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ORIGINAL ARTICLE

Ophthalmological evaluation in children referred to a low-vision rehabilitation project of a social assistance agency

Evaluación oftalmológica en niños derivados a un proyecto de rehabilitación en baja visión de un organismo de apoyo social

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Abstract

Introduction: A low-vision (LV) rehabilitated child can receive comprehensive education. **Objective:** To study the profile of school children referred for evaluation to a rehabilitation project in a social assistance agency. **Patients and Method:** Descriptive cross-sectional study of beneficiaries evaluated between September 2015 and September 2016 in the National Board of School Assistance and Scholarships (JUNAEB). The referral diagnosis, monocular visual acuity (VA) with optical correction at far (Feinbloom chart) and close (Zeiss chart) distances were considered. They were classified according to VA and perimetry. Treatment success was considered if VA reaches ≥ 0.4 at far and/or close distances with optical devices. **Results:** 278 students were assessed. 153 (55%) were men, 121 (43.5%) between the ages of 10 to 14. Bilateral congenital cataract, retinal dystrophies, high myopia, optic atrophy, and congenital nystagmus were the most frequent pathologies. 224 students (80.6%) received optical devices. 85 (37.9%) presented moderate LV and 63 (28.6%) severe LV; 122 (54.5%) presented normal perimetry, 68 (30.4%) tubular Visual Field (VF), 19 (8.5%) sectoral VF defects, and 15 (6.7%) central scotoma. 198 (88.4%) students achieved visual success at a far distance and all achieved visual success at a near distance. 48 (17.2%) students could not be rehabilitated due to a neuro-ophthalmological condition (41.7%), high refractive error (16.6%) or congenital glaucoma (10.4%).Six (2.2%) cases improved VA with a new optical correction. **Conclusion:** This success demonstrates the need to provide low vision aids to schoolchildren with LV. Our challenge is to maintain this program and to educate ophthalmologist for timely referral.

Keywords:
Children;
low vision;
low vision aids;
low vision/
rehabilitation

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Introduction

According to the World Health Organization (WHO), "a person with low vision (LV) presents a decreased visual function with visual acuity (VA) lower than 0.3 (20/60, 0.6 logMAR) and/or visual field (VF) lower than 20º from the fixation point in the best eye of the patient, which cannot be improved with conventional optical correction or with medical and/or surgical treatment, but who could use his/her remaining vision to plan or execute specific tasks"[1,2]. On the other hand, a "blind person" has a vision lower than 0.05 (3/60, 1.3 logMAR) and/or a visual field lower than 10º in the best eye with the best possible optical correction. WHO estimates that 19 million children in the world are visually impaired, where 1.4 million are blind and 17.6 million have limited vision[1]. By 2007, it was estimated that 90,000 adults[3] could be visually rehabilitated in Chile, but they are not referred due to lack of knowledge and/or services. There are no national estimates of affected children. Visual impairment in children affects their psychological, educational, and socioeconomic development, generating a costs burden to the community and, although its prevalence is low, it is important due to its long survival. Current blindness prevention strategies have allowed many cases to avoid blindness, but with a visual impairment that has significant functional and psychological consequences in childhood and that in the future will limit their educational and/or work performance.[4] This situation can be reversed with visual rehabilitation, where through training and habilitation in the use of optical, non-optical and/or electronic devices, those who are affected learn to maximize their remaining vision, allowing them to integrate into their community[5]. The etiology of childhood visual impairment varies in different regions of the country, and specific information is required to adapt to local needs and eradicate preventable causes. There are no complete statistics to estimate the prevalence of LV in Chilean schoolchildren or to evaluate the causes. A clinical analysis of 46 children with LV admitted to COALIVI Corporation (a specialized center that aids the visually impaired), Concepción, reported that their main causes of visual impairment were ocular malformations, followed by bilateral congenital cataract, and retinopathy of prematurity (ROP)[3]. An article published in 2000 shows that a visual impairment prevalence associated with refractive error in the pediatric population in the commune of La Florida was 7% and that 50 children (0.95%) had a vision lower than or equal to 0.25[6]. Another more recent study, regarding the refractive error prevalence in schoolchildren, detected two children (0.04%) with low vision integrated into a regular school, who used optical aids provided by the National Board of School Aid and Scholarships (JUNAEB), indicating their inclusion in the educational system[6,7].

