Prevalence of refractive errors in students in Northeastern Brazil

Prevalência dos erros refrativos em estudantes do Nordeste Brasileiro

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ABSTRACT

Purpose: To determine the prevalence of refractive errors in the public and private school system in the city of Natal, Northeastern Brazil. **Methods:** Refractometry was performed on both eyes of 1,024 randomly selected students, enrolled in the 2001 school year and the data were evaluated by the SPSS Data Editor 10.0. Ametropia was divided into: 1- from 0.1 to 0.99 diopter (D); 2- 1.0 to 2.99D; 3- 3.00 to 5.99D and 4- 6D or greater. Astigmatism was regrouped in: I- with-the-rule (axis from 0 to 30 and 150 to 180 degrees), II- against-the-rule (axis between 60 and 120 degrees) and III- oblique (axis between > 30 and < 60 and >120 and <150 degrees). The age groups were categorized as follows, in: 1- 5 to 10 years, 2- 11 to 15 years, 3- 16 to 20 years, 4- over 21 years. **Results:** Among refractive errors, hyperopia was the most common with 71%, followed by astigmatism (34%) and myopia (13.3%). Of the students with myopia and hyperopia, 48.5% and 34.1% had astigmatism, respectively. With respect to diopters, 58.1% of myopic students were in group 1, and 39% distributed between groups 2 and 3. Hyperopia were mostly found in group 1 (61.7%) as well as astigmatism (70.6%). The association of the astigmatism axes of both eyes showed 92.5% with axis with-the-rule in both eyes, while the percentage for those with axis against-the-rule was 82.1% and even lower for the oblique axis (50%). **Conclusion:** The results found differed from those of most international studies, mainly from the Orient, which pointed to myopia as the most common refractive error, and corroborates the national ones, with the majority being hyperopia.

Keywords: Refractive errors/epidemiology; Myopia/epidemiology; Astigmatism/epidemiology; Hyperopia/epidemiology; Students

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INTRODUCTION

Emmetropia is the absence of refractive error and ametropias are refractive defects in which refracted rays in the eye do not converge on the retina. These are classified as myopia, hyperopia and astigmatism. Hyperopia occurs when parallel light rays are brought to a focal point at a certain distance behind the retina, and is considered to be the most common refractive error and in fact constitutes one of the stages in normal development[1-2]. Myopia is a condition in which parallel light rays come to a focal point in front of the retina[1,2]. In astigmatism, the corneal surface is unevenly curved and light rays from different meridians cannot be focused on the same point on the retina[2].

The prevalence of ametropias in the literature is conflicting, mainly regarding myopia and hyperopia. According to Matsumura, myopia is the most common ocular disorder in Japan, affecting, at some ages, 65.6% of

individuals[3]. In Brazil, hyperopia is the most frequent refractive error in children, varying between 60 and 70%, demonstrated in studies at the Campo Grande University Hospital, between 1996 and 1998[4]. Some authors, in a sample of medical students in Singapore, discovered that 82% were myopic[5-6]. In Norway as well as in Greece, myopia has also been the most common refractive error[7-9].

The objective of this study was to study the prevalence of refractive errors (myopia, hyperopia and astigmatism), in the student population in Natal, a city located in Northeastern Brazil, taken from a randomly selected sample, and to relate the distribution of these errors to age.

METHODS

This is a cross-sectional study, in which the sample was randomly selected. It consisted of people between the ages of 5 and 46 years, enrolled in an elementary or secondary school, in the private or public system in the city of Natal, Northeastern Brazil, in 2001.

Four sample populations, which correspond to the four sanitation districts into wich the city of Natal is divided, were considered for purposes of the methodological model.

The population size was 196,116 pupils, distributed by district and type of institution. The methodological procedure for sample selection consisted of multiple stages: determining general sample size and random selection of the schools and pupils.

The sample size was determined from parameters obtained by the simple random sample method for proportion, with a 3% error, expected prevalence of 50% (as there is no *a priori* information in this regard, maximum variance was used), and confidence interval (CI) of 95%.

