Prevalence of low visual acuity in public school's students from Brazil

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Keywords
Visual acuity. School health. Eye health. Students. Prevalence. Health services accessibility.

Abstract

Objective
Low visual acuity (VA) is an important public health problem due to its high prevalence and because it needs early diagnosis in order to prevent damage in childhood development and apprenticeship. To describe and analyze low visual acuity (VA) prevalence among school children

Methods
Once performed the VA test to 1st and 4th grades primary school children data were analyzed by separating students according to sex, school grade, wearing of glasses, residence area and level of access to the supplementary medical assistance (SMA).

Results
The total of 9,640 students was evaluated during the year of 2000 and they presented a prevalence of low VA of 13.1% (CI 12.5-13.8%). There was a statistical significant lower prevalence in males (11.5%) compared to females (14.9%) - (PR=0.77). There was a statistical significant higher prevalence in 1st grade students (14.1%) compared to 4th grade (11.5%) - (PR=1.22). There was also a statistical significant lower prevalence for those who were not wearing glasses (12.1%) compared to those who were using glasses (42.0%) - (PR=0.29). Concerning to residence areas, Cajuru neighborhood had the lower prevalence of low VA (1.8%) and Vila Sabia neighborhood had the higher prevalence (32.4%), and a positive correlation, according to residence area, between the proportion of people with access to the Supplementary Medical Assistance and the proportion of children wearing glasses was found ($r=0.64$, $p<0.001$).

Conclusions
The low VA high prevalence shows lack in early diagnosis and continuity of assistance pointing out to the urgent need of implementation in visual health public.

INTRODUCTION

Vision is the primary means of integration between individual and external environment, and knowledge is to a great extent acquired visually. Visual problems have negative effects on learning and social interaction, thus affecting the natural development of intellectual, academic, professional, and social abilities.[15] Several authors recognize the association between adequate academic performance and good visual health.[6]

Data from international studies[11] show that approximately 25% of school-age children carry some form of visual deficiency. However, are unlikely to report such problems to relatives or teachers.[6]

Several surveys have demonstrated the importance

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of the early diagnosis of visual problems as an essential means of minimizing and preventing severe problems in the future, including amblyopia and strabismus.[6] In developing countries, the scenario is even more worrisome: data show that 80% of blindness cases worldwide occur in these countries, and that two-thirds of these cases are either preventable or curable.[14]

From the public health perspective, mass investigation of visual problems in children by ophthalmologists is too costly, which suggests the administration of visual acuity tests by non-physicians, as long as trained and supervised. This is the recommended procedure when dealing with populations clustered into schools, within the age group in which visual problems are a priority.[14]

Routine visual acuity evaluation is aimed at ensuring good visual health, helping to attenuate the high rates of school dropout and academic failure, and preventing several more important visual complications.[14] Thus, visual acuity screening programs in schools are directed towards the identification of children in need of ophthalmologic care.

In the municipality of Sorocaba, southeastern Brazil, such screening has been accomplished by the *Programa Escola Saudável* (Healthy School Program - PES). This program provides counseling by a healthcare team to maternities, day care centers, preschools, and elementary schools for the promotion of health and the prevention of diseases. Its activities include, among others, actions directed to Hygiene, Nutrition, and Mental, Oral, and Visual Health.

From the collective health standpoint, to describe and analyze the prevalence of low visual acuity in schoolchildren as diagnosed by healthcare agents may be of great value for the planning and improvement of preventive measures and for the establishment of local visual healthcare programs, capable of reducing the inequity existent in contemporary Brazilian healthcare, reported by various authors.[2]

Thus, the present study's general goal is to describe the prevalence of low visual acuity among elementary school students.

METHODS

The study was conducted with first- and fourth-grade students form elementary schools of the public network in Sorocaba, southeastern Brazil. LVA diagnosis was performed on 9.640 schoolchildren.

The study was carried out in two separate stages. The first of these was carried out in 2000 by School Healthcare Agents of the *Programa Escola Saudável*. These agents evaluated the visual acuity of 1st and 4th grade students from municipal and state elementary schools. The exam was carried out after parental/caretaker consent was obtained through School Administration.

Evaluation was performed using a Snellen chart (whose scores vary between 0.1 and 1.0). The child was placed five meters away from the chart, and optotypes were indicated using a black pencil placed vertically two centimeters below the character, as recommended by the *Conselho Brasileiro de Oftalmologia* (Brazilian Ophthalmology Council). Each eye was examined separately. Children who wore eyeglasses were examined with their eyeglasses appropriately placed. Children who recognized Snellen line 3 optotypes (VA=0.8) with both eyes were considered as having normal visual acuity. Children who did not recognize this line – with one or both eyes – were classified as with LVA.[3]

Data from each classroom were registered in a file, including student's name, grade and VA values for each eye. Students who had difficulty reading the table were referred to ophthalmologists at the Sorocaba Ophthalmologic Hospital.

