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**Comparison of physical and motoric characteristics of totally visually impaired
and low vision individual**
**Comparación de las características físicas y motrices de personas con discapacidad
visual totalmente baja visión**

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Abstract

The purpose of this study is to compare the physical and motor characteristics of individuals with total visual impairment (TVI) and individuals with low vision (LVI). 250 participants (136 participants=TVI, 114 participants=LVI) between the age 10-19 participated in the study. Participants' anthropometric features (age, height, weight, and BMI), balance, sitting reach, standing long jump, shuttle run, vertical jump, shuttle, hanging with bent arm, and handgrip strength were measured. Dr. Lovett's manual muscle strength measurement (MMSM) was used to determine the strength parameters. The strength of arm flexion strength (FS), arm extension strength (ES), leg FS, leg ES, hip FS, hip ES, back and abdominal strength were measured. For statistical analysis the SPSS 25 was used. Therefore, Independent Sample T Test was used to determine the difference between the two groups. As a result of the statistical analyzes, a significant difference was found between TVI and LVI in balance, sit and reach, standing long jump, shuttle run, vertical jump, shuttle, handgrip strength, abdominal strength, back strength, hip FS, arm FS, and arm ES ($p < 0.05$). LVI's motoric properties were better than TVI. There was no difference between groups in bent arm hanging (BAH), hip ES, leg FS and leg ES ($p > 0.05$). As a result of the study, it was found that the degree of vision significantly affects physical and motor development. TVI develop slower than LVI in terms of physical and motor characteristics. This study was conducted to reveal the difference in motor characteristics between TVI and LVI. According to the results of this study; In order to prevent insufficient physical and motor development in TVI individuals in developmental age, it is recommended to be supported with sportive activities. The development of TVI individuals should be followed from early childhood and appropriate strategies should be developed.

Keywords

Visual impairment; motor characteristics; physical activity.

Resumen

El propósito de este estudio es comparar las características físicas y motoras de personas con discapacidad visual total (TVI) y personas con baja visión (LVI). 250 participantes (136 participantes=TVI, 114 participantes=LVI) entre 10-19 años participaron en el estudio. Se midieron las características antropométricas de los participantes (edad, altura, peso e IMC), el equilibrio, el alcance sentado, el salto de longitud de pie, la carrera de lanzadera, el salto vertical, la lanzadera, colgarse con el brazo doblado y la fuerza de agarre. Se utilizó la medición manual de la fuerza muscular (MMSM) del Dr. Lovett para determinar los parámetros de fuerza. Se midió la fuerza de flexión de brazo (FS), fuerza de extensión de brazo (ES), FS de pierna, ES de pierna, FS de cadera, ES de cadera, espalda y fuerza abdominal. Para el análisis estadístico se utilizó el SPSS 25. Por lo tanto, se utilizó la prueba T de muestra independiente para determinar la diferencia entre los dos grupos. Como resultado de los análisis estadísticos, se encontró una diferencia significativa entre TVI y LVI

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en equilibrio, sentarse y alcanzar, salto de longitud de pie, carrera lanzadera, salto vertical, lanzadera, fuerza de prensión manual, fuerza abdominal, fuerza de espalda, cadera FS, brazo FS y brazo ES ($p < 0,05$). Las propiedades motoras de LVI fueron mejores que las de TVI. No hubo diferencia entre los grupos en brazo doblado colgando (BAH), cadera ES, pierna FS y pierna ES ($p > 0,05$). Como resultado del estudio se encontró que el grado de visión afecta significativamente el desarrollo físico y motor. TVI se desarrolla más lentamente que LVI en términos de características físicas y motoras. Este estudio se realizó para revelar la diferencia en las características motoras entre TVI y LVI. Según los resultados de este estudio; Para prevenir un desarrollo físico y motor insuficiente en individuos TVI en edad de desarrollo, se recomienda apoyarlos con actividades deportivas. El desarrollo de los individuos TVI debe seguirse desde la primera infancia y deben desarrollarse estrategias apropiadas.

