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Myopia Prevalence, Severity, and Risk Factors of University Students in Brunei Darussalam: a Survey-Based Study

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Abstract: **Clinical relevance: Determinants of myopia may be useful for formulating guidelines for time spent on online learning and its impact on eye health. Background: To determine the prevalence of myopia among university students and evaluate its association with screen usage and other potential sociodemographic determinants of myopia. Methods: An online, self-administered questionnaire was used to obtain students' refractive status, sociodemographic details (age, gender, ethnicity, education level), and risk factors of myopia including average daily screen usage, time spent on near-work and outdoor activities, the onset of myopia, and parental history of myopia. Univariate and multivariate analyses evaluated associations between myopia and the investigated factors. Results: A total of 269 eligible students were included, with a mean age of 21.9 ± 3.3 years. The prevalence of myopia was 66.2%. Parental history of myopia and current outdoor activities were found to be risk factors for myopia diagnosis in a logistic regression (p = 0.017, p = 0.046 respectively). Screen usage, regardless of time spent, was not significantly associated with myopia. Severe myopia was associated with earlier age of onset (*P*<0.001), parental history (*P*=0.020), and female gender (*P*=0.043). Conclusion: The prevalence of myopia among students at the Universiti Brunei Darussalam was high. Current outdoor activity (i.e., not childhood activity) was found to be a risk factor for students to be myopic, perhaps due to an idea among already myopic students that outdoor activity is protective. Other risk factors were relatively standard. Screen usage was not significantly associated with myopia.**

Keywords: **myopia risk factors, prevalence, questionnaire, screen usage, university students.**

I. INTRODUCTION

Myopia is a common cause of avertable visual impairment, with uncorrected myopia the leading cause of distance vision impairment.[1], [2] The worldwide prevalence of myopia has increased from 22.9% in 2000 to 34.0% in 2020,.,4 Its rapid increase is higher in developed Asian countries such as Taiwan, Korea, and Japan.[5]–[7] By 2050, it has been projected that almost 5 billion people - half of the world's total population - will have myopia, with 938 million people affected by high myopia.[3] Uncorrected myopia is a significant global economic and public health problem, estimated to cost US$ 244 billion to address the burden of associated visual impairment and productivity loss.[8] Even low levels of myopia can increase the risk of developing serious eye complications such as cataracts, glaucoma, and retinal detachment.[9]

The development of myopia is multifactorial and is reported to be an interaction between genetic and environmental factors.[10] Genetic factors such as gender, ethnicity, and family history are associated with the high prevalence of myopia in China.[11]–[13] Genetics have also been suggested to influence the onset of myopia.[14], [15] Environmental factors

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such as increased time spent on near work and reduced outdoor activities have been found to contribute to myopia prevalence.[16], [17]

The prevalence of myopia is increasing among young adults, who make up the majority of the university student population.[18,19] However, there have been few studies investigating the risk factors of myopia to this group. Furthermore, several studies have observed a correlation between higher education level and greater prevalence of myopia.[20,21] This place university students at higher risk of developing myopia. In addition, the surge of using digital devices in recent years has been cited to increase the risk of developing myopia.22 Smartphone usage worldwide increased from 3.7 billion to 5.6 billion) between 2016 and 2019.23 Furthermore, when the world was hit with the COVID-19 pandemic in early 2020, a new norm developed for increased online media as a learning tool. This has brought a marked increase in the total time spent on screen-based devices due to the implementation of online learning as well as school closures and in-house quarantine.24 A recent study in China investigated the effects of home confinement on schoolchildren aged 6-13 years during the pandemic.25 It was reported that in children between 6-8 years, a significant shift in spherical equivalent (SE) of approximately -0.3 D (dioptres) was observed compared to previous years (2015-2019). Myopic shifts were also associated with an increasing prevalence of myopia within the same age group in 2020.

We, therefore, decided to undertake the first study of myopia among students of the Universiti Brunei Darussalam (UBD), examining its association with screen usage and potential sociodemographic determinants of myopia.

II. METHODS

A. Study design

This was a cross-sectional study using an online self-administered questionnaire conducted between December 2020 and March 2021. It consisted of two phases: the first phase assessed the comprehensibility and validity of the questionnaire, and the second phase was the main study.

