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Prevalence and Risk Factors of Myopia among Undergraduate Students

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ABSTRACT

Background: This study aims to determine the prevalence of refractive error among undergraduate students in Far Western Nepal and association with ethnicity, parental history of myopia and environmental factors.

Methods: Non-interventional, cross-sectional study was done with random sampling involving 768 undergraduate students aged 18 to 26 years were included. Comprehensive ocular examinations were performed using non-cycloplegic refraction by single examiner. A structured, pre-validated questionnaire was used to gather personal demographics, outdoor activity levels, screen time, parental history of myopia, and ethnicity.

Results: The refractive error was found in 16.63% with myopia prevalent in 16.40% of the students. The findings revealed a significant association between myopia and several risk factors, including parental myopia (β=-0.86$\pm$0.05; $p<0.001$), extended near work (β=-0.60$\pm$0.08; $p<0.001$), and high screen time (β=-0.81$\pm$0.05; $p<0.001$). This significant association revealed higher incidences of myopia within academic departments that require intensive near visual tasks, especially in engineering department. Furthermore, ethnic variations indicated that Aryan students, particularly in the Brahmin and Chhetri communities has higher prevalence of myopia than other groups.

Conclusions: The higher prevalence of myopia among the undergraduate students in Far West Nepal was seen at the age of 19. This study suggests the critical risk factors associated with myopia, including age, outdoor activities, screen time, parental history, and ethnic variations which need early health initiatives with preventive strategies for the growing incidence of myopia.

Keywords: Myopia: near work; outdoor activity; undergraduate students and ethnicity.

INTRODUCTION

Uncorrected refractive error is a major cause of mild to severe vision impairment globally.[1] The increasing trend of myopia cause visual impairment affecting socioeconomic and health care aspects impacts of people in Nepal, Eastern Asian Countries, United States, and non-Asian countries.[2-4] It is predicted that by 2050, 50% of the global population will be myopic.[5] Age, Parental myopia,[6,7] maximum time spent in near work and less time outdoor activities,[8] educational pressure are risk factors for myopia development and progression.[9,10] A study conducted among medical students in Kathmandu City found significant association between refractive error and daily use of mobile phones and laptop.[11] However, there is not any study conducted in specialized group of Engineering, Science and Management students who are subjected to a lot of visual stress on higher education in Nepal. Among college students, this study is important to understand what refractive changes occur to school children when they reach college. Therefore, this study aims to determine the prevalence of myopia and its associated risk factor among undergraduate students of Far West Nepal, with a focus on differences across academic disciplines.

METHODS

This is a cross-sectional study among the undergraduate students of Dhangadhi city, Far West, Nepal, between June 2023 to May 2024.There was altogether six undergraduate college in Dhangadhi sub-metropolitan city. For the sampling population all the six collage were considered as six clusters. Among them, two college as two clusters were selected by using simple random sampling as a part of the study. All the eligible students meeting

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all the inclusion criteria (18-26 years), from selected collages who were present during the examination time were included using one stage cluster sampling. The final sample size was determined based on probability proportion to size (PPS) technique and feasibility of data collection. No exclusion was made based on ethnicity, socioeconomic status, or academic discipline. Popular academic disciplines among undergraduate students in the study area were Engineering, Management and Science. Informed consent was taken from interested ones and then participants were enumerated as per the study objectives.

Permission was obtained from education and health section of Dhangadhi sub-metropolitan city. Data was collected from 16th June to 12 November 2023 and was recorded in proforma. The research was adhered to the tenets of the Declaration of Helsinki and the study protocol was approved by the Nepal Health Research council, Kathmandu, Nepal in 11th July 2023 with reference number 3308.

