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Review of vision screening referrals in children

Pregled napotitev v okviru presejalnih pregledov vidne ostrine pri otrocih

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Abstract

Background: Childhood vision screening is aimed at the detection of reduced vision due to amblyopia, thus enabling early diagnosis and timely intervention. The purpose of the study was to review the demographics and visual parameters of children referred to the ophthalmologist at Community Health Centre Ljubljana from Slovenian community-based vision screening program and define the visual outcome after treatment in children with amblyopia.

Methods: Retrospective medical records review of children referred from community-based vision screening program for further assessment. Medical records were reviewed to determine findings from ophthalmic assessments, treatment received, and visual acuity at the final visit. The main outcome measures were the cause of visual impairment and the visual acuity at the final follow-up visit.

Results: From 439 children (mean age 7.3 +/- 3.7 years) referred from community-based vision screening program, 75 children (17%; mean age 5.3 +/- 2.6 years) had amblyopia and received treatment. They had amblyogenic refractive error (3.67 +/- 2.44 diopters of sphere and 1.86 +/- 1.23 diopters of astigmatism) with uncorrected visual acuity on average 0.32 +/- 0.28 logMAR in the worse eye. Visual outcomes after treatment were good with a visual acuity of 0.04 +/- 0.07 logMAR in the worse eye, 60% of them had a visual acuity of 0.00 logMAR (40/40).

Conclusion: Children with amblyopia in the presented clinical sample were mostly diagnosed and treated before the school-age. These children showed significant improvement in visual acuity in the amblyopic eye.

Izvleček

Izhodišča: Cilj presejalnih pregledov vida pri otrocih je zgodnje odkrivanje znižane vidne ostrine, kar omogoča pravočasno zdravljenje slabovidnosti. Namen študije je pregledati demografske značilnosti in parametre vidne funkcije otrok, napotenih na pregled k oftalmologu v Zdravstvenem domu Ljubljana zaradi slabšega vida ob presejalnem pregledu vida. To je del slovenskega programa preventivnih pregledov otrok in mladostnikov. Namen je tudi opredeliti vidno funkcijo otrok z ambliopijo po zdravljenju.

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Ključne besede: presejalni pregled vida; slabovidnost; otroci; refrakcija; vidna ostrina

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Metode: Retrospektivni pregled dokumentacije otrok, napotenih po presejalnem pregledu v nadaljnjo obravnavo pri oftalmologu. Analizirali smo ugotovitve, pridobljene ob oftalmološkem pregledu, zdravljenje in ostrino vida ob zadnjem obisku. Glavni merili za izid sta bili vzrok za okvaro vida in ostrina vida ob zadnjem obisku.

Rezultati: V študijo je bilo vključenih 439 otrok (povprečna starost 7,3 +/- 3,7 leta), napotenih po presejalnem pregledu. 75 otrok (17 %; povprečna starost 5,3 +/- 2,6 leta) je imelo ambliogeno refraktivno napako (3,67 +/- 2,44 dioptrij sfere in 1,86 +/- 1,23 dioptrij astigmatizma) in so jih zdravili. Nekorigirana vidna ostrina je bila pri teh otrocih 0,32 +/- 0,28 logMAR na slabšem očesu. Izid vidne funkcije je bil po zdravljenju dober, in sicer s končno vidno ostrino 0,04 +/-0,07 logMAR, kar 60 % od njih jih je imelo ostrino vida 0,00 logMAR (40/40).

Zaključek: V predstavljeni študiji so bili slabovidni otroci v večini primerov diagnosticirani in zdravljeni pred obdobjem šolanja. Ob sledenju se je pri teh otrocih vidna ostrina na slabovidnem očesu znatno izboljšala.

1 Introduction

Amblyopia, defined as poor vision due to abnormal visual experience early in life (1,2), affects approximately 1%–5% of the population (1,3-5). There is no obvious ocular pathology underlying the reduced visual acuity but rather, there is a predisposing condition, such as strabismus (disrupting the binocular vision development), refractive error or media opacification (e.g. congenital cataract) that influences the development of visual acuity after birth (1). The earlier in post-natal visual experience the predisposing condition presents and the longer the duration of abnormal visual experience the more profound the level of amblyopia (1).