B. Participants

The participants were students recruited from the Universiti Brunei Darussalam (UBD), across the nine academic faculties, and the inclusion criteria for the main study were as follows: (i) age between 18-40 years, (ii) full-time undergraduate/postgraduate student, (iii) able to read and understand the English language, and (iv) consented to participate in the study. Students who were above 40 years were excluded as they may have presbyopia.26

Ethics approval for this study was obtained from the joint committee of the Institute of Health Sciences Research Ethics Committee and the Ministry of Health Research Ethics Committee and adhered to the principles of the Declaration of Helsinki.

C. Research Instrument

A self-designed questionnaire was used as the research instrument for this study. The questionnaire was developed by collecting details from a literature review and validated sets of questionnaires conducted in other countries.[28-30] These were adapted to the objectives of the present study. The suitability of the items was then discussed with local clinical experts in the field of human vision. The questionnaire was pre-tested and piloted before distribution across the university.

The questionnaire (**Appendix A**) consisted of 12 closed-ended items and was classified into 3 domains. The first domain collected data on sociodemographic information, including (i) age (years), (ii) gender (male/female), (iii) ethnicity (Malay/Chinese/Others), and (iv) level of education (undergraduate/postgraduate). These variables have been reported to be myopia-associated risk factors in university students.28,29 The second domain included 4 items to identify myopia through self-reporting and is reported to have good sensitivity and specificity: 0.76 and 0.74, respectively.31 The participant's glasses/contact lenses prescription was obtained in this domain. Participants were encouraged to refer to their glasses/contact lenses or prescription provided to them by their attending optometrists. Participants enrolled in the study had been briefed through lectures on the different types of refractive errors. Investigators were also available should participants require clarification on the questionnaire. The third domain consisted of myopic risk factors: average time spent daily on digital screen usage, near work, and outdoor activities. The participant's parental history of myopia was also obtained in this domain.

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In this study, myopia was defined as "the need to wear glasses/contact lenses for distant vision, or equally important for distance and near work". Participants were considered to have 'low myopia' if the spherical equivalent (SE) of their prescription for glasses / contact lenses in both eyes was ≤ -0.50 D and > -6.00 D; 'high myopia' if it was ≤ -6.00 D.[32]

D. First Phase: Assessment of the Questionnaire's Comprehensibility and Validity

The questionnaire was pre-tested to evaluate comprehensibility and the language of the questions among 10 purposively sampled students. The feedback of the pre-testers was collected and used to adjust the questionnaire. No significant ambiguity was observed during the pre-test. The questionnaire was then piloted on another 30 students to assess its internal consistency and validity using the Cronbach alpha coefficient. The Cronbach's alpha value obtained was 0.64, which was deemed satisfactory.

E. Second Phase: The Main Study

An email invitation was first sent to the faculty administrator of Pengiran Anak Puteri Rashidah Sa'adatul Bolkiah, Institute of Health Sciences (PAPRSB, IHS). It was then forwarded to the university administrator (Student Welfare Officer) for its dissemination to all students. The email contained a link to the online questionnaire and the Participant Information Sheet (PIS). Consent was obtained by choosing the "I agree" option after the participants had read the provided PIS.

All students were initially given seven days to participate and complete the online questionnaire. This allowed the students time to check their emails and voluntarily join the study within the one-week period. A reminder email was forwarded a week later to increase the response rate over a second week.

F. Statistical analysis

The data collected were stored on 'Google Forms' and tabulated into an Excel sheet for statistical analysis. Univariate statistical analyses were conducted using RStudio (version 1.3.1056). Continuous variables were presented as mean ± standard deviation and categorical variables were defined by frequency and percentages. Univariate relationships between myopia and the investigated factors were evaluated using the chi-square test. Linear and logistic regression models were performed to determine the association between myopia and the risk factors investigated (MATLAB 2020, The MathWorks, Natick, MA). P-values of < 0.05 were considered statistically significant.

III. RESULTS

A total of 271 students responded to the main study. Two were older than 40 years and were excluded. Thus, 269 questionnaires were included in the analysis, yielding a response rate of 66.4%, where 206 (76.6%) were female and 63 (23.4%) were male participants; 233 (86.6%) were undergraduates and 36 (13.4%) postgraduates. The mean age of the participants was 21.9 ± 3.3 years.