The sample size was calculated using the Cochran's formula; z2 *p *(1−p)/d2, where p=51.4% the prevalence of refractive error taken from past study done by Rizyal, A. and research team in 2019 (Rizyal, A. et al.2019), z=1.96 at 95% confidence interval with precision 0.05. The expected prevalence p=51.4% refractive error was used as baseline value in previously published research article where sample size was 384.[11] In the study done by Rizyal, A. et al.2019, the prevalence of refractive error was two times greater inside Kathmandu valley, Nepal. Therefore, the sample size was increased two times of 385 which was equals to 768 using the prevalence formula, sample size = $\{(1.96)^2 \times 0.514 \times (1-0.514)\}/(0.05)^2$.

Inclusion Criteria: Students aged 18 to 26 years studying in undergraduate level colleges of Dhangadhi city and willing to participate in the study. Exclusion criteria: All students not satisfying inclusion criteria, history of any ocular disease, surgeries, strabismus, amblyopia, astigmatism greater than 3.00D were excluded.

Distant Visual Acuity (VA) was taken with electronic VA tester using snellen's multiple optotypes. Portable slit lamp biomicroscope was used for anterior segment eye evaluation and Ophthalmoscope was used for posterior segment eye evaluation. Refractive error was assessed objectively using manual retinoscope using Beta-Heine retinoscope by single optometrist with working distance 50cm. All the study tools had their own international standard and used in routine clinical practice. Structured pre-validated questionnaires were used to collect the student's demographics. Environmental factors including hours spent per day in near work and outdoor activity, history of parental myopia was recruited and proceed for further analysis.

All the examination was done for both eyes and an average value was taken for further analysis. Refractive status of the participants was further classified into emmetropia, Spherical Equivalent of Refraction (SER), myopia, astigmatism and hyperopia. The SER was calculated as (sphere+1/2 cylinder). The prevalence of refractive error utilizing different definitions was calculated based on non-cycloplegic refraction data. To be consistent with International Myopia Institute (IMI) and study in Nepal and abroad, refractive error was defined as follows: myopia as SER ≤-0.50D, low myopia as SER≤-0.50D to >-3.00D, moderate myopia as SER of -3.00D to >-6.00D, and high myopia as SER≤-6.00D. Hyperopia was defined as SER>+0.50D, astigmatism as a cylinder power ≥0.50D and high astigmatism ≥3.0D.

Outdoor activity: Out-door activity was defined as any activity performed while staying outdoors. The number of out-door activity hours in a day was recorded as reported by the participant. The average daily duration of total outdoor activities was calculated using the following formula: (hours spent on week-days×6+ hours spent on weekends)/7.

Nepal belongs to South Asia with two racial branches (Indo-Aryan and Mongolian), with six broad ethnicity (Khas-Arya, Janajati, Newar, Madhesi and others).[12] Major Sub-ethnicity including (Brahmin, Chhetri, Tharu, Dalit, Newar, Janajati, Muslim and Madhesi)[13] have more prevalence.

Statistical analyses were performed with SPSS 25.0 (SPSS Inc., Chicago, IL). P<0.05 was considered statistically significant. A comprehensive proforma was developed to record the findings. Chi-squared test was used to compare the categorical and nominal variables between groups and expressed as mean± SD. An independent One-way ANOVA were used to compare the mean SE between the groups. Mann-Whitney test and Krusal-Wallis test were used to compare the mean value of categorical data for different groups. Univariate linear regression model analysis was used to determine the associate factors for myopia and astigmatism.

