Prevalence of refractive errors and ocular disorders in preschool and schoolchildren of Ibiporã - PR, Brazil (1989 to 1996)

Prevalência de ametropias e afecções oculares em crianças pré-escolares e escolares de Ibiporã - PR, Brasil (1989 a 1996)

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ABSTRACT

Purpose: To establish the prevalence of refractive errors and ocular disorders in preschool and schoolchildren of Ibiporã, Brazil. **Methods:** A survey of 6 to 12-year-old children from public and private elementary schools was carried out in Ibiporã between 1989 and 1996. Visual acuity measurements were performed by trained teachers using Snellen's chart. Children with visual acuity <0.7 in at least one eye were referred to a complete ophthalmologic examination. **Results:** 35,936 visual acuity measurements were performed in 13,471 children. 1.966 children (14.59%) were referred to an ophthalmologic examination. Amblyopia was diagnosed in 237 children (1.76%), whereas strabismus was observed in 114 cases (0.84%). Cataract (n=17) (0.12%), chorioretinitis (n=38) (0.28%) and eyelid ptosis (n=6) (0.04%) were also diagnosed. Among the 614 (4.55%) children who were found to have refractive errors, 284 (46.25%) had hyperopia (hyperopia or hyperopic astigmatism), 206 (33.55%) had myopia (myopia or myopic astigmatism) and 124 (20.19%) showed mixed astigmatism. **Conclusions:** The study determined the local prevalence of amblyopia, refractive errors and eye disorders among preschool and schoolchildren.

Keywords: Eye infections/epidemiology; Refractive errors/epidemiology; Blindness/prevention and control; Amblyopia/epidemiology; Preschool child; Visual acuity

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INTRODUCTION

The implementation of programs for the prevention of blindness has been widely recommended by the World Health Organization (WHO) since the 70s[1]. Among the most important factors to be considered regarding prevention of blindness are the ophthalmologic disorders occurring at school age. However, in developing countries, preventive programs are not privileged, probably due to the limitation of available resources in the health area and to the lack of emphasis on health actions[2]. This would in part explain why the prevalence of severe visual deficiency is 10 to 40 times higher in certain areas of developing countries when compared with industrialized countries[3].

The investigation of the prevalence and causes of visual impairment allow the planning of preventive ophthalmologic programs, providing more precise interventions directed to the preservation of ocular health[4]. The purpose of sanitary ophthalmology includes the prevention or attenuation

of ophthalmologic diseases or disorders, their complications and consequences, the promotion of conditions for the preservation of normal vision, and the recovery of health through collective measures, motivating the population, but using the community's own resources[5].

According to Sommer, the greatest obstacle to preventive measures is not the lack of adequate technology, but the inability to create favorable conditions to motivate the population, to organize and to facilitate the access to ophthalmologic assistance[6].

Projects aiming at the improvement of vision in children at school age received special attention in the 70s, considering the influence of poor visual performance on the teaching-learning process and on the normal development of the child[7-11].

The improvement in vision screening performed by adequately trained and supervised nonmedical personnel allowed the identification of the prevalence of visual deficiency among preschool and schoolchildren[8,10,12-17]. The application of simple vision tests, and the observation of ocular signs and symptoms which are indicative of disorders by teachers, was shown to be efficient[18-19], making the early identification of functional and organic diseases in this population possible. It is also known that early detection of ocular problems in children, such as refractive errors, strabismus, and chronic infections prevents the establishment of permanent damage to visual acuity and binocular vision[13,20-22].

State supported school vision testing such as the Plan of Sanitary School Ophthalmology (*Plano de Oftalmologia Sanitária Escolar - POSE)* developed in the state of São Paulo (Brazil) from 1973 to 1976, showed that it is possible to detect and promptly treat ocular disorders in students, and stimulated the elaboration of similar plans in different Brazilian areas[9,12,20,23-24].

The purpose of the present study was to establish the prevalence of refractive errors and the most common ocular disorders found in preschool and schoolchildren during eight years of follow-up in Ibiporã, Brazil.

METHODS

A survey of a school population, consisting of preschool children and those of the first four grades of elementary school was carried out from 1989 to 1996, in the city of Ibiporã, PR, Brazil, located 13 km from Londrina. The population (predominantly rural) included the children registered in these grades of all public schools (state and municipal) during this period and all private schools from 1992 to 1995.