Amblyopia can lead to a permanent loss of vision with an impact on the quality of life. In the study from Chua and Mitchell it was found that people with amblyopia also had almost three times the risk of visual impairment in their better-seeing eye compared to people without amblyopia (6). Impaired visual acuity (VA) was also found to be associated with an increased risk of falls (7) and death (8).

Amblyopia is also the most common cause of preventable vision loss in children (9). Treatment can be highly successful with more than 75% of children, less than 7 years of age having a significant improvement in the moderate amblyopic eye (to 20/30 or better) as a result of the treatment (10). The principle of treating includes clearing any image blur and encouraging the use of the amblyopic eye through preventing the use of the better-seeing eye (2). After a maximum improvement in visual acuity with spectacles, which is usually greatest over the first few weeks of wearing glasses (11), the treatment options for the remaining amblyopia include patching or atropine penalization of the fellow eye (9). Children with a visually significant anatomic abnormality must be approached on an individual basis (12).

Children with unilaterally reduced vision, especially with early-onset like in amblyopia, are unlikely to be aware of the failure to develop normal vision in the affected eye. Therefore, the primary goal of childhood vision screening is the detection of reduced vision due to amblyopia, to enable timely intervention (13). Vision screening is recommended throughout childhood to detect amblyopia early enough to allow successful treatment (2,12,14-16). The prevalence of amblyopia in the 8-year-old population screened in infancy was found to be 1.0% compared with 2.6% in the 8-year-old population that had not been screened in infancy (17). In a Swedish study, it was reported that with screening, subsequent diagnosis, and treatment, the prevalence of deep amblyopia (visual acuity <0.3) has been reduced from 2% to 0.2% (18).

The screening system in Slovenia includes the following: within the first month of life paediatricians check newborns for optical media clarity. If no abnormalities were revealed earlier, such as latent strabismus at 18 months of age, a systematic check-up at 3 and 4.5 years of age is scheduled when visual acuity is tested using picture charts (12,14,19). In a case of a poor visual acuity, the child would be referred to the ophthalmologist (19).

In the existing literature, data on children referred to the ophthalmologist due to a poor visual acuity at vision screening in Slovenia is deficient. The aim of the study was to review the demographics and visual parameters in children referred from community-based vision screening program in Slovenia and define the visual outcome after treatment in children with amblyopia.

2 Methods

We conducted a retrospective study involving children referred to the ophthalmologist from community-based vision screening program for further

assessment. Children included in the study were those in whom visual acuity at screening system was not sufficient. Visual acuity is checked with optotypes at screening at the age of 3 and older. The study included children referred between August 2018 and August 2019 and was conducted at the Community Health Centre Ljubljana. Children included in the study were examined and treated by one ophthalmologist (A.K.). Parents applied their children for the exam at the particular ophthalmologist based on their personal decision. Children in the clinical sample were mostly from Ljubljana region.

Only children who attended the Slovenian vision screening program from birth were included in this study. Children who moved to Slovenia form other countries and were later included in the Slovenian screening program were excluded from the study. Children who had already been treated by the ophthalmologist due to poor visual acuity or other reasons were excluded from the study.

According to the screening system protocol in Slovenia a five-year-old child should recognize the smallest optotypes (0.00 logarithm of the minimum angle of resolution (logMAR); Snellen equivalent 40/40) from the distance of 5 meters at vision screening performed by a nurse at primary care paediatric office. A three-year-old child should recognize all optotype lines but the smallest one (0.10 logMAR; Snellen equivalent 32/40). Visual acuity is assessed monocularly. In case of a poor child´s cooperation, an additional appointment would be scheduled at the primary care paediatric office so that the visual acuity could be reliably determined. In case of a poor visual acuity, the child would be referred to the ophthalmologist (19,21).

At the ophthalmology office visual acuity in children from 3 to 5 years of age was assessed in the study using picture chart (Topcon CC-100XP; B1 type, Topcon, Japan) as a part of their regular ophthalmological examination. In children 6 to 7 years old, visual acuity was determined using the tumbling E chart. In children older than 7 years of age, Snellen chart was used. If the child cooperated poorly using the age-appropriate chart, then charts for other age groups would have been used. The children were occluded using occlusion glasses to ensure accurate monocular results.