In the second stage (2001-2002), the results recorded in the visual screening files were analyzed. The number of school children who underwent the test was recorded, as well as the number of LVA children (one or both eyes). These data were grouped initially by school, and then by Health Center reference area.

Children absent at the day of the test, whose names or scores were not legible written on the files, who's sex could not be defined based on the records, or who could not take the test, despite being willing to do so, due to comprehension problems, were excluded.

Children were classified according to visual acuity (normal (VA=0.8) or low (VA<0.8), sex, grade (1st and 4th) and use of eyeglasses (yes/no).

The proportion of subjects with access to supplementary healthcare in a given reference area was estimated based on the proportion of deliveries in the area performed by the SHC system (which includes direct procedure payment and health plans or insurance) in 2000.

The Relative Risk (Prevalence Ratio) of LVA was calculated between sexes (male/female), grades (1st/4th) and use of eyeglasses (yes/no).

Table 1 – Distribution of the public network students analyzed, according to studied variables and visual acuity. Sorocaba, 2000.

Variable	LVA		Total	PR	95% CI	X^2	p
	N	(%)					
Sex							
Male	564	(11.5)	4,921	0.77	0.69-0.85	24.6	<0.001
Female	702	(14.9)	4,719	1.00			
Grade							
1st	860	(14.1)	6,109	1.22	1.10-1.37	12.8	<0.001
4th	406	(11.5)	3,531	1.00			
Use of eyeglasses							
No	1,120	(12.1)	9,292	0.29	0.25-0.33	127.6	<0.001
Yes	146	(42.0)	348	1.00			
Total	1,266	(13.1)	9,640		12.5-13.8		

LVA – Low visual acuity

Pearson's correlation test was performed for the distribution of variables "access to supplementary healthcare", "use of eyeglasses", and "low visual acuity" by reference area. In case a correlation was significant, a Linear Regression analysis was carried out.

Data analysis was carried out using Epi Info v.6.04d and Bioestat 2.0 software.

RESULTS

The analysis included 47 public network schools and 19 private schools, located within the reference areas of 26 Health Centers, covering 100% of the municipality of Sorocaba, southeastern Brazil. The 4th grade schools evaluated were located in 19 Health Center areas, covering 73.1% of the municipality. The 1st grade schools were located in all 26 areas, that is, 100% of the municipality.

According to the number of students enrolled in the schools included in the visual screening, a total 10,982 students should have been evaluated. This did not happen in practice, however, due to the large number of absences registered on the day of the test (1,307 students, 11.9%). Furthermore, 7 students whose sex could not be determined based on the examination file, 14 whose names or test results were illegible, and 14 who were not able to take the test were excluded from the second stage of the study, totalizing 1,342 losses (12.2%). Thus the second stage of the study included information on 9,640 students, of which 1,266 had low visual acuity (13.1% prevalence, 95% CI 12.5-13.8%).

Of the 9,640 students evaluated, 4,921 (51.0%) were male and 4,719 (49.0%) female. Prevalence of LVA was 11.5% among male students (95% IC 10.6-12.4%), and 14.9% among female students (95% CI 13.9-15.9%). The prevalence ratio for male students was 0.77 (95% CI =0.69-0.85) (Table 1).

First-graders accounted for 63.4% of the sample (6,109 students), and fourth-graders for 36.6% (3,531 students). Prevalence of LVA was 14.1% among first-graders (95% CI 13.2-15.0%) and 11.5% among fourth-graders (95% CI 10.5-12.6%). The prevalence ratio for first graders was 1.22 (95% CI 1.10-1.37).

Of the total 9,640 students analyzed, 348 (3,6%) wore eyeglasses. Of these, 146 had visual acuity below 0.8 even with their eyeglasses appropriately placed (42.0% prevalence, 95% CI 36.7-47.3%). Of the 9,292 students who did not wear eyeglasses, 1.120 had VA<0.8 (12.1% prevalence, 95% CI 11.4-12.7%). The prevalence ratio for students without eyeglasses was 0.29 (95% CI 0.25-0.33).