Palabras clave

Discapacidad visual; características motoras; actividad física.

Introduction

A general definition states that visual impairment is the condition in which vision is less than normal (Keskin & Bayram, 2019). At the same time, visual impairment is defined as a person whose visual acuity is less than 1/10 after all corrections in both eyes and who cannot benefit from vision in educational studies (Rahi, Cable, & British Childhood Visual Impairment Study Group, 2003). Visually impaired (VI) people are divided into two groups: TVI and LVI in terms of visual residue. TVI is a person with visual acuity of 20/200 or less and a visual field of 20° in the visual eye after all necessary corrections. LVI means that the visual acuity of the refractive corrected eye is 20/70 and/or below, 20/200 and/or above in the visual field according to the metric system. It is less than 20° (Leuck, Dutton & Chokron, 2019; Belevska, Javanovic, Dastevska & Velkovski, 2019).

Vision is an important motivational tool for all areas of development (Majid & Chaudhary, 2018). The motor development and innate motor abilities of visually impaired people are not different from those who can see. He concluded that TVI did not have brain damage immediately after birth and their motor activities did not change. It was found that the motor activities of the same children decreased after about two months (Prechtel, Cioni, Einspieler, Bos & Ferrari, 2001; Elisa, Josee, Oreste, Claudia, Antonella, Sabrina & Giovanni, 2001; Bakke, Cavalcante, Oliveira, Sarinho & Cattuzzo, 2019). In addition, people with VI may not be able to activate their mobility and exploration skills, depending on the

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degree of their impairment (Brian, Haegele, Bostick, Lieberman & Nesbitt, 2018). Lack of or limited vision can lead to significant delays in developmental areas such as head and neck control, crawling, walking, speech, and concept development (Schott, Haibach-Beach, Knöpfle, & Neuberger, 2021). Motor skills such as posture, flexibility, balance, walking, and limb strength are negatively affected during the developmental period in visually impaired individuals (Zipori, Colpa, Wong, Cushing & Gordon, 2018; Portfors & Riach, 1995; Szlyk, Arditi, Coffey Bucci & Laderman). Children with LVI have been found to crawl for approximately 14 months (Martorel, De Onis, Martines, Black, Onyango & Dewey, 2006), and it takes 19 months for them to walk independently. This period is longer in people with TVI disability (Elisa, Josee, Oreste, Claudia, Antonella, Sabrina & Giovanni, 2001).

Fraiberg suggested that the main reason for the delay in motor characteristics of the visually impaired may be that the motor development of the visually impaired is not adequately supported (Fraiberg, 2006). Bigelow stated that the important input for motor development in children is the object and is the reason for delayed motor development in the visually impaired; he suspects that this obstacle is due to the lack of object permanence (Bigelow, 1992). Halleman et al. believe that the reason for inadequate motor development in the visually impaired is low multiple emotional input (Halleman, Ortibus, Truijen & Meire, 2011).

In reviewing the literature, it was found that the motor development of visually impaired individuals is impaired mainly in the early developmental period. It is found that TVI individuals are negatively impaired in their motor development processes compared to LVI. In this direction, after this study, physical and motoric differences between TVI and LVI will be determined. Therefore, the aim of this study is to investigate the effects of vision level on motor performance.

Method

Structure of the Study

This study is an experimental study aimed at comparing the physical and motor characteristics of TVI and LVI. The necessary approvals for this study were obtained from the

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Ethics Committee of the Institute of Health Sciences, Istanbul Esenyurt University. The study was conducted in accordance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects. Because participants were under 18 years of age, a "Voluntary Informed Consent Form" was obtained from participants' parents.