178 students self-reported themselves as myopic, yielding an overall prevalence of 66.2% (95% CI: 60.1, 71.7). 91.6% (n = 163) of myopic participants first started wearing their glasses/contact lenses when they were under 18 years old while 8.4% (n = 15) first started at 18 years or more, with the mean age of onset being 9.0 ± 6.8 years. In addition to that, 77.0% (n = 137) verified their myopia status by providing their glasses / contact lenses prescription for both eyes. These participants are referred to as the "definite myopes". Of those participants 89.8% (n = 123) had low myopia in both eyes (SE ≤ -0.50 D and > -6.00 D) while 5.1% (n = 7) had high myopia in both eyes (SE ≤ -6.00D). The remaining seven definite myopes had one severe eye and so were categorised as high myopes.

Table 1 shows the prevalence of myopia among the university students and its association with the factors investigated. There were no significant differences in myopia prevalence between male students (58.7%) and female students (68.4%) (p = 0.154). The prevalence of myopia was highest amongst the Chinese students (74.3%), followed by Malays (65.6%) and those of other ethnicities (56.6%), however, there was no significant difference observed between the different ethnicities (p = 0.414). Also, no significant difference was found in the myopia prevalence between the undergraduate (66.5%) and postgraduate students (63.9%) (p = 0.756). Other than that, no statistically significant differences were found between low screen-based device users (< 3hrs/day), moderate users (3-5 hrs/day), or high users (> 5hrs/day) ($X^2 = 4.39$, p = 0.111). Other factors investigated such as near work, outdoor activities and parental myopia were also not found to have significant associations with myopia, regardless of the level of severity of myopia.

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TABLE 1: the prevalence of myopia (n = 178) and its association with factors investigated

Factor	Number (n = 269)	Myopia (n)	Prevalence (%)	X^2	p-value
Gender					
Male	63	37	58.7	2.03	0.154
Female	206	141	68.4		
Ethnicity					
Malay	218	143	65.6	1.77	0.414
Chinese	35	26	74.3		
Others	16	9	56.3		
Education level					
Undergraduate	233	155	66.5	0.0967	0.756
Postgraduate	36	23	63.9		
Screen usage (hr/day)					
<3	5	5	100	4.39†	0.111
3-5	44	25	56.8		
>5	220	148	67.3		
Near-work (hr/day)					
<3	118	76	64.4	4.87	0.0876
3-5	89	54	60.7		
>5	62	48	77.4		
Outdoor activity (hr/day)					
<3	199	125	62.8	4.87	0.0875
3-5	55	40	36.4		
>5	15	13	86.7		
Parental myopia					
Neither	95	63	66.3	0.0972	0.953
Either	106	71	70.1		
Both	68	44	64.7		

† Fisher's test

The associations between myopia and the factors studied were further investigated using logistic regression analysis. Only the definite myopes (n = 137) and non-myopes (n = 91) were included in this analysis. Table 2 thus shows the association between low myopia and the parameters studied. Note that the fitted values, b, and their SE, are the log (Odds) of having low myopia per category or year. The use of screen devices was not a risk factor for low myopia (p = 0.975). Outdoor activity was found to be a risk factor for low myopia (p = 0.046), corresponding to an increased odds of 1.78× (95% CI 1.00× and 3.16×). Near-work was marginally significant (p = 0.090), odds of 1.37× (95% CI 0.95× and 1.98×).

TABLE 2. The association between low myopia (n = 123) vs. no myopia (n = 91) and factors investigated based on multiple logistic regression analysis. The estimates, b, are thus the log (Odds)

Factors	b	Standard Error	t stat	p-value
(Intercept)	-0.921	1.2	-0.77	0.444
Age	-0.018	0.050	-0.35	0.723
Gender	-0.223	0.325	-0.67	0.487
Ethnicity	0.045	0.251	0.18	0.859
Education level	-0.095	0.499	-0.19	0.850
Screen usage	-0.011	0.342	-0.03	0.975
Near-work	0.313	0.184	1.70	0.090
Outdoor activity	0.575	0.288	2.00	**0.046***
Parental history	-0.017	0.190	-0.09	0.929

* statistically significant   b regression coefficient = log (Odds)

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Table 3 shows the association between high myopia in at least 1 eye (n = 14) compared to non-myopes (n = 91). Screen usage was not significantly associated with high myopia (p = 0.880). Having a parental history of myopia was significantly associated with high myopia (p = 0.017), odds of 3.33× (95% CI 1.22× and 9.10×).