The refraction was measured using an autorefractometer (RC-5000 Auto Refkeratometer, Tomey, USA). Ophthalmological exam included anterior and posterior biomicroscopy. Ocular motility, ocular alignment, and pupillary responses were also assessed. In children older than 6 years of age, intraocular pressure was also measured using a non-contact air-puff tonometer (FT-1000 Non-Contact Tonometer, Tomey, USA). Preschool children (<7 years old) with poor visual acuity had retinoscopy generally done with 0.5% atropine. School children (>7 years old) with poor visual acuity had retinoscopy done with 2% homatropine.

Spectacles were prescribed for all amblyogenic

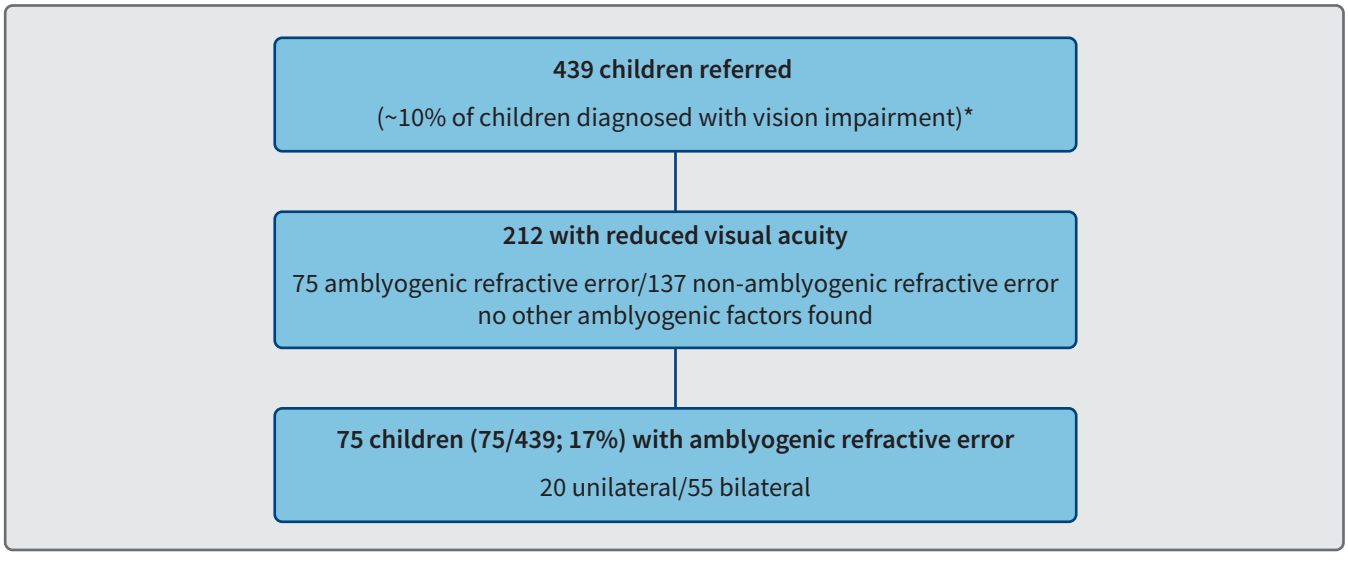

Figure 1: Flow-chart presents patients demographics and visual parameters of 439 referred children.
*Children were mainly referred from Ljubljana region and according to the data available from the Slovenian National Institute of Public Health for year 2018 (for year 2019 data is not yet available) in Ljubljana region 4246 children were diagnosed with eye disease or vision impairment at vision screening at primary care paediatric office (20).

