Research Article

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Ametropia in Lubumbashi: Status among School-Age Children

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ABSTRACT

Introduction: *The aim of this study was to assess the impact of refractive anomalies on the academic performance of students in Lubumbashi.*

Methodology: *This was a cross-sectional and analytical study with prospective data collection carried out in 6 schools in the city of Lubumbashi over a period of fourteen months and four days from February 24, 2023 to May 31, 2024. We carried out random sampling with a sample size of 407 students. All students present in each targeted school who responded to our questionnaire and whose ages varied between 5 and 19 years were included in the study. Any student with a VA ≤ 7/10 is ametropic.*

Results: *There were 162 (39.8%) cases of ametropia, of which 111 (68.5%) were myopic, 33 (20.4%) astigmatic and 15 cases of hyperopia. The age group of 12 to 14 years was the majority (46.3%) p = 0.000. The average age was 12.6 ± 2.5 years (p = 0.776). There was a slight female predominance, 56.8% F / M sex ratio of 1.3. Of all the students, the notion of repeating a class was observed in 97 (23.8%) students. Among the ametropes, there were 31.5% (n = 51) cases of repeating a class. We noted a statistically significant association between ametropia and grade repetition (p=0.003), ametropic students had 1.7 times the risk of grade repetition compared to non-ametropic students (RR: 1.7; CI: 1.187-2.369).*

Conclusion: *Ametropia is a real public health problem, its frequency in schools remains significant. Refractive errors negatively affect students' academic performance significantly.*

Keywords

Refractive errors, School performance, Students, Lubumbashi.

Introduction

Vision is a sensory function that provides information on the shape, size, color and mobility of the environment [1]. In addition to its vital importance in carrying out the most basic tasks of daily life, it allows us to enjoy beauty and also to see those we love. Vision is the most important of the five sense organs that nature has endowed man with. The loss of this invaluable gift is a source of profound suffering, even more so if it affects children, the hope and future of all societies [2]. According to the WHO, ametropia is defined as uncorrected visual acuity of less than or equal to 20/40 [3]. It is recognized as one of the most important causes of correctable visual disorders [4]. Some simple ametropias are reversible disturbances after correction and others can be amblyogenic or strabogenic [5]. Ametropia is the leading reason for ophthalmological consultation among school children [6,7]. The World Health Organization estimates that 153 million people suffer from visual impairment due to uncorrected refractive errors

[8,9]. At least 13 million children (aged 5 to 15) are affected [8,10]. Its prevalence varies from country to country from 2.72% to 15.8% [10,11].

Worldwide, uncorrected ametropia is the leading cause of visual impairment in children aged 5 to 15 years [8]. In school-age children, it is one of the most common causes of visual acuity loss and leads to behavioral problems and even educational delays [12]. It is well known that children with different uncorrected refractive errors can encounter different types of problems in life, including headaches and persistent eye discomfort, especially when working at close range, which can affect their reading efficiency and academic performance [9]. Several authors have been interested in studying the impact of refractive errors on academic performance around the world. In China, a study conducted in 2015 in a rural region concerning 120 primary schools, noted that ametropia had a great influence on the academic results of students (Odds Ratio at 2.13, CI: 2.10-2.87) [13]. In Spain in 2019, a study reported that children with poor visual health had poor academic performance compared to those with good visual health [11]. In Paris, Kovarski noted that the adoption of corrective measures improved visual comfort and had a positive impact on the results of students' end-of-year exams ($p < 0.01$) [14]. On the other hand, a study conducted in Portugal did not find a statistically significant association between ametropia and academic performance [15]. In Madagascar, Rakotoarisoa found a significant correlation between refractive errors and school performance ($p = 0.0025$) because 55.3% of ametropic students had repeated at least once [16]. In Ivory Coast, ametropic students who repeated at least one grade were 23.46% [7]. In the Democratic Republic of Congo, the few rare studies on refractive errors are those conducted in Kinshasa, in 96 health zones in children under 16 years of age with presumed visual problems where there were 42% of cases of ametropia [17] and that conducted in Lubumbashi in 2010 reporting 16.6% of cases with a rate of blindness and impairment of 4.57% [18]. We did not note any study evaluating the impact of refractive errors on school performance among students. However, in our environment, the lack of early detection as well as the scarcity of studies to evaluate the impact of refractive errors on academic performance justify the present study which will attempt to evaluate the impact of refractive anomalies on the academic performance of students in Lubumbashi.

