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ORIGINAL RESEARCH

Prevalence and associated factors of myopia among high school students in Gondar town, northwest Ethiopia, 2016

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Gizachew Tilahun Belete[1]
Dereje Hayilu Anbesse[1]
Adino Tesfahun Tsegaye[2]
Mohammed Seid Hussen[1]

[1]Department of Optometry, [2]Department of Biostatistics and Epidemiology, Institute of Public Health, College of Medicine and Health Science, University of Gondar, Gondar, Ethiopia

Introduction: Myopia is an important cause of correctable visual impairment and preventable blindness worldwide. Prevalence rates are approximately 20%–35% among the older teenage population globally. It has a medical burden of pathologic complications such as maculopathy and glaucomatous optic neuropathy. High school students experience high-performance and study pressures in the preparation for the final national examination. As a result they are exposed to excessive near work and indoor activities. They are also ignored for regular screening.

Objective: To determine the prevalence and associated factors of myopia among high school students in Gondar town, Ethiopia.

Methods: An institution-based cross-sectional study was conducted on 498 high school students with systematic random sampling method from April 18 to April 29, 2016, in three full-cycle high schools (9th–12th grades). A standardized structured questionnaire, Snellen acuity chart, pinhole, retinoscope, trial case lenses, pen torch, and direct ophthalmoscope were used to collect data.

Results: A total of 495 study participants were included, and they had a mean age of 17.48±1.59 years. The prevalence of myopia was 11.9% (95% confidence interval [CI]: 10.2, 17.9). Family history of myopia (adjusted odds ratio [AOR]=8.08 [95% CI: 4.30, 15.16]), school being private (AOR=2.88 [95% CI: 1.02, 8.11]), longer time spent for near work (AOR=2.89 [95% CI: 1.12, 7.43]), longer time spent partaking in indoor activities (AOR=4.32 [95% CI: 1.69, 10.99]), shorter near working distance (AOR=3.06 [95% CI: 1.33, 7.06]), lack of outdoor sport activities (AOR=2.27 [95% CI: 1.05, 4.90]), use of visual display units (AOR=2.81 [95% CI: 1.30, 6.10]), and abnormal ocular findings (AOR=6.69 [CI: 3.43, 13.03]) were found to be independently associated with myopia.

Conclusion: The prevalence of myopia was 11.9%. Family history for myopia, school being private, longer time spent partaking in indoor activities, shorter working distance, lack of outdoor sport activities, use of visual display units, and presence of abnormal ocular findings were positively associated with myopia.

Keywords: myopia, high school students, Gondar town, Ethiopia

Introduction

Myopia is defined as nearsightedness caused by an incongruity between the power of the optical elements of the eye and its axial length. The object image is projected in front of the retina, and corrective lenses are necessary to displace this image backward, thus producing a clear retinal image.[1] It is an important cause of correctable visual impairment and preventable blindness worldwide. The main clinical presentations are reduction of distance and/or near vision, reduction of color vision and contrast sensitivity, constriction of visual field, fear of light, and loss of vision.[2,3] Almost all patients with myopia can have good vision if early and appropriate correction has been given.[4]

Correspondence: Gizachew Tilahun Belete
Department of Optometry, College of Medicine and Health Science, University of Gondar, Gondar 196, Ethiopia
Tel +251 91 268 4323
Email gizachewtilahun1@gmail.com

Myopia has a global distribution with a widely varying incidence and prevalence. It is more common in Asian countries but relatively less common in Europe and North American countries.[5] Its prevalence and distribution in Africa is lower than both Asian and European countries.[5,6] The prevalence reaches 20%–25% in school age and young adults and 25%–35% among the mid- to late teenage population in the world.[2] The prevalence of myopia declines somewhat in the population over age 45 years, reaching about 20% in 65-year-olds, decreasing to as low as 14% of persons in the seventies.[2,7] On the other hand, the prevalence of myopia in the late teenage population becomes even higher in Asian countries, which extends up to 80% in China.[5,8]

Myopia and its pathological complication have reached epidemic proportions and become a large public health problem in certain parts of the world, especially in East Asian countries.[7,9] The medical burden of myopia includes pathologic complications such as maculopathy and glaucomatous optic neuropathy in association with high myopia and it becomes one of the leading causes of blindness and visual impairment.[3] Others such as choroidal neovascularization and cataract could also impair vision-related quality of life and increase difficulty in performing vision-related tasks.[5]

