

# Evaluation and screening of visual acuity in early childhood schoolchildren

## *Avaliação e triagem da acuidade visual em escolares da primeira infância*

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### ABSTRACT

**Objective:** To identify the incidence of visual impairment in 5-year-old children in public schools from Curitiba-PR. **Methods:** A selection of schools has been chosen randomly from Curitiba. The children, with completed 5 years at end of 2017 have been evaluated using Snellen table, through minimum distance for image sharpness and Hirschberg test. Parents answered a questionnaire about the use of screens, ocular symptoms and family history of the child. Significance levels were defined as begin  $p \leq 0,05$ . **Results:** The results have shown that four hundred fifty-nine children were screened. Two hundred nineteen are female (47,7%) and two hundred forty (52,3%), male. From all screened patients, one hundred were referred to specialized ophthalmic evaluation. After trial completing, has been attained a prevalence value of 10,7% for myopia, 17,6% of hyperopia and 0,9% of strabismus. Strong correlation between parents and children has been undiscovered ( $p < 0,05$ ). From listed ophthalmic complaints, headache (30,4%) and frown (10%) were most prevalent. **Conclusion:** It has been attained that the prevalence of visual acuity is 21,8%. The relation between visual acuity alteration and familiar history has been shown to be significant related. On the other side, the average time in front of television has been shown the only habit that has correlation with visual acuity reduction ( $p = 0,028$ ). Vision complaints, although very frequent, doesn't translate into increased probability of visual acuity alteration.

**Keywords:** Eye health/epidemiology; Mass screening; Visual acuity; Child health; School health services

### RESUMO

**Objetivo:** Identificar a prevalência de alterações visuais em crianças de cinco anos em escolas públicas de Curitiba-PR. **Métodos:** As escolas foram selecionadas aleatoriamente dentro do município de Curitiba. As crianças com cinco anos completos em 2017 foram avaliadas com a tabela de Snellen, através de distância mínima correta para nitidez de imagem e teste de Hirschberg. Os pais responderam um questionário sobre uso de telas, sintomas oculares e histórico familiar da criança. Os resultados das avaliações foram analisados estatisticamente considerando nível de significância  $p \leq 0,05$ . **Resultados:** Em uma população de 459 crianças triadas, 219 (47,7%) pertenciam ao sexo feminino e 240 (52,3%) masculino, sendo que do total, 100 foram encaminhadas para avaliação oftalmológica especializada. A partir da triagem observou-se a prevalência de miopia de 10,7%, hipermetropia de 17,6% e estrabismo de 0,9%. Houve relação entre genitores com miopia e filhos míopes ( $p < 0,05$ ). Dentre as queixas oftalmológicas predominaram cefaleia (30,4%) e franzir de testa (10%). **Conclusão:** A prevalência de alterações visuais encontrada foi de 21,8%. A relação entre distúrbios visuais e o histórico familiar se mostrou estatisticamente significativa. Entretanto, apenas o tempo médio em frente à televisão apresentou influência, dentre os hábitos de vida, sobre as alterações da AV ( $p = 0,028$ ). Queixas oftalmológicas apesar de frequentes, não apresentaram correlação expressiva com a diminuição da acuidade visual.

**Descritores:** Saúde ocular/epidemiologia; Rastreamento; Acuidade visual; Saúde da criança; Serviços de saúde escolar

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## INTRODUCTION

Visual disorders are within the context of public health problems. In childhood, during the neuropsychomotor development phase, visual alterations are crucial, since there is a strong correlation between poor school performance and acuity alterations.<sup>(1)</sup> International studies describe that approximately 25% of school-age children have some type of visual disorder. In Brazil, according to the Brazilian Council of Ophthalmology (CBO), these figures are close to 20%.<sup>(2)</sup> The early detection of these disorders is important to avoid possible difficulties in learning, which may lead to a decrease in the rates of disapproval, school dropout, and biopsychosocial improvement of the student's life. One of the obstacles to early diagnosis is that children do not show their visual difficulties to their parents or teachers.<sup>(3)</sup>