Ibiporã has a population of 38,602 including 5,595 children aged 6 to 12 years (presumed populational census of 1996). Between 1989 and 1996, 38,455 children were registered in preschool and in the first four grades of elementary school in six state, eight municipal and seven private schools. The municipality has also a Center of Assistance to the Visually Deficient (*Centro de Atendimento do Deficiente Visual - CADEVI)*, an institution that coordinates and controls vision screening in schools, providing training for the teachers. Ophthalmologic care is provided by a fully equipped ophthalmologic office in a municipal health center.

The following variables were studied: 1) monocular visual acuity measured with the Snellen's chart; 2) refractive errors and ocular disorders, identified by means of a complete ophthalmologic examination.

The visual acuity test (VAT) was applied at the beginning of each year by trained teachers, at a 5 m distance from the optotype table, using a cover to allow monocular examination. Children with a visual acuity of 0.7 or less, with complaints of asthenopia or with eye disorders (strabismus, nystagmus, ptosis, malformations and others) were referred to a complete ophthalmologic examination. VAT results of 0.8 or 0.9 in one eye, difficulty in informing or mental retardation lead to vision screening by an ophthalmologist with 2 m retinoscopy[25-26] in a darkened room. This method was first described by Brik and Brik[25] to screen preverbal children in order to detect amblyogenic factors. The technique, similar to photoscreening[27-28] but less expensive and easier to perform, allows both pupils to be illuminated simultaneously. Differences in color, brightness and speed of the retinoscopy reflex can be easily detected and are indicative of anisometropias, strabismus or refractive errors[26]. Children were considered untestable if they were unable to learn the test and to give reliable responses. If there was suspicion of refractive errors or ocular disorders, the child was referred to a complete ophthalmologic examination.

Ophthalmologic examination consisted of:

- measurement of the monocular linear visual acuity (optotype projector) at 5 m
- evaluation of ocular motility
- slit lamp biomicroscopy
- refraction under cycloplegia (cyclopentolate, every 5 minutes for 3 times). Retinoscopy was performed 45 minutes following the first instillation. Subjective refraction was also performed if the child collaborated
- direct ophthalmoscopy under mydriasis, and indirect ophthalmoscopy, when necessary
- applanation tonometry when necessary.

Criteria for amblyopia included best-corrected visual acuity less than or equal to 0.7 in the eye with the worst visual acuity or difference of two Snellen lines between the eyes. Children diagnosed with ambliopia were promptly treated with total occlusion, either part time or full time depending on the clinical situation. Anisometropia was defined as the difference of one spherical diopter or two cylindric diopters between the two eyes. The ametropias were classified into hyperopias (≥ 3.00 SD), simple and compound hyperopic astigmatisms (≥ 3.00 SD and ≥ 0.75 CD), mixed astigmatisms (≥ 0.75 CD), mild myopias (-0.25 SD to -1.00 SD), moderate

myopias (-1.25 SD to -4.00 SD), high myopias (≥ 4,25 SD) and simple and compound myopic astigmatisms (≥0.75 CD).

RESULTS

Table 1 shows the distribution of the 35,936 VATs performed in 13,471 children from 1989 to 1996. There was a high percentage of VATs performed in relation to the number of registered children (93.5%). Of the total screened children, 76.42% underwent the VAT twice or more.

Seven hundred forty seven children (5.5%) were untestable. The total number of students undergoing 2 m retinoscopy was 3,467 (25.8%) among whom 112 (3.2%) were referred to a complete examination. Among the 1,966 children referred to an ophthalmologic examination, 894 (45.5%) showed refractive errors or ocular disorders.

Table 2 shows the frequency of the most common eye diseases in the examined population. The percentual data refer to the patients undergoing the visual acuity screening (n^1=13,471) and to the patients who underwent a complete ophthalmologic examination (n^2=1,966). The prevalence of strabismus was 0.84%, with predominance of esotropias (0.54%) over exotropias (0.25%), whereas the prevalence of amblyopia was 1.76%. The diagnosis of amblyopia was made at a mean age of 8.44 ± 1.87 years. Active or atrophic chorioretinitis was found in 38 children (0.28%), 9 cases being bilateral and 29 unilateral. Cataract was observed in 17 patients (0.12%), 10 of which were congenital (0.07%). Six patients (0.04%) showed eyelid ptosis, whereas 10 exhibited other congenital anomalies: microphthalmos (n=3), iris coloboma (n=2), optic disc hypoplasia (n=1), tilted disc (n=1), and persistence of hyperplastic primary vitreous (n=1). Three children showed keratoconus, 4 had optic atrophy and 2 showed nasolacrimal duct obstruction. The percentage of normal cases erroneously referred to an ophthalmologic examination was 54.5%.

