Original Article

EARLY DETECTION OF VISUAL IMPAIRMENT AND ITS RELATION TO ACADEMIC PERFORMANCE

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ABSTRACT

Objective. To perform early detection of visual impairment in schoolchildren and to investigate its association with academic performance.

Methods. Cross-sectional study using a sample of third-grade students from public elementary schools of the municipality of Juiz de Fora, state of Minas Gerais, Brazil. Students performed the visual acuity (VA) test using the Snellen chart. We also analyzed school records and administered a previously validated self-administered questionnaire. We considered that there was low VA when the VA value achieved using the chart was lower than or equal to 0.7, while poor academic performance was identified when the average grades of the last school year did not reach 60 points.

Results. We analyzed 222 students from five public schools. In terms of visual acuity, 31% of the students had impaired VA in the right eye and 29.8% of the students had impaired VA in the left eye. Our sample had 15.5% of students with fair or poor academic performance. Among the students with normal VA, 89.5% had satisfactory academic performance, while among those with impaired VA, only 75% achieved satisfactory performance ($p = 0.015$).

Conclusion. The present study suggests that there is an association between low VA and poor academic performance in the sample assessed.

Key words: Visual acuity. Ophthalmology. Poor academic performance. Eye health. Visual perception.

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Introduction

Early detection of vision problems is an important primary care measure because around 85% of our relationship with the outside world is accomplished primarily through vision; therefore, eye problems may impair children's learning and socialization[1].

According to the most recent census carried out by the Brazilian Institute of Geography and Statistics (IBGE) in 2000, approximately 16.5 million people had visual disability in Brazil (almost 10% of the population). Of these people, 20 to 30% were children with visual acuity (VA) problems[2].

A research conducted by the Brazilian Council of Ophthalmology (CBO) showed that there were between 1 and 1.2 million blind people and 4 million people with severe visual disability in Brazil in 2004, and 5% of the children had at least one blind eye and 60% of blindness cases could be prevented with early treatment. Also, according to the World Health Organization (WHO), about 500,000 children become blind in the world every year[3].

Visual disability at an early age impairs the development of motor skills, cognition, and language during significant periods of child development. Low VA may affect several areas of child development related to skills mediated by vision[4].

Thus, Temporini (2007) states that schools are institutions where a large number of children get together and the performance of VA tests at this stage of life enables a partial bridging of the gap between birth and school entry[5].

Ophthalmologic disorders are a major cause of limitations at school age with regard to the teaching-learning process. The most common causes of reduced VA in students are refractive errors (hyperopia, astigmatism, and myopia), strabismus, and amblyopia, while uncorrected refractive errors are a major cause of visual disability in Brazilian

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children. Early detection of refractive errors allows for their correction or minimization with the purpose of promoting better overall performance of school-age children[6].

It has also been demonstrated that the implementation of programs for the detection of low VA and prevention of ophthalmic problems in developed countries have significantly lower costs than the costs of the treatment of patients with eye disorders[7].

EHowever, in developing countries, socioeconomic and cultural factors prevent or hinder children from having access to ophthalmologic examination before school entry. Unfortunately, the public health system in these countries does not provide children with easy access to such examination. Thus, the implementation of screening programs of VA in students is a great opportunity to evaluate their eye health and, sometimes, it is the first and rare chance of vision assessment for most students[8].

Hence, children's eye health should always be assessed regardless of age group and presence of symptoms. Therefore, early detection of visual disabilities and treatment, thus avoiding learning disorders, are strategies able to decrease the rates of grade retention and, as a consequence, the dropout rates, since low VA has a major influence on school dropout[8,9].

The objective of the present study was to achieve early detection of impaired VA in students and to identify its association with their academic performance, enabling actions that prevent and treat ophthalmologic disorders and promote eye health in schools.

Methods

Cross-sectional study aimed at detecting visual disabilities in children of both sexes enrolled in the third grade of elementary school of public state and city schools located in Juiz de Fora, state of Minas Gerais (MG), Brazil. Schools were randomly selected. The sample size was set based on the formula used in study cited by James et al. (2005), which considered that 20% of the children aged between eight and ten years had low VA, with a suspected prevalence variability of 15% to 25%[10].