The calculated sample size was 1,100 pupils, distributed proportionally throughout the 341 schools in all four districts, in such a way as to establish the number of pupils that should be examined in each of the districts. Subsequently, the number of schools to be selected from each district was determined. Of 341 schools, 79 were chosen to make up the sample, according to the nature of the institution (public and private), its level (elementary and secondary), and study period (morning, afternoon and evening), by the proportional probability of size method (PPS), using a Delphi language software. Once the school was selected, and classes per study period randomly drawn, students were then drawn from the class attendance sheet, obeying the proportionality observed in the population, and sent to the Ophthalmology Department, Onofre Lopes University Hospital (HUOL), Federal University of Rio Grande do Norte (UFRN). The protocol of the study was submitted to and approved by the UFRN Ethics Commission, number 18/01. All pupils were examined after submission of a consent form signed by their parents or guardians.

2,048 eyes of 1,024 students were examined at HUOL-UFRN, by ophthalmologists, between March and June, 2001. Students under 35 years were submitted to cycloplegia and then refractometry, using skiascopy and subjective method, was performed after 40 minutes.

Studied refractive errors were myopia, hyperopia and astigmatism in each eye. The T-paired test was applied to verify whether there was association between the ametropias in both eyes. With the association confirmed, a new variable was determined so that only the ametropias would be considered, and not the ametropia from the right and left eye separately. Individuals who presented a great disproportion between right and left eyes, which compromised the general sample (3 hyperopic and 4 astigmatic students with a difference greater than 5 diopters (D) between the eyes) were excluded and classified as emmetropic, because it did not change the statistic results.

The average refractive errors: myopia, hyperopia and astigmatism, were grouped in the following manner: Group 1- from 0.1 to 0.99 D. Group 2- 1.0 to 2.99D. Group 3- 3.00 to 5.99D and Group 4- 6D or greater. Astigmatism was regrouped in I- with-the-rule (axis between 0 and 30 and 150 and 180 degrees), II- against-the-rule (axis between 60 and 120 degrees), and III- oblique (axis between >30 and <60 and >120 and <150 degrees). Age groups were categorized as: 1- 5 to 10 years, 2- 11 to 15 years, 3- 16 to 20 years, 4- 21 years or more. Variables were categorized and frequencies were analyzed by SPSS ("Statistical Package for Social Science" analized Inc. Chicago, Illinois, USA); Data Editor 10.0.

RESULTS

Of the ametropias, hyperopia, with 71% (727 students) was the most common, followed by myopia with 13.3% (136 students) (Figure 1). There were 127 emmetropic students, 12.4% of the sample. In relation to astigmatism, a frequency of 34% was observed, in which the degree of axis found can still be referred to. For the right eye (RE), 77.9% of astigmatic students with axis with-the-rule and 17.7% against-the-rule were

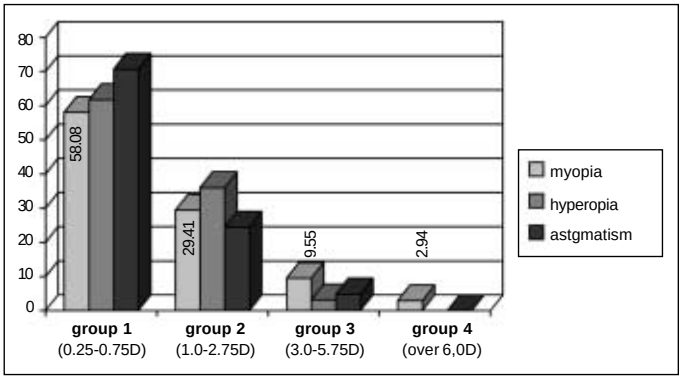

Figure 1 - Prevalence of refractive errors per diopter group, in students in Natal, Northeastern Brazil - 2001

observed; the minority, 5.0%, belonged to the oblique group. Frequencies in the left eye (LE) were similar: 77.5% with-the-rule, 18.6% against-the-rule and only 3.9% oblique (Table 2). Astigmatism appeared in 34.1% (248) of hyperopic and in 48.5% (66) of myopic students. Astigmatism, without another ametropia, occurred in only 3,3% of the all students (Table 3).