LVA prevalence ranged, according to reference area, from 1.8% in *Cajurú* to 32.4% in *Vila Sabiá*; the proportion of subjects with access to supplementary healthcare varied between 0.13 in *Lopes de Oliveira* and *Nova Esperança* and 0.49 in *Vila Santana*; and the prevalence of eyeglasses ranged from 1.3% in *Eden* to 9.8% in *Vila Santana*. No significant correlation was observed between LVA and access to SHC (r=-0.0476; p=0.8174), nor between LVA and use of eyeglasses (r=0.2097; p=0.3039). However, a significant correlation was observed between use of eyeglasses and access to SHC (r=0.6376; p=0.005) (Table 2).

Linear regression analysis between access to SHC (independent variable) and use of eyeglasses (dependent variable) results were: F=16.41, strongly significant (p=0.0007), intercept (a) =0.2760, and regression coefficient (b) =12.91 (Figure).

DISCUSSION

Situation in Sorocaba

The prevalence of low visual acuity among 1st and 4th grade students found in the present study was 13.1%. There are few studies in the literature including students from these two grades only, which limits the validity of comparisons. Moreover, many studies

have different methodologies. Most studies use the visual acuity test only as a preliminary exam for the selection of subjects for more detailed examination. Still, we have managed to compare our data to those of other somewhat similar studies. The prevalence of LVA among studies similar to ours varied from 7.6 to 29%.[1,7]

A comparison of the LVA prevalence found in Sorocaba and those from the aforementioned studies places Sorocaba in an intermediate position. This does not mean that Sorocaba students have good visual health, for the 13.1% prevalence found is potentially reducible. Despite being less than half the value of the highest prevalence found (29%),[7] the prevalence in Sorocaba is still almost twice the lowest value (7.6%).[1]

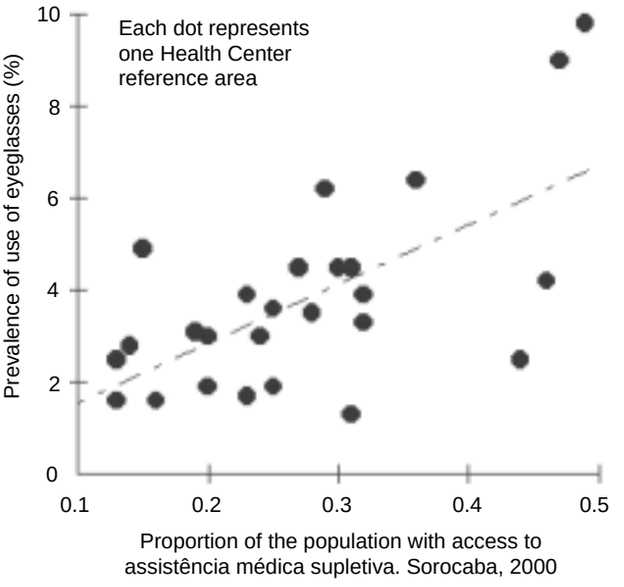

Figure – Regression analysis between access to supplementary healthcare and use of corrective lenses.

The number of students absent on the day of the test (11.9%) must be considered when discussing the prevalence of LVA found in the present study. Such a high rate of absenteeism will led to a underestimation of actual levels in case a larger proportion of LVA individuals is included among the absentees.

Two studies help us understand factors that may have led to the large number of absentees registered.[10,4] In a study carried out in the city of Osasco (southeastern Brazil), 2,238 of the 2,280 enrolled students were tested, a 1.84 absentee rate.[10] However, this evaluation included a prior effort directed towards increasing family awareness and pedagogically preparing the target population; teachers were instructed to develop means of raising the students' interest in the test through games and recreational activities. The *Oftalmologia Sanitária* project[4] found that a large

Table 2 – Proportion of the population with access to supplementary healthcare, prevalence of low visual acuity and prevalence of use of eyeglasses among the public network students analyzed, according to reference area. Sorocaba, 2000.

Reference area*	LVA (%)	Proportion with access to SHC	Prevalence of eyeglasses (%)
Aparecidinha	7.6	0.20	3.0
Brigadeiro Tobias	13.8	0.14	2.8
Cajuru	1.8	0.28	3.5
Cerrado	14.3	0.36	6.4
Centro de Saúde-Escola	19.2	0.47	9.0
Éden	3.8	0.23	1.7
Jardim Simus	12.2	0.32	3.9
Laranjeiras	21.8	0.20	1.9
Lopes de Oliveira	9.7	0.13	2.5
Marcia Mendes	17.9	0.31	4.5
Maria do Carmo	14.2	0.44	2.5
Maria Eugenia	9.4	0.31	1.3
Mineirão	8.8	0.24	3.0
Nova Esperança	7.9	0.13	1.6
Nova Sorocaba	13.6	0.23	3.9
São Bento	14.4	0.19	3.1
Sorocaba I	14.6	0.25	3.6
Vila Angélica	15.2	0.27	4.5
Vila Barão	8.7	0.25	1.9
Vila Barcelona	13.8	0.30	4.5
Vila Fiore	11.8	0.29	6.2
Vila Haro	12.6	0.46	4.2
Vila Hortência	17.1	0.32	3.3
Vila Sabiá	32.4	0.15	4.9
Vila Santana	7.9	0.49	9.8
Vitória Régia	14.2	0.16	1.6