The third grade was selected because the study sample was restricted to children between eight and 10 years old. The choice of this age group was based on the fact that the optical system continues to develop after birth, reaching its maturity at around seven years of age. Therefore, vision, which results from a learning process, reaches its maximum potential at this age. Thus, we selected the age at which children already achieved full visual maturity, allowing for early diagnosis of low VA (VA lower than or equal to 0.7)[11]. Moreover, it is expected that during third grade students have already mastered reading, which makes it easier to perform the examination using the Snellen chart.

Snellen's test provides an initial diagnosis of the students' eye health status. Its administration is recommended as a prerequisite for referral to an ophthalmologic examination, as an ophthalmologist is responsible for establishing the final diagnosis of the case and the proper treatment[12]. Researchers were guided using an informative script about how to carry out the examination. They were also trained by an expert in the field and examined a pilot sample.

The children received a previously validated questionnaire to be answered by their parents, that is, the questionnaire was based on the study by Granzotto (2003) and was administered to a pilot sample[7]. Among other data, this questionnaire included the results of the students' VA tests, personal data, academic performance, and the children's perceptions of their own vision. Next, VA was measured using the Snellen chart.

As for the guidance offered to the children, the researchers provided the students with information about the test in the classroom. In addition, lectures on the importance of early diagnosis of visual disorders were held for students, parents or guardians, and teachers.

Those students who did not attend school on the days scheduled for examination, as well as those who did not provide the questionnaire with parental permission and the informed consent form, were excluded from the study. We also excluded the students wearing corrective lenses or glasses, with total visual disability (blind) and those who did not belong to the predetermined age group (between eight and 10 years old).

Data regarding VA were collected at the schools, in rooms adequately prepared for this activity. In order to analyze these results, we considered that normal VA was higher than 0.7 (according to the Snellen chart), while the values of VA impairment were equal to or lower than 0.7, according to the criteria proposed by the WHO. Students with VA equal to or lower than 0.7 in at least one eye, with or without signs and symptoms, were considered to have low VA[13].

The outcome variable was the researchers' evaluation of the student's performance considering the average grades of the last school year included in their school records[14]. According to the criterion suggested by Hanff[15], an annual attendance rate of at least 75% and a general average grade of 60 points or higher are required for approval in the numerical quantitative system. In the present study, academic performance was considered as follows: satisfactory - overall average grade higher than or equal to 70 points; fair - overall average grade lower than 70 points up to 60 points; and poor - overall average grade lower than 60 points.

It is important to emphasize that we did not measured the variables that could also be related to the outcome, such as cognitive deficits, severe emotional disorders, family background, influence of school environment, and educational discontinuities caused by changes of schools. Depending on each context, such factors can be decisive for the occurrence or maintenance of learning problems[14].

The present study was approved by the Research Ethics Committee of Universidade Federal de Juiz de Fora (UFJF), report no. 089/2008, with prior authorization provided by the educational institutions and the children's parents or guardians, seeking cooperation and authorization to complete this work.

The participants who had low visual acuity in at least one eye, regardless of symptoms and academic performance,

Questionnaire

Part I - Interview with the child's guardian

1- School name: _____

2- Child's name: _____

3- Child's age: ____years.

4- Child's sex:

( ) Male

( ) Female

5- Name of the child's guardian: _____

6- How old was your child when he/she entered 1st grade of elementary school?

____years.

7- Has your child ever failed in school because of a low overall average grade?

( ) YES

( ) NO

8- If the previous answer was YES, how many times has he/she failed?

( ) ONCE

( ) TWICE

( ) MORE THAN TWO times.

9- Has your child ever undergone an ophthalmologic examination?

( ) YES

( ) NO

9.1- If the previous answer was yes, answer the following questions:

How many?_____

How old was he/she?_____

The last examination was performed _____(days, months, or years) ago.

9.2- Were glasses (or contact lenses) recommended to your child?

( ) Does not know

( ) Yes, my child wears glasses today.

( ) Yes, my child wore glasses, but they are not necessary anymore.

( ) Yes, but I did not get the glasses for my child because I could not afford them or I don't believe they are necessary.

( ) Yes, but my child doesn't wear his/her glasses as often as recommended.

( ) No.

10- What is your child's perception of his/her own vision?

( ) Reports GOOD vision.

( ) Reports BLURRED vision.

( ) Reports DOUBLE vision.