The most common causes of reduced visual acuity (VA) in schoolchildren are refractive errors (hypermetropia, astigmatism and myopia), amblyopia, and strabismus. Not treating these refractive errors is among the main causes of children's visual deficiency in Brazil. VA screening programs are an excellent tool for evaluating ocular health in schoolchildren, but financially speaking this mass screening is very costly, so a possible option is supervised training of non-medical professionals to carry out the screening tests.<sup>(1)</sup> VA measurement is used as a screening instrument to estimate the functionality of the vision, and the use of VA tables in the ophthalmologic examination is the most common practice for this evaluation.<sup>(4)</sup> There are several distinct screening methods; however, the use of tables such as Snellen's (in the screening for myopia and hyperopia) and the Hirschberg's test (for strabismus) are shown to be infinitely more viable due to their extremely low cost and their high agreement when compared to more sophisticated methods.<sup>(5)</sup>

The absence of epidemiological record of visual alterations in children in Curitiba - Paraná motivated the present study, since it is a problem of high incidence, and when not identified can cause delays in the development of the child. Thus, it aimed to identify the prevalence of visual alterations in children of 5 years in 2017 in municipal centers of early childhood education in Curitiba-PR, from the screening examination. In addition, we intended to correlate visual alterations (myopia, hyperopia and strabismus) to family history, ophthalmological symptoms, and life conditions and habits, as well as work on health education on the topic addressed.

## METHODS

The present study was previously presented, discussed and authorized by Secretaria Municipal de Educação de Curitiba-PR. The planning also included contact with school principals and classroom teachers, as well as the provision of guidance in advance to parents or legal guardians with illustrated brochures. The informed consent form (WICF) was attached to it.

For adequate screening of participants in the present study, the researchers responsible for the tests took a specific and updated training directed by the physician responsible for ophthalmology of the Medicine Course at Universidade Positivo.

The children's approach occurred in the schools from July to October of the year 2017. For the data collection, measurement instruments were used such as questionnaires to assess the family history of visual diseases and use of the child's visual accommodation, as well as the ophthalmologic screening test. The researchers ensure all secrecy, privacy and respect for the

participants. Participant names were omitted, and their data identified by a number generated in Microsoft Excel®.

Children were selected for screening from public schools within a universe of 14379 five-year-olds enrolled in 2017, according to the Department of Planning, Structure and Information of Secretaria Municipal de Educação de Curitiba. For the sample calculation, we considered a 95% confidence interval and a sample error of 5%, estimating the need to evaluate 375 students. The inclusion criteria for the study were children of 5 years of age in 2017 enrolled in public schools of Curitiba of any color / ethnicity / gender with WICF signed by their legal guardians, questionnaires filled out and present during the period of application of the tests. The exclusion criteria adopted were non-collaborative schoolchildren or with amaurosis.

In the present study we used a) WICF according to resolution 466/2012 for parents or legal guardians; b) questionnaires for parents or legal guardians addressing signs, symptoms, and length of stay in the child's accommodative effort, and the family history of visual impairments (myopia, hyperopia, astigmatism and strabismus) in first-degree relatives to test the hypothesis of heredity of selected diseases.

The visual screening methods used were: 1) Snellen Table used for VA evaluation. For this test, the ambient light was adjusted to the maximum possible, and the child removed any corrective lenses if necessary, remaining standing and positioned at 6 meters from the table with the head aligned to the axial axis. The appropriate acuity is 20/20 (patient sees at 20 feet, or 6 meters, which should see at 20 feet), from 20/60 it is classified as subnormal vision, and from 20/200 legal blindness, and 20/400 blindness;<sup>(6)</sup> 2) The Hirschberg test used for strabismus screening consisting of observing the relative position of the corneal reflex through simultaneous binocular illumination. It allows identifying the presence of obvious ocular deviations (heterotropy) when the light reflex does not seem centralized on the pupil. To perform this test the environment had its lighting reduced, and the child remained immovable with the head aligned to the axial axis and fixing the gaze at infinity (6 meters); 3) Correct minimum distance for image sharpness: in this evaluation we measured the distances used by the research participants to read the Jaeger table. A ruler was used to measure the distance between the table and the child's eyes, and the results were compared to the ideal one and compared with the conclusions of the other tests used.<sup>(6)</sup>

