Prevalence of refractive errors in students in Northeastern Brazil

Prevalência dos erros refrativos em estudantes do Nordeste Brasileiro

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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.

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\(^{(3,4)}\). In Norway as well as in Greece, myopia has also been the most common refractive error\(^{(3,9)}\).

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 which 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 dioptries (D) between the eyes) were excluded and classified as emmetropic, because it did not change the statistical 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- against-the-rule (axis between 0 and 30 and 150 and 180 degrees), II- along-the-rule (axis between 30 and 60 and 120 and 150 degrees), and III- oblique (axis between >30 and <60 or 120 and <150 degrees). Age groups was 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

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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 groupI, 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 I, 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

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

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

*Only those with cylindrical diopters were considered

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

<table>
<thead>
<tr>
<th>Classification of left eye axis</th>
<th>Frequency</th>
<th>Classification of right eye axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>With-the-rule*</td>
<td>Absolute (%)</td>
<td>177 (95.2)</td>
</tr>
<tr>
<td>Against-the-rule**</td>
<td>Absolute (%)</td>
<td>5 (12.8)</td>
</tr>
<tr>
<td>Oblique***</td>
<td>Absolute (%)</td>
<td>4 (33.3)</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th></th>
<th>Myopia</th>
<th>Hyperopia</th>
<th>Astigmatism</th>
<th>Emmetropia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myopia</td>
<td>70 (51.4%)</td>
<td>479 (65.8%)</td>
<td>248 (34.1%)</td>
<td>127 (12.4%)</td>
<td>136 (13.3%)</td>
</tr>
<tr>
<td>Hyperopia</td>
<td>479 (65.8%)</td>
<td>66 (48.5%)</td>
<td>248 (34.1%)</td>
<td>127 (12.4%)</td>
<td>727 (71.0%)</td>
</tr>
<tr>
<td>Astigmatism</td>
<td>248 (34.1%)</td>
<td>66 (48.5%)</td>
<td>248 (34.1%)</td>
<td>127 (12.4%)</td>
<td>34 ( 3.3%)</td>
</tr>
<tr>
<td>Emmetropia</td>
<td>127 (12.4%)</td>
<td>127 (12.4%)</td>
<td>127 (12.4%)</td>
<td>1024 (100%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>136 (13.3%)</td>
<td>727 (71.0%)</td>
<td>34 ( 3.3%)</td>
<td></td>
<td>1024 (100%)</td>
</tr>
</tbody>
</table>
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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.

**REFERENCES**


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**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: I- de 0,1 até 0,99D (diplopia); II- 1,0 até 2,99D; III- 3,00 até 5,99D e IV- 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 <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 miopes e 34,1% dos hipermetrópes tinham astigmatismo. De acordo com as dioptrias, 58,1% dos miopes estão no grupo 1, 39% distribuídos entre os grupos 2 e 3. Os hipermetrópes enquadraram-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 corroborar os nacionais, em geral, sendo hipermetrópes.