Methodology

This was a cross-sectional and analytical study with prospective data collection carried out in 6 schools in the city of Lubumbashi. Over a period of fourteen months and four days from February 24, 2023 to May 31, 2024. We carried out a random sampling with a sample size of 407 students. All students present in each targeted school who responded to our questionnaire and whose ages varied between 5 and 19 years were included in the study. We excluded students who did not consent or who did not receive parental consent as well as students with organic eye pathology explaining the loss of vision. The study variables were age, gender, history, work mode, functional signs, near vision, types of ametropia and the notion of repeating a grade explaining academic performance (poor academic performance was defined by the notion of repeating a grade at least once). The data were collected by a senior ophthalmologist and an ophthalmologist, an orthoptist (visual therapist), two teachers (who are in the inclusive education project). We collected the measurement of VA carried out using optotypes and refraction under cycloplegic in children under 10 years old: retinomax or skiascopy. Any student with a VA ≤ 7/10 is ametropic. The distance separating the child from the optotype was 5m. The unexplored eye was blocked by a cache of the trial frame.

Three degrees of severity of spherical ametropia have been adopted:

- ametropia: a refraction less than 3D;
- Moderate spherical ametropia: a refraction between 3 and 6D;
- Strong spherical ametropia: a refraction beyond 6D.

- Astigmatism was considered to be:
  - Low when below 2D.
  - Moderate when between 2 and 4D.
  - Strong beyond 4D.

All data were analyzed with IBM SPSS statistical software version 23. For univariate analyses: qualitative variables were expressed in absolute frequency and percentage, quantitative variables were described using the mean and standard deviation. The data were grouped into classes according to the Sturges formula ($k=1+3.3 \log_{10} N$ where k=number of classes) when conditions allowed. For bivariate and multivariate analyses: we used several tests to verify either independence, adequacy, or the intervention of such or such other events. The normal distribution of the variables was carried out using the Kolmogorov-Smirnov test. For a parametric distribution, the student test was performed. Following a non-parametric distribution, the following tests were used: the non-parametric Kruskal -Wallis test or U Mann-Whitney, for quantitative variables and the chi-square test, the RR with the 95% confidence interval were calculated for qualitative variables. For all tests, the significance threshold was 0.05. Participation in the study was free and informed consent was obtained before filling out the forms. We insisted on anonymity. The authorization number of the ethics committee of Unilu : UNILU/CEM/139/2022

Results

Frequency af Ametropia

Out of a total of 407 students examined, there were 162 cases of ametropia, i.e. a frequency of 39.8%. Non-ametropes represented 60.2%. 111 students, i.e. 68.5%, were myopic (myopia was mild in 108 students, i.e. 97.3%, moderate in 1.8% and severe in 0.9%), astigmatism concerned 33 students, i.e. 20.4% (weak in 26 students, i.e. 78.8%, moderate in 3 students, i.e. 9.1% and severe in 4 students, i.e. 12.1%) and hyperopia concerned 15 students, i.e. 9.3% (weak in 14 students, i.e. 93.3% and moderate in 6.7%) (Figure 1 and Table 1).