Our objective is to show the national experience in the care of schoolchildren with LV, referred to the JUNAEB rehabilitation project, characterizing the affected school population in Chile, their etiologies, and their visual rehabilitation results. We consider that this information will educate the ophthalmologist and pediatrician for an early referral, it will facilitate the design of preventive measures of pathologies causing LV in children and the planning of visual rehabilitation services necessary for the detection, treatment, and monitoring of students in this condition.

Patients and Method

A cross-sectional descriptive study was conducted in schoolchildren of the Chilean public educational system who are detected in refractive consultation of JUNAEB providers at a national level, and then referred to the JUNAEB LV rehabilitation project, to be evaluated by the LV team of the School of Medicine of the University of Concepción, under public bidding modality, which carried out operations in the regions between September 2015 and September 2016. Children were characterized by age, sex, referral diagnosis, best corrected monocular visual acuity (VA) for far and near distances, and perimetry. Monocular VA for far distance was assessed with Feinbloom chart (*Designs for Vision Inc.*) at three meters (Figure), and for near distance with Zeiss chart on a reading stand at 25 centimeters. In cases of illiterate patients, the LEA symbols test was used for far and near distances (Figure 1). It was considered the best VA achieved in the best eye with optical correction. Monocular perimetry study was carried out using the Bjerrum tangent screen at one meter. The best perimetry achieved with optical correction was considered.

Patients were classified according to vision and perimetry criteria. Considering the VA at far distance, in the best eye with the best optical correction, it was used the international statistical classification of diseases and related health problems, 10th revision (ICD-10)[8] of the World Health Organization in its 2016 version, where it is similar to the LV severity standard proposed by Faye[9] and to the visual impairment classification (9D90) of the WHO IC-11 version. They are classified as moderate LV, severe LV, and profound LV (Table 1), considering the latter as functional and legal blindness with remaining vision, and the WHO considers an additional category for unqualified visual impairment.

Based on the best perimetry, they were classified according to the dominant VF defects in four functional

groups[9] (FG), where FG1 presents central VF compromise, GF2 presents peripheral VF compromise, GF3 has sectorial VF defects, and GF4 does not present VF alterations. Optical and non-optical aids were prescribed for each patient, for a distance of 3m (far) and a reading distance of 25cm (near), with training and supervision for its correct use.

Treatment success was considered in accordance with the low vision protocol of the *ONCE* Foundation for cooperation and social inclusion of people with disabilities in Spain[10], which considers success if they achieved VA for far distances higher than or equal to 0.4 with optical aid, since with this vision a functional range is reached that allows vision at three meters. Treatment success was considered for near distances if they achieved a VA higher than or equal to 0.4 with technical assistance, since with this vision a functional range is reached that allows reading school texts with standard eye charts[10]. The objective of the visual rehabilitation program is to train the remaining vision and provide patients with the optical and non-optical aids that help them to carry out needed daily actions from near and far distances. The whole process of visual rehabilitation contemplates the needs evaluation of each person, the diagnosis and prognosis of their pathology, the functional vision evaluation, training in the remaining vision use and the selected optical aids.

The referral diagnoses were defined by the ophthalmologist treating each schoolchild and extracted from their medical record. In cases with more than one diagnosis, the one that caused the greatest visual impairment and/or constituted a preventable condition was considered. The data were tabulated with Microsoft Excel for analysis.

Results

Records of 278 schoolchildren from all over Chile were obtained, corresponding to records of several years of patients evaluated in operations. Out of these, 153 (55%) were male and 125 (45%) were female, aged between 4 and 20 years. The group of schoolchildren aged 10 to 14 years was the most frequently referred (43.5%) (Table 2).

In relation to the best Visual Acuity at far distance, in the best eye with the best optical correction, 272 children were analyzed (Table N°3), considering that other six (2.2%) did not present low vision since when improving their optical correction, they achieved vision greater than 0.3. Out of the 272 children with low vision, 89 children (33.1%) presented moderate LV, 86 (31.6%) severe LV, and 67 (24.6%) profound LV. Of 29 schoolchildren (10.7 %) no visual acuity was obtained, 25 because they could not achieve fixation, and four children did not cooperate because they were under five years of age. Considering the 67 cases with profound LV, 63 (94.0%) could be habilitated.

Table 1. Low Vision Category according to IC-10 classification

Visual impairment category *	Lower than**:	Equal or better than:
Moderate Low Vision	20/60 (6/18 - 0.3 0.6logMAR)	20/160 (6/48 - 0.125 0,9LogMAR)
Severe Low Vision	20/200 (6/60 - 0.1 1.0logMAR)	20/400 (6/120 - 0.05 1,3logMAR)
Profound Low Visión	20/500 (6/150 - 0.04)	20/1.000 (6/300 - 0.02)

*ICD-10 WHO Classification: 2016 Version. **Vision Scale: US feet (UK metrics / decimal / logMAR).

