

# Risk factors for myopia in Inner Mongolia medical students in China

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## ABSTRACT

**Objective:** The aim of the study was to investigate myopia and related factors in Inner Mongolia Medical Students, China. **Methods:** The survey employed a self-administered questionnaire. All medical students from the Inner Mongolia Medical University campus and those living and learning on campus were eligible. The questionnaire consisted of three sections: students' basic information, attitude on myopia behavior, and myopia status of students. **Results:** A total of 6040 (90.5%) students aged 16 to 28 years (mean  $21 \pm 1.5$  years) completed the questionnaire, of which 1772 (29.3%) were male and 4268 (70.6%) were female. The Mongolia of medical students had the lowest rate (64.3%) of myopia. The prevalence of myopia in Han nationality was highest (72.8%). Myopia occurred more frequently among students living in the city than in the rural. 76.4% urban and 66.6% rural students had myopia ( $p < 0.001$ ). For myopia students it was established that 85.5% had begun to wear spectacles in middle school. **Conclusion:** A high myopia prevalence was demonstrated among medical students in the Inner Mongolia area of China. Our study's findings could help health care professionals develop targeted myopia control policies for the population of students in Inner Mongolia of China and ensure the policies are more rational, useful, and effective.

**Keywords:** Medical Students; Myopia; Prevalence; Ethnicity; Area

## 1. INTRODUCTION

"Myopia is a global public health problem leading to

visual impairment and blinding complications" [1]. "The aetiology of myopia is multifactorial and both genes and environment play important roles. Twin studies indicate a strong genetic influence and a weak environmental impact" [2]. "However, results from experimental studies, including in primates, support the evidence of environmental factors from human epidemiology. These studies show that changes in visual experience by fitting of diffrusers or both positive and negative lenses over the eyes can generate signals that promote eye growth, leading to myopia, as well as signals that slow eye growth." [3] Vitale, *et al.* [4] "compared data between the periods 1971-1972 and 1999-2004 in the USA. The study, "using similar methodology to collect data from both periods, finds a significant increase from 25 to 41.6% ( $p < 0.001$ ) in rates of myopia in both men and women cohorts between the ages of 12 and 54" [4]. The prevalence of myopia is also increasing in Europe as well [5]. "In developed countries in east and southeast Asia, such as Singapore, China, Taiwan, Hong Kong, Japan, and Korea, the prevalence of myopia has rapidly increased in the past 50 - 60 years" [6,7]. The economic costs of myopia are also high. "In the United States, the National Health and Nutrition Examination Survey (NHANES) reported the annual direct cost of correcting distance vision impairment due to refractive errors to be between US\$3.9 and US\$7.2 billion" [8]. "In Singapore, the mean annual direct cost of myopia for each Singaporean school children aged 7 - 9 years was estimated to be US\$148" [9]. "The medical burden of high myopia includes pathologic complications such as myopic macular degeneration, choroidal neovascularisation, cataract and glaucoma" [1]. "Uncorrected refractive error could also impair vision-related quality of life and increase difficulty in performing vision-related tasks" [10].

Therefore, these factors "call for adequate diagnosis and correction of myopic refractive errors, effective treatment of myopic pathologies, and, above all, prevention

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of myopia” [11]. In the past few decades, “numerous epidemiology studies have provided information on the pattern of prevalence and risk factors for myopia” [12-14]. “Population-based studies with sufficient sample sizes, high response rates and few biases provide the strongest evidence for examining the aetiology of myopia” [7]. Until now, in Inner Mongolia, no study has been conducted on the prevalence of myopia among Han, Mongolia and other nationality. Consequently, we tend to explore the epidemiology of myopia in our university undergraduates and to evaluate the association between myopia, ethnicity, area, and attitude of myopia behavior among medical students of Inner Mongolia Medical University.

## 2. MATERIALS AND METHODS

The data analysed in our study came from a questionnaire survey of physical and mental health for the university students. The purpose of previous study was to determine the prevalence of and factors associated with daily smoking [15], myopia, body weight levels and the physical health status [16], etc. among medical students in Inner Mongolia of China. Jiang Bian *et al.* [15] reported that the test-retest reliability was 96.4%, the range of the Kappa index 6.03 - 8.03, and the average value of the Kappa index 7.13.