Universe and Sample

The G-Power program was used in the power analysis to determine the research sample. When the type I error (α) was analyzed as 0.05 and the power ($1-\beta$) as 0.80, it was determined that there should be at least 90 participants for each group in the study. According to this result, the sample of our study consists of visually impaired students studying in schools for the visually impaired. Students were included in the study randomly. Individuals with a- chronic illness, b- have current infection, c- feeling unwell before the test, d- using drugs that would affect their performance were not included in the study. According to these results, 136 participants with TVI (92 men, 44 women) aged 13.31 ± 1.62 years and 114 participants with LVI (69 men, 45 women) aged 13.49 ± 1.44 years participated in our study. The demographic data of the participants are shown in Table 1. For the volunteer participants, necessary permissions were obtained from their parents to participate in the study.

Collection of Data

After collecting anthropometric data from the participants, the Eurofit test battery was used to determine the motor characteristics of the participants (Kemper & Van Mechelen, 1996). The Eurofit test battery is one of the most commonly used test batteries to determine the motor characteristics of students (Tomkinson, Carver, Atkinson, Daniell, Lewis, Fitzgerald, Lang & Ortega, 2018). In this context, standing long jump, balance, sit and reach, shuttle, BAH, shuttle run, handgrip strength, and vertical jump strength of the participants were recorded. To test the strength parameters, Dr. Lovett's MMSM method was used. In Dr. Lovett's MMSM, the researcher applies resistance in the opposite direction of the participant's movement and rates this force between 0-5 (Harrington, Pauda, Battaglini, Michener, Guiliani, Myers & Groff, 2011). In this testing technique, participants' arm ES, arm FS, leg ES, leg FS, hip ES, hip FS, back muscles strength and abdominal strength were measured.

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Prior to use, information was obtained on the general health of the participants. Participants were informed that the study was voluntary and that they could withdraw from the study at any time. A suitable environment for the measurements was provided at the school where the application was conducted, and participants were allowed to attempt to introduce the tests once. After the experiment, each person was tested twice and the best score was recorded. The experiment was conducted in such a way that the test results were not affected by the visual aid.

Analysis of Data

SPSS 25 package program was used for statistical operations. The mean (\bar{x}) and standard deviation (ss) of all subjects were calculated, and the values for kurtosis and skewness (between +1.5 and -1.5) were checked for normality analysis between groups. It was found that the data were normally distributed. The Independent Sample T test was used for comparisons between groups. The significance level in the study was set at 0.05.

Results

Within the scope of this research, 60% of the schools for the visually impaired across Turkey were included in the research. In this context, the participants (aged 13.49 ± 1.44 LVI and 13.39 ± 1.54 TVI) included in the study.

Table 1. Participants' Anthropometric Characteristics

	TVI (n=134)		LVI (n=114)	
	Women	Men	Women	Men
n	44	92	45	69
Age (y1)	13.02 \pm 1.63	13.45 \pm 1.60	13.06 \pm 1.35	13.76 \pm 1.44
Weight (kg)	44.33 \pm 12.83	49.19 \pm 18.03	49.04 \pm 15.38	52.02 \pm 19.55
Height (cm)	149.70 \pm 10.75	154.85 \pm 12.81	153.17 \pm 9.11	157.23 \pm 12.47
BMI (kg/cm ²)	19.59 \pm 4.65	20.06 \pm 5.11	20.67 \pm 5.33	20.60 \pm 5.43

BMI: Body Mass Index

Table 2. Comparison of the Physical and Motoric Characteristics of the Participants

Parameters	TVI	LVI	t	p
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	$\bar{x} \pm ss$	$\bar{x} \pm ss$		
Vertical Jump (cm)	32.02 ± 13.08	36.43 ± 12.27	2.732	.007
Balance Test (sn)	1.22 ± 4.01	3.46 ± 6.66	3.282	.001
Sit and Reach (cm)	10.94 ± 7.06	13.78 ± 8.27	2.932	.004
SLJ (cm)	101.44 ± 35.92	126.63 ± 38.87	5.318	.000
BAH (sn)	.80 ± 2.38	.92 ± 2.26	.434	.665
Hand Grip (kg)	23.58 ± 19.93	30.78 ± 19.49	2.873	.004
Shuttle Test (nummer)	13.46 ± 5.72	15.44 ± 7.72	2.328	.021
Shuttle Run (sn)	28.31 ± 4.31	26.96 ± 3.86	2.577	.011

SLJ: Standing Long Jump, BAH: Bent Arm Hanging,

Table 2 shows that no significant difference was found in the BAH value of the participants ($p > 0.05$). A significant difference was found in vertical jump, balance, sit and reach, SLJ, handgrip, shuttle, and shuttle run scores ($p < 0.05$).