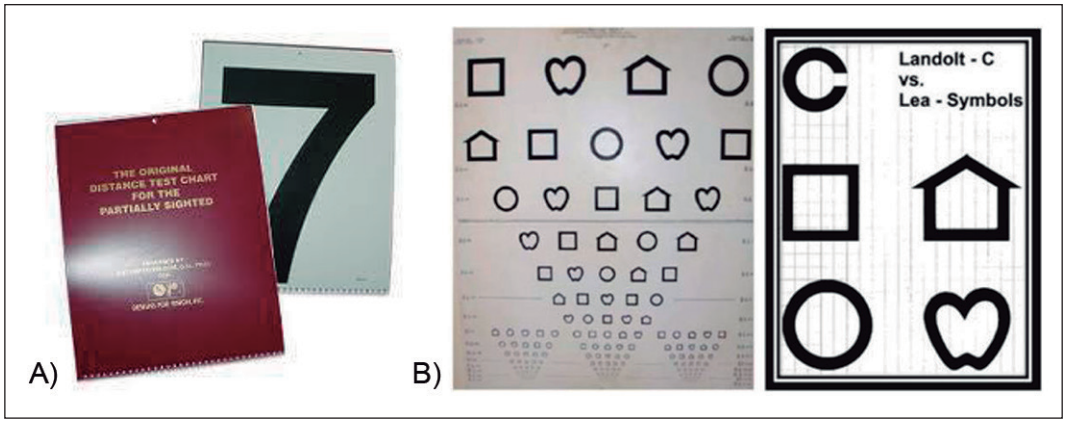

Figure 1. Numerical Optotype Chart of Feinbloom (**A**) and LEA Hivarinen simbol test (**B**). Personal photos of Patricia Ramos.

Regarding admission diagnoses, the most frequently reported causes of LV were: 41 (14.7%) cases of congenital cataracts, 30 (10.8%) retinal dystrophies, 24 (8.6%) high myopia associated with macular chorioretinal involvement, and 16 (5.8%) bilateral optic atrophy (Chart 1). Considering a pathologies anatomical classification, 61 (21.9%) schoolchildren present retinal involvement, 47 (16.9%) neuro-ophthalmological affections, 41 (14.7%) cataracts, 34 (12.2%) ocular malformation, and 33 (11.9%) refractive error. Among the 33 students with refractive error, 24 had high myopia associated with macular retinal damage, and nine had high hyperopia with bilateral amblyopia that does not correct their vision with glasses.

Out of the total evaluated, 224 schoolchildren (80.6%) could be visually habilitated, achieving a vision higher than 0.4 at far (198 schoolchildren) and/or at near distances (199) with low vision aids, 48 (17.3%) could not be habilitated, and six (2.2%) improved their basal VA to functional range with a new optical correction and do not require LV aids. With regard to schoolchildren enabled by age group (Chart 2), it was observed that 90.0% of children aged 15 years and over could be habilitated, and this is reduced to 73.1% in the 5-9 age group. The group of children under five years of age (four cases) was supported with non-optical aids (reading and writing stand) and visual stimulation until they need optical aids for their school integration.

Table 2. Distribution of schoolchildren admitted to the Low Vision program dependent on JUNAEB according to sex and age groups

Age (years)	Male Number (%)	Female Number (%)	Total Number (%)
Younger than 5 years	3 (2.0)	1 (0.8)	4 (1.4)
5 to 9 years	49 (32.0)	44 (35.2)	93 (33.5)
10 to 14 years	74 (48.4)	47 (37.6)	121 (43.5)
Equal or greater than 12	27 (17.6)	33 (26.4)	60 (21.6)
Total	153 (100.0)	125 (100.0)	278 (100.0)

Table 3. Distribution of the schoolchildren admitted to the Low Vision Program, according to the Low Vision Category and his Habilitation

Low vision*	Habilitated Number (%)	Not habilitated Number (%)	Total Number
Moderate	76 (33.9)	14 (29.2)	89 (33.1)
Severe	85 (38.0)	1 (2.1)	86 (31.6)
Profound	63 (28.1)	4 (8.3)	67 (24.6)
No fixation	0 (0)	25 (52.1)	25 (9.2)
No cooperate	0 (0)	4 (8.3)	4 (1.5)
Total	224 (100.0)	48 (100.0)	272 (100.0)

*OMS ICD-10 Classification: 2016 Version.