It has considerable burden on individual and society that can have negative impact on career choice, ocular health, and sometimes self-esteem. Students constitute a particularly vulnerable group, where myopia may have a great impact on learning capability and educational potential, as well as economic cost to the family and government.[10]

The causes of myopia are unclear, although evidence supports both genetic and environmental components; it has been associated with socioeconomic status, level and length of education, parental myopia, exposure to near work, and level of intelligence.[9–12] Even though, they are not major factors, level of lighting,[13] stress, pharmacological agents, and amount of time spent for indoor activities have an effect on the development of myopia.[14]

Although myopia is a common public vision problem, except a few community- and school-based studies on preschool and schoolchildren, there are limited information among high school students particularly in the study area.[15]

According to different studies done across the world, the prevalence of myopia has a discrepancy and varies widely.

Different cross-sectional studies in the world showed that the prevalence of myopia ranges from 2.9% to 96.54%.[3,8,16–24]

The major associated factors revealed through different literature are sociodemographic characteristics, such as sex, with being female found to increase risk,[3,4,6,11,18,24] and age;[25] but religion had not been found to have an association with myopia.[26] Environmental and educational factors including close working distance[3,21] and longer time spent for near work had a significant association with myopia.[27] Family history of myopia is also a determinant factor to have myopia and the probability becomes higher when both parents had myopia.[22,27,28]

Therefore, high school students are at high performance and study pressure in the preparation for the final national examination that may lead to the development of myopia. Most of them spent their time reading at near, which in turn was a major factor for myopia development and progression even after distance correction. These groups of students are also ignored for regular screening and studies were not well revealed. In addition, myopia is of high public health importance in Ethiopia with regard to preventing visual impairment. This reason is true in particular if one considers that the young myopic generation of today can eventually develop age-dependent myopia-associated complications such as myopic maculopathy and myopic glaucomatous optic neuropathy, when the myopic individuals grow older.

Materials and methods

Institution-based cross-sectional study was conducted in Gondar town, northwest Ethiopia, between April 18 and April 29, 2016. Data obtained from Gondar town administration statistical office indicated that Gondar city is located in North Gondar zone, which is situated 748 km from the capital city, Addis Ababa. According to the 2007 National Census, it has a population of 207,044 divided in 21 kebeles (the smallest unit of administration) and 10 subcities and approximately the town hosts about 53,725 households.[29] According to the Gondar town educational office there are 14 high schools (9 government and 5 private) that hosts 18,122 students. Out of these schools, eight of them are 9th–12th grades (full cycle) and the rest six are 9th–10th grades. The data were collected from high school students at Azezo, Debre Selam, and Shenta high schools. There is one government hospital – University of Gondar tertiary eye care and training center and two private clinics, which provide different specialty eye care services and training of eye care professionals such as optometrists and ophthalmologists.

Source population and sample size

Out of all high school students, 498 students were selected for the study. However, students who had recent history of ocular trauma and active ocular infection especially on the cornea and crystalline lens were excluded from the study.

Sample size determination

Sample size for objective one

Sample size was determined by single proportion formula taken from similar study in Tanzania:[11]

$$n = \frac{(Z_{\alpha/2})^2 P(1-P)}{d^2}$$

where n, sample size; Z, value of z statistic at 95% confidence interval (CI) =1.96; P, proportion of myopia from similar study conducted in Mwanza City town, Tanzania, was 5.59% (0.0559), $1 - P = 0.9441$, d, margin of error 3% = 0.03, and the sample size was 226.

Sample size for objective two

By taking a similar study conducted in Mwanza City town, Tanzania, parental/familial myopia was considered as main consistent factor for myopia and used for sample size determination. By using EPI INFO version 7 computer software and considering 95% CI, 80% power, by considering the ratio of those who have no familial myopia to those who have familial myopia as 1:1, 37% of unexposed develop the case, and the computer-generated sample was 148. Sample size of objective one was selected because it was larger and adequate to meet both objectives. Therefore, by considering 10% to nonresponse rate and 2 for a design effect during the sampling procedure, the final required sample size was 498.