By studying each ametropia of the already defined four groupings, it was observed that group I led with 58.0% (79) of myopic students, 38.9% (53) distributed between groups 2 and 3 and the smallest proportion, severe myopia (group 4) was presented by 2.9% (4). Of the hyperopic students, 61.7% were from group I, 36.0% from group II and only 3.2% (16) from group III; no student had hyperopia above 6D. The highest incidence of astigmatism was in group 1, 70.6% (Figure 1).

Of the children in the 5 to 10 year age group (211) 9% were myopic and 79.15% hyperopic. In the 11 to 15 year age group (459), 13.29% were myopic and 69.93% hyperopic (Table 1).

When relating refractive error with age, the majority of myopic students (79.4% - 108) were between 11 and 20 years of age. This is similar to hyperopia with 72.4% in the same age group. With astigmatism, there were 77.8% between 11 and 20 years of age (Figure 2).

A final association between the astigmatism axes of the two eyes was observed, in which 95.2% of the students who presented astigmatic axis with-the-rule (group 1) in one eye also had it in the other eye. In group 2, there was an association of 82.1% between the eyes and, for oblique axis (group 3), and, only 50% of the students remained in the same group for both eyes (Table 2).

DISCUSSION

The prevalence of ametropias of 71% for hyperopia, 13.3% for myopia and 34% for astigmatism corroborates the national literature, but disagrees with international publications, mainly from the Orient, where myopia is always considered to be the most common refractive error in students[3,5-8,10-16]. Some studies cite severe myopia with a prevalence of 24 to 41%, disagreeing with this study, in which it is approximately 2%[5].

Hyperopia appears with a higher frequency among the young, however, the proportion in this study is greater than those in other publications[5-8,10-11,17].

A prevalence of astigmatism of 34% was encountered, principally in group 1, in which the error is considered small (<1D). Few data concerning astigmatism axis were found, as well as in respect to association between both axes. A majority comment on the type of astigmatism (whether myopic, hyperopic or mixed)[4,11-12,17]. What can be observed is that the great majority (77.5%) is in the group in with-the-rule, corroborating

Table 1. Correlation between age group and ametropias, in students in Natal, Northeastern Brazil - 2001

Age group	Myopia n / (%)	Hyperopia n / (%)	Astigmatism* n / (%)	Emmetropia n / (%)	Total n
5-10 years	19 / 9.00	167 / 79.15	6 / 2.84	19 / 9.00	211
11-15 years	61 / 13.29	321 / 69.93	14 / 3.05	63 / 13.73	459
16-20 years	47 / 15.46	206 / 67.76	12 / 3.95	39 / 12.83	304
21 years >	9 / 18.00	33 / 66.00	2 / 4.00	6 / 12.00	50
Total	136	727	34	127	1024

*Only those with cylindrical diopters were considered

Table 2. Prevalence of right and left axis of astigmatism, in students in Natal, Northeastern Brazil - 2001

Classification of left eye axis	Frequency	Classification of right eye axis: With-the-rule	Against-the-rule	Oblique	Total
With-the-rule*	Absolute (%)	177 **(95.2)**	6 (3.2)	3 (1.6)	186 (100.0)
Against-the-rule**	Absolute (%)	5 (12.8)	32 **(82.1)**	2 (5.1)	39 (100.0)
Oblique***	Absolute (%)	4 (33.3)	2 (16.7)	6 **(50.0)**	12 (100.0)

*With-the-rule: 0º - 30º and 150º - 180º; **Against-the-rule: 60º - 120º; ***Oblique: 30º - 60º and 120º - 150º

Table 3. Prevalence of myopia, astigmatism, hyperopia and emmetropia, in students in Natal, Northeastern Brazil - 2001

	Myopia	Hyperopia	Astigmatism	Emmetropia	Total
Myopia	70 (51.4%)		66 (48.5%)		136 (13.3%)
Hyperopia		479 (65.8%)	248 (34.1%)		727 (71.0%)
Astigmatism	66 (48.5%)	248 (34.1%)	34 (3.3%)		34 (3.3%)
Emmetropia				127 (12.4%)	127 (12.4%)
Total	136 (13.3%)	727 (71.0%)	34 (3.3%)	127 (12.4%)	1024 (100%)