Considering the 224 (80.6%) schoolchildren who could be visually habilitated, 124 (55.4%) are men and 100 (44.6%) are women. According to the far distance vision at de admission, 85 (38.0%) presents severe LV (Table 3) and according to their perimetry, 122 (54.5%) presented normal range, 73 (32.6%) tubular VF, 19 (8.5%) VF sectorial defects, and 5 (2.2%) central involvement of the VF. Their admission diagnoses were: 39 (17.4%) cases of bilateral congenital cataract, 26 (11.6%) with retinal dystrophy, 17 (7.6%) with high myopia, 16 (7.1%) with congenital nystagmus, and 14 (5.8%) with ocular and/or oculocutaneous albinism. In evaluating the success of the visual habilitation treatment, 198 (88.4%) schoolchildren achieved the success goal of a VA higher than or equal to 0.4 for far distance with optical aid (telescope). Another 23 (10.3%) schoolchildren did not improve their vision, and three (1.3%) did not require optical aid. Evaluating vision at near distance, all schoolchildren achieved success in their treatment by reaching vision higher than 0.4. 199 (88.8%) schoolchildren required optical aids for near distance (optical and/or electronic magnifying glasses) as well as non-optical ones (reading and writing stand), and 25 (11.2%) only non-optical aids. All schoolchildren reached VA greater than or equal to 0.4 for near distance with aids, distributed in similar percentages in all ages, independently of the LV degree and perimetry.

Considering the 48 (17.3%) schoolchildren who could not be visually habilitated, 26 (54.2%) were men and 22 (45.8%) were women. The 5-9 age group is the most represented, with 23 (47.9%) children. According to vision at far distance at admission, in 25 (52.1%) cases it is not possible to quantify their VA due to poor fixation associated with neurological damage, 14 (29.2%) present moderate LV, one (2.1%) severe LV, and four (8.3%) profound LV (Table 3). The remaining four (8.3%) children included are under five years of age, therefore, they were supported with non-optical aids (reading and writing stand) and visual stimulation, until they required visual habilitation with optical aids for schooling. The main diagnoses in the non-habilitated group were: 10 (20.8%) cases with cortical visual impairment, 5 (10.4%) cases of high myopia associated secondary to chorioretinal damage with macula involvement, 5 (10.4%) cases of congenital glaucoma, 4 (8.3%) cases of bilateral optic atrophy, 4 (8.3%) cases of retinal dystrophy, 4 (8.3%) cases of ROP, and 2 (4.2%) bilateral optic nerve hypoplasia. In these cases, it was not possible to indicate optical aids to improve their vision. Considering an anatomical classification of these diagnoses, the most frequent is