TABLE 3. The association between high-myopia (n = 14) vs. no myopia (n = 91) and factors investigated based on multiple logistic regression analysis

Factors	b	Standard Error	t Stat	p-value
(Intercept)	-5.208	2.781	-1.87	0.061
Age	-0.018	0.075	-0.24	0.808
Gender	-101.1	> 1000	0.00	1.000
Ethnicity	0.075	0.587	0.13	0.898
Education level	0.641	0.948	0.68	0.499
Screen usage	0.114	0.756	0.15	0.880
Near-work	0.220	0.429	0.51	0.608
Outdoor activities	-0.071	0.693	-0.10	0.919
Parental history	1.203	0.503	2.39	**0.017***

* statistically significant b regression coefficient = log (Odds)

Table 4 shows the relationship between the severity of myopia and the factors studied among 'definite myopes' (n = 137) based on multiple linear regression analysis. Severity was 1 = low myopia, 1.5 = one eye low myopia and one eye high myopia, 2 = both eyes high myopia. No significant relationship was observed between screen usage and the severity of myopia. The earlier age of onset and the presence of at least one myopic parent were found to increase the severity of myopia (p = <0.001 and p = 0.020, respectively). The severity of myopia was also found to be lower in females (p = 0.043). On a severity scale with steps of 0.5, the effects was only -0.096 ± 0.047 step, and may simply reflect our particular sample group.

TABLE 4. The relationship between myopia severity and the factors investigated in the "definite myopes" (n = 137)

Factors	b	Standard Error	t stat	p-value
(Intercept)	1.081	0.170	6.35	<0.001
Age	0.012	0.009	1.37	0.173
Age of onset	-0.022	0.006	-3.47	**<0.001***
Gender	-0.095	0.047	-2.04	**0.043***
Ethnicity	-0.015	0.036	-0.42	0.674
Education level	0.040	0.073	0.55	0.583
Screen usage	0.011	0.045	0.25	0.806
Near-work	-0.004	0.023	-0.17	0.864
Outdoor activity	-0.038	0.034	-1.13	0.259
Parental history	0.063	0.0267	2.35	**0.020***

* statistically significant b regression coefficient

IV. DISCUSSIONS

The prevalence of myopia among UBD students was found to be 66.2%. This is relatively low compared to university students in China. For example, in Anyang, the prevalence of myopia was found to be 83.2%28 and similarly, in Nanjing, the prevalence was 86.8%.[29] This could be due to the difference in time spent reading, studying or outdoors during childhood. Academic performance in East Asian countries is highly valued, leading to children spending more time at school and on their education.[33]

In this study, screen usage was not significantly associated with myopia. The use of screen-based devices has been thought to be a risk factor in the development of myopia. This claim is not supported in this study and is consistent with the findings from other studies. In a study of 11,138 medical students in Inner Mongolia, China, daily computer use and the use of a

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computer for more than 3 hrs/day were not significantly associated with myopia.34 Furthermore, using computers and smartphones for more than 3 hrs per day were not found to be significant risk factors for myopia in university students in Nanjing, China.29 Similarly, Dixit et al. found that there were no significant differences between the different categories of screen use (low, moderate and high) among 289 Indian adolescents aged 12-15 years.30 However, a positive association between screen use and myopia has been found in other studies involving children.

In a recent study by Wang et al. involving 123,535 Chinese children, significant myopic shifts were seen in younger children aged 6, 7, and 8 years (-0.32D, -0.28D, and -0.29D respectively).25 This shift was also associated with a rise in the prevalence of myopia in children of the same age group in 2020, compared to that in 2015 to 2019. This significant change was observed following home confinement during the COVID-19 pandemic, which was accompanied by increased time spent time on screen-based devices at home for online learning. Another study in Delhi, India of 9884 children aged 5 to 15 years reported a positive association between screen usage and myopia. Watching television for more than 21 hrs per week (OR = 12.3, 95% CI: 8.93, 16.90, $p < 0.001$) and playing computer and video games for more than 4 hours weekly (OR=8.1, 95% CI: 4.05, 16.2, $p < 0.001$) were risk factors of myopia in children studying in private school.35 This suggests that the development of myopia is less during the university period and has higher risk in younger children.