RESULTS

A total of 789 college students were available, of which 768 meeting the inclusion criteria were included in the study. Of the students not satisfying inclusion criteria 7 had strabismus, 9 had amblyopia and 4 students were under 18 years old. Since high correlation was observed between two eyes for SE (r=0.93), myopia (r=0.93), only data from right eye was included for the analysis. The demographic characteristics and refractive distribution were presented in **Table 1**. **Figure 1** shows the frequency distribution of myopia with maximum magnitude seen by the age of 19. The prevalence of myopia by sex, race, broad-ethnicity, ethnicity, academic department, is shown in **Table 2**. Emmetropia was found in 83.5% (641) students, 16.5% (127) students were found to have a refractive error and among 127 students, 126 had myopia. Parental history using prescribed glasses was seen in 46 (6%). The relationship between myopia and independent predictors including demographics, academic department, parental history of myopia, outdoor work and screen time are shown in **Table 3. Figure 2** shows the strong association of myopia with outdoor work (β=-0.60±0.08; p<0.001), gadgets screen time (β=-0.81±0.05; p<0.001), academic departments (β=-0.73±0.05; p<0.001) and parental history (β=-0.68±0.05; p<0.001) using univariate model. **Table 4** shows the different environmental exposure and education stream with the increasing magnitude of myopia. Almost half of the participants (50.7%) performed outdoor activities for less than 2 hours whereas more than two third participants (87.1%) had screen time of more than 2 hours. Majority of the participants (91.8%) did not have parental myopia.

Table 1.Demographics of participants and refractive distribution.

	Participants, % (95%CI)	Mean Age (Years), 95%CI	Mean (SE) (D), 95%CI	Mean Cylinder (D),95%CI
Total Participants	768	20.70±2.85 (17-34)	-0.75±0.57 (0.75 to -3.50)	-0.76±0.56 (-0.50 to -3.00)
Sex				
Male	406 (52.9%)	21.29±3.10 (17-34)	-0.77±0.53 (0.75 to -2.00)	-0.88±0.70 (-0.50 to -3.00)
Female	362 (47.1%)	20.04±2.39 (17-29)	-0.74±0.62 (-0.25 to -3.50)	-0.64±0.18 (-0.50 to -1.00)
	$P_{Mann-Whitney}$	U=52364; p<0.0001*	U=17770.5; p=0.30	U=441.5; p=0.41
Self-identified Race				
Aryan	756 (98.4%)	20.71±2.86 (17-34)	-0.75±0.57 (0.75 to -2.00)	-0.75±0.51 (-0.50 to -3.00)
Mongolian	12 (1.6%)	20.58±2.79 (18-28)	-0.37±0.17 (-0.25 to -0.50)	-0.75±0.35 (-0.50 to -1.00)
	$P_{Mann-Whitney}$	NA	NA	NA
Self-identified Broad-Ethnicity				
Indo-Aryan[a]	655 (85.3%)	20.67±2.85 (17-34)	-0.74±0.50 (0.75 to -2.00)	-0.79±0.57 (-0.50 to -3.00)
Sino-Tibetan[b]	7 (0.9%)	20.57±2.37 (18-24)	-0.50±0.00 (-0.50 to -0.50)	-1.00±0.00 (-1.00 to -1.00)
Indo-Aryan and austroasiatic[c]	103 (13.4%)	20.83±2.81 (17-32)	-0.90±0.90 (-0.25 to -0.25)	-0.60±0.17 (-0.50 to -1.00)
Indo-Aryan and Sino-Tibetan[d]	3 (0.4%)	24.33±3.51 (21-28)	-0.25±0.00 (-0.25 to -0.25)	-0.50±0.00 (-0.50 to -0.50)

Table 1.Demographics of participants and refractive distribution.