All children detected with possible visual changes had their parents or legal guardians informed of the possibility of a complete ophthalmological evaluation for diagnosis and therapeutic planning. The parents or legal guardians, the directors and the teachers of the participating classes were provided with a folder to explain the diseases addressed, with explanatory content in order to guide adequate demand for specialized care, regardless of the result of the screening.

General statistics were developed using 95% confidence intervals. The Mann-Whitney tests were used to evaluate if there was any difference between the average time in front of the television (TV) between the patients with different visual impairments, as well as the average time of use of the tablet, cell phone or book (in hours). The Fisher's exact tests were used to correlate whether the proportions of complaints varied among children with and without visual impairment. Data was grouped by region and evaluated by the chi-square hypothesis test. Statistical analyzes were performed considering a significance level of 5% ( $\alpha = 0.05$ ).

## RESULTS

Of the total of 815 explanatory brochures and WICFs delivered, a total of 459 screened children was obtained. Of these, 240 (52.3%) were male, and 219 (47.7%) were female. The presence of visual alterations by gender was 23.3% and 20.2%, respectively. The survey of the nosological profile showed a higher prevalence of hypermetropia in the population studied, with 17.6%, followed by myopia with 10.7%, and strabismus with 0.9% (n = 459), according to table 1.

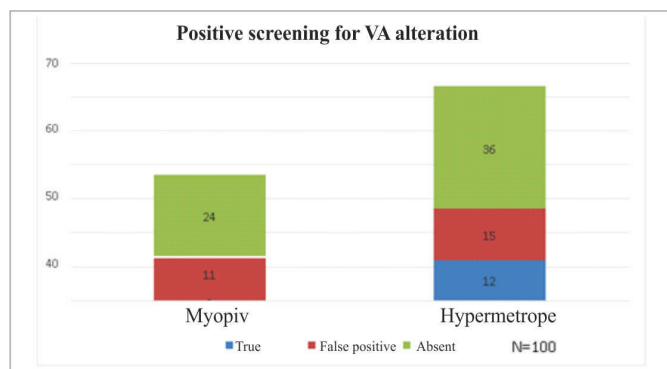
**Table 1**  
**. Vision alteration in the sample of schoolchildren**

Variable	F	% Sample	CI95%
Myopia alt. (N=459)	49	10.7%	8.2% 13.8%
Hypermetropia alt. (N=459)	81	17.6%	14.4% 21.4%
Strabismus alt. (N=459)	4	0.9%	0.3% 2.2%

After the screening, 100 children were referred for professional evaluation, of which only 40 attended the examination at the ophthalmology department. Of the 13 patients who were screened as myopic and went to the ophthalmologist examination, only 2 of them were confirmed to have visual alteration (15.4% of true positives, and 84.6% of false positives). On the other hand, for hypermetropes, 12 (44.4%) of those 27 classified in the screening, were true positives, and 15 (55.6%) were false positives, as shown in figure 1.

For the family history we considered the presence of any type of alteration in at least 1 eye in at least one of the parents. Table 2 presents such results (n = 459).

Regarding family history, the correlation is that the proportion of myopic children with myopic parents is always higher, as shown in table 3 (p < 0.05). In hypermetropic children, this relation is present when associated with maternal alteration, according to table 4 (p = 0.05).



**Figure 1:** Referrals to ophthalmology

The presence of complaints such as headache, eye pain, blurred vision, and frowning is not related to the presence or absence of visual alterations. The average time in front of the TV presented a strong correlation with the presence of VA decrease, according to table 5. Prolonged exposure to a tablets, cell phones, or books was not significantly related to VA alterations.