Sampling technique and procedures

Multistage sampling technique was used during the sampling process. To ensure representativeness, sample was taken from about 37.5% of the total full-cycle high schools. As shown in Figure 1 first, 3 schools out of 8 full-cycle high schools were selected using simple random sampling method after a list of schools obtained from the Gondar town educational office. In the three selected schools, there were a total of 5642 students. Then systematic random sampling method

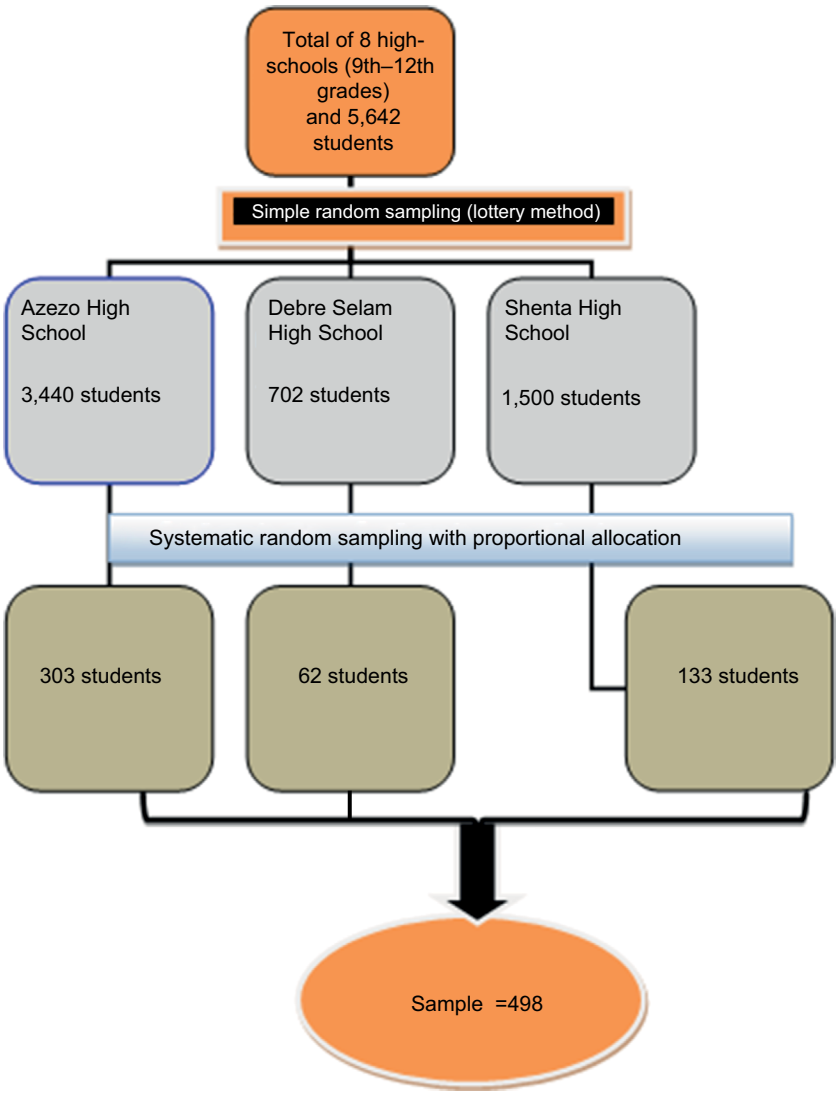

Figure 1 Schematic presentation of sampling procedure.

was used to select participating students with proportional allocation by a sampling fraction of 11.

Operational definitions

- Myopia: Defined as spherical equivalent refractive error (SER = sphere + 1/2 cylinder) of −0.50 D or more in either eye. Participants with anisomyopia were categorized based on the more myopic eye. On the basis of the American Academy of Optometry myopia <−3.00 D is low myopia, −3.00 D to −6.00 D is medium, and >−6.00 D is high myopia.
- Familial myopia: The presence of any degree of myopia in first-degree relatives (father, mother, brothers, and sisters) diagnosed by eye care professionals during examination.
- Working distance: The habitual distance at which a person adapts to do near tasks and 33 cm is considered as the average/normal value. Any working distance <25 cm is considered as close working distance.
- Ocular abnormality: Any ocular disorder (such as keratoconus and other corneal ectasias, corneal degenerations and dystrophies, cataract, lens subluxation/dislocation, and retinal disorders) that can induce myopia during its course or as a consequence of the disease process as determined by ocular examination.