	Participants, % (95%CI)	Mean Age (Years), 95%CI	Mean (SE) (D), 95%CI	Mean Cylinder (D),95%CI
	$P_{Krusal\text{-}Wallis}$	H (3) =4.89; p=0.18	H (3) =1.84; p=0.60	H (3) =5.72; p=1.26
Sub-Ethnicity				
Brahmin	254 (33.1%)	20.61±2.60 (17-29)	-0.81±0.55 (0.75 to -2.00)	-0.85±0.69 (-0.5- to -3.00)
Chhetri	352 (45.8%)	20.75±3.03 (17-34)	-0.67±0.42 (-0.25 to -2.00)	-0.76±0.47 (-0.50 to -3.00)
Dalit	44 (5.7%)	20.39±2.83 (17-32)	-1.00±1.06 (-0.25 to -1.75)	-0.50±0.00 (-0.50 to -0.50)
Tharu	103 (13.4%)	20.83±2.81 (17-32)	-0.90±0.90 (-0.25 to -3.50)	-0.60±0.17 (-0.50 to -1.00)
Newar	3 (0.4%)	24.33±3.51 (21-28)	-0.25±0.00 (-0.50 to -0.50)	-0.50±0.00 (-0.50 to -0.50)
Janajati	6 (0.8%)	20.33±2.50 (18-24)	-0.50±0.00 (-0.50 to -0.50)	-1.00±0.00 (-1.00 to -1.00)
Muslim	3 (0.4%)	20.00±2.65 (18-24)	0.00±0.00	0.00±0.00
Madhesi	3 (0.4%)	20.67±2.89 (19-24)	0.00±0.00	0.00±0.00
	$P_{Krusal\text{-}Wallis}$	H (7) =5.78; p=0.56	H (5) =3.72; p=0.59	H (5) =4.94; p=0.42
Academic Department				
Engineering	217 (28.3%)	23.10±3.43 (19-34)	-0.90±0.40 (-0.25 to -2.00)	-1.17±0.86 (-0.50 to -3.00)
Science	44 (5.7%)	21.39±1.98 (19-25)	-0.25±0.00 (-0.25 to -0.25)	-0.50±0.00 (-0.50 to -0.50)
Commerce	507 (66.0%)	19.61±1.81 (17-28)	-0.71±0.61 (0.75 to -3.50)	-0.68±0.38 (-0.50 to -3.00)
	$P_{Krusal\text{-}Wallis}$	H (2) =202.19; p<0.001**	H (2) =9.71; p<0.05*	H (2) =8.13; p<0.05*

Abbreviations: D, Diopter; *significance difference <0.05; **significance difference <0.01; CI=Confidence Interval; a=Brahmin, Chhetri, Dalit, Muslim, Madhesi; b=Janajati; c=Tharu; d=Newar; SE=Spherical Equivalent; NA= Not Applicable due to insufficient participants.

Table 2. Magnitude of myopia stratified by sex, race, broad-ethnicity, cast-ethnicity, academic department in Nepalese University students.

Variables	n	Myopia, n, % (95% CI), (≤-0.50D)	Low myopia, n, % (95% CI), (≤-0.50 to >-3.00D)	Astigmatism, n, %, (95% CI),
Total Participants	768	15 (2%)	56 (7.3%)	64 (8.3%)
Sex				
Male	406 (52.9%)	11 (73.3%)	31 (55.4%)	31 (48.4%)
Female	362 (47.1%)	4 (26.7%)	25 (44.6%)	33 (51.6%)
	$P_{Mann-Whitney}$	U=22.00; p=1.00	U=413.00; p=0.66	U=557.50; p=0.50
Race				
Aryan	756 (98.4%)	15 (100.0%)	56 (100.0%)	62(96.9%)
Mongolian	12 (1.6%)	0.00	0.00	2 (3.1%)
	$P_{Mann-Whitney}$	NA	NA	U=53.0; p=0.70
Broad-ethnicity				
Indo-Aryan[a]	655 (85.3%)	13 (86.7%)	50 (89.3%)	49 (76.6%)
Sino-Tibetan[b]	7 (0.9%)	NA	NA	2 (3.1%)
Indo-Aryan and austroasiatic[c]	103 (13.4%)	2 (13.5%)	6 (10.7%)	12 (18.8%)
Indo-Aryan and Sino-Tibetan[d]	3 (0.4%)	NA	NA	1 (1.6%)
	$P_{Krusal-Wallis}$	H (1) =0.00, p=1.0	H (1) =1.14, p=0.28	H (3) =5.72, p=0.12
Sub-Ethnicity				
Brahmin	254 (33.1%)	5 (33.3%)	26 (46.4%)	20 (31.3%)
Chhetri	352 (45.8%)	8 (53.3%)	23 (41.1%)	29 (45.3%)
Dalit	44 (5.7%)	NA	1 (1.8%)	1 (1.6%)
Tharu	103 (13.4%)	2 (13.3%)	6 (10.7%)	12 (18.8%)
Newar	3 (0.4%)	NA	NA	1 (1.6%)
Janajati	6 (0.8%)	NA	NA	1 (1.6)
Muslim	3 (0.4%)	NA	NA	NA
Madhesi	3 (0.4%)		NA	NA
	$P_{Krusal-Wallis}$	H (2) =5.78, p=0.56	H (3) =3.72, p=0.59	H (5) =4.94, p=0.42
Academic Department				
Engineering	217 (28.3%)	3 (20%)	21 (37.5%)	10 (15.6%)
Science	44 (5.7%)	NA	NA	1 (1.6%)
Commerce	507 (66.0%)	12 (80%)	35 (62.5%)	53 (82.8%)
	$P_{Krusal-Wallis}$	H (1) =0.00; p=1.00	H (1) =2.74; p=0.09	H (2) =8.13; p=0.01*