*significant correlation (r=0.6376; p=0.0005) between use of eyeglasses and access to SHC; nonsignificant correlations between LVA and use of eyeglasses (r=0.2097; p=0.3039) and LVA and access to SHC (r=-0.0476; p=0.8174).
LVA = Low visual acuity
SHC = supplementary healthcare

number of children did not come to school on the day of the test. A large number absences was registered throughout the entire length of the project, and the authors suggest that, since the absent children belonged to low purchasing-power classes, socioeconomic factors might have contributed towards such high absenteeism. This could be explained by the lack of information and interest in matters related to education observed among poorer classes, which combine with the health-related problems characteristic of these populations, such as malnutrition and the consequent increase in disease incidence, to prevent school attendance.

On the other hand, the low specificity of this form of diagnosis may have contributed towards an overestimation of the prevalence in Sorocaba. In a 1989 study,[4] the number of false-positives reached 63.4% of students referred to more detailed examination after visual acuity screening. In this study, the high incidence of false-positive outcomes may be explained by a certain level of insecurity observed among volunteer screeners, who, in case of doubt, refer the student to ophthalmologic examination.

The use of a =0.8 visual acuity level as a referral criterion yields 17 false-positives for every 3 false-negatives. However, if a =0.7 visual acuity cutoff point is employed (as in the present study), this relationship shifts to 9 false-positives for every 6 false-negatives.[14] This corroborates the hypothesis that the prevalence of LVA found in the municipality of Sorocaba may be an overestimate, since, even though there is a certain level of compensation, false-positives still exceed false-negatives in 50%.

If the cutoff point were VA=0.8, the number of false-positives would be more than twice the number found when using the AV=0.7 threshold, generating a costly exaggeration in terms of public health planning. A VA=0.5 cutoff point would generate an almost threefold increase in the number of false-negatives (the main error to be avoided in this type of program). Thus, the VA=0.7 threshold seems to be the most adequate.[14]

An alternative for reducing the prevalence of LVA in Sorocaba would be the implementation of sanitary ophthalmology projects among non-school-age children (or preschool children) who seek medical care with pediatricians from the municipal healthcare network. Most forms of amblyopia do not respond to treatment after age 6-7 years, resulting in permanent visual deficiency. In addition, at age 7 years most children are already passed the age when best therapeutic results can be obtained for refraction problems associated with strabismus and amblyopia.[14]

However, such proposal may be hampered by pediatricians' lack of knowledge of ophthalmologic problems in children and newborn.[9] Furthermore, the number of pediatricians who do not perform ophthalmologic exams on their patients is also high. Only 20% of pediatricians perform routine evaluations in newborn babies, and 64% do not perform any routine examinations on infants. Thus, training these professionals is a necessary step, since survey results indicate that 25.4% of pediatricians consider it unnecessary to verify the vision of children below school age.[9]

Several specialists emphasize the importance of early detection of ocular problems in infants, preschool children, and first-grade children as one of the most effective measures for the prevention of visual deficiencies.[1,10,14]

Relationship between LVA and gender

The present study found a significant difference in the prevalence of low visual acuity between sexes; LVA prevalence was greater among girls (14.9%) than among boys (11.5%). This is probably due to the greater frequency suggested for ocular diseases among females. This hypothesis is corroborated by a study carried out in 1994, in which 217 children with visual deficiencies were found in a screening of 1,397 students aged 5-17 years. Of these 217 subjects selected for a more detailed examination, 149 (69%) were females, and 68 (31%), males. After ophthalmologic examination, of the 135 students with some sort of refraction problem, 94 (70%) were female and 41 (30%) were male.[13]

Data from a study conducted by the *Associação Brasileira de Deficientes Visuais* (Brazilian Visual Deficient Association) in 98 municipalities of Northeastern Brazil[15] also supports this hypothesis. This study found a predominance of females (62.6%) when compared to males (37.4%) among subjects with visual impairment.

Relation between LVA and grade

The present study found a greater prevalence of LVA among 1st grade students when compared to 4th graders. This difference maintained itself even when the comparison was restricted to the 19 areas with data registered for both grades (data not shown).