This study found that myopia severity increases significantly with earlier age of onset ($p < 0.001$) (Table 4). A small significant effect of gender was also found but may simply reflect our study group rather than a real effect. Early-onset myopia is known to develop into high myopia during adulthood. In a prospective, cohort study involving 443 Chinese individuals, the risk of developing high myopia was approximately 50% in those with myopia onset at age 7 or 8 years old.36 Another study (n = 928) found that children with earlier age of onset or longer duration of myopia progression was associated with a higher risk of high myopia (OR = 2.86, 95% CI: 2.39-3.43).37

Near-work was not found to be a risk factor for myopia in this study, or only marginally (Table 2). This result contrasts with previous studies in other countries. In a longitudinal study among Norwegian engineering students, reading scientific literature for more than 7 hours a week was significantly associated with myopia ($p < 0.001$).38 In addition, Saw et al. found that reading more than 2 books a week was a risk factor (OR = 3.05, 95% CI: 1.80-5.18) among Singaporean children aged 7 to 9 years.39 It is hypothesized that during prolonged near work activities, the shape of the eyeball changes to accommodate incoming light and to produce a sharp, close images on the retina.33

Outdoor activities were found to be an increased risk factor ($p = 0.046$) for low myopia in multivariate analysis among participants with low myopia (Table 2) but not high myopia (Table 3). This finding is somewhat inconsistent with other studies. The Sydney Myopia Study found that increased outdoor activities were associated with less myopia in children.40 Another study by Lingham et al. discovered that in 303 adults (aged 25 to 30 years), increased outdoor time during childhood reduced the risk of developing myopia (OR=0.82, CI 95%: 0.69, 0.98). Engaging in more outdoor activities during both the childhood and adolescence period was associated with less myopia.41 Increased outdoor activities are generally accepted as a protective factor against myopia as the high light intensity stimulates the retina to secrete dopamine, which inhibits eye growth.42 A note of caution is that this study measured current time outdoors of university students under 40 years, not time outdoors during childhood.

Having myopic parents was associated with high myopia in this study ($p = 0.017$) (Table 3). Sun et al. observed that university students with at least one myopic parent were significantly more myopic than those with no history of parental myopia.42 Similarly, Hwang et al. found that having a parent with myopia was a risk factor for myopia (OR=3.58, 95% CI= 1.96-6.54, $p < 0.001$).29 This suggests that genetic factors play a role in the development of myopia.

This study had some limitations. First, the status of myopia was determined using a self-reporting method. This may have underestimated the prevalence of myopia, as students with mild myopia may not require visual aid for distant vision, and thus reported themselves as a nonmyopic. Additionally, as the factors investigated were obtained using a self-reported questionnaire, this study is subjected to recall bias. By contrast, a study that assessed validity of the questionnaire using self-report refractive status showed a relatively acceptable sensitivity of up to 0.50 and specificity of up to 0.84, more so for myopia compared to hyperopia and astigmatism. Lastly, since the targeted sample size was not achieved (66.4% response rate) and only one university was selected in this study, the findings may not accurately represent other university populations.

V. CONCLUSIONS

In summary, the prevalence of myopia among students at the University Brunei Darussalam was found to be 66.2%. Parental myopia and current outdoor activities (i.e., not childhood activity) were found to be risk factors of myopia for students at this university. The severity of myopia increased with earlier age of onset and female gender. Screen use and near-work were not significantly associated with myopia.

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CONFLICTS OF INTEREST

None of the following authors has proprietary interests or conflicts related to this submission.

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REFERENCES

[1] C.-W. Pan, D. Ramamurthy, and S.-M. Saw, "Worldwide prevalence and risk factors for myopia," Ophthalmic and Physiological Optics, vol. 32, no. 1, pp. 3–16, Jan. 2012, doi: 10.1111/j.1475-1313.2011.00884. x.

[2] R. R. A. Bourne et al., "Causes of vision loss worldwide, 1990-2010: a systematic analysis.," Lancet Glob Health, vol. 1, no. 6, pp. e339-49, Dec. 2013, doi: 10.1016/S2214-109X (13)70113-X.

[3] B. A. Holden et al., "Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050.," Ophthalmology, vol. 123, no. 5, pp. 1036–1042, May 2016, doi: 10.1016/j.ophtha.2016.01.006.

[4] World Health Organization, World report on vision, vol. 214, no. 14. 2019.