Six hundred and fourteen children showed refractive errors according to the established criteria (Table 3). Positive degree ametropias (hyperopia and hyperopic astigmatism) were more frequent (46.25%), followed by negative degree ametropias (myopia and myopic astigmatism) (21.17%), and by mixed astigmatisms (20.19%).

Table 1. Number of annually registered students and screened children in Ibiporã, Brazil (1989-1996)

Year	Registered Students	Tested Students	%
1989	4,031	3,751	93.0
1990	4,697	4,362	92.9
1991	4,807	4,429	92.1
1992	5,294	4,867	91.9
1993	4,913	4,600	93.6
1994	4,795	4,586	95.6
1995	4,836	4,518	93.4
1996	5,082	4,823	94.9
Total	38,455	35,936	93.5

Table 2. Prevalence of ocular disorders in (1) the screened population and (2) the population who underwent a complete ophthalmological examination

Ocular disorders	f	% (1) (n^1 = 13.471)	% (2) (n^2 = 1.966)
Amblyopia	237	1.76	12.05
secondary to strabismus	42	0.31	2.13
anisometropic	99	0.73	5.03
refractive	54	0.40	2.74
ex-anopsia	8	0.05	0.40
unknown etiology	34	0.25	1.72
Manifest strabismus	114	0.84	5.79
esotropia	73	0.54	3.71
exotropia	35	0.25	1.78
vertical deviation	6	0.04	0.30
Cataract	17	0.12	0.86
congenital	10	0.07	0.50
traumatic	2	0.01	0.10
aphakia and pseudophakia	5	0.03	0.25
Chorioretinitis	38	0.28	1.93
monocular	29	0.21	1.47
binocular	9	0.06	0.46
Eyelid ptosis	6	0.04	0.31
Keratoconus	3	0.02	0.15
Other congenital diseases	10	0.07	0.50
microphthalmos	3	0.02	0.15
iris coloboma	2	0.01	0.10
persistence of the hyperplastic primary vitreous	1	0.007	0.05
optic disc anomalies	2	0.01	0.10
others	2	0.01	0.10
Optic atrophy	4	0.02	0.20
Nasolacrimal duct obstruction	2	0.01	0.10

Table 3. Prevalence of refractive errors

Refractive errors	f	% (n=614)*	% (n=13,471)**
Hyperopia (≥ + 3.00 SD)	133	21.66	0.98
Simple and compound hyperopic astigmatism (≥+ 3.00 SD and ≥ 0,75 CD)	151	24.59	1.12
Mixed astigmatisms (≥ 0.75 CD)	124	20.19	0.92
Slight myopia (- 0.25 SD to - 1.00 SD)	44	7.16	0.32
Moderate myopia) (- 1.25 SD to - 4.00 SD	20	3.25	0.14
High myopia (above - 4.00 SD)	12	1.95	0.08
Simple and compound myopic astigmatism (above - 0.25 SD and ≥ 0.75 CD)	130	21.17	0.96

* Corresponds to the total number of children with refractive errors
** Total of screened children

DISCUSSION

Conduction of preventive programs directed to preschool and schoolchildren requires the participation of several sectors of the community involving physicians, educators,

family members and volunteer personnel[8,10,26]. In addition to human resources, the basic infrastructure required to diagnose the most frequent eye diseases in this population involves a relatively small investment compared to the benefit provided to the children by prevention of a definitive debilitating condition[8-9,11,13-14]. Some authors, however, have questioned the cost-effectiveness of visual screening programs in children, suggesting that the proportion of potential amblyopes who are identified and successfully treated may be small[16,29-32].