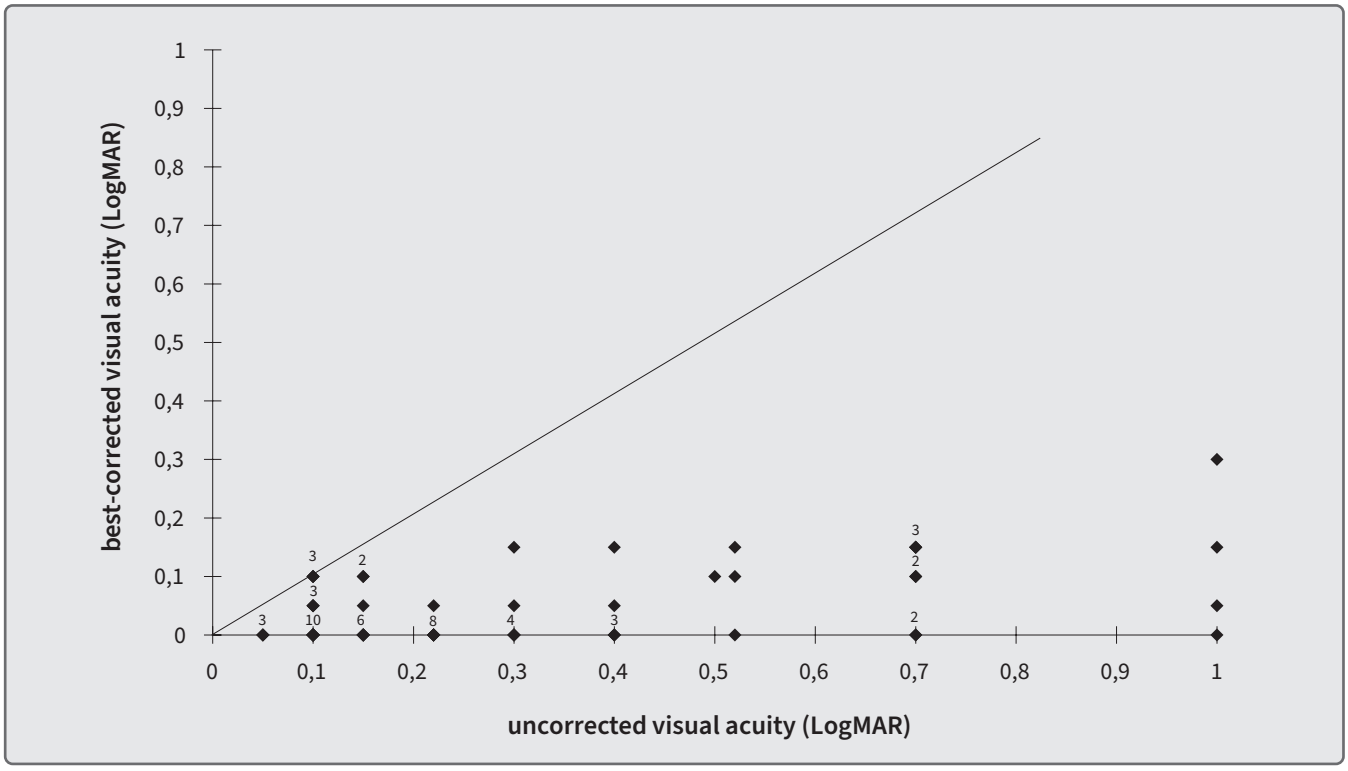

Figure 2: Change in visual acuity in 63 children with amblyogenic refractive error who were treated and followed-up for amblyopia.
Each dot presents the worse eye in each child with amblyogenic refractive error. Numbers above the dots indicate the number of children, where numbers are not written, dot presents one eye.
Legend: LogMAR – logarithm of the minimum angle of resolution.

refractive errors. At follow-up visits, occlusion therapy was prescribed if necessary. Spectacles prescription and occlusion therapy depended individually on the age, visual acuity and retinoscopy findings, but generally followed the published guidelines and literature (22-25).

Amblyogenic refractive error was defined similarly as in the literature: hyperopia >3.50 diopters, myopia >3.00 diopters, anisometropia >1.5 diopters, and astigmatism >1.5 diopters at 90° or 180°, or >1.0 diopters in oblique axis (2,26). Ophthalmological examination was done to reveal any other ocular pathology (e.g. strabismus, significant ptosis or media opacities).

In two children with reduced visual acuity parents refused further cycloplegic refraction and the treatment. Ten children from the follow-up group did not come for a planned check-up or were referred to other offices (e.g. for a contact lens prescription in case of anisometropia) and were followed-up there. These children were not included in the follow-up group.