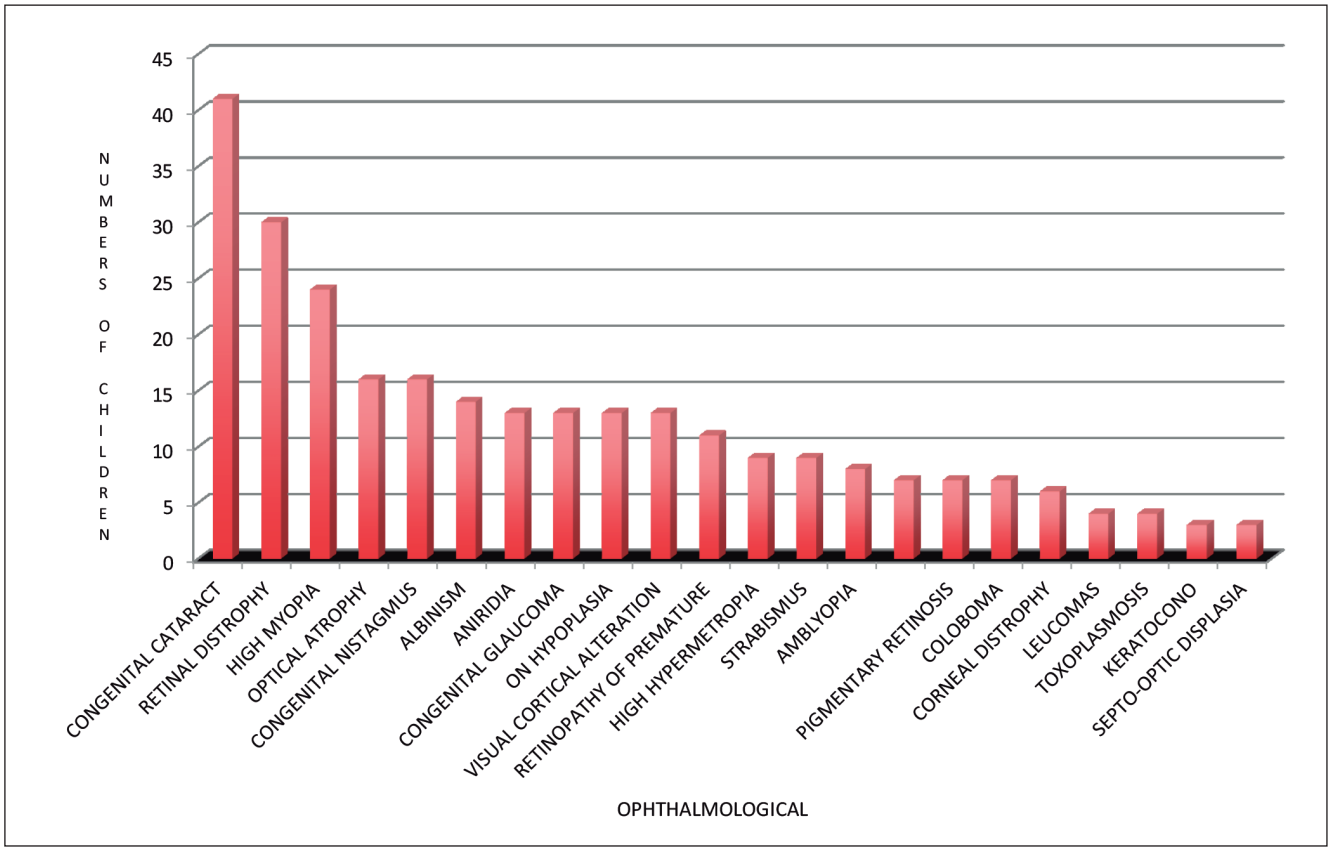

Chart 1. Distribution of schoolchildren admitted to the Low Vision program, according to the admission diagnoses.

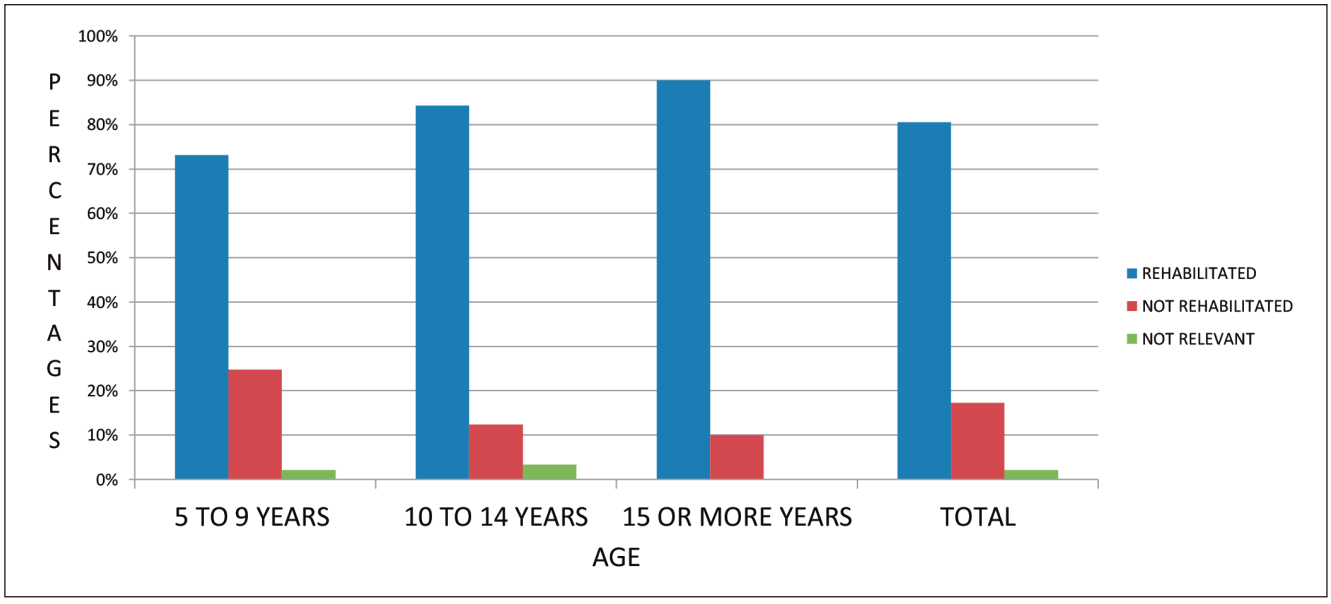

Chart 2. Distribution of schoolchildren admitted to the Low Vision program, according to his/her Habilitation and age groups.

a neuro-ophthalmological condition with 18 (37.5%) cases, followed by 5 (10.4%) cases of myopia with macular retinal damage, 5 (10.4%) cases with congenital glaucoma, and 5 (10.4%) with ocular malformation.