Data collection procedures (instrument, personnel)

The standardized structured questionnaire was used to collect data regarding sociodemographic, family-related, environmental, and educational information. Data recording format and checklist were used for near reading, refraction, and ocular examination. Six trained optometrists were participated in data collection. The selected students were interviewed and ocular examination was carried out at each specific school by using Snellen acuity test chart, pinhole, retinoscope, trial case lenses, hand-held portable slit lamp, and direct ophthalmoscope. The examination room was semi-dark during refraction with a local available blue-black curtain. After adjusting the room illumination visual acuity was taken for all students. Visual acuity of worse than 6/9 was taken as cutoff point and pinhole was performed for any visual acuity improvement, then noncycloplegic objective refraction was carried out by a senior experienced optometrist to determine myopia. However, cycloplegic refraction was done for suspected pseudo-myopes to confirm their myopia. The principal investigator decided when there is a discrepancy in diagnosis of myopia. Myopia was defined as SER =sphere + 1/2 cylinder of −0.50 D or more in either eye. Participants with anisomyopia were categorized based on the more myopic eye.

Data processing and analysis

After coding, the data were entered into EpiData 3.1 then exported and analyzed by using SPSS version 20. Proportions and summary statistics were performed. Bivariable and multivariable logistic regressions were used to determine the associated factors. The variables that were found with $p<0.2$ at bivariable logistic regression were entered to multivariable analysis and those variables with p-value <0.05 were considered statistically significant.

Ethical consideration

Ethical clearance was obtained from the ethical review board of the University of Gondar. Each participating school was visited a week before the data collection day, and permission to conduct the study was also obtained from the schools. A written informed consent form was given to each of the students aged <18 years to be taken to their parents or guardians the day before data collection. Students aged <18 years were only recruited if their parents or guardians gave assent and signed the consent forms, and were willing for the students to take part in the study. All study participants aged ≥18 years and above provided their own written informed consent. Confidentiality of their information was assured through not writing their name, interviewing participants privately, and by keeping the collected information locked (not to make accessible for others other than the research team). Participants who were found to have myopia and any other ocular disorders were referred to University of Gondar Tertiary Eye and Training Center and underwent full ocular examination.

Results

Sociodemographic characteristics of the study participants

A total of 495 study participants were included in the study with a response rate of 99.4%. Among them, 257 (51.9%) were females. The mean age of the study participants was 17.48±1.59 years (range 15–22 years) and the mean age at start of formal school was 6.49+1.35 years (range 3–9 years). Most of the study participants were Ethiopian Orthodox (type of Christianity), 425 (86%). One-third of the study participants' parental educational status was found to be able to read and write, 134 (27.1%) (Table 1). Among the study participants, 278 (56.2%) were of 9th and 10th grades.

Magnitude of myopia

Out of 495 study participants, 59 (11.9%) (95% CI: 10.2, 17.9) were myopic and among them 32 (54.2%) had familial myopia. In more than half of the students with familial

Table 1 Sociodemographic characteristics of study participants among high-school students in Gondar town, northwest Ethiopia, 2016

Variables	Frequency (%)
Age category	
15–17 years	150 (30.3)
18–19 years	218 (44.0)
20–22 years	127 (25.7)
Age at start of formal school	
3–6 years	244 (49.3)
7 years	152 (30.7)
8–9 years	99 (20.0)
Sex	
Female	257 (51.9)
Male	238 (48.9)
School type	
Government	432 (87.3)
Private	63 (12.7)
Religion	
Ethiopian orthodox	425 (85.9)
Muslim	44 (8.9)
Protestant	16 (3.2)
Catholic	10 (2.0)
Parental education status	
Unable to write and read	95 (19.2)
Able to read and write	134 (27.1)
Primary school	58 (11.7)
Secondary school	96 (19.4)
College/university	112 (22.6)

Table 2 Proportion of myopia, familial myopia, and ocular abnormalities among study participants in Gondar town, northwest Ethiopia, 2016

Variables	Frequency (%)
Myopia (n=495)	
Yes	59 (11.9)
No	436 (88.1)
Degree of myopia (n=495)	
Low	40 (8.1)
Moderate	15 (3.0)
High	4 (0.81)
Ocular abnormality (n=495)	
Yes	68 (86.3)
No	427 (13.7)
Familial myopia (n=495)	
No family history	411 (83.0)
History in one family member	49 (9.9)
History in more than one family member	35 (7.1)

myopia, 17 (53.1%) had >1 family with myopia. On the basis of the degree of myopia, 40 (67.8%) had low degree of myopia. Among the study participants, 68 (13.7%) had ocular abnormalities of whom 26 (44.0%) had myopia (Table 2).