Abbreviations: D, Diopter; *significance difference <0.05; **significance difference <0.01; CI=Confidence Interval; a=Brahmin, Chhetri, Dalit, Muslim, Madhesi; b=Janajati; c=Tharu; d=Newar; SE=Spherical Equivalent; A= Not Applicable due to insufficient participants.

Table 3. Summary of regression analysis for variable predicting spherical equivalent of myopia (SEM), myopia, low myopia, moderate myopia and Astigmatism.

	SEM (β±SD; p-value)	Low Myopia (β±SD; p-value)	Astigmatism (β±SD; p-value)
Age	-0.01±0.40; p=0.99	0.03±0.01; p=0.13	1.04±0.52; p=0.05
Sex			
Male	-0.77±0.07; p<0.001**	0.005±0.10; p=0.95	-0.64±0.08; p<0.001**
Female	-0.75±0.06; p<0.001**	0.005±0.10; p=0.95	-0.87±0.08; p<0.001**
Race			
Aryan	-0.76±0.05; p<0.001*	-1.10±0.05; p<0.001	-0.75±0.06; p<0.001**
Mongolian	NA	NA	-0.75±0.25; p=0.25
Broad-ethnicity			
Indo-Aryan[a]	-0.87±0.12; p<0.001**	-1.33±0.15; p<0.001**	-0.65±0.13; p<0.001**
Sino-Tibetan[b]	-0.76±0.05; p<0.001**	NA	-0.74±0.06; p<0.001**
Indo-Aryan and austroasiatic[c]	-0.74±0.05; p<0.001**	-1.08±0.52; p<0.001**	-0.78±0.07; p<0.001**
Caste-ethnicity			
Brahmin	-0.70±0.06; p<0.001**	-1.09±0.06; p<0.001**	-0.71±0.07; p<0.001**
Chhetri	-0.86±0.06; p<0.001**	-1.18±0.06; p<0.001**	-0.75±0.08; p<0.001**
Dalit	-0.76±0.05; p<0.001**	-1.09±0.04; p<0.001**	-0.75±0.06; p<0.001**
Tharu	-0.74±0.05; p<0.001**	-1.08±0.05; p<0.001	-0.78±0.07; p<0.001**
Newar	-	NA	-0.75±0.06; p<0.001**
Janajati	-0.76±0.05; p<0.001**	NA	-0.75±0.06; p<0.001**
Academic Department			
Engineering	-0.73±0.05; p<0.001**	-1.18±0.06; p<0.001**	-0.67±0.06; p<0.001**
Commerce	-0.85±0.10; p<0.001**	-0.97±0.07; p<0.001**	-1.14±0.14; p<0.001**

Abbreviations: D=Diopter; CI=Confidence Interval; a=Brahmin, Chhetri, Dalit, Muslim, Madhesi; b=Janajati; c=Tharu; d=Newar; SEM=Spherical Equivalent Myopia; *significance difference <0.05; **significance difference <0.01; NA= Not Applicable due to insufficient participants

Table 4. Distribution of participants and environmental exposure for myopia distribution.