Considering the 6 (2.2%) cases classified as non-relevant, 3 (50.0%) were men, where the 10-14 age group was the most frequent with 4 (66.6%) children. Their admission diagnoses were: 3 (50.0%) children with re-

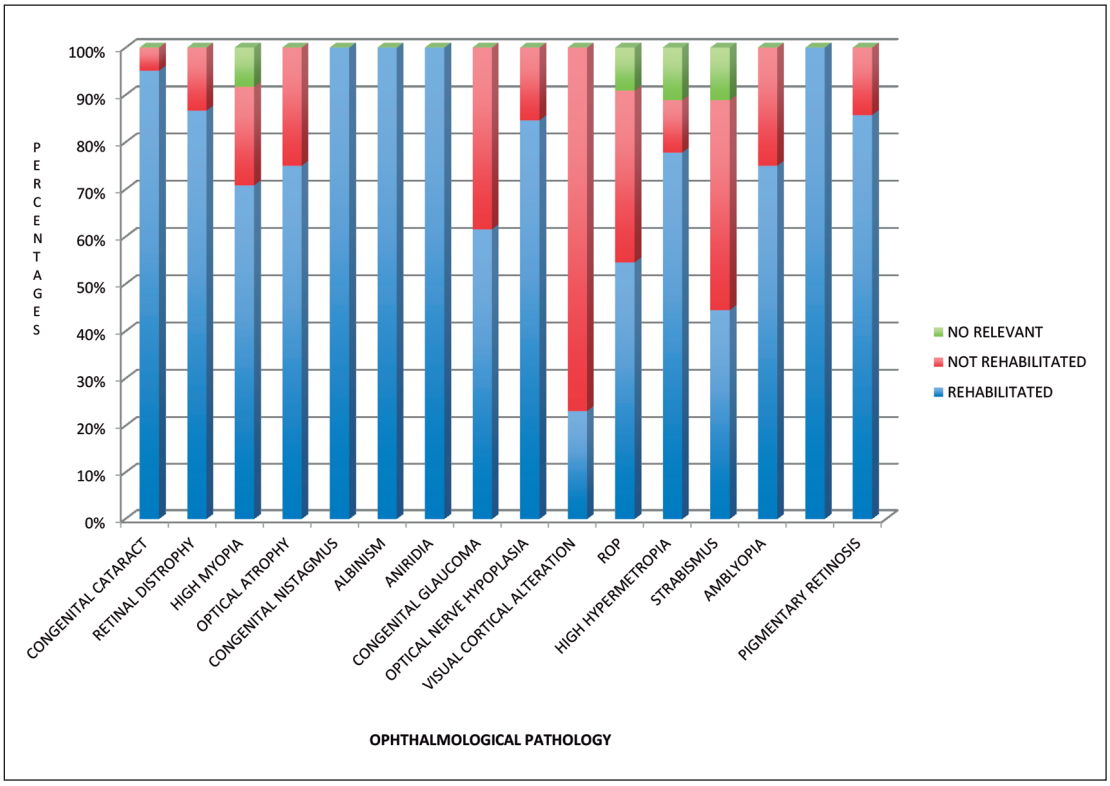

Chart 3. Distribution of schoolchildren admitted to the Low Vision program, according to the referral diagnoses and his/her visual habilitation.

fractive error due to high myopia (2) and high hyperopia (1), 1 (16.7%) child with strabismus, 1 (16.7%) with coloboma, and 1 (16.7%) case with congenital cataract and glaucoma. All cases improved their VA with new refraction and optical lenses, without entering the project.

Considering all referral diagnoses, the pathologies with the highest treatment success were aniridia, albinism, and congenital nystagmus, with 100% of cases habilitated. The pathologies with the lower treatment success were cortical visual impairment with 23.1% habilitated, ROP with 54.5%, and congenital glaucoma with 61.5% (Chart 3).