One child was not compliant with the prescribed therapy and did not wear glasses. In this child visual acuity was the same after a follow-up of 9 months (0.10 log MAR; 32/40). One child was diagnosed with homocystinuria and had luxation of the lenses during the study after she was corrected to 0.00 logMAR (Snellen equivalent 40/40) visual acuity in both eyes.

Children ages, uncorrected visual acuity, retinoscopy values and visual acuity at the final follow-up visit (average value +/- standard deviation) were analysed.

The study design was approved by the Ethics Committee of the Community Health Centre Ljubljana (No. 852-1/2019-2, date 7 November 2019).

3 Results

A total of 439 children (mean age 7.3 +/- 3.7 years; range 3 to 17 years; 238 girls and 201 boys) referred due to poor vision or poor cooperation at vision screening were included in the study (Figure 1). In this study, the only amblyogenic factor was found to be visually significant refractive error. The initial ophthalmological exam did not reveal any other potentially amblyogenic factors (e.g. cataract, strabismus) in these children. 75/439 children (17%) had amblyogenic refractive error (mean age 5.3 +/- 2.6 years; range 3 to 16 years). In children with amblyogenic refractive error 20 children

Table 1: The table shows 63 children where amblyogenic refractive error was identified and were followed-up.

Age (years)	Number of children with uncorrected visual acuity </= 1.00 logMAR (4/40) in the worse eye*	Retinoscopy values in the worse eye* (average value +/- standard deviation; absolute values in minus cylinder form)		Best corrected visual acuity in the worse eye* on their last visit (average value +/- standard deviation; logMAR)
		Sphere (D)	Cylinder (D)	
3-5	2	4.75 +/- 2.25	1.88 +/- 1.13	0.15 +/- 0.21
5-6	0	/	/	/
6-8	2	6.63 +/- 0.88	1.88 +/- 1.59	0.10 +/- 0.07
≥8	0	/	/	/
Age (years)	**Number of children with uncorrected visual acuity > 1.00 logMAR (4/40) to </= 0.30 logMAR (20/40) in the worse eye***	**Retinoscopy values in the worse eye* (average value +/- standard deviation; absolute values in minus cylinder form)**		**Best corrected visual acuity in the worse eye* on their last visit (average value +/- standard deviation; logMAR)**
		Sphere (D)	**Cylinder (D)**	
3-5	9	5.22 +/- 2.31	2.39 +/- 1.52	0.06 +/- 0.07
5-6	3	1.83 +/-1.61	2.17 +/- 1.26	0.01 +/- 0.03
6-8	5	4.33 +/- 2.87	2.55 +/- 1.75	0.03 +/- 0.05
≥8	5	1.99 +/- 2.47	1.63 +/- 2.2	0.13 +/- 0.03
Age (years)	**Number of children with uncorrected visual acuity > 0.30 logMAR (20/40) to </= 0.05 logMAR (36/40) in the worse eye***	**Retinoscopy values in the worse eye* (average value +/- standard deviation; absolute values in minus cylinder form)**		**Best corrected visual acuity in the worse eye* on their last visit (average value +/- standard deviation; logMAR)**
		Sphere (D)	**Cylinder (D)**	
3-5	17	1.61 +/- 1.99	1.67 +/- 0.95	0.03 +/- 0.05
5-6	11	2.68 +/- 2.13	1.73 +/- 0.95	0.00 +/- 0.00
6-8	5	3.90 +/- 2.18	1.50 +/- 0.94	0.00 +/- 0.00
≥8	4	3.25 +/- 2.95	0.33 +/- 0.58	0.05 +/- 0.07

Children are divided into three major groups according to their visual acuity in the worse eye (</=1.00 logMAR (4/40), >1.00 logMAR (4/40) to </=0.30 logMAR (20/40), >0.30 logMAR (20/40) to </=0.05 logMAR (36/40)). Groups are subdivided into age groups. For each subgroup range of refraction is presented and final best corrected visual. Children older than 8 years who were developing myopia are not shown in this table.
Legend: *If both eyes had the same reduced visual acuity, right eye was chosen.
D – diopters; logMAR – logarithm of the minimum angle of resolution.

