DOI: https://doi.org/10.2298/SARH171016192T
UDC: 617.7-76-056.262; 159.946.4-056.262

ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Reading performance of low vision children after using low vision aids

Zorica Tončić[1], Nataša Jovović[1], Nada Šakotić[2], Veselinka Milović[2], Katarina Janićijević[3], Mirjana Petrović Janićijević[3], Svetlana Jovanović[3]

[1]Clinical Center of Montenegro, Clinic for Children's Diseases, Ophthalmology Service, Podgorica, Montenegro;
[2]University of Montenegro, Faculty of Philosophy, Nikšić, Montenegro;
[3]University of Kragujevac, Faculty of Medical Sciences, Department of Ophthalmology, Kragujevac, Serbia

SUMMARY

Introduction/Objective The objectives of the paper are to assess the causes of low vision (LV) in pediatric population in Montenegro and to evaluate the influence of low vision aids (LVA) on reading performance regarding the speed of reading and the understanding of the read text.

Methods A prospective study was conducted on 40 "treatable" LV children what represent all registered LV children in Montenegro. All participants read the same text before and after using LVA. Reading rate was calculated as the number of words read per minute. Functional speed of reading was calculated as the ratio of the rate of reading and the understanding of the read text multiplied by 100.

Results The study comprised 40 LV children with the mean age of 12.60 ± 4.06 years (20 boys and 20 girls). The most common cause of LV in children were premature retinopathy (10/40 or 25%), retinitis pigmentosa (8/40 or 20%), optic nerve anomaly (5/40 or 13%), degenerative myopia (4/40 or 10%), macular dysgenesis (4/40 or 10%), Stargardt disease (3/40 or 7%), optic nerve atrophy (2/40 or 5%), and albinism (2/40 or 5%). Nystagmus was found in 11 LV children or 28% of the group. LVA were prescribed to all of them. Reading speed before *vs.* after LVA use was 36.58 ± 35.60 *vs.* 73.83 ± 27.05 words/minute ($p < 0.001$), while functional reading was 26.00 ± 30.43 *vs.* 59.41 ± 29.34 ($p < 0.001$).

Conclusion LV children demonstrate a significant improvement in reading performance by using LVA.

Keywords: low vision aid; low vision children; reading performance

INTRODUCTION

According to the International Classification of Diseases 10, there are four levels of visual function: normal vision, moderate visual impairment (VI), severe VI, and blindness [1]. Moderate and severe VI are grouped under the term "low vision" (LV). "Functional" LV is defined as presenting best-corrected visual acuity (BCVA) in the better-seeing eye of less than 0.3 and more than 0.05 according to the World Health Organization (WHO) criteria, VA < 0.3 and VA ≥ 0.05 (or according to the United States (US) criteria VA < 0.5 and VA ≥ 0.1) and as blindness (WHO criteria VA < 0.05; US criteria VA < 0.1) [1]. LV cannot be improved or corrected with medical treatment, surgery, nor with conventional glasses or with contact lenses. Unlike total blindness, most individuals with LV have some degree of useful, residual sight even when vision loss is significant. The WHO estimated that 19 million children worldwide are visually impaired; of these, 1.4 million are irreversibly blind [2]. The International Classification of Functioning, Disability and Health adopted by the WHO can be used as a framework to comprehensively describe the problems of persons with VI and the environmental factors which influence their lives [3]. Surely, LV significantly interferes with the functioning of a person. Common subjective complains of LV persons include the loss of central and/or peripheral vision, constricted visual filed, abnormal color perception, generalized haze, blurred vision, extreme light sensitivity, and night blindness. LV patients represent unique challenge in ophthalmic and optometric care.