[5] Y. Y. Lee, C. T. Lo, S. J. Sheu, and J. L. Lin, "What factors are associated with myopia in young adults? A survey study in Taiwan military conscripts," Invest Ophthalmol Vis Sci, vol. 54, no. 2, pp. 1026–1033, 2013, doi: 10.1167/iovs.12-10480.

[6] S. K. Jung, J. H. Lee, H. Kakizaki, and D. Jee, "Prevalence of myopia and its association with body stature and educational level in 19-year-old male conscripts in Seoul, South Korea," Invest Ophthalmol Vis Sci, vol. 53, no. 9, pp. 5579–5583, Aug. 2012, doi: 10.1167/iovs.12-10106.

[7] E. Ueda et al., "Trends in the Prevalence of Myopia and Myopic Maculopathy in a Japanese Population: The Hisayama Study.," Invest Ophthalmol Vis Sci, vol. 60, no. 8, pp. 2781–2786, Jul. 2019, doi: 10.1167/iovs.19-26580.

[8] T. S. T. Smith, K. D. Frick, B. A. Holden, T. R. Fricke, and K. S. Naidoo, "Potential lost productivity resulting from the global burden of uncorrected refractive error," Bull World Health Organ, vol. 87, no. 6, pp. 431–437, 2009, doi: 10.2471/BLT.08.055673.

[9] B. Holden, P. Sankaridurg, E. Smith, T. Aller, M. Jong, and M. He, "Myopia, an underrated global challenge to vision: Where the current data takes us on myopia control," Eye (Basingstoke), vol. 28, no. 2, pp. 142–146, 2014, doi: 10.1038/eye.2013.256.

[10] E. Goldschmidt and N. Jacobsen, "Genetic and environmental effects on myopia development and progression," Eye (Basingstoke), vol. 28, no. 2. Nature Publishing Group, pp. 126–133, 2014. doi: 10.1038/eye.2013.254.

[11] J. Sun et al., "High prevalence of myopia and high myopia in 5060 Chinese University students in Shanghai," Invest Ophthalmol Vis Sci, vol. 53, no. 12, pp. 7504–7509, 2012, doi: 10.1167/iovs.11-8343.

[12] L. J. Wu et al., "Prevalence and associated factors of myopia in high-school students in Beijing," PLoS One, vol. 10, no. 3, pp. 1–12, 2015, doi: 10.1371/journal.pone.0120764.

[13] M. Mrugacz, "Role of the Genetic Factors in the Development of Myopia," in Genetic Disorders, InTech, 2013. doi: 10.5772/52543.

[14] M. Dirani, S. N. Shekar, and P. N. Baird, "Adult-onset myopia: The genes in myopia (GEM) twin study," Invest Ophthalmol Vis Sci, vol. 49, no. 8, pp. 3324–3327, Aug. 2008, doi: 10.1167/iovs.07-1498.

[15] R. Iribarren et al., "Family history and reading habits in adult-onset myopia," Curr Eye Res, vol. 25, no. 5, pp. 309–315, 2002, doi: 10.1076/ceyr.25.5.309.13494.

[16] M. Czepita, D. Czepita, and W. Lubiński, "The influence of environmental factors on the prevalence of Myopia in Poland," J Ophthalmol, vol. 2017, 2017, doi: 10.1155/2017/5983406.

[17] H. Guan et al., "Impact of various types of near work and time spent outdoors at different times of day on visual acuity and refractive error among Chinese school-going children," PLoS One, vol. 14, no. 4, Apr. 2019, doi: 10.1371/journal.pone.0215827.

[18] C. Lanca and S. M. Saw, "The association between digital screen time and myopia: A systematic review," Ophthalmic and Physiological Optics, vol. 40, no. 2, pp. 216–229, 2020, doi: 10.1111/opo.12657.

[19] S. O'Dea, "Global smartphone penetration rate as share of population from 2016 to 2020," 2020.

[20] C. Wai Wong et al., "Digital Screen Time During COVID-19 Pandemic: Risk for a Further Myopia Boom?," Am J Ophthalmol, Jul. 2020, doi: 10.1016/j.ajo.2020.07.034.

[21] J. Wang et al., "Progression of Myopia in School-Aged Children after COVID-19 Home Confinement," JAMA Ophthalmol, pp. 1–8, 2021, doi: 10.1001/jamaophthalmol.2020.6239.