	Participants, n, % (95%CI)	Mean (SEM) (D), 95%CI	Mean Cylinder (D),95%CI
Total Participants	768	126	126
Outdoor Activities			
Less than 2 hours	379 (49.3%)	-0.84±0.60 (-0.25 to -3.50)	-0.81±0.55 (-0.50 to -3.00)
More than 2 hours	389 (50.7%)	-0.60±0.40 (-0.25 to -1.63)	-0.69±0.46 (-0.50 to -3.00)
	$P_{Mann-Whitney}$	U=2233.50; p=0.02*	U= 613; p=0.13
Parental myopia			
Yes	63 (8.2%)	-1.08±0.69 (-0.25 to -3.50)	-0.88±0.83 (-0.50 to -3.00)
No	705 (91.8%)	-0.68±0.48 (-0.25 to -2.00)	-0.73±0.44 (-0.50 to -3.00)
	$P_{Mann-Whitney}$	U=1821; p=0.001**	U=231.0; p=0.72
Screen time			
Less than 2 hours	99 (12.9%)	-0.50±0.37 (-0.25 to -1.75)	-0.64±0.16 (-0.50 to -1.00)
More than 2 hours	669 (87.1%)	-0.81±0.56 (-0.25 to -3.50)	-0.77±0.55 (-0.50 to -3.00)
	$P_{Mann-Whitney}$	U=684.5; p=0.02*	U=303; p=0.87
Academic Department			
Engineering	217 (28.3%)	-0.85±0.36 (-0.25 to -1.50)	-1.17±0.86 (-0.50 to -3.00)
Science	44 (5.7%)	NA	-0.50±0.00 (-0.50 to -0.50)
Commerce	507 (66.0%)	-0.73±0.60 (-0.25 to -3.50)	-0.68±0.38 (-0.50 to -3.00)
	$P_{Krusal-Wallis}$	H (1) =5.06; p=0.02*	H (2) =8.13; p=0.01*

Abbreviations: D=Diopter; CI=Confidence Interval; SEM=Spherical Equivalent Myopia; *significance difference <0.05; **significance difference <0.0; NA= Not Applicable due to insufficient participants

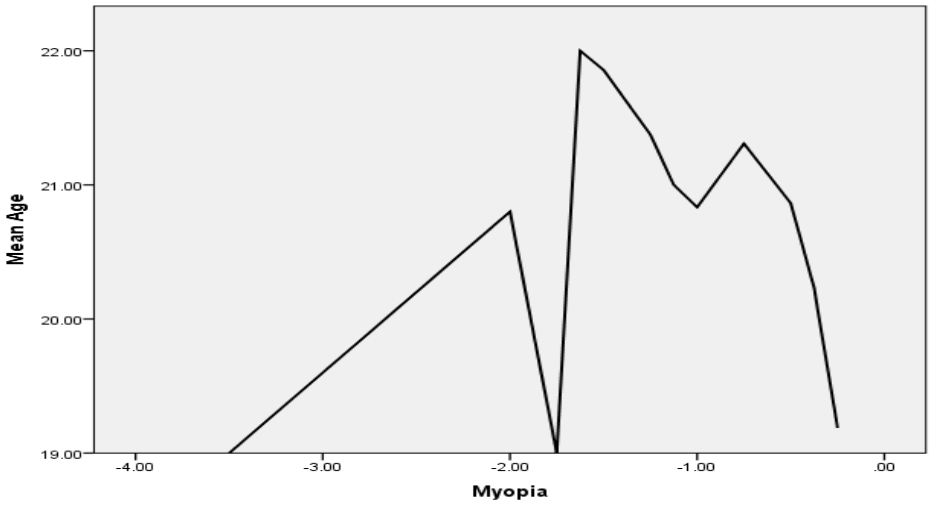

Figure 1. Frequency distribution of myopia in University students with age showing maximum myopia progression occur by the age of 19.