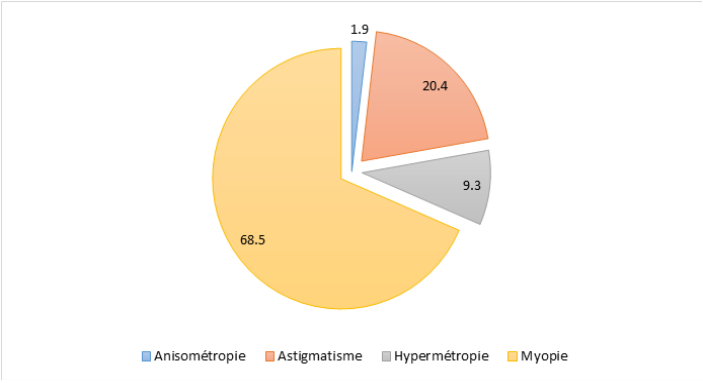

Figure 1: Types of ametropia.

Table 1: Degrees of severity of ametropia.

Severity levels	Myopia	Astigmatism	Hyperopia
	n(%)	n(%)	n(%)
Weak	108(97.3)	26(78.8)	14(93.3)
Moderate	2(1.8)	3(9.1)	0
Forte	1(0.9	4(12.1)	1(6.7)

Characteristics of the Students Surveyed

Sociodemographic Characteristics

The students were aged 6 to 19 years, the average age was 11.6 ± 2.5 years. The age group of 12 to 14 years was the most represented with 167 students or 41.0% (Figure 2). It was the majority among the ametropic with 46.3%, followed by those aged 9 to 11 with 26.5% (p = 0.000). The ametropic had an average age of 12.6 ± 2.5 years (p = 0.776) (Figure 3). Students aged 12 to 14 years also predominated among the myopic (48.6%), followed by those aged 9 to 11 (25.2%), there was no significant association (p = 0.651). Among astigmatics, the same age group was in the majority with 36.4% followed by those aged 15 to 17 and those aged 9 to 11 with 27.3% each, there was no significant association (p = 0.465). Regarding hyperopia, the majority of students were aged 12 to 14 (46.7%) followed by the 9 to 11 age group (33.3%), no significant association was observed (p = 0.413) (Table 2). There was a slight female predominance among all students examined, i.e. 56% with a F/M sex ratio of 1.3. This trend was also observed among ametropic students (female: 56.8% F/M sex ratio of 1.3). Female predominance was observed in the different types of ametropia in varying proportions, 53.2% in myopia, 63.6% in astigmatism and 80% in hyperopia, it should be noted that the associations were not statistically significant (p>0.05) (Table 2).

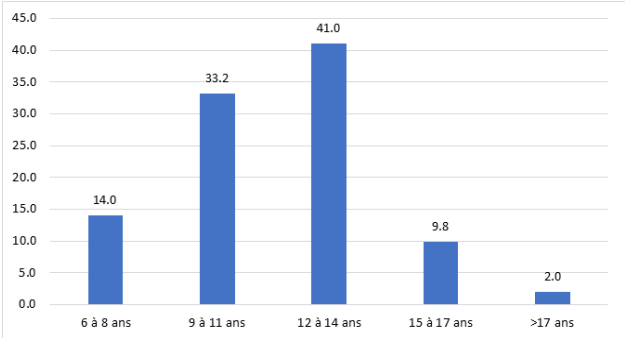

Figure 2: Distribution of students by age group.

Table 2: Sociodemographic characteristics of ametropic students.

Age	Myopia	hyperopia	Astigmatism
6 to 8 years old	6 (5.4)	2(13.3)	2(6.1)
9 to 11 years old	28(25.2)	5(33.3)	9(27.3)
12 to 14 years old	54(48.6)	7(46.7)	12(36.4)
15 to 17 years old	17(15.3)	1(6.7)	9(27.3)
>17 years old	6(5.4)	0	1(3.0)
p	0.651	0.413	0.465
Sex			
Female	59(53.2)	12(80.0)	21(63.6)
Male	52(46.8)	3(20.0)	12(36.4)
Total	111(100)	15(100)	33(100)
p	0.168	0.057	0.374