Factors associated with myopia

As a result, those study participants who had positive family history of myopia were 8 times more likely to develop myopia as compared to those who had no family history of myopia (adjusted odds ratio [AOR]=8.08 [95% CI: 4.30, 15.16]). Those students who were using a working distance of <33 cm were 3 times more likely to develop myopia as compared to those who used a working distance of >60 cm (AOR=3.06 [95% CI: 1.33, 7.06]). The study participants who spent 9–11 hours per day for near work were 2.89 times more likely to develop myopia as compared to those who spent <3 hours per day (AOR=2.89 [95% CI: 1.12, 7.43]). Students who spent 9–11 hours for indoor activities per day were also 4.32 times more likely to develop myopia as compared to those who spent <3 hours per day (AOR=4.32 [95% CI: 1.69, 10.99]). Those study participants who did not spend time for outdoor sport activities were 2.27 times more likely to develop myopia as compared to those who spent time in outdoor sport activities (AOR=2.27 [95% CI: 1.05, 4.90]). Students who used visual display units (VDUs) were 2.8 times more likely to develop myopia as compared to the nonusers (AOR=2.81 [95% CI: 1.30, 6.10]). Study participants who were in private school were 2.88 times at risk of developing myopia as compared to those who attend government schools (AOR=2.88 [CI: 1.02, 8.11]). Students who had ocular abnormality were 6.70 times more likely to develop myopia as compared to those who had not abnormal ocular findings (AOR=6.69 [CI: 3.43, 13.03]) (Table 3).

Discussion

In this study the prevalence of myopia was 59 (11.9%) (95% CI: 10.2, 17.9). This finding is consistent with other studies conducted in Poland (13.3%)[17] and Amman city (17.6%).[22] However, compared with studies done in Tanzania (5.59%), Ghana (4.5%), and Nigeria (2.9%),[6,11,24] this finding is larger. The possible explanation could be that the proportion of female participants to male in this study was higher. As reviewed earlier, females are more susceptible than males to myopia. Therefore, the prevalence in this study is higher as compared with the Nigeria, Ghana, and Tanzania studies. On the other hand, the prevalence of myopia in this study is relatively lower than other studies done in America (53.4%), Israel (20.3%), and India (19.1%).[4,16,19] In addition, in studies done in China (80%–95%), Hong Kong (85%–88%), and South Korea (96.54%),[3,9,20] the prevalence of myopia is very high as compared with this study. This difference might be because of the variation in race between the study participants and Asian descent. Most Asian nations were more myopic as a result of complex genetic trait and environmental factors responsible for myopia;[2] on the other hand, because of advancement of technology in developed nations, students were subjected for excessive near tasks.

Table 3 Factors associated with myopia of study participants among high-school students, Gondar town, northwest Ethiopia, 2016

Variables	Myopia		Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
	Yes	No		
Sex*				
Male	16	222	1.00	
Female	43	214	2.79 (1.52, 5.10)	
School type				
Government	46	386	1.00	1.00
Private	13	50	2.18 (1.10, 4.31)	2.88 (1.02, 8.11)**
Duration of schooling*				
9–10 years	13	148	1.00	
11–12 years	34	215	1.80 (0.91, 3.52)	
>12 years	12	73	1.87 (0.83, 4.30)	
Family history				
No	27	384	1.00	1.00
Yes	32	52	13.43 (6.22, 28)	8.08 (4.30, 15.16)***
Time spent in indoor activities				
<3 hours/day	12	145	1.00	1.00
3–8 hours/day	12	160	0.90 (0.40, 2.08)	0.91 (0.33, 2.51)
9–11 hours/day	24	88	3.30 (1.57, 6.92)	4.31 (1.69, 10.99)**
>11 hours/day	11	43	09 (1.27, 7.50)	2.43 (0.75, 7.84)
Ocular abnormalities				
No	33	394	1.00	1.00
Yes	26	42	7.40 (4.03, 13.52)	6.69 (3.43, 13.03)***
Time spent for near work				
<3 hours/day	10	164	1.00	1.00
3–8 hours/day	13	165	1.29 (0.55, 3.03	0.85 (0.32, 2.22)
9–11 hours/day	21	59	5.84 (2.60, 13.11)	2.89 (1.12, 7.43)**
>11 hours/day	15	48	5.12 (2.16, 12.14)	1.98 (0.66, 5.98)
Time spent in outdoor activities*				
<3 hours/day	23	128	0.88 (0.39, 1.98)	
3–8 hours/day	13	139	0.46 (0.191, 11)	
9–11 hours/day	13	120	0.53 (0.22, 1.29)	
>11 hours/day	10	49	1.00	
Outdoor sport activities				
No	45	234	2.77 (1.48, 5.20)	2.27 (1.05, 4.90)**
Yes	14	202	1.00	1.00
Working distance				
<33 cm	32	72	5.23 (2.59, 10.56)	3.06 (1.33, 7.06)**
33–60 cm	14	211	0.78 (0.36, 1.70)	0.49 (0.18, 1.20)
>60 cm	13	153	1.00	1.00
Active rest during studying*				
No	22	116	1.64 (0.30, 2.90)	
Yes	37	320	1.00	
Type of illumination*				
Candle	12	54	2.73 (1.19, 6.26)	
Table light	13	68	2.35 (1.05, 5.25)	
Dim light	20	142	73 (0.84, 3.55)	
Fluorescent/lamp	14	172	1.00	
Visual display unit use				
No	17	191	1.00	1.00
Yes	42	245	1.93 (1.06, 3.49)	2.81 (1.96, 6.10)**