( ) Reports NEARSIGHTEDNESS.

( ) Reports FARSIGHTEDNESS.

( ) Does not know.

( ) Other

Thank you for the answering this questionnaire

_____

Signature of the child's guardian Date: __/__/__

Part II - Results of the Visual Acuity (VA) Measurement - Snellen's Test

VA in the right eye without glasses or contact lenses: _____

VA in the left eye without glasses or contact lenses: _____

Examiner's name: _____ Date: __/__/__

were referred to the Outpatient Clinic of Ophthalmology, University Hospital, Health Care Center, Universidade Federal de Juiz de Fora (HU/CAS-UFJF). Priority appointments were scheduled in the Primary Health Care Unit of the district where the student lived upon presentation of a medical authorization document signed by the service physicians. When this was the case, the students' parents or guardians received the result of the test and were informed about the need of seeing a specialist.

RESULTS

We assessed students from five public schools, two state and three city schools, randomly selected considering the proportionality of the public schools in the municipality.

All third-grade students of elementary school from the schools selected were invited to participate in our study. First, we identified 104 students from state schools and 118 from city schools. Of this total, 42 wore glasses and 19 did not return the informed consent form properly filled out, being excluded from the study. Thus, we assessed 161 students.

With regard to sex, 50.9% of the sample was female. In relation to any previous ophthalmologic examinations, 67.7% reported that they had never undergone such a test. Of the participants, 38.5% reported blindness or visual disability in 1st degree relatives and 20.5% could not provide such information. Regarding the presence of glaucoma or treatment for this disease in 1st degree relatives, 46.6% of the students reported that there were no cases of glaucoma in their families, 23.6% said that there were cases of glaucoma, and 29.8% did not know. Table 1 shows the main characteristics of the study population.

In relation to the children's perception of their own vision, 48.40% reported they could see well and the others reported some perceived abnormality (1.30% had double vision; 14.60% had blurred vision, 7% had nearsightedness; 1.90% had farsightedness). In terms of visual acuity, 50 students had impaired VA in the right eye and 48 students had impaired VA in the left eye. The frequency of grade retention was 16.1%.

The analysis of the distribution of visual acuity in students according to their visual self-perception showed the report of abnormal/impaired vision in 37.5% of students with low visual acuity (vs. 23.8% of the students with normal VA) and, among those with normal visual acuity, 55.4% of students reported no vision impairment (vs. 35.7% of the students with impaired VA) ($p = 0.05$) (Table 2). We found that among students with normal VA, 89.5% showed satisfactory academic performance, while among those with impaired VA, only 75% achieved satisfactory academic performance, that is, 25% had fair or poor academic performance ($p = 0.015$) (Table 3).

The selection of the study population was based on random sampling, and after all exclusions related to the predefined criteria, only 8.6% of the cases previously identified (n = 19) did not provide the authorization for assessment, suggesting little influence of the healthy patient bias in the present study.

Table 1 - Distribution of the study population according to sex and previous ophthalmologic examination

Variáveis	*N#*	%
Sex		
Male	79	49.1%
Female	82	50.9%
Previous ophthalmologic examination		
Yes	52	32.3%
No	109	67.7%

#The total (n) of each variable is different because of some missing data (unanswered questions)

Table 2 - Distribution of students' visual acuity (VA) according to visual self-perception

Variables	Normal VA N (%)	Impaired VA N (%)	p-value
Visual self-perception#			0,05
Impaired	24 (23.8)	21 (37.5)	
Normal	56 (55.4)	20 (35.7)	
Did not know	21 (20.8)	15 (26.8)	

#The total (n) of each variable is different because of some missing data (unanswered questions)

Table 3 - Distribution of students' visual acuity (VA) according to academic performance

Variables	Normal VA N (%)	Impaired VA N (%)	p-value
Academic performance#			0.015
Fair or poor	11 (10.5)	14 (25)	
Satisfactory	94 (89.5)	42 (75)	

O total (n) de cada variável difere devido à ocorrência de dados ignorados (questões não respondidas)

Discussion

Assessment and detection of potential eye problems should occur as early as possible because the longer the delay in identifying visual problems, the smaller the chances of recovery and correction of the problem, in addition to the fact that eye problems promote deficit of academic performance and socialization and are related to child emotional and psychological disorders[13,16] .

