

EVALUATION OF EUSCREEN - VISION SCREENING – DATA

Oana Teodosescu , Mihai Mara, Cristina Vladutiu, Simona Cainap, Daniela Rajka
UMF Iuliu Hatieganu, Cluj-Napoca

Abstract

AIMS: The EUSCREEN study aims to compare vision and hearing screening programs for children in all EU states by using a cost-optimization model. A model-developed vision screening program has been tested in the county of Cluj in Romania. The ultimate goal would be to implement a nationwide vision screening program designed to detect visual deficiencies in children.

METHODS: 98 nurses trained by UMF Cluj examined children aged 4 and 5 in public and private kindergartens and in rural family doctors' offices in 2018 and 2019: 6951 children were examined in Cluj-Napoca, 2677 children in the other 5 municipalities in the county and 3241 children were tested in the rural areas.

RESULTS: In the city of Cluj-Napoca 49 nurses from public kindergartens and 4 nurses and 1 doctor from the private kindergartens were enrolled in the project. They examined 6951 children (74% of the eligible). In the five smaller cities 23 nurses examined 2677 children (76% of the eligible). In the rural areas 3241 children (47% of the eligible) were examined by 33 screeners: 2 travelling nurses, 2 family doctors, 29 family doctors nurses.

12080 children were first examined using the E charts while 789 children were examined using the Lea charts. On the second examination 125 children were examined using the E charts and 210 using the Lea charts, and on the third examination 24 children were examined using only Lea charts.

From the 12869 examined children 11328 children had a normal visual acuity for their age, while 1507 children were referred for an ophthalmologic

examination: 946 children from Cluj-Napoca (13.60%), 253 children (9.45%) from the other five cities in the country and 308 children (9.5%) from rural areas. Only 419 results were collected from the ophthalmologists: 280 (30%) reports of children from Cluj-Napoca, 88 (35%) forms from children in the small cities, and only 51 (17%) reports of children from the rural areas.

In 212 out of the total 419 children examined by ophthalmologists (representing 50.59%) a visual acuity disorder was documented. 201 children (47.97%) had a visual acuity within the normal range for the age. The leading causes supposedly responsible for the reduction in visual acuity were: refractive errors (194), strabismus (19), functional amblyopia (38) and organic causes (3). Strabismus was detected in a number of 19 children (4.53%).

Optical correction was prescribed in 171 cases, while 37 patients were also recommended occlusion therapy. According to the ophthalmological reports, 234 children required a follow-up at a variable interval (ranging between 2 months and 1 year)

CONCLUSIONS: The high number of confirmed cases of visual acuity disorders, the important number of glasses prescriptions and the detection of cases that require occlusion treatment emphasizes the value of visual screening.

KEY-WORDS: visual screening, children

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* **Author correspondent:** Oana Teodosescu, UMF Iuliu Hatieganu, Cluj-Napoca, e-mail: teodosescuoana@yahoo.com

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Introduction

Amblyopia is a relatively common neurodevelopmental abnormality, established in early childhood, that results in physiological alterations in the visual pathways and impaired vision in one eye, less commonly in both [1]. Current studies have reported a 1.6% prevalence of amblyopia among preschoolers in the US [2,3]. As it is, uncorrected visual impairment in childhood is associated with reduced academic performance and psychological stress [4]. Furthermore, it is worth mentioning that amblyopia also carries an increased lifetime risk (at least three times that of the general population) of serious vision loss of the fellow eye, which was estimated at least 1.2% [5]. However, if detected early and appropriately treated, amblyopia is reversible.

Pediatric vision screening programs generally stress upon early detection and facilitation of appropriate visual rehabilitation to prevent or minimize visual disability [6]. A recent review of the pediatric vision screening program in 18 countries across five continents concluded that the implementation of a vision screening program is diverse within countries preceded by limited resources issues [7]. At this time, in Romania there is no regulated national preschool visual screening system.

EUSCREEN, or else, "Implementation of optimized childhood vision and hearing screening programs in middle-income countries in Europe", is a 4-year multicenter European project funded by the HORIZON 2020 program which aims to compare vision and hearing screening programs for children in all EU states by using a cost-optimization model [8]. Accordingly, model-developed screening programs have been tested in the county of Cluj in Romania for vision, and in three counties in Albania for hearing screening.

The pilot study in the county of Cluj was conducted over a 2-year period: 2018 and 2019. Visual screening was coordinated and supervised by the "Iuliu Hațieganu" University of Medicine in Cluj-Napoca and the Department of Social and Medical Assistance (DASM), official partners in the EUScreen project.