[22] R. Du Toit, "How to prescribe spectacles for presbyopia," Community Eye Health Journal, vol. 19, no. 57. International Centre for Eye Health, pp. 12–13, Mar. 2006.

[23] L. Huang, H. Kawasaki, Y. Liu, and Z. Wang, "The prevalence of myopia and the factors associated with it among university students in Nanjing: A cross-sectional study," Medicine, vol. 98, no. 10, p. e14777, 2019, doi: 10.1097/MD.0000000000014777.

[24] S. Wei et al., "Refractive errors in university students in central China: The anyang university students eye study," Invest Ophthalmol Vis Sci, vol. 59, no. 11, pp. 4691–4700, Sep. 2018, doi: 10.1167/iovs.18-24363.

[25] J. J. Walline, K. Zadnik, and D. O. Mutti, "Validity of surveys reporting myopia, astigmatism, and presbyopia," Optometry and Vision Science, vol. 73, no. 6, pp. 376–381, Jun. 1996, doi: 10.1097/00006324-199606000-00004.

[26] L. Wang et al., "Prevalence of and Factors Associated with Myopia in Inner Mongolia Medical Students in China, a cross-sectional study," BMC Ophthalmol, vol. 17, no. 1, Apr. 2017, doi: 10.1186/s12886-017-0446-y.

[27] R. Dixit, M. Jindal, P. Gupta, and A. Dubey, "Excessive usage of illuminated screen a risk factor for myopia in adolescent population," Journal of current medical and applied science, vol. 10, no. 3, pp. 173–176, 2016.

[28] R. Saxena et al., "Prevalence of myopia and its risk factors in urban school children in Delhi: The North India myopia study (NIM study)," PLoS One, vol. 10, no. 2, pp. 1–11, 2015, doi: 10.1371/journal.pone.0117349.

[29] Y. Hu, X. Ding, X. Guo, Y. Chen, J. Zhang, and M. He, "Association of Age at Myopia Onset With Risk of High Myopia in Adulthood in a 12-Year Follow-up of a Chinese Cohort," JAMA Ophthalmol, vol. 138, no. 11, pp. 1129–1134, Nov. 2020, doi: 10.1001/jamaophthalmol.2020.3451.

[30] S. Y. L. Chua et al., "Age of onset of myopia predicts risk of high myopia in later childhood in myopic Singapore children.," Ophthalmic Physiol Opt, vol. 36, no. 4, pp. 388–394, Jul. 2016, doi: 10.1111/opo.12305.

[31] B. Kinge, A. Midelfart, G. Jacobsen, and J. Rystad, "The influence of near work on development of myopia among university students. A three-year longitudinal study among engineering students in Norway," Acta Ophthalmol Scand, vol. 78, no. 1, pp. 26–29, Feb. 2000, doi: 10.1034/j.1600-0420.2000.078001026. x.

[32] S. M. Saw et al., "Nearwork in early-onset myopia," Invest Ophthalmol Vis Sci, vol. 43, no. 2, pp. 332–339, 2002.

[33] E. Dolgin, "The myopia boom," Nature, vol. 519, no. 7543, pp. 276–278, Mar. 2015, doi: 10.1038/519276a.

[34] E. Ojaimi, K. A. Rose, W. Smith, I. G. Morgan, F. J. Martin, and P. Mitchell, "Methods for a population-based study of myopia and other eye conditions in school children: the Sydney Myopia Study.," Ophthalmic Epidemiol, vol. 12, no. 1, pp. 59–69, Feb. 2005, doi: 10.1080/09286580490921296.

[35] G. Lingham et al., "Time spent outdoors in childhood is associated with reduced risk of myopia as an adult," Sci Rep, vol. 11, no. 1, pp. 1–11, 2021, doi: 10.1038/s41598-021-85825-y.

[36] C. S. McCarthy, P. Megaw, M. Devadas, and I. G. Morgan, "Dopaminergic agents affect the ability of brief periods of normal vision to prevent form-deprivation myopia.," Exp Eye Res, vol. 84, no. 1, pp. 100–107, Jan. 2007, doi: 10.1016/j.exer.2006.09.018.

[37] J. Sun et al., "High prevalence of myopia and high myopia in 5060 Chinese University students in Shanghai," Invest Ophthalmol Vis Sci, vol. 53, no. 12, pp. 7504–7509, 2012, doi: 10.1167/iovs.11-8343.