Very few LV clinics are available even in the most developed of countries. The Low Vision Service for pediatric patients at the Clinical Center of Podgorica, Montenegro (a referral tertiary health care center in Montenegro) has been established in 2013. The Service is a pioneer of LV service in the region, covering all the needs of LV children, including education, training, and sight rehabilitation. A team of trained specialists with comprehensive, multidisciplinary approach to LV children has the purpose to help them maximize the remaining functional vision and maintain their independence in daily living. Podgorica pediatric LV service meets the WHO recommendation for establishing LV centers to fight avoidable childhood blindness. Namely, since 2004, the WHO in partnership with Lions Clubs International has established a global network of 45 childhood blindness centers in 35 countries for the preservation, restoration, or rehabilitation of

Received • Примљено: October 16, 2017
Accepted • Прихваћено: October 24, 2017
Online first: October 31, 2017

Correspondence to:
Zorica TONČIĆ
Clinical Center of Montenegro
Ljubljanska bb, 81000 Podgorica
Montenegro
maculareader@gmail.com

sight in children [2]. The LV center in Podgorica is exceptional since all registered LV children have the use of LV aids (LVA) at no cost to them.

According to the available data, there are approximately 1,000 blind and visually impaired persons of all ages registered in Montenegro. The exact number of blind LV children is unknown. There is no precise national register on the prevalence of childhood VI, but, according to available sources (referral associations, primary health care registers, etc.), it has been estimated that there are 200 VI children and 50–60 LV children in Montenegro at this moment. The assessment of the causes of VI is important to develop preventive and therapeutic strategies. The standardized protocol for reporting causes of blindness in children, with coding instructions and a database for statistical analysis developed by the International Centre for Eye Health, the WHO Collaborating Centre for Blindness Prevention, and the WHO, also serves as a mechanism to monitor changing pattern of childhood blindness [4].

The objectives of this paper are to assess the causes of LV in pediatric population in Montenegro and to evaluate the influence of using LV aids in reading performance regarding the speed of reading and the understanding of the read text.

METHODS

A prospective study was conducted on 40 "treatable" LV children, who represent all registered LV children in Montenegro. Including criteria were the BCVA ranging 0.05–0.3 in the better-seeing eye and age less than 17 years. The term 'treatable LV person' represents a person who has demonstrated an improvement in reading or in distance vision using LVA. Children were recruited from registers of Association of Blind and LV Persons (one association with eight local branches), followed by two schools for special education of blind and LV children (in Podgorica and Bijela) and primary eye care registers from all over the country. All amblyopic children (215 of them) underwent complete ophthalmological examination. In total, 40 children met the criteria of a 'treatable LV person'. The study was performed in accordance with the tenets of the Declaration of Helsinki and approved by the Institutional Review Board (decision number 03/01-12238/2). Written informed consent was obtained from all parents.

All the participants read the same text before and after using LVA. The words were printed in seven lines with 1.5-line spacing (0.8 cm), with black letters on white background to enhance contrast; the font used was Times New Roman, the letter size was N12. Reading rate was calculated as the number of read words per minute. Understanding of the read text was measured by a multiple-choice test with 20 questions related to the text. Scores were rated from 0 to 20 and presented as a percentage (for example, if an LV child had 12 correct answer, the score of understanding was 60%). Functional speed of reading was calculated as the ratio of the rate of reading and the understanding of the read text multiplied by 100.

Statistical analysis

All parameters were expressed as mean ± standard deviation (SD). Differences between pre- and post-LVA use were evaluated by the Wilcoxon signed-ranks test. The level of statistical significance was set at 0.05. All statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Forty LV children with the mean age of 12.60 ± 4.06 years (20 boys and 20 girls) underwent complete ophthalmological examination and socio-epidemiological assessment. The mean age of the girls was 10.95 ± 4.16 years, while that of the boys was 14.25 ± 3.28 years. All the LV children lived in families with both biological parents.

Regarding the educational profile of fathers of the LV children, 20 of them had completed primary school (50%), 19 had secondary degree (47.5%), and one (2.5%) had obtained higher education. Among mothers, none had finished higher education, 19 mothers had secondary school finished (47.5%), and 21 had completed primary school.

In the group of children with retinal dystrophy, eight children (20%) had retinopathy pigmentosa, in three cases (7%) was diagnosed Stargardt macular dystrophy. Development anomalies of the optic nerve had four children with optic hypoplasia and one with congenital coloboma of the optic disc. Associated macular and optic nerve anomalies were found in two cases, while four children had isolated macular hypoplasia. Causes of LV were presented in Table 1.