The ultimate goal would be to implement a nationwide vision screening program designed to detect visual deficiencies in children. Choosing the perfect target group for the screening was the subject

of much controversy. Suitably, the child should be old enough to cooperate but in the same time young enough for the likely amblyopia treatment to be effective. Telleman et al. 2019 determined that "measurement of VA at the age of 36 months cannot be recommended as a screening test in the general population" [9]. Traditionally, the treatment of amblyopia commenced prior the age of 7 has shown significant success rates and the younger the child is when treatment commences, the more rapid the response to treatment and the better the visual outcome [10]. On the other hand, one study revealed that 74% of children aged 7–12 years treated with patching, and 80% treated with atropine have some degree of residual amblyopia on long-term follow-up [11]. Within the EUScreen project, it was eventually established that the eligible age of the children to be included in the study would be 4 and 5 years.

Due to a shortage of pediatric ophthalmologists and to the limited financial resources of the program, nurses, who were already involved in preventive and health promotion activities, were considered to be the most appropriate healthcare providers to perform the actual screening. Because in Romania the distribution of school dispensaries is not uniform at the level of the counties, with 95% of them being in the urban environment [12], visual acuity was measured in project by the nurses in the kindergartens in the city of Cluj-Napoca and in the other five towns/municipalities (Turda, Câmpia-Turzii, Huedin, Dej, Gherla), respectively the family doctors or their nurse practitioners in the rural areas in the county. A comprehensive literature review of the pediatric vision screening program in 18 countries across five continents similarly revealed that non-eyecare practitioners, including trained staff, nurses, and even parents, were involved in the visual screening in 94% of the countries [7].

Materials and methods

The medical personnel involved in the screening were required to attend a mandatory two-day training session organized at the University of Medicine and Pharmacy Cluj-Napoca prior to the commencement of the screening. The structure of these courses included an initial overview of the EUScreen project and an induction on visual acuity screening and visual

disorders, followed by a detailed exemplification of the visual acuity measurement technique and a practical workshop in which every partaker had the opportunity to perform a visual acuity test under the direct supervision of a pediatric ophthalmologist [13]. At the end of each course, the participants were expected to pass a multiple-choice test. The UMF team organized a total of five training sessions.

154 nurses attended the course, 98 of whom decided to enroll in the project.

Both the preschoolers from the public kindergartens and those from the private kindergartens were included in the EUSCREEN project. During the two years of the implementation of the vision screening in urban areas, the nurses in kindergartens screened a total of 9710 children aged between 4 and 6 years: 6951 children were examined in Cluj-Napoca and the remaining 2677 children in the other 5 municipalities in the county. Additional 3241 children were tested in the rural areas.

Results and discussions

Out of the 72 nurses from the kindergartens in Cluj-Napoca that attended the training course, only 49 (68,05%) agreed to take part in the screening. Additionally, 4 nurses and 1 doctor from the private kindergartens in Cluj-Napoca were enrolled in the project; they examined children from several private kindergartens in the city. Similarly, 31 nurses in the 5 municipalities followed the course and 23 (74,19%) enrolled in the Euscreen project. The lowest percentage was recorded in the rural areas, where only 26 out of the 51 (50,98%) trained general practitioners and nurses chose to sign up for the visual acuity screening.

Prior to the introduction of the EUSCREEN project, some of the nurses and doctors in the kindergartens usually included the visual acuity testing in the routine health check-up; however, this was not done consistently and systematically and not every kindergarten owned a visual acuity eye chart. According to one of our previous research, 64.60% of the medical staff who attended the training course (115 out of 178) acknowledged not having screened vision acuity in children before [13]. *Hence, some of the participants to the course might not have been willing to take*

up further responsibility or did not find the financial reward substantial enough.

Nurses	Followed course	Screened children
Cluj-Napoca	72	49
Small cities	31	23
Rural areas	51	26

Table 1: nurses who followed the course and nurses who screened children

During the two years of the implementation of the vision screening in urban areas, the nurses in kindergartens screened a total of 9710 children aged between 4 and 6 years: 6951 (74% of the eligible) children were examined in Cluj-Napoca and the remaining 2677 (76% of the total eligible) children in the other 5 municipalities in the county.

In Cluj county approximately 35% of the children eligible for visual acuity measurement in the EUSCREEN project (four- and five-year-olds, meaning all children born in Cluj County in 2013, 2014 and 2015) live in the rural area. This is a total of 6877 children. Considering the fact that the school medicine network is present in only 3 of the 74 communes of the Cluj county, rural screening was planned to take place in the family doctors' offices.