Table 3. Comparison of Strenght Parameters of Participants

Parameters	TVI	LVI	t	p
	$\bar{x} \pm ss$	$\bar{x} \pm ss$		
AS (point)	4.0 ± 0.75	4.35 ± 0.83	3.422	.001
BS (point)	4.02 ± 0.75	4.30 ± 0.74	2.995	.003
Hip FS (point)	4.09 ± 0.56	4.25 ± 0.51	2.299	.022
Hip ES (point)	4.10 ± 0.58	4.23 ± 0.52	1.890	.060
Leg FS (point)	4.12 ± 0.60	4.18 ± 0.57	.792	.429
Leg ES (point)	4.13 ± 0.63	4.17 ± 0.58	.557	.578
Arm FS (point)	3.68 ± 0.62	3.91 ± 0.71	2.695	.008
Arm ES (point)	3.66 ± 0.66	3.91 ± 0.71	2.865	.005

AS: Abdominal Strenght, BS: Back Strenght, FS: Flexion Strenght, ES: Extension Strenght

Table 3 shows that a statistically significant difference was found between participants' abdominal strength, back strength, hip FS, arm FS, and arm ES ($p < 0.05$). It was seen that there was no difference between the participants' hip ES, leg FS, and leg ES ($p > 0.05$).

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Discussion

In our study comparing the physical, motor characteristics, and strength parameters of TVI and LVI participants, it was concluded that the physical, motor characteristics, and strength parameters of TVI did not develop compared with LVI. Although there was no difference between the two groups in BAH, leg ES, leg FS and hip ES ($p > 0.05$), the average values of these parameters were in favor of LVI. Comparing the results of our study with the literature on this topic, we find that there is no difference in physical and motor abilities between TVI and LVI in the first years after birth, but this difference becomes evident in the following years.

Matthias et al. in their study comparing the gross motor skills of visually impaired and non-visual individuals; concluded that visually impaired participants performed worse than the control group in basic skills such as running, jumping, kicking and catching (Mattias, Pamela & Lauren, 2013). In the study by Brambring; It has been determined that the arm and leg movements of TVI individuals are significantly less when compared to AG and normal individuals (Brambring, 2011).

In Troester and Brambring's study of motor development in visually impaired and sighted babies, it was found that congenitally visually impaired babies had similar motor development to sighted babies, except for the skills requiring the act of seeing. He found that 9- and 12-month-old babies with congenital visual impairment cannot reach the developmental level of sighted babies (Tröster & Brambring, 1993). In the study by Houwen et al., significant differences were found between TVI disabled and LVI in speed, hand-eye coordination, catching, static balance, and dynamic balance (Houwen, Visscher, Lemmink & Hartman, 2008).

When examining the literature, it was found that motor developmental delay due to the degree of visual acuity in visually impaired people is minimized by exercise. Blessing et al. found significant improvement in the cardiovascular system of participants after 16 weeks of aerobic exercise in visually impaired people. At the same time, it was found that the body

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composition of the participants also improved significantly (Blessing, McCrimmon, Stoval & Williford, 1993).

As a result of the literature review we conducted, it was found that the physical and motor development problems that begin in early childhood in visually impaired people continue to increase in later life. However, movement exercises were found to minimize this difference in motor development between TVI and LVI. For this reason, movement exercises that improve physical and motor characteristics are recommended for TVI individuals from childhood. Visually impaired individuals should be introduced to appropriate sports in early childhood. It is recommended that physical education classes be designed to include visually impaired people in schools where there are visually impaired people. It is recommended to promote national and international sports activities for visually impaired people.