Table 1. Causes of low vision in children

Clinical finding	Number of patients	%
Retinal dystrophy	11	27
Premature retinopathy	10	25
Macular dysgenesis	4	10
Optic nerve anomaly	5	13
Associated macular and optic nerve anomalies	2	5
Central nervous tumor	2	5
Degenerative myopia	4	10
Albinism	2	5
Total	40	100

Optic atrophy in two cases was a consequence of intracranial tumor, but it was also found in two premature children and in one with albinism. Nystagmus was found in 11 cases (nine horizontal, one rotatory, and one vertical). Macular scars were diagnosed in two highly myopic cases and in three children with retinitis pigmentosa. Four children had esotropia, while two had exotropia.

BCVA concerning the better seeing eye was hand moving in eight children (20% of all); in 12 children (30% of all) the score was 0.1 while 20 children (50% of all) had a score of 0.2–0.4. In three children, fellow eye was blind, 16 children (40% of all) had BCVA described as hand movement only, while 21 children had less than 0.2 according to Snellen chart.

Regarding the refractive error, 27/40 children had myopia, 3/40 (7.5% of all) had hyperopia, 2/40 (5% of all) had astigmatism, while eight children had no possibility of being optically corrected.

All the children accepted LVA for reading distance. In Table 2 are listed devices which they had used.

Table 2. List of low vision aids for reading prescribed to low vision children

Low vision aid	Number of children	%
Electronic magnifier	17	42
Ready fit prism	21	53
Telescope	2	5
Total	40	100

The speed of reading and understanding of content was measured before and one month after using of LVA for reading. The results are presented in Table 3. As it has been shown, speed and functional speed of reading has been significantly improved.

Table 3. Speed of reading and functional reading results in low vision children before and after using low vision aids

Tested parameter		Before $\bar{x} \pm$ sd med. (min.–max.)	After $\bar{x} \pm$ sd med. (min.–max.)	p
Reading	speed	36.58 ± 35.60 21.5 (0–120)	73.83 ± 27.05 81 (31–121)	< 0.001[a]
	functional reading	26.00 ± 30.43 13.72 (0–108)	59.41 ± 29.34 62.65 (14.40–114.95)	< 0.001[a]

[a]Wilcoxon signed-ranks test

DISCUSSION

VI results in different degrees of difficulty in performing daily activities and tasks. Great progress has been made in the development and deployment of intraocular LVA, such as implantable monocular telescope, followed by the global positioning system-based navigation system, location-aware LVA. LV children have particular and additional tasks concerning education, and reading is one of the core activities of their studies. As it is well known, LV and VI affect their sensorial development, physical, psychological, and social well-being. Socio-epidemiological or so-called external factors (i.e. education/employment and parental influence) can either facilitate or hinder participation [3]. In our study, all the parents had completed primary and approximately half of them had completed secondary school. Finishing at least primary school is a legislative obligation that can explain a relatively high percentage of parents who had completed at least primary education level.

The commonest cause of LV among children and adolescents in Montenegro was retinal dystrophy – retinitis pigmentosa (20%), followed by Stargardt disease (7%). Also present are premature retinopathy (25%), macular dysgenesis (10%), and myopic degenerative changes (10%). The etiology of childhood VI in Montenegro includes 13% of those who had VI with coexisting neurological disability. In contrast, in Brazil, the most frequent finding was congenital glaucoma (21.1%), while in a Sao Paolo study congenital glaucoma (30.6%) was found to have higher prevalence, followed by macular retinochoroiditis due to congenital toxoplasmosis (16.7%), congenital cataract (12.8%), retinal and macular inherited disorders (11.7%), and optic atrophy (9.8%) [4, 5]. Furthermore, Haddad et al. [5] reported that only 2% of children with congenital glaucoma had normal visual acuity levels, while 29% had mild VI, 28% had moderate VI, 15% had severe VI, 11% had profound VI, and 15% had near blindness. Principal causes of blindness among VI children in New Zealand were cerebral VI in 61 children (42.4%), optic nerve atrophy in 18 children (12.5%), and retinal dystrophy in 13 children (9%). The main avoidable causes of blindness in 27 children (19%) were neonatal trauma, asphyxia in nine children (33%), and non-accidental injury in six children (22%) [6].