There was a significant difference in the proportion of myopics in the regionalization of the city of Curitiba. There is

a higher prevalence in the neighborhoods of Bairro Novo and Cidade Industrial de Curitiba (CIC), according to table 6.

**Table 2**  
**Ocular alteration and family history**

	N	% Sample	IC95%
With alt. with family history	70	15.3%	18.8% 12.3%
With alt. without family history	30	6.5%	9.2% 4.6%
Without alt. with family history	146	31.8%	36.2% 27.7%
Without alt. without family history	213	46.4%	51.0% 41.9%

**Table 3**  
**Family history and myopia**

Father with myopia?	Child with myopia?		P-value
	Yes	No	
Sim	13	47	0.006
Não	36	363	
Mother with myopia?	Child with myopia?		P-value
	Yes	No	
Sim	20	101	0.024
Não	29	309	

**Table 4**  
**Family history and hypermetropia**

Mother with hypermetropia?	Child with hypermetropia?		P-value
	Yes	No	
Yes	8	16	0.050
No	71	356	

**Table 5**  
**Average length of stay of children in front of TV**

Visual alteration?	N	Average	Standard deviation	P-value
Yes	96	2.32	1.57	0.028
No	353	1.95	1.38	

**Table 6**  
**Visual alterations and regionalization of schools**

Regional	Myopia		P-value
	Yes	No	
New Neighborhood	15	59	0.032
Boa Vista	6	92	
Boqueirão	3	35	
Cajuru	3	40	
Cic	18	113	
Pinheirinho	2	28	
Portão	2	43	

## DISCUSSION

Sight is important to the establishment of the relation between man and the external world. The development of learning in humans is intrinsically related to the sensory information received through sight.<sup>(7)</sup> It is known that it is easier to perceive

VA alterations in the school environment, and that alterations in children of preschool and school age are easier to be corrected, therefore screening programs are essential to avoid visual disabilities and help in the diagnosis and treatment of these alterations.<sup>(4-9)</sup>

In Curitiba, the place of the sample group of the present study, there are no public policies aimed at screening school children for VA evaluation. Also, the literature shows no epidemiological data found in Curitiba on this topic. In the present study, 459 children were evaluated with ocular screening, a similar value to the studies carried out in Santa Catarina, Minas Gerais and Rio Grande do Sul, in which the samples varied between 201 and 1538.<sup>(5-8)</sup> To achieve this result, 815 forms and authorizations were sent, of which 54% were screened. The main reasons for the impossibility of screening were the absence of the child for examination, a form with an unsigned authorization, or a form not returned to the school. A similar study carried out in the schools of São Paulo presented a 50% abstention rate based on the hypothesis of poor understanding of the proposal by parents or legal guardians, and this was also evidenced in the present study. The low socioeconomic level of the families was pointed out as a possible justification for the number of abstentions.<sup>(10,11)</sup> In a study carried out in the city of Londrina-PR, the prevalence of reduced VA in students in the 1st grade of public education was 17.1%.<sup>(12)</sup> In a similar study in Chile with children aged 5 to 15 years, the prevalence was 15.8%.<sup>(13)</sup> In Colombia, however, it was 19.6%, and in Argentina 18.7%.<sup>(15-16)</sup> In the current study, the prevalence was 21.8%, even though there criteria and population samples were different from the other studies. In a study conducted in Botucatu, 4,623 children were evaluated, of which 752 were referred after screening. A frequency of 63.2% of hypermetropic astigmatism, 15.7% of myopic astigmatism, 12.5% of mixed astigmatism, 4.9% of hypermetropia and 3.7% of myopia was observed. In another study in Herval D'Oeste, a prevalence of 10% of hypermetropia and 3.3% of myopia was obtained. In the city of São Caetano, the prevalence of strabismus was 1.78%. Other studies published in the literature present prevalence values for hypermetropia between 23.3% and 45.4%, myopia between 2% and 10.2%, and strabismus between 1.7% and 8.4%.