Limitations of Study

This research was conducted on visually impaired students aged 12-16. In order to intervene earlier, research can also be conducted on participants in early childhood.

Conclusion

According to the research results, TVI participants showed lower motor skills than LVI participants. This may cause problems in the developmental age of TVIs. For this reason, physical education and sports activities should be given high priority in TVIs. The hours of physical education and sports lessons in schools for the visually impaired can be increased. Extracurricular sports activities can be planned for the visually impaired. It is recommended to open summer sports schools for visually impaired individuals who stay away from their friends and lessons for a long time, such as during the summer vacation. Sports clubs can be established in schools for the visually impaired, so that these individuals can be active outside of school. The families of TVIs should also be informed about this issue. They should be closely monitored from early childhood and other factors affecting their development should be identified. Although the number of participants is at the desired level (n=250), larger groups can also be analyzed.

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References

- Bakke, H. A., Cavalcante, W. A., Oliveira, I. S. D., Sarinho, S. W., & Cattuzzo, M. T. (2019). Assessment of motor skills in children with visual impairment: A systematic and integrative review. *Clinical Medicine Insights: Pediatrics*, 13: 1-10.
- Belevska, M., Jovanovic, J., Dastevska, E. G., & Velkovski, Z. (2019). The importance of individual predictors and psychosocial working conditions in assessing the work ability index of people with low vision. *International journal of occupational safety and ergonomics*. 27 (2): 442-51. <https://doi.org/10.1080/10803548.2019.1613811>
- Bigelow, A. (1992) Locomotion and search behavior in blind infants. *Infant Behav Dev*, 15, 179–89. [https://doi.org/10.1016/0163-6383\(92\)80022-M](https://doi.org/10.1016/0163-6383(92)80022-M)
- Blessing, D.L., McCrimmon, D., Stoval, J. & Williford, H. N. (1993) The effect of regular exercise programs for visually impaired and sighted schoolchildren. *Journal of Visual Impaired and Blindness*, 87 (2), 50-2.
- Brambring, M. (2001) Motor activity in children who are blind or partially sighted. *Visual Impairment Research*, 3 (1), 41-51. <https://doi.org/10.1076/vimr.3.1.41.4415>
- Brian, A. S., Haegele, J. A., Bostick, L., Lieberman, L. J., & Nesbitt, D. (2018). A pilot investigation of the perceived motor competence of children with visual impairments and those who are sighted. *Journal of Visual Impairment & Blindness*, 112(1), 118-24.
- Elisa, F., Josee, L., Oreste, F. G., Claudia, A., Antonella, L., Sabrina, S. & Giovanni, L. (2002). Gross motor development and reach on sound as critical tools for the development of the blind child. *Brain Dev*, 24: 269–75. [https://doi.org/10.1016/S0387-7604\(02\)00021-9](https://doi.org/10.1016/S0387-7604(02)00021-9)
- Fraiberg, S. (2006) *Insights from the blind*, A Condor Book Souvenir Press, New York.
- Halleman, A., Ortibus, E., Truijen, S. & Meire, F. (2011) Development of independent locomotion in children with a severe visual impairment. *Res Dev Disabil*, 32 (6), 2069–74. <https://doi.org/10.1016/j.ridd.2011.08.017>

