamental human activity enjoyed by both sighted and blind children. However, certain prerequisites such as coordination, balance, and body posture are necessary for appropriate walking development. It has been observed that blind children exhibit specific characteristics during walking, including minimal upper body movement, limited arm swinging, forward head inclination, and a fan-shaped foot placement. Furthermore, posture disorders, gait abnormalities, and physical deformities are common in children with impaired vision, often manifesting as downward head posture, rounded shoulders, sunken chest, convex abdomen, and spinal curvature.

In our research, walking was assessed as a dependent variable based on known characteristics. **Table 4** indicates that during the initial measurement, 3.3% of participants in the E group exhibited five or more poor walking characteristics, compared to 10% in the K group. The majority of participants (60%) in both groups displayed 2 to 4 poor walking characteristics, while 36.7% in the E group and 30% in the K group were categorized as having a good walk. There was no statistically significant difference between the groups due to even distribution.

Following treatment, a significant reduction in poor walking characteristics was observed among E group participants. No participants in the E group exhibited five or more poor characteristics, whereas 6.7% did so in the K group. Additionally, 60% of E group participants demonstrated a good walk post-treatment, compared to 30% in the K group. Notably, the highest percentage of E group participants exhibited a good walk, while the highest percentage of K group participants fell into the category of 2 to 4 poor walking characteristics (63.3%). A statistically significant difference between the groups was observed after the second measurement (p=0.010), with a correlation coefficient of r=0.329. This analysis suggests that somatopedic treatment positively impacted the characteristics of walking among blind and visually impaired participants, reducing the number of poor characteristics.

To verify the obtained results, a t-test was conducted to determine if there were differences within the E group after treatment. The correlation analysis revealed that the E group significantly differed from the K group after somatopedic treatment. To address concerns regarding potential regression in the K group and stagnation in the E group, an additional t-test was performed.

Conclusion

Our study reveals a significant presence of motor functioning difficulties among children with visual impairments, aligning with findings from previous research in this domain. However, our results underscore the potential for significant improvement in various aspects of motor functioning through timely intervention and targeted training.

These findings provide valuable insights for practitioners in designing targeted training and rehabilitation programs tailored to the needs of this population. Emphasizing early detection and intervention is crucial, highlighting the importance of initiating somatopedic treatment at the earliest age possible.

By prioritizing early intervention and implementing tailored programs, we can enhance the motor functioning outcomes and overall well-being of children with visual impairments, ultimately fostering their optimal development and quality of life. The results of this research can also serve as a foundation for other more extensive and comprehensive studies on this topic.

References

1. Knežević V, Abazović M, Dickov A, Ratković D, Čomić M, Savić P. Adjunctive use of metformin in the treatment of atypical antipsychotic-induced weight gain. Med Pregl. 2022;75(5-6):151-7.

2. Bishop VE. Teaching visually impaired children. 3rd ed. Springfield: Charles C Thomas; 2004. 335 p.

3. Udo JP, Fels DI. Enhancing the entertainment experience of blind and low-vision theatregoers through touch tours. Disabil Soc. 2010;25(2):231-40.

4. Jablan B. Motorne i taktilne funkcije kod slepe dece. Beograd: Univerzitet u Beogradu - Fakultet za specijalnu edukaciju i rehabilitaciju; 2007. 175 p.

5. Rahi JS, Cable N; British Childhood Visual Impairment Study Group. Severe visual impairment and blindness in children in the UK. Lancet. 2003;362(9393):1359-65.

6. Jablan, B. Motorne sposobnosti dece sa oštećenjem vida. Beogradska defektološka škola. 2003;(3):97-105.

7. Houwen S, Visscher C, Lemmink KA, Hartman E. Motor skill performance of school-age children with visual impairments. Dev Med Child Neurol. 2008;50(2):139-45.

8. Jablan B, Vučinić V, Gligorović M. Motoričke funkcije i prostorna orijentacija slepe dece. In: Gligorović M, editor. Novine u specijalnoj edukaciji i rehabilitaciji: tematski zbornik radova: godišnja prezentacija rezultata naučno-istraživačkih projekata Fakulteta za specijalnu edukaciju i rehabilitaciju koje finansira Ministarstvo prosvete, nauke i tehnološkog razvoja RS (2011-2014). Beograd: Univerzitet u Beogradu – Fakultet za specijalnu edukaciju i rehabilitaciju; 2013. p. 131-48.

9. Brambring M. Divergent development of gross motor skills in children who are blind or sighted. J Vis Impair Blind. 2006;100(10):1-22.

10. Stošljević L, Stošljević M, Odović G. Procena sposobnosti osoba sa motoričkim poremećajima: praktikum. 2nd ed. Beograd: Univerzitet u Beogradu – Fakultet za specijalnu edukaciju i rehabilitaciju; 2017. 250p.

11. Bojanin S, Ćordić A. Opšta defektološka dijagnostika. 3rd ed. Beograd: Zavod za udžbenike; 2011. 313 p.

12. Povše-Ivkić V, Govedarica T. Praktikum opšte defektološke dijagnostike. Beograd: Institut za mentalno zdravlje; 2000.

13. Zemcova MI. Slabovidi učenici. Beograd: Savez društava defektologa Jugoslavije; 1975.

14. Nikolić S, Ilanković V, Ilić-Stošović D. Motoričke sposobnosti učenika sa senzornim oštećenjima. Beogradska defektološka škola. 2005;(1):129-40.

Rad je primljen 23. IV 2024.
Recenziran 7. VI 2024.
Prihvaćen za štampu 7. VI 2024.
BIBLID.0025-8105:(2024):LXXVII:1-2:36-43.