### 2.1. Research Targets

“A cross-sectional survey was conducted among medical students at the Inner Mongolia Medical College of China who resided on campus at the time of the survey. The survey focused on medical students and employed a self-administered questionnaire. At the time of the survey, a total of 6677 students were present at the Inner Mongolia Medical College campus” [15].

### 2.2. Questionnaire and Measures

“Subjects myopia were those who gave details about the age at which they started to wear spectacles or contact lenses. If they used spectacles or contact lens for looking at far objects, the parent was classified as myopic” [13]. Participants excluded from analyses included those reporting a history of cataract and/or glaucoma. The first concentrated on visual problems with distance or near vision, use of spectacles or contact lenses, attitude regarding myopia behavior and a self-reported medical history of cataract and/or glaucoma. The second included epidemiological variables such as age, gender and family ocular history. These data will be presented elsewhere. The third section was only answered by myopia students, and contained 4 questions about the attitude regarding myopia behavior.

In terms of the Mongolian ethnic minority, we divided ethnicity into 3 categories: Han, Mongolian, and other. Participants’ ethnicity information came from their basic information contained in the school database. The dates were same with Jiang Bian *et al.* [15] reported. Students coming from an urban area or suburb (area surrounding an urban area and under the jurisdiction of an urban government) were defined as city students, while those coming from a village or pastoral area were defined as rural students.

### 2.3. Statistical Analysis

Age of students was expressed as the mean age and standard deviation (SD) [15]. We investigated demographic characteristics between myopia and the following factors: gender, ethnicity, area, picky eater, have a rest after reading one hour, use computers, do eye exercises and number of myopic parents (all of which were in the survey). All variables were placed in a model of binary logistic regression analysis to ascertain factors associated with myopia. This technique is used for analyses with dependent variables with two levels (myopic and non-myopic in this case). Independent variables included in the model were gender (male/female), ethnicity (han nationality, mongolia, other nationality), area (city/rural), picky eater (yes/no), have a rest after reading one hour (yes/no), use computers (yes/no), do eye exercises (yes/no), number of myopic parents (zero, one, two), time of go to bed (before 22:00, 22:00-00:00, after 00:00, nothing regular) and the attitude of the participants to the myopia behavior.

Quantitative data were entered using EpiDate (Epi-Data Association, Denmark; v3.1). For all analyses, we used SPSS for Windows v13.0. A two-tailed  $p < 0.05$  was considered statistically significant.

### 2.4. Ethical Approval

The project was approved by the Ethical Committee of Inner Mongolia. Participants’ written informed consent was obtained.

## 3. RESULTS

A total of 6044 (90.5%) students aged 16 to 28 years (mean  $21 \pm 1.5$  years) completed the questionnaire, of which 1772 (29.3%) were male and 4268 (70.6%) were female. **Table 1** provides the baseline characteristics of the study participants and the prevalence of myopia in relation to each survey item. The myopia prevalence among Inner Mongolia medical students was 70.5% and the prevalence of myopia among females was higher than among male medical students (72.8% vs. 65.0%). The prevalence of myopia was 72.8% among the Han nationality, 64.3% Mongolia nationality and 67.0%