Williamson et al.[30], reported that 43% of the preschool population did not attend the screening examination and suggested that screenings should be performed at the first year of attendance of children to school. Interestingly, our study confirms that screening older children may be associated with higher rate of attendance (93.5%). Furthermore, this can be explained by a preexistent infrastructure, which does not add any cost to the health care system. A simple measurement of the visual acuity using different charts, carried out in day nurseries, preschools and elementary schools, is successful in identifying children with visual disorders[29,33-34]. Measurement of visual acuity using Snellen's chart has been adopted in Brazil because it is an easy and low-cost method associated with low indices of untestability[13,19]. Studies performed in São Paulo in order to verify visual screening criteria in schoolchildren showed 87.10% and 80.86% rates of correct screening when carried out by the teacher[18-19]. The high percentage of right answers when teachers perform the VAT may be credited to the more reliable information due to a strong teacher-student relationship[18]. In this study, 5.54% of the children were untestable. In Brazil, similar studies by Moreira[23] and Brik[13] reported indices of 2.00% and 14.49%, respectively, whereas Lippmann[35] reported an index of 15.8% among 347 children aged 3 to 4 years. These differences may be secondary to the methodology or to difficulties related to either the child or the person applying the VAT. In the present study, we observed difficulties with the regular application of VATs by teachers in the classroom, due to lack of regular training of the teaching staff. This limitation was overcome in 1992 by substituting classroom teachers for teachers who already had experience with classes of visually deficient children.

Of the 13,471 children screened during the period, 1,966 (14.59%) were referred to a full ophthalmologic examination. The efficiency of visual screening programs is closely related to factors such as time saving, and the sensitivity and specificity of the criteria used for referral to an ophthalmologic examination. As this is a public health program, the identification and quantification of cases of normal children erroneously referred to an ophthalmologic examination (false-positive referral) is of utmost importance, in view of the limited resources. In the present study, an index of 54.5% false-positive referrals was observed, a considerably large number of unnecessary referrals. In this study, the referrals were made not only based on the VAT, but also on subjective criteria included in a wide range of asthenopia complaints, such as headache, discomfort when reading, frequent ocular irritation, and repeated blinking. In addition, reapplication of the VAT in positive cases, suggested by several authors[8, 6], was not routinely performed. A research carried out in the state of São Paulo, Brazil, evidenced 49.3% of false-positive referrals and 7.12% false negative referrals in 573 preschool children[36], confirming that there is a tendency to over-referral. The amount of false-negative referrals was not quantified in this study, since we did not examine a sample of children considered to be negative. However, this number is thought to be negligible, since all children with a "doubtful" result were referred to an ophthalmologic examination and many children underwent the test several times during the eight years of the study.

The prevalence of eye diseases has not been widely studied in Brazil. Some programs were applied to school populations with the purpose of establishing a diagnosis and analyzing therapeutic procedures[9,12,20]. However, prospective, longitudinal studies in school populations provide more reliable data regarding visual impairment. The present study focuses on a population of school children who were annually screened until the fourth grade of elementary school. This allowed a more precise analysis of the visual impairment generated by ocular disorders in this population.

The most frequent disorder was amblyopia, which affected 1.76% of the screened children. Several studies have been carried out to determine the prevalence of this condition[9,20,25,37-38]. Reported results, however, show great disparity due to differences in the definition of amblyopia, in screening methods, and in the criteria for referral. One of the most extensive visual surveys involving 156,252 school children of the city of Detroit, disclosed a 2.9% prevalence of amblyopia[39]. Scarpi et al.[38] investigated 1,400 students with ages ranging from 6 to 14 years in São Paulo, Brazil, and found a prevalence of 4.07%. Other studies observed prevalence rates ranging from 2.8% to 4.6% in preschool children[20,23] and from 0.8% to 3.72%[9,22,40-41] in school children.

Among the children with amblyopia, 20.68% showed manifest strabismus, 48.76% showed anisometropia and 26.60% presented refractive causes. Macchiaverni et al.[9], studying 564 school children of Paulínia, Brazil, found that amblyopia was primarily associated with anisometropia in 61.9% of the cases and with strabismus in 28.57%. Early detection of amblyopia and other visual disturbances in children up to 4 years constitutes a valuable preventive measure[14,42-45]. There is no doubt that results of visual recovery are more rewarding when the problem is detected and treated in younger children. However, performing visual screening in younger children is structurally more difficult in developing countries, since the percentage of young children regularly registered in preschools is below the expected. Furthermore, patching therapy has been shown to be effective after the age of 8[46].