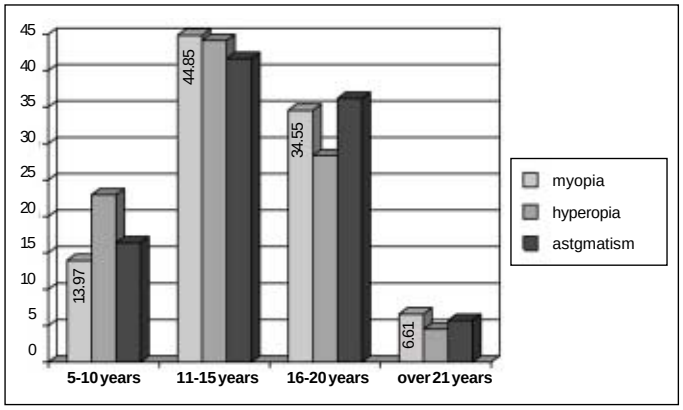

Figure 2 - Prevalence of refractive errors by age group, in students in Natal, Northeastern Brazil - 2001

results by Alves[2,18]. Variable frequency of astigmatism is encountered in the literature, possibly due to the manner of classification, on average 40%[11-12]. In this sample, it was possible to evaluate the concordance of the axes of the eyes and to conclude that the student who presented astigmatism with axis in with-the-rule in one eye, 95.2%, also presented it in the other. Against-the-rule, this value falls to 82.1% and if oblique only, 50% is maintained in both eyes.

It cannot be concluded that there was a decrease of hyperopia and increase of myopia with age, as stated by some authors, since the encountered data are not statistically significant[4,13]. It can only be said that both types were found in students up to 20 years. Lin et al. encountered an incidence of 84% of myopia in students from 16 to 18 years and pointed to a gradual increase in myopia with age: 7 years - 20%; 12 years - 61% and 15 years-81%[13].

CONCLUSION

A larger sample with a greater age range and a continuation in refractometry advances over the next few years are necessary to conclude any correlation between refractive error and age, and to be better able to draw a profile of ametropias in a given population.

RESUMO

Objetivo: Determinar a prevalência das ametropias em estudantes das redes pública e privada de Natal-RN. **Métodos:** Foi realizada refratometria de 2.048 olhos de estudantes matriculados no ano letivo de 2001 e os dados avaliados com planilha do SPSS Data Editor 11. As ametropias foram divididas em: 1- de 0,1 até 0,99D (dioptria); 2- 1,0 até 2,99D; 3- 3,00 até 5,99D e 4- 6D ou maior. O astigmatismo foi reagrupado em I- a favor da regra (eixo entre 0 a 30 e 150 a 180 graus), II- contra a regra (eixo entre 60 e 120 graus) e III- oblíquo (eixo entre >30 e <60 e >120 e <150 graus). A faixa etária foi categorizada em 1- 5 a 10 anos, 2- 11 a 15 anos, 3- 16 a 20 anos, 4- 21anos ou mais. **Resultados:** Dos erros refrativos, a hipermetropia foi o mais comum com 71%, em seguida astigmatismo, 34% e miopia, 13,3%. 48,5% dos míopes e 34,1% dos hipermétropes tinham astigmatismo. De acordo com as dioptrias, 58,1% dos míopes estão no grupo 1, 39% distribuídos entre os grupos 2 e 3. Os hipermétropes enquadram-se em sua maioria no grupo 1 (61,7%) e o astigmatismo no mesmo grupo com 70,6%. A associação dos eixos do astigmatismo dos dois olhos mostrou 95,2% com eixo a favor da regra nos dois olhos, diminuindo a porcentagem para os do eixo contra a regra (82,1%) e menor ainda para os do eixo oblíquo, apenas 50%. **Conclusão**: Os resultados encontrados mostraram discordância com a maioria dos trabalhos internacionais, principalmente os orientais, que apontam a miopia como o erro refrativo mais comum e corrobora os nacionais, com a grande parte sendo hipermétropes.