(20/75; 27%) had unilaterally and 55 children (55/75; 73%) had bilaterally reduced visual acuity (Figure 1). Children with amblyogenic refractive error (3.67 +/- 2.44 diopters of sphere and 1.86 +/- 1.23 diopters of astigmatism) had an uncorrected visual acuity of 0.32 +/- 0.28 logMAR in the worse eye.

49 from 75 children (65%) with the amblyogenic refractive error were diagnosed in a pre-school period. 12 from 75 children (16%) children with the amblyogenic refractive error were diagnosed when they were 8 years of age or older. A visual acuity > 1.00 logMAR (4/40) to </= 0.30 logMAR (20/40) in the worse eye was found in 8 of children diagnosed at 8 years of age or older.

63 (63/75; 84%) children in the study with the amblyogenic refractive error were followed-up on average for 10 +/-4.7 months (range from 5 to 23 months; Table1 and Figure 2). These children had an uncorrected visual acuity of 0.31 +/- 0.27 logMAR in the worse eye. On the final follow-up visit they had a best corrected visual acuity of 0.04 +/- 0.07 logMAR in the worse eye, 38/63 (60%) of them had a visual acuity of 0.00 logMAR (40/40) in the worse eye (Figure 2).

4 Discussion

Children included in the presented study were mainly referred from Ljubljana region and according to the data available from the Slovenian National Institute of Public Health for year 2018 (for year 2019 data is not yet available) in Ljubljana region 4246 children were diagnosed with eye disease or vision impairment at vision screening at primary care paediatric office (20). 439 children from the study represent approximately 10% of the children diagnosed with eye disease or vision impairment within 1 year at community-based vision screening. 17% of children included in the presented study were treated for refractive amblyopia. Visual acuity in amblyopic eyes improved during the treatment, similarly as in other studies (18,27,28). Since amblyopia was unilateral in 20 cases and the visual acuity was normal in the other eye, there are chances that poor visual acuity could be unnoticed without vision screening. This showed the importance of continued childhood screening and timely treatment of children with amblyopia to minimize the burden of disease later in life associated with the vision loss.

The aim of childhood vision screening is the detection of reduced vision due to amblyopia early in life, before the school-age, when the results of the treatment are the most optimal. In the present study, 1.8% children with amblyogenic refractive error and a visual acuity from 1.00 logMAR (4/40) to </= 0.30 logMAR (20/40) in the worse eye were diagnosed when they were 8 years of age or older. In these children visual acuity had been assessed during vision screening program also earlier but poor vision had not been noticed probably due to different reasons, such as poor child's cooperation, peeking with a better-seeing eye in the unilateral poor visual acuity or other reasons which were beyond the scope of this study, but still worth exploring to avoid missing such children at vision screening. It is expected that some children would be missed on vision screening program, but keeping this number to minimum is the goal. In the study from Webber and Wood it was summarized that the population studies of amblyopia indicated a prevalence of approximately three percent in untreated childhood and current adult populations. With the detection and treatment of amblyogenic condition by five years of age, the prevalence of clinically significant amblyopia was reduced to around two percent and before three years of age to around one per cent (1). This prevalence is lower than in our study where we had 1.8% of children 8 years of age or older with amblyogenic refractive error and moderate amblyopia while vision screening system in Slovenia starts screening with optotypes at the age of 3 years.

If visual acuity is not optimal or amblyopia risk factors are suspected to be present, refraction in cycloplegia of all children with reduced VA or visual symptoms is recommended (29). In two children from the study, parents did not agree with the cycloplegic refraction and the treatment. Treatment in children without visually significant anatomic abnormality includes wearing glasses and patching of the fellow eye (9,30), but compliance is key to successful treatment. One of 63 children who were followed-up (1.6%) reported having refused to wear glasses, while in other study nearly half of the children were non-compliant with the spectacle wear (27).