Causes of LV in childhood and adolescence in Africa and Asia differs from those in other parts of the world. In Nigeria, the most common causes were cataract (21%), followed by glaucoma (12.9%), but in as much as 43.6% of LV children, causes of blindness were found to be treatable [7], while Olusanya et al. [8] reported that the most common cause of LV in children was albinism (24.4%) and optic atrophy (24.4%). In Ekiti State Special Education School, Nigeria, in a study conducted in May–June 2008 it was reported that the most common causes of VI are cataract (26.7%), glaucoma (20%), retinitis pigmentosa (16.7%), and posttraumatic phthisis bulbi (6.7%); blindness was avoidable in as much as 61% of the cases[9]. In Ethiopia, the most common causes of childhood VI were corneal disease/phthisis (62.4%), followed by optic nerve lesions (9.8%), cataract/aphakia (9.2%), and lesions of the uvea (8.8%). The etiology was unknown in 45.1% of the cases, while 68% of the cases were considered to be potentially avoidable [10]. Cataract and corneal damage are the leading causes of LV in children in India as well. Even though the time difference between the studies is almost 20 years, the conclusions of both studies were that in prevention of avoidable blindness, it is very important to provide measles and rubella immunization and nutrition care [11].

Among LV children in Nepal, refractive error and amblyopia (20.1%), retinitis pigmentosa (14.9%), and macular dystrophy (13.4%) were the most common causes of pediatric VI. Nystagmus (50%) was the most common cause of LV in the one to five years age group, whereas refractive error and amblyopia were the major causes in the six to 10 and 11 to 16 years age group (17.6 and 22.9%, respectively) [12].

It is a widely accepted belief in clinical practice that children with VI can benefit from the use of an LVA [13]. To LV patients at the Instituto Brasileiro de Oftalmologia e Prevencao da Cegueira, telescopic system was the only optical aid indicated for distance (44%) and glasses were the most indicated aid for near vision (54.5%), which were prescribed as such [14]. In India, only 18% of LV children with coloboma, microcornea, and microphthalmos have been using telescopes, while a stand magnifier has been prescribed in 6% of children [15]. LV children from Montenegro have a special possibility to be treated with the

most diverse range of LVA for large distance, intermediate distance, and short distance, respectively.

CONCLUSION

According to the published data, this is the first study targeting the influence of LVA use in LV children on reading performance, as well as the first report on demographic data and causes of LV among LV children in Montenegro. Our results indicate that LVA for reading or short distances significantly improves reading performance in LV children and should be applied in everyday practice.

NOTE

This paper is a part of the doctoral thesis by Zorica Tončić, titled "The influence of visual rehabilitation on the quality of life using low vision aids in low vision children."

ACKNOWLEDGMENT

Authors would like to thank Dr. Vesna Jakšić, associate professor at the Faculty of Medicine of the University of Belgrade, who established the Low Vision Service at the Clinical Center of Podgorica, Montenegro.