In the present study, we found low visual acuity in 34.8% of the students. Such finding is in disagreement with the results of studies using similar methodology but performed in public schools that had programs of ophthalmologic examination and campaigns for early detection of visual disorders. In the study conducted by Granzoto et al., 15.1% of the students had low visual acuity[7], and, in studies conducted by Ventura et al. and Figueiredo et al., these percentages were 17.3% and 11, 9%, respectively[5,17].

Approximately two thirds of our sample neither had seen an ophthalmologist nor had undergone visual acuity screening, either at school or at their pediatrician's office. Such finding was also found in the study conducted by Soldera, which assessed students from Rio Grande do Sul between four and 15 years old using the Snellen chart[18]. This finding suggests a reason for concern: children are not being adequately assessed in terms of visual acuity in Brazil.

Regarding visual self-perception, the highest percentage of abnormal/impaired vision reports was found among those students with low visual acuity (37.5%) and the highest percentage of normal vision reports was observed among those with normal visual acuity (55.4%) ($p = 0.05$). However, we found a high frequency of students who did not report abnormalities in their visual perception among those who had low visual acuity and high frequency of students with impaired visual perception among those who had normal visual acuity (35.7% and 23.8%, respectively). These findings may reveal students' difficulty to express their visual perception, depending on their age and they may also be influenced by the high percentage of students who were unable to provide such information (36 students - 22.9%).

The Snellen chart was used mainly because of its easy administration. According to Temporini (1993) "in a WHO report, visual acuity is considered the best indicator of visual functioning, and the administration of this test does not require extensive training for examiners or use of sophisticated equipment"[5].

The definition of academic performance was based on the technically recognized literature[15]. However, it is important to consider the progressive inclusion of new assessment methods in the Brazilian educational system in recent decades, such as automatic approval[19], which may have hampered the characterization of poor academic performance, with a probable stronger influence on public schools.

Among students with low visual acuity, 25% of them had fair or poor academic performance, which was a significant percentage when compared with students with fair or poor academic performance but normal visual acuity (10.5%) ($p = 0.015$). Therefore, it is important to provide professionals with qualified training in the detection of visual deficits in public schools because very little has been done to identify and treat the causes of low visual acuity in children, a health problem related to the educational status in Brazil[20]. It is important to emphasize the need for campaigns of visual acuity assessment during the first school year with the purpose of detecting possible eye problems, so that they can be corrected, and preventing their worsening, since socioeconomic and cultural conditions make it difficult for children to have access to an ophthalmologic examination[21]. It is worth highlighting that the need for such actions was reinforced by a study conducted in Brazil about the major causes of blindness and low vision, which showed that 59% of eye diseases are preventable or treatable[22].

Conclusion

The present study showed that 34.8% of the students assessed had impaired visual acuity and, among these, only 75% had satisfactory academic performance compared with the percentage of satisfactory academic performance found for students with normal VA (89.5%).

There is a huge difficulty of access to preventive measures aimed at eye health partly because of insufficient coverage of the health system in Brazil and the lack of public awareness about the importance of prevention by means of early ophthalmologic evaluation. As vision problems may affect children's learning process and socialization, this screening and subsequent referral of students with impaired VA contributed to better individual academic performance and, as a consequence, better performance of the whole class, in addition to enabling the improvement of the students' quality of life.

Thus, the present study highlights the need for preventive measures aimed at eye health in the early stages of life, encouraging campaigns for the detection and prevention of vision problems and thus allowing a better investigation of visual impairment in public schools.