Population surveys that quantify ametropias are rare both in the national and international literature[23,47-49]. There are also a reduced number of studies, which quantify refractive errors in the school population because of the change in refractive behavior occurring during child growth.

Among the 1,966 children who were referred to a full ophthalmologic examination, 614 (31.23%) showed refractive errors according to the criteria established in this study. Simple and compound hyperopic astigmatisms were the most frequent errors (24.59%), followed by hyperopias (21.66%), myopic astigmatisms (21.17%), mixed astigmatisms (20.19%) and myopias (12.36%). However, since we did not use plus lenses to screen for hyperopia[50], and we did not perform a complete ophthalmologic examination in a sample of nonreferred children[18,36], the prevalence of hyperopia in this series may be underestimated. Kara-José et al.[47], investigated the prevalence of refractive errors in 1,634 school children aged 7 to 13 years, and found a 14.7% prevalence of refractive errors. However, the authors suggested that in 78.2% of the cases the schoolchildren could be classified as "physiologically ametropic", since the refractive errors were small. Similarly to our study, the authors reported a high prevalence of hyperopic errors (hyperopia or hyperopic astismatism), occurring in 73.6% of the ametropic cases, although the prevalence of myopia (2.9%) was rather low. Rodriguez et al.[40], examining 17,697 schoolchildren aged 5 to 14 years, found prevalences of 33.2%, 13% and 15% of hyperopia, astigmatism and myopia, respectively, with 7 out of each 10 hyperopic children presenting physiological hyperopias (between +0.25 and +1.50 spherical diopters). Moreira[23] identified 13.47% ametropic eyes in preschoolchildren aged between 7 months and 8 years, with a predominance of compound hyperopic astigmatisms (4.87%). However, these percentages cannot be compared with our findings, since they involve different age groups and methodology.

Guidelines for visual screening of schoolchildren should be officially established and constantly reinforced by both the Health and Education Departments. Both Departments would coordinate the execution of visual screening and the setting up of basic offices for ophthalmologic examinations in municipal health centers, and would provide the required infrastructure for ophthalmologic examination of schoolchildren. The integration of those Departments, teacher training, screening coordination and follow-up of the visually deficient may be facilitated by the creation of specialized schools for the visually deficient.

Preventive programs such as this are effective, once most of the important causes of visual deficiency (i.e. amblyopia, strabismus) can be adequately treated if diagnosed at due time. The development of visual screening programs in elementary schools needs to be emphasized, having in mind the necessity of early detection and treatment of refractive errors and eye disorders.

RESUMO

Objetivo: Estabelecer a prevalência de ametropias e afecções oculares em uma população pré-escolar e escolar de Ibiporã, Brasil. **Métodos:** Entre 1989 e 1996, realizou-se estudo populacional envolvendo crianças de 6 a 12 anos provenientes de escolas públicas e privadas de Ibiporã. Medidas de acuidade visual foram realizadas por professores treinados usando a Tabela de Snellen. Crianças com a acuidade visual ≤ 0.7 em pelo menos um dos olhos foram encaminhadas para exame oftalmológico completo. **Resultados:** Foram realizadas 35.935 medidas de acuidade visual em 13.471 crianças. Destas, 1966 crianças (14,59 %) foram encaminhadas para exame oftalmológico completo. Ambliopia foi observada em 237 (1,76%) casos, ao passo que estrabismo foi diagnosticado em 114 (0,84%) casos. Foram também observados 17 (0,12%) casos de catarata, 38 (0,28 %) casos de coriorretinite e 6 (0,04%) casos de ptose palpebral. Entre as 614 crianças diagnosticadas com erros refracionais, 284 (46,25%) tinham hipermetropia ou astigmatismo hipermetrópico, 206 (33,55%) apresentavam miopia ou astigmatismo miópico e 124 (20,19%) apresentavam astigmatismo misto. **Conclusão:** Este estudo determinou a prevalência local de ambliopia, erros refracionais e afecções oculares envolvendo crianças pré-escolares e escolares.

Descritores: Infecções oculares/epidemiologia; Cegueira/prevenção e controle; Erros de refração/epidemiologia; Ambliopia/epidemiologia; Pré-escolar; Acuidade visual

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