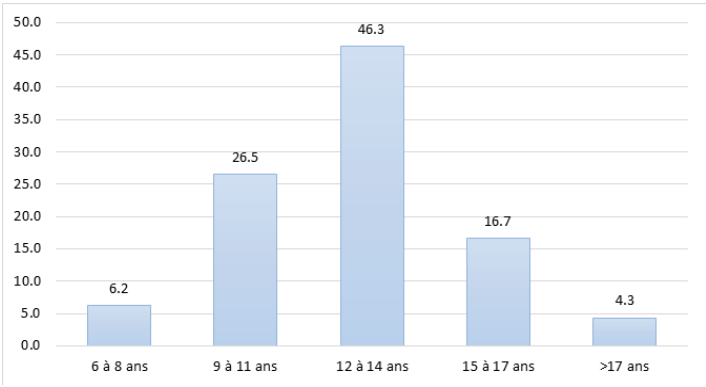

Figure 3: Distribution of ametropic students according to age groups.

Personal and Family Background

The notion of wearing glasses was observed in 29 ametropic students (17.9%) and in 14 non-ametropic students (5.7%) the difference was significant (p = 0.000). Similar cases in the family were 49.4% in ametropic students against 38.0% in non-ametropic students, (p = 0.022). Two ametropic students or 1.2% had a neurological history, this history was observed in one non-ametropic student (0.4%), there was no significant difference (p = 0.346). Ametropic students had the use of near vision for 2.8 ± 2 hours on average, against 2.7 ± 2.2 hours, there was no significant difference (p = 0.563). The working mode in bright light was effective in 145 ametropic students (89.5%) and in 197 non-ametropic students (80.4%), note that the difference was significant between the two groups (p=0.014) (Table 3).

Functional Signs

Functional signs were variable, visual acuity loss was 58.6% in ametropes and 44.1% in emmetropes (p=0.004). Visual blur was 58% in ametropes and 38% in emmetropes (p=0.000). Astenopia was 37.7% in ametropes and 12.7% in emmetropes (p=0.000). Other symptoms headache, diplopia, and tearing were also observed in both groups.

Table 3: Distribution of ametropic pupils according to history and functional signs.

History and functional signs	n(%)	P
Wearing glasses	29(17.9)	0.000
Similar case in the family	80(49.4)	0.022
Neurological history	2(1,2)	0.346
Works in bright light	145(89.5)	0.014
Decreased visual acuity	95(58.6)	0.004
Headaches	86(53.1)	0.876
Visual blur	94(58.0)	0.000
Diplopia	55(34.0)	0.183
Tearing	87(53.7)	0.653
Visual astenopia	61(37.7)	0.000

School Performance

Of all the students examined, the notion of repeating a grade was observed in 97 students, or 23.8% of cases. Among the ametropic students, there were 31.5% (n=51) of cases of repeating a grade. We noted a statistically significant association between ametropia and repeating a grade (p=0.003), ametropic students had 1.7 times the risk of repeating a grade compared to emmetropic students (RR: 1.7; CI: 1.187-2.369). On the other hand, we did not note any association between the different refractive errors and the notion of repeating a grade (p>0.05).

Table 4: Distribution of students according to academic performance.

		Repeating a class		p	RR [IC]
		No	Yes		
Ametropia	Yes	111(68.5)	51(31.5)	0.003	1,677 [1,187-2,369]
	No	199(81.2)	46(18.8)		
Myopia	Yes	75(67.6)	36(32.4)	0.701	1,103 [0.667-1.823]
	No	36(70.6)	15(29.4)		
Hyperopia	Yes	10(66.7)	5(33.3)	0.872	1.065 [0.501-2.266]
	No	101(68.7)	46(31.3)		
Astigmatism	Yes	25(75.8)	8(24.2)	0.316	0.727 [0.379-1.394]
	No	86(66.7)	43(33.3)		