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References

1. Lopes CLR, Barbosa MA, Marques ES, Lino AIA, Morais NHF. O trabalho da enfermagem na detecção de problemas visuais em crianças/adolescentes. Rev Eletrônica Enferm. 2003;5:45-9.
2. Vieira SR. À primeira vista. Universo Visual 2003. [citado 14 dez 2007]. Disponível em: http://www.universovisual.com.br/publisher/preview.php?edicao=1203&id_mat=293.
3. Campinas tem projeto contra cegueira infantil. Muito mais informação da região metropolitana de Campinas 2004. [citado 22 nov 2007]. Disponível em: http://www.mmais.com.br/pff.cfm/idedicao/2/tb/ultimas/id/189.
4. RemígioMC, Leal D, Barros E, Travassos S, Ventura LO. Achados oftalmológicos em pacientes com múltiplas deficiências. Arq Bras Oftalmol. 2006; 69:929-32.
5. Figueiredo RM, Santos EC, Jesus IAA, Castilho RM, Santos EV. Proposição de procedimento de detecção sistemática de perturbações oftalmológicas em escolares. Rev Saúde Publica. 1993;27:204-9.
6. Lopes GJA, Casella AMB, Chui CA. Prevalência de acuidade visual reduzida nos alunos da primeira série do ensino fundamental das redes pública estadual e privada de Londrina-PR, no ano de 2000. Arq Bras Oftalmol. 2002; 65:659-64.
7. Granzoto JA, Ostermann CSPE, Brum LF, Pereira PG, Granzoto T. Avaliação da acuidade visual em escolares da 1ª série do ensino fundamental. Arq Bras Oftalmol. 2003;66:167-71.
8. Abud AB, Ottaiano JAA. Aspectos socioeconômicos que influenciam no comparecimento ao exame oftalmológico de escolares com alterações visuais. Arq Bras Oftalmol. 2004;67:773-9.
9. Secretaria de Estado de Saúde do Distrito Federal. A qualidade de vida começa com uma boa visão das coisas. Programa de Saúde Boa Visão; 2006. [citado 5 dez 2007]. Disponível em: http://www.saude.df.gov.br/003/00301009.asp?ttCD_CHAVE=22554.
10. Jekel JF, Katz DL, Elmore JG. Epidemiologia, bioestatística e medicina preventiva. 2ª ed. São Paulo: Artmed; 2005. p. 207.
11. José NK. Campanha menina (e menino) dos olhos de Garulhos-Campanha de Prevenção e Reabilitação Visual Olho no Olho. Faculdade de Medicina da USP 2005/2006. [citado 8 nov 2007]. Disponível em: www.v2020la.org/pub/boletin_6/olho_no_olho.pdf.
12. Madeira LT. A importância da visão na aprendizagem. [citado 15 nov 2007]. Disponível em: http://www.levimadeira.com.br/livro/importancia.htm.
13. Alves MR, Kara JN. Campanha "Veja Bem Brasil". Manual de orientação. São Paulo: Conselho Brasileiro de Oftalmologia; 1998.
14. Fioravante C. Faça suas aulas serem bem vistas. Nova escola 1998. [citado 6 nov 2007]. Disponível em: http://novaescola.abril.uol.com.br/ed/111_abr98/html/saude.htm.
15. Hanff BBC. O impacto das mudanças nas políticas de avaliação do rendimento escolar no trabalho de professores e estudantes: um estudo em escolas públicas no ensino fundamental. 2008. [citado 2 jul 2009]. Disponível em: http://www.fae.ufmg.br/estrado/cdrom_seminario_2008/textos/trabajos.
16. Kassir M. An exhaustive study of the frequency of vision disorders in children 5-18 years of age at a Lebanese school. Sante. 1996;6:323-6.
17. Ventura LO, Gondim P, Celino ACB, Barros EA. Campanha olho no olho - veja bem Brasil/1999: Resultados e experiências no estado de Pernambuco. Arq Bras Oftalmol. 2000;63:4.
18. Soldera J. Estudo da acuidade visual em escolares em um projeto de atenção primária à saúde do nordeste do Rio Grande do Sul. Rev AMRIGS. 2007;51:185-9.
19. Frigotto G, Leher R. Aprovação automática: educação neoconservadora e negação do direito ao conhecimento. [citado 20 abr 2010]. Folha de São Paulo; 2007. Disponível em: http://www.adur-rj.org.br/5com/pop-up/aprovacao_automatica.htm. (2ª revisão)
20. Simionato EZR, Soldera J, Rizzon ES, Pires EM, Pires FR. Relação da baixa acuidade visual com reprovação escolar em crianças do nordeste do Rio Grande do Sul. Arq Catarinense Med. 2007;36:3-16.
21. Kara-José N, Alves MR. Problemas oculares mais freqüentes em escolares. São Paulo: Sarvier; 1994. p.195-203.
22. Brito PR, Veitzman S. Causas de cegueira e baixa visão em crianças. Arq Bras Oftalmol. 2000;63:49-52.

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