Descritores: Erros de refração/epidemiologia; Miopia/epidemiologia; Astigmatismo/epidemiologia; Hiperopia/epidemiologia; Estudantes

REFERENCES

1. Duke-Elder S. Erros de refração. In: Duke-Elder S. Refração prática. 10ed. Rio de Janeiro: Rio Méd; 1997. p.57-77.
2. Alves AA. Emetropias e ametropias. In: Alves AA. Refração. 3ed. Rio de Janeiro: Cultura Médica; 1999. p.79-86.
3. Matsumura H, Hirai, H. Prevalence of myopia and refractive changes in students from 3 to 7 years of age. Surv Ophthalmol. 1999;44(Supp 1):S109-15.
4. Barros EV, Dias VG. Incidência das ametropias no Hospital Universitário em Campo Grande (MS) entre 1996 e 1998. Arq Bras Oftalmol. 2000;63(3):203-8.
5. Chow YC, Dhillon B, Chew PTK, Chew SJ. Refractive erros in Singapore medical students. Singapore Med J. 1990;31(5):472-3.
6. Zhan MZ, Saw SM, Hong RZ, Fu ZF, Yang H, Shui YB, et al. Refractive errors in Singapore and Xiamen, China - a comparative study in school children aged 6 to 7 years. Optom Vis Sci. 2000;77(6):302-8.
7. Kinge B, Mildelfart A, Jacobsen G. Refractive errors among young adults and university students in Norway. Acta Ophtalmol Scand. 1998;76(6):692-5.
8. Kinge B, Mildelfart A. Refractive errors among engineering students in Norway. Ophthalmic Epidemiol. 1994;1(1):5-13.
9. Mavracanas TA, Mandalos A, Peios D, Golias V, Megalou K, Gregoriadou A, et al. Prevalence of myopia in a sample of Greek students. Acta Ophtalmol Scand. 2000;78(6):656-9.
10. Lewallen S, Lowdon R, Courtright P, Mehl GL. A population-based survey of the prevalence of refractive error in Malawi. Ophthalmic Epidemiol. 1995;2(3): 145-9.
11. Kaimbo Wa, Kaimbo D, Missotten L. [Ocular refraction in Zaire]. Bull Soc Belge Ophtalmol. 1996;261:101-5. Francese.
12. Mandalos AT, Peios DK, Mavracanas A, Golias VA, Megalou KG, Delidou KA, Gregoriadou AC, Katsougiannopoulos BC. Prevalence of astigmatism among students in northern Greece. Eur J Ophthalmol. 2002;12(1):1-4.
13. Lin LL, Shih YF, Hsiao CK, Chen CJ, Lee LA, Hung PT. Epidemiologic study of the prevalence and severity of myopia among school children in Taiwan in 2000. J Formos Med Assoc. 2001;100(10):684-91.
14. Johnson GJ, Green JS, Paterson GD, Perkins ES. Survey of ophthalmic conditions in a Labrador community: II Ocular disease. Can J Ophthalmol. 1984; 19(5):224-33.
15. Sales SG, Pessoa SAR, Carvalho RF, Trigueiro AS, Bueno LG. Afecções oculares encontradas em pacientes da periferia de Jaboatão dos Guararapes (PE) [resumo]. Arq Bras Oftalmol. 1998;61:434.
16. Cavalcanti SJL, Lopes Race, Carvalho RF. Anomalias refrativas em população escolar [resumo]. Arq Bras Oftalmol. 1996;59:352.

17. Kara-José N, Holzchuh N, Temporini ER. Vícios de refração em escolares da cidade de São Paulo, Brasil. Bol Oficina Sanit Panam. 1984;96(4):326-33.
18. Vaughan DG, Asbury T, Riordan-Eva P. Oftalmologia geral.In: Riordan-Eva P. Óptica e refração. 4ed. São Paulo. Atheneu; 1998. p.375-80.
19. Auzemery A, Andriamanamihaja R, Boisier P. [A survey of the prevalence and causes of the eye disorders in primary school children in Antanarivo]. Santé. 1995;5(6):163-4. French.
20. Kwitko S, Kwitko I. Casuística de erros de refração no Hospital das Clínicas de Porto Alegre. Rev AMRIGS. 1984;28(4);318-24.
21. Loman J, Quinn GE, Kamoun L, Ying GS, Maguire MG, Hudesman D, et al. Darkness and near work: myopia and its progression in third-year law students. Ophthalmology. 2002;109(5):1032-8. Comment in: Ophthalmology. 2003;110(6):1069-70; author reply 1071-2.