**Table 1.** Selected characteristics in myopic students.

| Variable                                   | N (%)       | Myopic n (%) | 95% CI      |
|--|-------------|--------------|-------------|
| <b>Gender (n = 6040)</b>                   |             |              |             |
| Male                                       | 1772 (29.3) | 65.0         | 62.8 - 67.2 |
| Female                                     | 4268 (70.6) | 72.8         | 71.5 - 74.1 |
| <b>Ethnicity (n = 6040)</b>                |             |              |             |
| Han nationality                            | 4314 (71.4) | 72.8         | 71.5 - 74.1 |
| Mongolia                                   | 1405 (23.3) | 64.3         | 61.8 - 66.8 |
| Other nationality                          | 321 (5.3)   | 67.0         | 61.9 - 72.1 |
| <b>Area (n = 5924)</b>                     |             |              |             |
| City                                       | 2483 (41.3) | 76.4         | 74.7 - 78.1 |
| Rural                                      | 3535 (58.7) | 66.6         | 65.0 - 68.2 |
| <b>Picky eater (n = 5949)</b>              |             |              |             |
| No   | 3769 (63.4) | 70.8         | 69.3 - 72.3 |
| Yes  | 2180 (36.6) | 71.4         | 69.5 - 73.3 |
| <b>Have a rest after reading one hour</b>  |             |              |             |
| No   | 4809 (80.9) | 74.2         | 73.0 - 75.4 |
| Yes  | 1105 (19.1) | 57.4         | 54.5 - 60.3 |
| <b>Use computers</b>                       |             |              |             |
| No   | 52 (0.9)    | 46.2         | 32.6 - 59.8 |
| Yes  | 5988 (99.1) | 70.8         | 69.6 - 72.0 |
| <b>Do eye exercises (n = 6025)</b>         |             |              |             |
| No   | 3498 (58.1) | 73.9         | 72.4 - 75.3 |
| Yes  | 2527 (41.9) | 66.2         | 64.4 - 68.0 |
| <b>Number of myopic parents (n = 6040)</b> |             |              |             |
| Zero                                       | 5163 (85.5) | 68.1         | 66.8 - 68.4 |
| One  | 754 (12.5)  | 83.8         | 81.2 - 86.4 |
| Two  | 123 (2.03)  | 91.1         | 87.1 - 96.7 |
| <b>Time of go to bed (n = 6026)</b>        |             |              |             |
| Before 22:00                               | 112 (1.9)   | 61.6         | 52.6 - 70.6 |
| 22:00-00:00                                | 4406 (73.1) | 70.4         | 69.1 - 71.7 |
| After 00:00                                | 1114 (18.5) | 71.9         | 69.3 - 74.5 |
| Nothing regular                            | 394 (6.5)   | 72.3         | 67.9 - 76.7 |

among the other nationality. The Han nationality of students with highest prevalence of myopia in inter Mongolia medical university. 76.4% urban and 66.6% rural students had myopia. It was observed that myopia oc-

curred more frequently among students living in the city than in the rural. The myopia prevalence in students who had one or two myopic parents was higher than in those without myopic parents. The myopia prevalence was 1.29 times higher for those students who did not have a rest after reading one hour compared to those who have a rest after reading one hour.

We included all factors in binary logistic regression models (**Table 2**). Univariate logistic regression analysis determined that age was significantly associated with myopia: 1.0 (ref) in male, score of adjustment to the female (OR = 1.42,  $p < 0.001$ ); 1.0 (ref) in Han nationality, score of adjustment to the Mongolia ethnicity (OR = 0.68,  $p < 0.001$ ); 1.0 (ref) in city, score of adjustment to the rural area (OR = 0.74,  $p < 0.001$ ). Number of myopic parents: 1.0 (ref) in zero parent, one parent OR = 2.02, two parents OR = 3.62,  $p < 0.001$ . Significant difference in students' myopia prevalence was found for students who have a rest after reading one hour ( $p < 0.001$ ). The attitudes of students toward myopia behavior showed statistical significance: Do more physical exercises are good for your eyes ( $p < 0.05$ ; **Table 2**).

In **Table 3**, for myopia students (4261) it was established that 85.5% had begun to wear spectacles in middle school. Only 28.6% myopia students go to the ophthalmic hospital to fit for spectacles. More than 90% of myopia students often rubbed their eyes by hands. Among all the questioned myopia students, 136 of the students have a habit of wearing contact lenses for a long time.

#### 4. DISCUSSION

Our study shows that the myopia prevalence among medical students is 70.5%, with a higher prevalence among female students (72.8%) compared to male students (65.0%). These findings are similar to results of another Chinese study in Weifang Medical University [17]. This is considerably higher compared to the recently reported prevalence of myopia among general population in Western countries; 33.1% in the United States [18], 35.0% in Norway [5], 26.6% in Western Europe and 16.4% in Australia [19]. Compared with medical students in other countries, the prevalence of myopia in our study is also considerably higher: myopia is the most common vision condition affecting approximately 50% of European medical students [12] 50.0% (45.0% and 53.9% for males and females, respectively), in Denmark [12] 50.3% in Norway [20] and 42% in Polish [21]. Our data additionally show that the prevalence of myopia is more common in females, similar to another study of university students [22,23].