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- Harrington, S., Padua, D., Battaglini, C., Michener L. A., Giuliani, C., Myers, J. & Groff, D. (2011) Comparison of shoulder flexibility, strength, and function between breast cancer survivors and healthy participants. *J Cancer Surviv*, 5 (2), 167–74. <http://doi.org/10.1007/s11764-010-0168-0>
- Houwen, S., Visscher, C., Lemmink, K. A. & Hartman, E. (2008) Motor skill performance of school-age children with visual impairments *Developmental Medicine and Child Neurology*, 50, 139-45. <https://doi.org/10.1111/j.1469-8749.2007.02016.x>
- Kemper, H. C., & Van Mechelen, W. (1996). Physical fitness testing of children: a European perspective. *Pediatric exercise science*, 8(3), 201-214. <https://doi.org/10.1123/pes.8.3.201>
- Keskin, D. Ö. Y., & Bayram, L. (2019). Comparison of Multiple Intelligence Areas of Hearing and Visually Impaired Individuals in Terms of Age, Gender and State of Doing Sport. *World Journal of Education*, 9(6), 98-105. <https://doi.org/10.5430/wje.v9n6p98>
- Lueck, A. H., Dutton, G. N., & Chokron, S. (2019). Profiling children with cerebral visual impairment using multiple methods of assessment to aid in differential diagnosis. In *Seminars in pediatric neurology*. 31: 5-14. <https://doi.org/10.1016/j.spen.2019.05.003>
- Majid, S., & Chaudhary, S. (2018). An Exploratory Study of Preferred Learning Styles of Visually Impaired Children. *Journal of Inclusive Education*, 2(1), 1-16.
- Martorell, R., De Onis, M., Martines, J., Black, M., Onyango, A. & Dewey. K. G. (2006) WHO motor development study: Windows of achievement for six gross motor development milestones. *Acta Paediatrica*, 95: 86-95. <https://doi.org/10.1111/j.1651-2227.2006.tb02379.x>
- Mattihas, O. W., Pamela, S. H. & Lauren, J. L. (2013) Gross motor skill performance in children with and without impairments-Reserch to practice. *Research in Developmental Disabilities*, 34 (10), 3246-52. <https://doi.org/10.1016/j.ridd.2013.06.030>
- Prechtel, H. F., Cioni, G., Einspieler, C., Bos, A. F., & Ferrari, F. (2001). Role of vision on early motor development: lessons from the blind. *Developmental medicine and child neurology*, 43(3), 198-201.

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Portfors, C. V. & Riach, C.L. (1995) Frequency characteristics of postural control of children with and without visual impairment. *Developmental Medicine and Child Neurology*, 37 (5), 456-63. <https://doi.org/10.1111/j.1469-8749.1995.tb12029.x>

Rahi, J. S., Cable, N., & British Childhood Visual Impairment Study Group. (2003). Severe visual impairment and blindness in children in the UK. *The Lancet*, 362(9393), 1359-1365. [https://doi.org/10.1016/S0140-6736\(03\)14631-4](https://doi.org/10.1016/S0140-6736(03)14631-4)

Schott, N., Haibach-Beach, P., Knöpfle, I., & Neuberger, V. (2021). The effects of visual impairment on motor imagery in children and adolescents. *Research in Developmental Disabilities*, 109, 103835. <https://doi.org/10.1016/j.ridd.2020.103835>

Szlyk, J. P., Arditi, A., Coffey Bucci, P. & Laderman, D. (1990) Self Report in Functional Assessment of Low Vision. *Journal of Visually Impairment and Blindness*, 1, 61- 6.

Tomkinson, G. R., Carver, K. D., Atkinson, F., Daniell N. D., Lewis, L. K., Fitzgerald, J. S., ... & Ortega, F. B. (2018). European normative values for physical fitness in children and adolescents aged 9–17 years: results from 2 779 165 Eurofit performances representing 30 countries. *British Journal of Sports Medicine*, 52(22), 1445-1456.

Tröster, H. & Brambring M. (1993) Early motor development in blind infants. *J Appl Dev Psychol*, 14 (1), 83-106. [https://doi.org/10.1016/0193-3973\(93\)90025-Q](https://doi.org/10.1016/0193-3973(93)90025-Q)

Zipori AB, Colpa L, Wong AMF, Cushing SL, Gordon KA (2018) Postural stability and visual impairment: Assessing balance in children with strabismus and amblyopia. *PLoS ONE* 13(10): e0205857. <https://doi.org/10.1371/journal.pone.0205857>