Discussion

Frequency of Ametropia

Out of a total of 407 students examined, we observed 162 cases of ametropia, i.e. a frequency of 39.8%. This figure is close to that of Ombgwa et al. [19], 33.1%, it remains higher than that of a Malagasy study on the consequences of uncorrected refractive disorders on school performance in 414 children reporting 13.5% of students with refractive disorders [20], also to those of Kouassi L et al. [21], 21.40% and Assoumou P et al. [12], 16.2%, but lower than those of Diallo S. [4] and Maul E et al. [22] who had reported respectively 46.8% and 56.3% of cases of ametropia. It should also be noted that Alla NS et al. [7] found a prevalence of 87.54% of ametropia in the school environment. This divergence of results between studies would probably be due to the methodological difference (random versus convenience recruitment of subjects, operational definitions of refractive errors applied and study environment: general population, hospital or school environment). However, refractive errors are the most common cause of visual impairment in the world and their proportions are very variable between societies; partly reflecting genetic and environmental divergences [23].

In our study, most of the ametropic students had myopia at a proportion of 68.5%, this figure is similar to that of Khalaj [24] in Iran where myopia affected 65.03% of patients. In Nigeria, Ezinne et al. [20] also reported a predominance of myopia at 46.4% in students under 13 years of age. Our prevalence is lower than that of Hashim Au et al. [25] in Malaysia who reported 77.5% of cases. Our result differs significantly from those found in the pediatric population where Rakotoarisoa RTR et al. [20] observed a low prevalence of 10.7% for myopia; an Australian study found a myopia rate of 8.4% among ametropic children aged 4 to 12 years [26]. Another study conducted in the USA [27], out of 212 children aged 4 to 15 years, 34.4% were myopic. In Ireland, 23.3% of children under 13 years were myopic [9]. Low myopia was the most common type in our series with 97.3% of cases, followed by moderate myopia 1.8%; this result corroborates those of Clara M et al. [28] where low myopia predominated with 81% followed by moderate myopia 19% in students aged 6 to 11 years.

We found that astigmatism came in second place with 20.4% of cases, it was low at 78.8%. A series of studies carried out in China found a prevalence of between 3.75 and 12% [29]. Other authors have reported higher prevalences, notably series in Benin [30] and Uganda [31] noted a predominance of astigmatism with 91.99% and 52% of cases respectively. Assoumou P et al. [12] and Gbé [6] also observed a predominance of astigmatism with 89.2% and 73.42% respectively. Diallo S. [4] recorded 55.53% of cases.

Hyperopia represented 9.3% in our study, it was the least frequent type of ametropia in our series. This frequency is slightly higher than the 4% of hyperopia among the 13,039 students examined in 66 primary schools in Togo [32]. In the USA, out of 3,209 children examined aged 12 to 19, 0.9% were hyperopia [33]. However, our results are lower than those of Rakotoarisoa RTR et al. [20] who observed a prevalence of 30% for hyperopia. In a study carried out in Nigeria [34], 17.5% were hyperopia; the same for Hashemi H et al. [35] who reported 21.7% of hyperopia in Iran. In Tunisia, out of 300 school-age children examined, the prevalence of hyperopia was 65% [36]. Kovarski C et al. [37] found 50.4% hyperopia and Clara M et al. [28], 56.3% and Kouassi L et al. [21] found 67.32% after cycloplegia in his study.

Characteristics of the Students Surveyed

Sociodemographic characteristics

The students surveyed were aged 6 to 19 years, the average age was 11.6 years. The age group of 12 to 14 years was the most represented with 167 students (41.0%). This corroborates with the study of Diallo S. [4] in which a total of 220 children were examined their average age was 11 years, children aged 13 years (15%) were the most represented followed by those aged 11 years. According to Alla NS et al. [7] the average age of the schoolchildren was 9.76 years and the age group of 9 to 13 years was the most represented (69.36%). According to Cristina A et al. [38] the average age of the

participants was 8 years in their study. These differences could be explained by the variation in age between the study populations.