Discussion

Visual rehabilitation in children with LV depends on the visual needs, personal abilities, and remaining vision of each child[10]. Functionally, it is required that they have a remaining vision enough to see the light and use it properly. An LV classification is necessary to work on their rehabilitation and on the education of their family and environment. A child with profound LV perceives movements; cases of severe LV can distinguish medium-sized objects, without recognizing special details or color. A child with moderate LV is able to perceive small objects or symbols. There is an inverse relationship between the child's LV level and his or her functional independence at school and social interaction[11]. Visual rehabilitation improves their quality of life and unites the LV aids with the skill development for their community integration. With optical, non-optical and/or electronic aids, most children with LV can read and write with ink[10]. The Pan American Health Organization (PAHO/WHO) emphasizes the importance of visual rehabilitation of children in order to improve their reading ability, ensuring their learning and education, which is one of the priorities of the regional visual health plan[12,13]. In our study, 80.6% of schoolchildren referred to the project were visually habilitated, considering that they achieved VA that allows them to perform daily activities independently and integrate into the educational system, which was more important in schoolchildren with severe LV, where habilitation was possible in 94% of cases. According to age groups, 90.0% of children over 15 years of age were habilitated, which drops to 73.1% in the group of 5 to 9 years of age, due to the admission of children with neurological pathologies that do not improve their VA. Only 2.2% of the referred children were not relevant and improved their vision with new refraction, thus leaving the low vision group but remain with visual impairment so they are also helped and guided for the development of their daily activities.

The prevalence and causes of childhood visual im-

pairment vary widely, relating to socioeconomic and cultural factors[11]. It is estimated that 900 children per million require LV treatment, 106 early intervention, and 230 educational support[12]. Out of 17.6 million children with LV worldwide, approximately 60% are visually impaired due to treatable or preventable causes[14]. Describing the population treated in an LV service and its causes at the local level allows planning and developing strategies aimed at maximizing the effectiveness of available visual rehabilitation services and programs and implementing preventive strategies for prevalent pathologies, training ophthalmologists and child health professionals. Advances in medicine and health policies have prevented many cases of blindness associated with trachoma or vitamin A deficiency, but have increased cases of visual impairment due to congenital cataract or glaucoma, which are also potentially treatable conditions[11]. There is little literature on visual impairment in schoolchildren and most of it is based on populations in schools or specialized centers, methodologies that present a risk of bias, especially in vulnerable and low-income environments[15]. In China, a national survey of children under 14 years of age reported a low vision prevalence of 0.58%, demonstrating that cataract (48%) and refractive error associated with bilateral amblyopia (14%) are the main causes[16,17]. In Canada, it was estimated that 19,700 (2.4% of the total) children under 14 years of age were affected with BV[11], forecasting a future increase in cases associated with congenital or acquired conditions[2]. Another child visual impairment study, in New Zealand, evaluated 267 children, 144 (53.9%) blind and 123 (46.1%) with LV. In them, the three main blindness causes were cerebral visual impairment (42.4%), optic nerve atrophy (12.5%), and retinal dystrophy (9.0%), while the LV main causes were albinism (17.9%), followed by retinal dystrophy and cerebral visual impairment (13.0% each), highlighting that 18.8% of blind children and 22.0% of those with LV had a preventable cause[18]. In Nepal, out of 558 visually impaired children, the most common LV causes were refractive error associated with amblyopia (20.1%), retinitis pigmentosa (14.9%), and macular dystrophy (13.4%). 86% of them were prescribed LV aids, showing that 72% of them improved their VA for far and/or near distance with aids[19].

Our study analyzed 278 children, referred to the LV rehabilitation program as admitted or controls patients at the national level during two years, and although the prevalence of LV is low, its management is important. This considering that in 2017, out of the 134,428 refractive consultations performed by the National Board of School Aid and Scholarships (JUNAEB) program, 57 children (0.04%) were referred to the program. The first cause of LV is bilateral congenital cataract (14.7%), where these cases are a potentially treatable pathology, therefore, a preventable secondary LV. In terms of frequency, it is followed by retinal dystrophies (10.8%), and high myopia (8.6%) associated with macular damage, both of which cannot be modified. 3.2% of children are associated with high hyperopia, where 77.8% were habilitated, in addition to one case not habilitated due to bilateral amblyopia, and another case that improves his/her vision with optical correction. Another aspect to consider is the cases referred with a diagnosis of unclear admissions such as strabismus, which produces a unilateral impairment or amblyopia, but the basal pathology that causes this LV is not described, being impossible to classify its real etiology. It is necessary to establish rules for the evaluation and standardization of referral diagnoses for LV care and training of ophthalmologists.