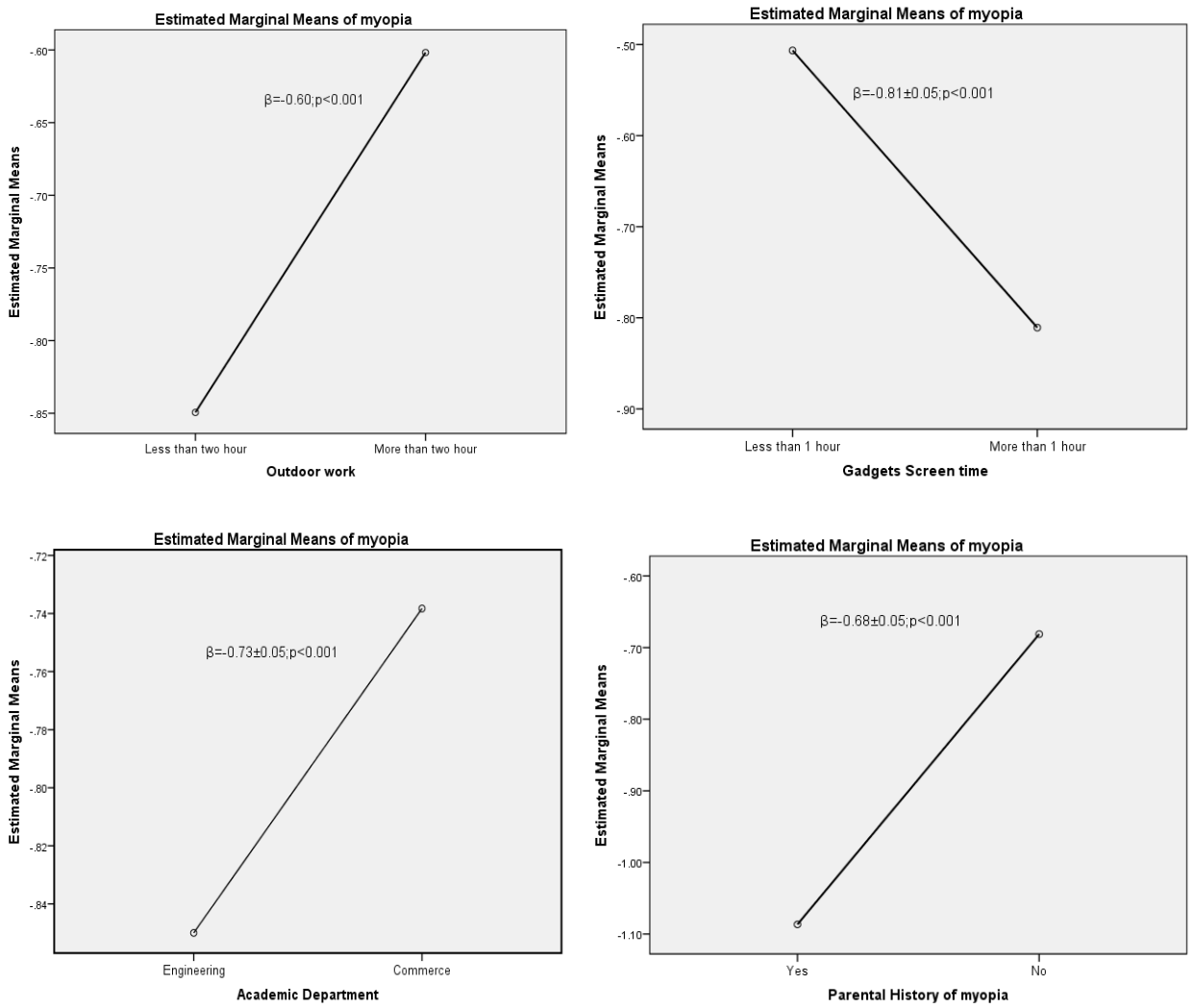

Figure 2. Regression plot showing the relationship between outdoor works, gadgets screen time, academic departments and parental history of myopia, showing the increase risk of having myopia.