Among ametropic students, the average age was 12.6 years. The predominant age group was 12 to 14 years with 46.3%. Kouassi L et al. [21] reported an average of 11.96 years, for Ndoye et al. [39], the average age of ametropes was 10.28 years. Sounouvou I et al. [30] reported the average age of 8.5 and a predominance in the age group of 6 to 11 years. Assoumou P et al. [12] found a significant representation in the age group of 5 to 6 years with 32.2% of cases; for Ombgwa et al. [19], it was the age group of 8-9 years that grouped the most ametropes and for Zan et al. [40] it was that of 10-12 years. This diversification would be due to the process of emmetropization which ends around 14-15 years and would be linked to the fact that older children would have a greater susceptibility to express their vision problem compared to younger children.

The age group of 12 to 14 years also predominated among myopes (48.6%), followed by those of 9 to 11 years (25.2%), there was no significant association (p = 0.651). Among astigmatics the same age group was the majority with 36.4% followed by those of 15 to 17 years and those of 9 to 11 years with 27.3% each, no significant association was objectified (p = 0.465). Regarding hyperopia, the majority of students were aged 12 to 14 years (46.7%) followed by the 9 to 11-year group (33.3%), there was no significant association (p = 0.413). Furthermore, according to the study by Assoumou P et al. [12], the distribution of myopes was almost equal in the age groups of 5 to 6 years, 7 to 8 years, and 9 to 10 years, each representing 30% of the population, without significant variation. Among hypermetropics, the most represented age groups concerned those of 7 to 8 and 9 to 10 years without significant variation in hyperopia (p>0.05). Among astigmatics, the age group of 7 to 8 years had grouped 28% of astigmatics with a statistically significant difference between the age groups (p>0.05). Among the total number of students surveyed, there was a female predominance (56%, F/M sex ratio: 1.3). This trend was also observed among ametropic students (female: 56.8% F/M sex ratio of 1.3). Several authors have reported female predominance in their series, Diallo S. [4] found a sex ratio of 1.178, Kouassi L et al. [21] (0.47), Sounouvou I et al. [30] (1.076), Cristina A et al. [38] (1.085), Assoumou P et al. [12] (1.04), the same observation was made by Ombgwa et al. [19], Ndoye et al. [39] and Fanny et al. [41]; On the other hand, Odoulami et al. [42] found a male predominance in 51.54% of cases, Alla NS et al. [7] also reported a male predominance with a sex ratio of 1.06. Female predominance was observed in the different types of ametropia in varying proportions, 53.2% in myopes, 63.6% in astigmatism and 80% in hypermetropes, note moreover the associations were not statistically significant (p>0.05). Assoumou P et al. [12] had found male predominance in astigmatics in 56% of cases without statistically significant difference, both myopes and hypermetropes were predominantly female.

History and functional signs

The notion of wearing glasses was observed in 29 ametropic students (17.9%) the difference was significant (p = 0.000). This proportion is lower than that of Zhao et al. [47], Assoumou P et al. [12] and Kassir et al. [48] who found respectively 28.8%, 28.2% and 29.93% of children wearing corrective lenses at the time of the examination. However, Zan et al. [40], and Cristina A et al. [38] found a lower proportion of 0.95% and 12.11% respectively.

According to the present study, similar cases in the family were 49.4% in ametropics versus 38.0% in emmetropics, (p=0.022). Ametropic students had the use of near vision for an average of 2.8 hours, versus 2.7 hours in emmetropics, there was no significant difference noted between the two groups (p=0.563). The bright light working mode was effective in 145 ametropic students (89.5%) and in 197 emmetropics, i.e. 80.4%. Note that the difference was significant between the two groups (p=0.014).