Measuring vision for far and near distance is necessary to plan visual rehabilitation and evaluate its results[10]. To quantify the VA in children has particularities related to their personality, the need for previous learning of eye charts and the anxiety and collaboration that they give before the exams[20]. Their visual rehabilitation should be based on the measurement of vision for near distance, as this is fundamentally what they require to carry out school work. There is no clear evidence or guidelines to standardize this measurement. A systematic review[20] to determine the impact of an eye chart of vision for near distance and the methods for estimating recommends that children up to 3 years old use preferential vision procedures; between 4 and 7 years old use tests based on LEA charts, and for those over 8 years old, with verbal response or that understand symbols, ETDRS charts, because they would be more predictable for functional vision[21]. In our study, the Zeiss chart for near distance was used on literate children and it was considered a success to achieve VA higher than or equal to 0.4 with optical aid, because it is a recommendation of the ONCE Foundation, a recognized Spanish institution dedicated to visual rehabilitation[10], and because this vision allows them to read and enter the regular education. The evaluated and habilitated students in the LV program are able to carry out their educational activities such as reading their school books and copying from the blackboard with the provided optical and non-optical aids. With this, they can read and write in ink and therefore continue their schooling considering that without these aids they have to know braille system or use large print.

The benefit of the optical reading aids use for children and adolescents with LV is consolidated in recommendations of experts and work teams in LV, despite this, there is still no evidence of quality to recommend specific aids, mainly due to lack of randomized studies. Future studies should standardize their results to facilitate comparisons in meta-analyses. The functional re-

sults of LV treatments are not easy to unify[22] due to the presence of non-standard variables, such as vision, primary reading ease (reading speed and comprehension) and duration, learning, print size, as well as questionnaires or cost-effectiveness analysis, among others. To measure the success of the treatment, a study[23] assessed changes in the functional vision of 183 children, using Prasad-Functional Vision Questionnaire, at admission and 3-4 months later, demonstrating that an LV service improves the visual function independent of its cause and emphasizes the need to visually rehabilitate children with LV. Our perception is that these children have been integrated into the educational system with LV aids, given for free by JUNAEB, achieving greater equity, but in the future it will be necessary to include questionnaires in the follow-up of the JUNAEB project to evaluate the maintenance of the success achieved, after the child's adaptation to his or her visual aid and the impact this represents on his or her educational and community integration. It is also proposed to identify causes of rehabilitation failure and non-use of aid in order to plan strategies to prevent them.

In order to develop public policies, it is necessary to determine the effectiveness of treatments in children, since the available literature is mostly related to adults[24]. A systematic review sought to objectify the benefit of visual rehabilitation in children, obtaining only 28 articles meeting inclusion criteria. It showed that visually habilitate children with LV is very important, but there is little literature on the subject, usually case reports. Another review[22] did not allow developing recommendations due to a lack of randomized studies but highlighted the importance of child visual rehabilitation.

There are some limitations of the study such as having a small sample and that they are referred patients thus it is not possible to estimate prevalence or know the burden of different pathologies in low vision, because it is associated with spontaneous detection and knowledge of the program on the part of the treating physician. On the other hand, we consider the referral diagnosis of the treating physician as the main diagnosis for analysis, partly because it is a sample derived from the JUNAEB program present throughout Chile. This also leads to non-standardized diagnoses and some causes are not clear, as for example amblyopia without cause or strabismus that can be secondary or a wrong diagnosis as visual cortical alteration, and in order to partly correct this, it was made an anatomical classification.

In conclusion, it is necessary to implement LV rehabilitation services to help children become independent, avoiding loss of educational and work opportunities, and deterioration of quality of life. Since 1992, JUNAEB has been detecting and managing visual impairments associated with refractive error[25] and, since 2015, has incorporated the visual rehabilitation project, habilitating schoolchildren with LV through the delivery of optical, non-optical, and electronic aids, at no cost to beneficiaries. 80.6% of children were successful in their visual rehabilitation which demonstrates the efficiency of this program in the child habilitation with optical aids, allowing him or her to see at near distance. Our challenge is to maintain this LV child care model of national coverage, involve it with other integration projects, work, and train teachers and caregiver, and educate the ophthalmologist provider to adequately and promptly refer those affected. All of this must generate networks that make it possible to optimize state resources for these schoolchildren.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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