Compared to the present study - in which a prevalence of 17.6% of hypermetropia was observed, followed by myopia with 10.7% and strabismus of 0.9% - the values are out of the range found in the literature, although not very significantly.<sup>(8,18)</sup>

Of the 100 children who were referred to the Specialized Ophthalmology Service, only 40 attended for full evaluation. Similar research in Campinas - SP showed a 56.4% rate of absence after referral.<sup>(19)</sup> In Botucatu, SP, the rate of absence of children screened was 20.6% even after repeated requests to parents, according to the authors.<sup>(8)</sup> Thus, we can see that low adherence is frequent, and the most common causes of abstention according to the literature are access to the supplementary health system, difficulties in transportation, and absence to work by parents.<sup>(20)</sup>

The hereditary predisposition to myopia is already known; studies show that inheritance may be autosomal dominant, recessive and polygenic. In autosomal dominant myopia, myopia develops late in childhood, and usually does not reach high degrees. Autosomal recessive myopia is characteristic of communities with high frequency of consanguinity, but is also related to sporadic cases. A positive relation between myopia and family history was found in the study ( $p < 0.05$ ).

Regarding hypermetropia, no genetic relation is observed with the agreement of hypermetropia in univiteline twins being surprising.<sup>(22)</sup> Some authors believe that the vast majority of newborns are hypermetrope, and that over time it tends to decrease. In the present study, the causal relation between hypermetropic mothers and children with the same alteration was verified, but based on the literature, it may be considered a screening finding because of its high sensitivity.<sup>(22,23)</sup>

The presence of complaints such as headache, eye pain, and blurred vision was not related to the presence or absence of visual alterations in the present study. A systematic analysis carried out in 2014 sought the relation between asthenopia (subjective sensation of visual fatigue, ocular weakness or eye strain, manifesting through lacrimation, pruritus, diplopia, blurred vision, eye pain, headache, sensation of dry eye and redness) and alteration in VA, showing controversial results.<sup>(24)</sup> In the present systematic review, some studies showed a strong correlation between refractive symptoms and problems,<sup>(25)</sup> and others a low relation between variables.<sup>(26)</sup>

In the study in question, there was a significant relation between the life habits related to the length of stay in front of the TV and the presence of visual alteration ( $p = 0.028$ ), although it did not present significant "p" for myopia. Exposure to computers, tablets, cell phones, and books also did not show significant statistical correlation with visual alterations. On the other hand, the study by Cunha et al. considers that the use of computers and the habit of watching TV are risk factors for myopiogenesis or its progression in youngsters and adults.<sup>(21)</sup>

The option of a cross-sectional design allowed for low cost and faster execution of the study, but restrained data collection in a single moment. On the other hand, among the hundred children with suspicion of visual alterations in the screening and who could have benefited from the free evaluation in the ophthalmology office, only 40 attended. The difficulty of adherence and/or displacement of the parents was another limitation, since the examination with the specialist doctor could better elucidate the visual condition of the child. It should be emphasized that the family history was obtained through a questionnaire and self-referenced by parents or legal guardians, which may generate a potential information bias. In addition, we should consider the fact that children who were not at school on the pre-scheduled dates were excluded from the study, which may have underestimated the prevalences reported.

However, the present study helped raising awareness, disseminating and guiding on the importance of visual health in the community through the student body, children and families linked to the participating schools. There was distribution of illustrative folders as well as informal conversations with those interested to clear doubts about the visual alterations and their impacts on school performance and quality of life. The internal validity of the study is attested by the use of scientific instruments for visual screening supported by Sociedade Brasileira de Oftalmologia. In addition, the schools requested its continuity.

## CONCLUSION

The study points out the importance of discussing the behavior of children facing current communication technologies and promoting eye health within the domestic and school environment, with public policies to address this issue.

It is suggested to continue investigations to evaluate the sensitivity and specificity of the screening test, since it is an easy, inexpensive and useful examination to promote eye health.

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