Our study shows that living in an urban or a rural environment may have an influence on the occurrence of myopia among students. "Inner Mongolia has vast terri-

**Table 2.** Results of logistic regression analysis of myopia among medical students.

|   | <b>B</b> | <b>S.E.</b> | <b>Wald</b> | <b>p</b> | <b>OR</b> | <b>OR (95% CI)</b> |
|---|----------|-------------|-------------|----------|-----------|--------------------|
| <b>Gender (n = 6040)</b>                                |          |             |             | 0.000**  |           |                    |
| Male  |          |             |             |          | 1         |                    |
| Female  | 0.352    | 0.067       | 27.598      |          | 1.421     | 1.247 - 1.620      |
| <b>Ethnicity (n = 6040)</b>                             |          |             | 34.478      | 0.000**  |           |                    |
| Han nationality   |          |             |             |          | 1         |                    |
| Mongolia  | -0.389   | 0.071       | 29.814      |          | 0.678     | 0.590 - 0.779      |
| Other nationality                                       | -0.390   | 0.134       | 8.503       |          | 0.677     | 0.521 - 0.880      |
| <b>Area (n = 5924)</b>                                  |          |             |             | 0.000**  |           |                    |
| City  |          |             |             |          | 1         |                    |
| Rural   | -0.307   | 0.066       | 21.906      |          | 0.736     | 0.647 - 0.837      |
| <b>Picky eater (n = 5949)</b>                           |          |             |             | 0.799    |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.016   | 0.064       | 0.065       |          | 0.984     | 0.868 - 1.115      |
| <b>Have a rest after reading one hour</b>               |          |             |             | 0.000**  |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.591   | 0.076       | 60.990      |          | 0.554     | 0.477 - 0.642      |
| <b>Use computers</b>                                    |          |             |             | 0.091    |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | 0.583    | 0.345       | 2.849       |          | 1.791     | 0.910 - 3.525      |
| <b>Do eye exercises (n=6025)</b>                        |          |             |             | 0.000**  |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.289   | 0.061       | 22.604      |          | 0.749     | 0.665 - 0.844      |
| <b>Number of myopic parents (n = 6040)</b>              |          |             |             | 0.000**  |           |                    |
| Zero  |          |             | 53.603      |          | 1         |                    |
| One   | 0.704    | 0.111       | 40.073      |          | 2.023     | 1.626 - 2.516      |
| Two   | 1.287    | 0.324       | 15.768      |          | 3.622     | 1.919 - 6.838      |
| <b>Time of go to bed (n = 6026)</b>                     |          |             | 1.534       | 0.674    |           |                    |
| Before 22:00  |          |             |             |          | 1         |                    |
| 22:00-00:00   | -0.142   | 0.230       | 0.383       |          | 0.867     | 0.553 - 1.362      |
| After 00:00   | -0.225   | 0.241       | 0.870       |          | 0.799     | 0.498 - 1.280      |
| Nothing regular   | -0.118   | 0.258       | 0.208       |          | 0.889     | 0.536 - 1.474      |
| <b>Often see green is good for your eyes</b>            |          |             |             | 0.052    |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.173   | 0.089       | 3.778       |          | 0.841     | 0.706 - 1.001      |
| <b>Use of eye drops is good for your eyes</b>           |          |             |             | 0.449    |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.060   | 0.079       | 0.574       |          | 0.942     | 0.806 - 1.100      |
| <b>Do more physical exercises is good for your eyes</b> |          |             |             | 0.015*   |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | -0.251   | 0.104       | 5.882       |          | 0.778     | 0.635 - 0.935      |
| <b>Reading while lying is bad for your eyes</b>         |          |             |             | 0.581    |           |                    |
| No  |          |             |             |          | 1         |                    |
| Yes   | 0.087    | 0.158       | 0.304       |          | 1.091     | 0.800 - 1.478      |

\*p &lt; 0.05; \*\*p &lt; 0.01.