Functional signs were variable, visual acuity loss was 58.6% in ametropes and 44.1% in non-ametropes (p=0.004). Blurred vision was reported in 58% of cases in ametropes and 38% in non-ametropes (p=0.000). Astenopia represented 37.7% in ametropes and 12.7% in non-ametropes (p=0.000). Headaches were present in 53.1% of ametropic students versus 53.9% in non-ametropes (p=0.876). In their study Cristina A et al. [38] reported 21.13% of cases of headaches. According to Assoumou P et al. [12] tearing was the predominant presenting sign in 31.6% followed by decreased visual acuity, pruritus and headaches in 18%, 15.1% and 14% of cases respectively. The work of Ndoye et al. [39] showed the presence of decreased visual acuity in 96.64% of cases. In his study Diallo S. [4] reported 60% decreased visual acuity, 17.3% tearing and 9.1% eye pain.

School Performance

Of all the students examined, the notion of repeating a grade was observed in 97 students, or 23.8%. Among the ametropic, 51 students, or 31.5%, had repeated a grade at least once. We noted an association between ametropia and repeating a grade (p = 0.003), the ametropic students had approximately twice the risk of repeating a grade compared to non-ametropic students (RR: 1.7; CI: 1.187-2.369). Studies have shown that the probability of academic difficulties is increased in the presence of refractive disorders, accommodation anomalies and even more so when there are binocular vision anomalies. Similarly, when participants do not consult regularly (preventive measure for screening for visual disorders), the probability of academic difficulties is increased. Furthermore, the adoption of corrective measures improves visual comfort and wearing corrective glasses has a statistically positive impact on the academic performance of participants [37]. In their research, Rakotoarisoa RTR et al. [20] found 55.3% of ametropes who had repeated at least once, the correlation was statistically significant (p = 0.0025) between ametropia and academic performance. Studies carried out in China, including the first by Resnikoff S et al. [45], observed that in most students with refractive errors, academic ability is reduced and their concentration also decreased. The second study by Hongwei Y et al. [29] in 120 primary schools in rural areas of China objectified that ametropia had a great influence on students' academic results

(Odds Ratio at 2.13, 95% CI: 2.10 – 2.87). In Madagascar, the ophthalmological problem of children is considered as one of the causes of absenteeism at school and school dropout in severe cases such as amblyopia, academic performance was insufficient: the repeat rate was 21.1% for public schools and 15.4% for private schools [46]. Cristina A et al. [38] had found a high proportion of visual disorders in students with poor academic performance (19.98%) and decreased in students with good academic performance (7.66%) ($p < 0.001$). Alla NS et al. [7] reported that among ametropic schoolchildren, 23.46% had repeated at least one class. Assoumou [12] had observed 16.2% of class repeats. Diallo had observed 62% of children with 1 repeat [4]. It should also be noted that a study conducted by Clara M et al. [28] did not note any significant differences between refractive status and academic performance.

According to our study, there were 32.4% of children with myopia who had repeated a grade, 33.3% with hyperopia and 24.2% with astigmatism, there was no association between the different types of ametropia and the notion of repeating a grade (p>0.05). Cristina A et al. [38] had found 4.57% of cases of myopia with poor academic performance (p=0.231). Ayed et al. [47] had noted that all types of ametropia were highly associated with academic delay in Tunisia. Thus, our results could be explained on the one hand by the fact that ametropes become less competent: the child falls asleep on his notebooks each time he learns his lessons, he has his nose stuck to his notebook to write and sees almost nothing on the board and on the other hand by the different functional signs induced by each type of ametropia given that 80% of the child's learning would be linked to sight.

Conclusion

Ametropia is a real public health problem, its frequency in schools remains significant. The results of this study sufficiently show the difficulties that ametropic students have in their daily lives but also and seriously, these refractive errors negatively affect their academic performance significantly because ametropic students were more likely to repeat a grade compared to non-ametropic students. Certainly, poor academic performance is multifactorial but we cannot exclude refractive errors as being partisan. However, in order to best help school-age children, a thorough ocular-visual examination (refraction, binocular vision and accommodative function) systematic throughout schooling for the early detection of vision disorders and the adoption of corrective measures are really necessary.

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