DISCUSSION

This is the first study to determine the prevalence of refractive error among undergraduate students in Far West Nepal. In this study majority of the study participants were male (52.9%) which is supported by Kamara D et. al.[14] where male students were 240 (65%) and 128 (35%) were females, and Mehta et al[15] where myopia was distributed in males and females as 54.47% vs. 45.52% ($p<0.05$) respectively. Female gender (51.6%) had significantly higher astigmatism than male (48.4%) whereas low myopia was found more in male (55.4%) than female (44.6%). Ethnicity wise data showed, Aryan was found to have higher side of refractive error (-0.75±0.57) than Mongolian (-0.37±0.17). Ethnicity and racial traits may alter eye growth leading to the development of refractive errors, especially myopia and astigmatism. In this study the overall prevalence of myopia among undergraduate students was found to be 16.4%, which is significantly two times higher than the school children (7.2%) of Far West Nepal.[16] Regarding to the broad ethnicity, Indo-Aryan with Brahmin and Chhetri community has shown higher prevalence of myopia which is comparable with earlier study among school children suggesting similar prevalence pattern of myopia among ethnic group. These results may be due to educational background of parents, urban lifestyle, better socio-economic condition, modern lifestyle, more competitive educational environment, and early school entry than other communities.[17,18] Likewise, among undergraduate students, engineering students had found significantly higher prevalence of myopia and astigmatism.[19] Engineering students have high educational pressure, spend more time

on gadgets screen than other educational stream in same geographical area yields higher chance of having myopia.[20,21,22] Study by Lingham et al. discovered the increased outdoor time during childhood reduced the risk of developing myopia (OR=0.82, CI 95%: 0.69, 0.98) in 303 adults (aged 25 to 30 years).[23] Increased outdoor activities plays a protective factor against myopia, as the natural light intensity stimulates the retina to secrete dopamine, which inhibits eye growth and reduce the myopia progression.[24]

This study revealed the strong association of positive family history with myopia among the students (β=-0.86±0.05;p<0.001), and this findings was also supported in previous study.[25] Study done by Wu et al involving 4798 children between the ages of 16 and 18, found that parental myopia increases the likelihood of developing myopia (OR=2.28, 95% CI=1.80–2.801).[26] It was discovered that having myopic parents was linked to a higher incidence of myopia in offspring in the Singapore Cohort Study of the Risk Factors for Myopia (SCORM).[27] Study done by Jing Sun et al in 5060 Chinese University Students in Shanghai, found the family history of myopia in university which is significantly linked with hereditary factor.[28] From these all findings it can be concluded that various environmental factor, family history, ethnicity play important role in myopia among university students.

This cross-sectional study was university-based investigation rather than population-based and provides the non-cycloplegic refraction data which might alter prevalence findings slightly. As colleges from Dhangadhi Sub Metropolitan City is only included, this might not be representative of college students from other parts of Far West Nepal. The study is not able to tell specifically about the types of outdoor and screen activity performed.

CONCLUSIONS

The prevalence of myopia among undergraduate students in Far Western Nepal is significantly higher with 16.53% than reported in school children in the region. This study suggests the critical risk factors associated with myopia, including age, outdoor activities, screen time, parental history, and ethnic variations suggesting urgent need for public health initiatives with preventive strategies for the growing incidence of myopia.

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CONFLICTS OF INTEREST

No conflict of interest related to this submission.

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