The improvement of visual acuity was evident in the follow-up group in the presented study. Visual acuity also improved in the older age groups where, according to the studies, treatment should also be attempted (12,31-33). It would also be valuable to assess the binocular vision functions in treated children in the future. Follow-up time was heterogeneous in the study because final visual acuities were analysed for all children one year after the last child was referred. Additionally, some of the parents did not bring their children for the scheduled check-ups (e.g. improvement of the visual acuity was reported on the first follow-up visit so they did not come for additional check-ups) or were referred to other offices (e.g. for a contact lens prescription in case of anisometropia) and were followed-up there so the reported follow-up times were shorter in these children.

Every second child in the study (52%) who had been referred to the ophthalmologist had normal visual acuity at the ophthalmic exam. Poor cooperation at vision screening at primary care paediatric office could also be a factor here and probably reflects challenges in testing preschool children. The success of the test depends mainly on the child's cooperation and is based on visual acuity. Visual acuity measurement is variable in young children and preschool vision screening programs based solely on visual acuity can be in uncooperative children unreliable compared with other objective measurements, such as retinoscopy and autorefraction (27). The rate of false-positive referrals in some other studies was from 20% (28) to almost 30% (27).

We generally used picture chart (Topcon CC-100XP; B1 type, Topcon, Japan) in children 3 to 5 years of age, Tumbling E in children 6 to 7 years of age and in older children Snellen charts, comparable to other paediatric vision screening programs (34). In the literature, the preferred optotypes are LEA symbols, Sloan letters, and HOTV, as they are standardized and validated (16,35). In another study it was found that in screenings where visual acuity is the gold standard, Tumbling E was a good

instrument for visual acuity assessment in children aged 3 and 4 years (36). In Slovenia, picture charts are used in the screening program in this age group (34).

Similarly, as in vision screening in Slovenia, it was suggested in the literature that amblyopia screening should be viewed as a continuous process that occurs throughout visual development (16). It was recommended that all children aged 3 to younger than 6 years should be screened annually (best practice) or at least once (acceptable minimum standard) during the interval between their third and sixth birthdays (16). Exceptions to this included for example children with the readily observable ocular abnormalities or systemic conditions that have associated ocular abnormalities. These children should be referred directly to an ophthalmologist for a comprehensive eye examination (16). In Slovenia, children are generally screened twice between their third and sixth birthdays (3 and 4.5 years of age).

Limitations of the present study are that it presented a clinical sample, so the data obtained could not be used to estimate the prevalence of amblyopia in the population or to present the efficacy of vision screening program in Slovenia. Children included in the clinical sample were mostly from Ljubljana region, parents usually decided and applied for a specific institution and an ophthalmologist based on their personal decision. Access to the ophthalmologist is usually easier in the Ljubljana region as it may be in some other Slovenian regions so it might also be easier for patients and their parents to come for frequent check-ups and to be encouraged to follow the treatment plan. All of that could influence the results in the presented clinical sample compared to the Slovenian population. National systematical data on the prevalence of amblyopia in the population would however be of great value in the estimation of the vision screening program in Slovenia.

Also, other amblyogenic factors such as media opacities or strabismus were not detected in the studied group. To include children with these amblyogenic factors probably all referrals should be included as parents often, if they notice strabismus, actively and usually earlier (before children could reliably read optotypes) seek and receive medical treatment and do not wait for vision screening. Data available from the Slovenian National Institute of Public Health for the year 2018 (for the year 2019 data is not yet available) in Ljubljana region shows that among 4246 children who were diagnosed with eye disease or vision impairment at vision screening at primary care paediatric office, only 141 (3%; 141/4246) were diagnosed with strabismus in school period or visual disorder in pre-school period (in pre-school period strabismus category is not shown) (20). The study reviewed the demographics and visual parameters in a group of children referred from Slovenian community-based vision screening program since no data on the topic was available in the literature. The study also highlighted outcomes for a group of children referred to the ophthalmologist due to poor vision at vision screening and showed the evident improvement of visual acuity in children treated for refractive amblyopia. In everyday clinical practice, we are faced with patients' and parents' doubts in the diagnostics and treatment of refractive amblyopia so we felt it was important to show good visual outcomes in the treated group.

5 Conclusion

Children in the presented clinical sample who were diagnosed and treated for amblyopia were mostly discovered and their treatment was started before the school-age. These children showed significant improvement in visual acuity in the amblyopic eye.

Conflict of interest

None declared.

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