In the two years of the Euscreen project, 3241 rural children (47% of the eligible preschoolers) were examined by 33 screeners: 2 travelling screening nurses, 2 family doctors and 29 nurses (5 of whom also examined children in the surrounding communes, and one of them became, towards the end of the project, the third travelling screening nurse). In 2018, 1100 children were examined, and in 2019, 2141 children were examined.

The percentage of screened children, fluctuating from 47% in the rural areas to 74-76% in the urban areas resembles the overall results of a recently published survey on the likelihood of vision testing of children aged 3-5 years in the United States. The latter study disclosed that parent-reported vision testing rates by state ranged from 41% to 84% [14]. Furthermore, the same study stressed upon the fact that the requirement of a state-level school vision testing was associated with an increased parent-reported vision testing in children 3-5 years of age [14].

This information could well relate to one of the findings in our previously published analysis on the main reasons why the study did not include a higher number of preschoolers, among which the participants

to the survey mentioned lack of parents' consent, their lack of time or even lack of interest as long as it was not a mandatory assessment [15].

Area	Total eligible (3 birth years)	Screened	Percentage
Cluj-Napoca	9382	6951	74%
Small cities	3495	2677	76%
Rural areas	6877	3241	47%
Total	19754	12869	65%

Table 2: eligible children and screened children

Following the screening, 946 children in Cluj-Napoca were referred to an ophthalmological test, that is 13.60% of the number of children that had been tested. In the other 5 municipalities in the county, 253 (9,45%) children were referred to the ophthalmologist. A total of 308 out of 3241 screened children (9.5%) from rural areas received the recommendation to be examined by an ophthalmologist in a city.

These results are significantly lower than the ones reported by a study in Baltimore City Public Schools according to which 34% of students failed vision screening, with children in kindergarten and 3rd grade and higher being statistically more likely to fail screening than those in 1st grade [16]. A different study carried out in Wayne County, Michigan in 2016 showed that of 56,572 children screened, 4,689 (8.3%) failed [17], hence the number of children that

required follow-up examination after a failed screening is closer to the one in the Cluj county rural areas.

Only 280 (30%) eye examination reports were returned to the nurses in the city, and 88 (35%) forms filled out by an ophthalmologist were received in the small municipalities. The rates are even lower in the rural areas, where only 17% of the referred children actually turned in their ophthalmological reports. Similar studies in literature usually report higher follow-up reports. Likewise, Donahue and colleagues' study of 15,000 preschool children found that about 50% of referred children had documented follow-up care [18]. A previously mentioned study showed that 47.6% of the Wayne County school-age children had the required follow-up examination within 16 weeks of the failed screening [17].

	Referrals	F5 in database	% F5 in database
Cluj-Napoca	946	280	30%
Small cities	253	88	35%
Rural	308	51	17%
Total	1507	419	28%

Table 3: referrals and forms 5 entered in the project database

An important issue of examining children in rural areas is that of referring children with visual impairments to the ophthalmologist and collecting the results of the ophthalmological examination. In the rural areas there are no ophthalmologists, meaning parents from rural areas had to take their child to a city for an ophthalmological assessment and repeat visits for treatment of amblyopia. Similarly, the University of

Southern California Los Angeles Preschool Vision Program initially reported an overall examination rate of 64.8% among 1,554 preschool children who met referral criteria from screening tests and noted a higher examination rate (70.8%) among children who had an appointment in their own school than having to go to a different school (53.9%) [19].

Almost twice as many ophthalmological reports from Cluj-Napoca as from the rural areas were entered in the database. A possible explanation for a very small number of results from the ophthalmologist is the lack of financial resources of the family for travelling to the city for a doctor appointment, but also a lack of understanding the detected health problem. It is also possible that some parents of visually impaired children may no longer have considered it necessary to transmit the result of the examination to the family doctor or to the Euscreen team. Kemper and colleagues reported that the rate of follow-up eye

care was much greater when parents were contacted to verify follow-up [20].

From the total of 12869 examined children a total of 12500 were examined only once by the nurses before reaching a conclusion (*either Examination OK or Referral to an ophthalmologist*). 369 children needed a second examination, but only 341 of them were examined the second time. From these 341 children: 311 cases were concluded during the second examination. 30 children needed a third retesting, as per screening protocol, but only 24 children were screened a third time. A total of 34 children that needed retesting weren't retested.