REFERENCES

1. Verhoeven VJ, Wong KT, Buitendijk GH, Hofman A, Vingerling JR, Klaver CC. Visual consequences of refractive errors in the general population. Ophthalmology. 2015; 122(1):101–9.
2. Global Data on Visual Impairments 2010. World Health Organization; 2012. Available at: http://www.who.int/blindness/GLOBALDATAFINALforweb.pdf?ua=1
3. Leissner J, Coenen M, Froehlich S, Loyola D, Cieza A. What explains health in persons with visual impairment? Health Qual Life Outcomes. 2014; 12:65.
4. Silva AM, Matos MH, Lima Hde C. [Low vision service at the Instituto Brasileiro de Oftalmologia e Prevencao da Cegueira (IBOPC): analysis of the patients examined on the first year of the department (2004)]. Arq Bras Oftalmol. 2010; 73(3):266–70.
5. Haddad MA, Lobato FJ, Sampaio MW, Kara-Jose N. Pediatric and adolescent population with visual impairment: study of 385 cases. Clinics (Sao Paulo). 2006; 61(3):239–46.
6. Chong CF, McGhee CN, Dai S. A Cross-sectional Study of Prevalence and Etiology of Childhood Visual Impairment in Auckland, New Zealand. Asia Pac J Ophthalmol (Phila). 2014; 3(6):337–42.
7. Omolase CO, Aina AS, Omolase BO, Omolade EO. Causes of blindness and visual impairment at the school for the blind owo, Nigeria. Ann Ib Postgrad Med. 2008; 6(1):49–52.
8. Olusanya B, Onoja G, Ibraheem W, Bekibele C. Profile of patients presenting at a low vision clinic in a developing country. BMC Ophthalmol. 2012; 12:31.
9. Onakpoya OH, Adegbehingbe BO, Omotoye OJ, Adeoye AO. Causes of blindness in a special education school. West Afr J Med. 2011; 30(1):47–50.
10. Kello AB, Gilbert C. Causes of severe visual impairment and blindness in children in schools for the blind in Ethiopia. Br J Ophthalmol. 2003; 87(5):526–30.
11. Waddell KM. Childhood blindness and low vision in Uganda. Eye (Lond). 1998; 12(Pt 2):184–92.
12. Uprety S, Khanal S, Morjaria P, Puri LR. Profile of paediatric low vision population: a retrospective study from Nepal. Clin Exp Optom. 2016; 99(1):61–5.
13. Schurink J, Cox RF, Cillessen AH, van Rens GH, Boonstra FN. Low vision aids for visually impaired children: a perception-action perspective. Res Dev Disabil. 2011; 32(3):871–82.
14. Silva AM, Matos MH, Lima Hde C. [Low vision service at the Instituto Brasileiro de Oftalmologia e Prevencao da Cegueira (IBOPC): analysis of the patients examined on the first year of the department (2004)]. Arq Bras Oftalmol. 2010; 73(3):266–70.
15. Hornby SJ, Adolph S, Gothwal VK, Gilbert CE, Dandona L, Foster A. Requirements for optical services in children with microphthalmos, coloboma and microcornea in southern India. Eye (Lond). 2000; 14 (Pt 2):219–24.

Брзина читања код слабовиде деце после коришћења помагала за слабовиде

Зорица Тончић[1], Наташа Јововић[1], Нада Шакотић[2], Веселинка Миловић[2], Катарина Јанићијевић[3], Мирјана Петровић-Јанићијевић[3], Светлана Јовановић[3]

[1]Клинички центар Црне Горе, Дечја клиника, Служба офталмологије, Подгорица, Црна Гора;
[2]Универзитет Црне Горе, Филозофски факултет, Никшић, Црна Гора;
[3]Универзитет у Крагујевцу, Факултет медицинских наука, Крагујевац, Србија

САЖЕТАК

Увод/Циљ Циљ овог рада је био да се утврде разлози слабовидости деце у Црној Гори и утицај специјалних помагала на брзину и на функционално читање код ове деце.

Методе Проспективна студија спроведена је на 40 слабовиде деце која су користила специјална помагала. Сва деца су добила да прочитају исти текст пре и после кошћења помагала. Брзина читања је исказана као број прочиатних речи у минути, а функционално читање као однос између брзине читања и разумевања прочитаног × 100.

Резултати Средњи узраст слабовиде деце је био 12,60 ± 4,06 година (20 дечака и 20 девојчица). Најчешћи разлози слабовидости су били: прематурна ретинопатија (10/40; 25%), пигментни ретинитис (8/40; 20%), аномалије оптичког нерва (5/40; 13%), дегенеративна миопија (4/40; 10%), макуларне дизгенезије (4/40; 10%), Старгард дистрофија (3/40; 7%), атрофија оптичког нерва (2/40; 5%), албинизам (2/40; 5%). Нистагмус је дијагностикован код 11 деце (28%). Свој слабовидој деци су прописана помагала. Брзина читања пре у односу на брзину читања после коришћења помагала је била 36,58 ± 35,60, тј. 73,83 ± 27,05 речи/мин. ($p < 0,001$), док је функционално читање било 26,00 ± 30,43, тј. 59,41 ± 29,34 ($p < 0,001$).

Закључак Слабовида деца показују значајно побољшање читања после коришћења специјалних помагала.

Кључне речи: помагала за слабовиде; слабовида деца; брзина читања