**Table 3.** The myopia status of students in Inner Mongolia Medical University. N = 4261.

| Category                                       | n    | (n/N) (%) |
|--|------|-----------|
| <b>When wear spectacles n = 3949</b>           |      |           |
| Kindergarten                                   | 14   | 0.4       |
| Primary school                                 | 307  | 7.8       |
| Middle school                                  | 3375 | 85.5      |
| University                                     | 398  | 6.4       |
| <b>Where be fitted for spectacles n = 4098</b> |      |           |
| Ophthalmic hospital                            | 1172 | 28.6      |
| Eyeglasses Store                               | 2706 | 66.0      |
| Both of them                                   | 220  | 5.4       |
| <b>Wear contact lens n = 4109</b>              |      |           |
| No   | 3978 | 96.8      |
| Yes  | 131  | 3.2       |
| <b>Often rubbed eyes by heads n = 4256</b>     |      |           |
| No   | 320  | 7.5       |
| Yes  | 3936 | 92.5      |

tory and long nomadic history, which cause the imbalance development between rural area and city area, so there is a large difference in living environment between rural area and city area" [15]. "The importance of environmental risk factors is strongly supported by experimentation with animals, and by the rapid changes in the prevalence of myopia. Associations of myopia with years of schooling and school results have been consistently reported" [6]. "The rise in myopia prevalence in urban east Asia might therefore be plausibly associated with the increasing intensity of education. Moreover, east Asian countries with high myopia now dominate international rankings of educational performance, according to the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment" [11].

"Myopia is thought to be multi-factorial with environmental and genetic factors as well as their interactions being involved" [23,24]. The present study supported such observation. We found that myopia prevalence among different ethnic groups was different. Mongolia is considered one of China's five minority areas. The Mongolia of medical students had the lowest rate (64.3%) of myopia. The prevalence of myopia in Han nationality was highest (72.8%). Several studies demonstrates the association of PAX6 variants with susceptibility to high myopia. "The PAX6 locus may contain polymorphisms playing a role in high myopia in southern Han Chinese"

[24,25].

Also our studies showed a higher proportion of myopic students among families with two myopic parents compared with one and no-myopic-parent families. This accord with previous research: "parental history of myopia has been postulated to be an important risk factor for the development of myopia" [26,27]. These results all support some genes influence in the etiology of myopia.

Several findings in current study can be used to inform the development of effective health promotion programs to prevent myopia among medical university students. First, as have a rest after reading one hour was recently shown to be another major factor, it is possible that increased rest after reading one hour may protect against myopia. Because of the "eyes are harmed by continuous reading" [2].

Second, our study also suggesting eye exercises and physical exercises are helpful. Eye exercises and physical exercises are protective factor for myopia. "We did not find any studies suggesting eye exercises are harmful" [28]. "An association between physical activity and myopia was observed, suggesting a protective effect of physical exercises on the development and progression of myopia in university students [29]." School managers should attempt made to "reduce accommodative fatigue by introducing pauses during reading and teaching and by eye exercises, etc. have been successful in reducing the number of students who develop myopia" [2].

Third, over 80% myopia students had begun to wear spectacles at middle school. "Added to this concern is myopia progression in teenage school students is very important" [30].

Fourth, over half of myopia students were not fitted for spectacles in ophthalmic hospital. "The extent of disability may be greater if myopia is not optimally corrected with appropriate spectacles or contact lenses" [30].

Fifth, more than 90% of myopia students often rubbed their eyes by hands. It is well known that if you don't pay attention to hygiene of eyes and often rubbing the eyes with dirty hands that causing eye irritation. In addition, there are 136 medical students still have a habit of wearing contact lenses for a long time. "Contact lens wear is known to lead to squamous metaplasia on the ocular surface" [31], "which is the primary cause of contact lens intolerance and has been identified in most ocular surface disorders, particularly in dry eye" [32]. Students must break those bad habits can be good for the eyes.

Based on the above research, school administrators should encourage them to actively participate in training and education to improve attitudes toward myopia, to increase protective factors, and reduce the risk factors for myopia behavior.

The present study had limitation. Myopia behavior

was assessed on the basis of self-reported data only, without the use of biochemical measurements.

## 5. CONCLUSION

A high myopia prevalence was demonstrated among medical students in the Inner Mongolia area of China. Our study's findings could help health care professionals develop targeted myopia control policies for the population of students in Inner Mongolia of China and ensure the policies are more rational, useful, and effective.

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