	One examination	Two examinations	Three examinations
Cluj-Napoca	6867	44	-
Small cities	2591	95	-
Rural areas	3042	172	24
TOTAL	12500	311	24

Table 4: number of examinations needed for a result (either Examination OK or Referral to an ophthalmologist)

12080 children were first examined using the E charts while 789 children were examined using the Lea charts (522 in Cluj-Napoca, 30 in small cities, 237 in rural area). On the second examination 125 children were examined using the E charts and 210 using the Lea charts, and on the third examination 24 children were examined using only Lea charts. Indeed, Lea symbols, consisting of a set of four symbol optotypes, are especially helpful because each

optotype blurs similarly as the child is presented with smaller symbols, increasing the reliability that individual symbols will be identified [21]

From the 12869 examined children 11328 children had a normal visual acuity for their age, while 1507 children were referred for an ophthalmologic examination. The project team managed to collect only 419 results from the ophthalmologists (roughly 28%) (Table 5).

	Examined	OK	Referred	Results from ophthalmologist
Cluj-Napoca	6951	5985	946	280
Small cities	2677	2412	253	88
Rural	3241	2931	308	51
Total	12869	11328	1507	419

Table 5. Number of examined and referred childrens

From the total number of 1507 of children referred for ophthalmological assessment a merely low percentage (27,8%) have returned the F5 forms (419 children). The rest of them, meaning 1088 (72,2%) children, may be considered lost to the follow up. The main reasons why this happened were investigated by the UMF team and recorded in the previous chapter.

In 212 out of the total 419 children examined (representing 50.59%) a decreased VA, that is to say, a visual acuity disorder, was documented. 201 children (47.97%) had a visual acuity within the normal range for the age. In six cases (1,43%) the F5 forms provided could not be interpreted due to unavailability of data.

A study conducted in Nobeoka City, Japan revealed that out of 3,303 eligible children, 2,161 (65.4%) underwent secondary screening [22]. Other studies have shown a significantly lower false positive rate of 13% [23]

The leading causes supposedly responsible for the reduction in visual acuity were: refractive errors (194), strabismus (19), functional amblyopia (38) and organic causes (3). One or more causes of reduced visual acuity were present in each of the confirmed cases.

91,5% of the children presenting with a reduced visual acuity or 46,3% of the referred children exhibited an associated refractive error. Other studies indicated the presence of a refractive error in 44% [23] or 33% [24] of cases. The analysis of the refraction numbers revealed myopia in 19 children, hyperopia in 28 and astigmatism in 100 children; anisometropia was noted in 47 preschoolers. In the absence of cycloplegia in all children, the inclusion in a certain of refractive error category was correlated with the level of the visual acuity.

Strabismus was detected in a number of 19 children (4,53%). Other studies signaled a misalignment of the visual axis in 3% [22] or 13% [23] of cases.

The category of functional amblyopia included children with strabismus, anisometropia or both in which the glasses did not fully correct visual acuity. The 38 (9,06%) cases of functional amblyopia were separated in strabismic (4 cases), anisometropic (26 cases), isoametropic (1case) and mixed amblyopia (7). Amblyopia was present in 16% [22] or 30% [23] of cases according to other studies.

Associated ophthalmological conditions were described in 3 children: chorioretinal scars, corneal scarring and congenital cataract. The Walsall study also come across a wide range of conditions, such as cataract, ptosis, nystagmus, corneal scarring, Duane

retraction syndrome, unexplained vision loss, and latent strabismus [23].

Optical correction was prescribed in 171 cases, while 37 patients were also recommended occlusion therapy. According to the ophthalmological reports, 234 children required a follow-up at a variable interval (ranging between 2 months and 1 year) (Table 6).

Optical correction	171
Occlusion therapy	37
Follow-up is recommended (in 2-12 months)	234

Table 6. Measures recommended by ophthalmologists

The majority of the ophthalmologists (356) use a decimal visual acuity measurement system, while 37 use a LogMAR eye test; in 29 cases the value of the visual acuity was recorded in both decimal and LogMar systems.

The distance between the child and the eye chart also varied: 33 children were examined at a distance of 3 meters, 64 children at 4 meters, 122 children at 5 meters, while for 201 children the distance was not mentioned.

The decimal system was used for the visual acuity for 356 children, the logarithmic system was used for 37 children (for 29 children both systems were used), while for 55 children the visual acuity was not mentioned at all.

Conclusions

The high number of confirmed cases of visual acuity disorders (*212 cases out of 419 ophthalmologist' results, 50.6%*), the important number of glasses prescriptions (*171 prescriptions from 419 results, 40.8%*) and the detection of cases that require occlusion treatment emphasizes the value of visual screening.

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