This may be a result of the low academic achievement of students with ophthalmologic impairment, who, unable to keep up with other students, would be transferred to special classes (the so-called 'acceleration classes'). When first-graders are evaluated, those

with ophthalmologic problems are included in the evaluation, since there has not been enough time for the teacher to identify these students' academic shortcomings. However, when evaluating the visual acuity of fourth-graders, students with poor academic standings were not evaluated, for the period between 1st and 4th grades gives teachers enough time to identify any academic achievement problems and thus to refer students to the 'acceleration classes'.

This hypothesis is supported by a including 270 low-achievement students, which concluded, by means of ophthalmologic exams, that only 50 (19.5%) satisfied all criteria for being considered as 'normal'.[6] According to the authors, this is equivalent to saying that 80.5% of subjects in this sample could have their academic shortcomings explained by low visual acuity or refraction problems. It should be emphasized that a large number of children labeled as incapable – many of which are referred to 'special classes' – may actually be suffering from refraction problems.[12]

Another hypothesis is that 4th graders are at a higher level of psychomotor development, and thus are capable of better understanding the explanations preceding the test, and hence achieving better test results.

Furthermore, since 4th graders are obviously older – around age 10 years –, it is expected that they have already been submitted to the Snellen test in other occasions, and perform better due to their familiarity with the table.

The hypothesis that prevalence is lower among fourth-graders because of adequate care and correction of visual acuity by the use of corrective lenses can be discarded, since, as we pointed out in the results section, and will further discuss in the section below, the prevalence of LVA is greater among eyeglass wearers.

Relation between LVA and use/nonuse of eyeglasses

The prevalence of low visual acuity was higher among eyeglass wearers (42.0%) when compared to non-wearers (12.1%). This may be related to a lack of follow-up and updating of the prescription lenses worn by children. The unfavorable economic scenario and the lack of complaints from the child or of observation by parents and teachers may account for the insufficient correction provided by lenses worn by children.

In a study carried out in 1979, of the 564 schoolchildren evaluated, 52 wore optical correction. After ophthalmologic evaluation, 12 eyeglasses (23.8%) were maintained, 18 (34.6%) were updated, and 22 (42.8%) were removed. Furthermore, of the remaining students, 55 required optical correction.[8] In a study carried out with pre-school children,[5] of the five eyeglass wearers selected for further examination, 3 (60%) had their prescriptions updated. These data support the results found in the present study, since the majority of eyeglass wearers required prescription updating, or even removal.

It would be appropriate that all children, when they are enrolling in 1st grade, undergo ophthalmologic examinations, or, at least, have their visual acuity measured.[14] But this is not enough. It seems to us inadequate to promote a visual health program for children one year – 1st grade – and not to provide follow-up in subsequent years, since the optical correction provided may cease to fulfill the child's needs, or even, in certain cases, become hazardous to the child's health. A minimal goal for visual health programs should be to perform visual evaluations at ages 4, 7 and 13 years.[14]

Access to supplementary healthcare and use of corrective lenses

The analysis of LVA prevalence according to reference area was not related to access to supplementary healthcare. As an initial hypothesis, this may be related to shortcomings in this sector in terms of diagnosis and treatment. The hypothesis of treatment failure is supported by the absence of a correlation between LVA and use of eyeglasses, a result consistent with that of the association analysis between use of eyeglasses and LVA, which indicated a greater risk of LVA among wearers, already discussed above. However, we wish to emphasize that the data indicate that treatment failure does not occur only among students who depend on the public network, but also among those with access to supplementary healthcare.

On the other hand, the significant positive correlation between access to supplementary healthcare and use of eyeglasses indicates that early diagnosis is lacking especially for the share of the population that depends on the public network, which demonstrates yet another facet of the inequities in Brazilian healthcare. Even assuming a likely classification bias in the "access to supplementary healthcare" variable, given that this information was determined based on an indirect indicator, its most probable effect would be the weakening of the correlation. Furthermore, if we assume that LVA cases are more prevalent and severer among social groups with worse socioeconomic conditions, we could argue that the actual correlation should be stronger than that registered.

The present study indicates the existence of shortcomings in the early diagnosis of low visual acuity, as evidenced by the high prevalence registered among students without eyeglasses. It also suggests that such shortcomings are especially prejudicial to those without access to supplementary healthcare, and points towards a poor continuity of ophthalmologic care, as evidenced by the high prevalence of LVA among eyeglass wearers due to the inadequacy of their corrective lenses. Therefore, the implementation of a public visual health program is urgent, necessary, and imperative if a reduction of the negative consequences of LVA prevalence is to be achieved.

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