Notes: *Nonsignificant, **p-value <0.05, *** p-value <0.001.
Abbreviation: CI, confidence interval.

The study participants who had positive family history of myopia were 8 times more likely to develop myopia as compared to those who had no family history of myopia. Studies conducted in Amman city, Beijing, and Greece agree with the finding of this study.[22,27,28] This is because of that myopia had high genetic basis as suggested that juvenile-onset myopia may be inherited as a complex trait involving genetic and environmental factors and it is true that myopia should cluster in families.

Those study participants who use short working distance of <33 cm were 3 times more likely to develop myopia as compared to those who used a working distance of >60 cm. This result is supported by other studies done in Norway,[30] China,[3] and Vietnam.[21] This might be because of the fact that persistent short working distance leads to peripheral blur and inherent ciliary spasm that could cause myopia gradually.

The study participants who spent 9–11 hours per day for near work were 2.89 times more likely to develop myopia as compared to those who spent <3 hours per day. This study is in line with other studies done in Beijing, China.[27] This might be as a result of that subjects who spent more time for near work are at higher risk of inherent ciliary spasm that in turn will lead to defocused retinal image and myopia development.

In this study, students who spent 9–11 hours for indoor activities per day were also 4.32 times more likely to develop myopia as compared to those who spent <3 hours per day. This result is supported by other studies in Australia and Taiwan.[30,31] This may be as a result of the illumination condition during indoor activities being different from natural light that prevents the release of dopamine. In addition, the distance where activities are performed while performing indoor activities is short as compared to outdoor activities.

Those study participants who did not spend time for outdoor sport activities were 2.27 times more likely to develop myopia as compared to those who spent time in outdoor sport activities. It is in agreement with a study in Ohio State University, America.[13] It may be explained in a way that, by nature most of the outdoor sport activities do not need any near focusing and accommodation and performed under natural illumination in contrast to those who did not spend time in outdoor sport activities. It is also suggested that natural light and outdoor sport activities might prevent myopia by increasing the release of dopamine from the retina, because dopamine has been known to be an inhibitor of axial elongation.[27]

Students who used VDUs were 2.8 times more likely to develop myopia as compared to nonusers. A study conducted in Beijing childhood study center[27] also confirmed the effect of VDUs on myopia development. The reason behind this may be the constant stimulation of accommodation and pupillary dilation that leads to retinal image defocus. Study

participants who were in private school were 2.88 times at risk of developing myopia as compared to those who attend government schools, and this finding agrees with a study conducted in China.[27] The possible reason for this may be educational facilities such as computers and books and that the time spent in class in private schools was higher as compared to government schools.

Students who had ocular abnormality were 6.70 times more likely to develop myopia as compared to those who had no abnormal ocular finding. This result is similar to the study done in Singapore.[7] The most likely reason to this association is that different ocular abnormalities can disturb the optical integrity of the eye, either the curvature or the axial length.

Conclusion

The prevalence of myopia among high-school students in Gondar town was 11.9%. Positive family history for myopia, school being private, longer time spent for indoor activities, short working distance, lack of outdoor sport activities, use of VDUs, and presence of abnormal ocular findings were positively associated with myopia.

Disclosure

The authors report no conflicts of interest in this work.

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