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# Effective Refractive Error Coverage (eREC) and Related Factors Among First-Year Medical Students at Pham Ngoc Thach University of Medicine in the Academic Year 2023–2024

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## Abstract

**Background:** Uncorrected refractive error is a leading cause of visual impairment globally, significantly impacting socio-economic development. The World Health Organization (WHO) recommends measuring the "effective refractive error coverage" (eREC) to assess the quality of eye care services. This study aimed to determine the eREC and its associated factors among first-year medical students at the Pham Ngoc Thach University of Medicine, Vietnam.

**Purpose:** To determine the effective refractive error coverage (eREC) and some related factors in first-year medical students at Pham Ngoc Thach University of Medicine in the 2023-2024 academic year.

**Methods:** A cross-sectional study was conducted on 179 first-year students. Data were collected through surveys and visual acuity examinations and analyzed using descriptive statistics and multivariate logistic regression.

The outcome variable is defined as effective refractive correction, determined when a student has uncorrected visual acuity below 6/12 in the better eye (or below 6/9 in the better eye according to the IAPB threshold) and corrected visual acuity above 6/12 in the better eye (or above 6/9 in the better eye according to the IAPB threshold).

### Results:

- The eREC rate was 94.1% according to the WHO 6/12 threshold and 85.1% according to the IAPB 6/9 threshold.

- Factors such as monthly spending ( $p=0.015$ ) and the timing of the last eye examination ( $p=0.003$ ) were significantly associated with eREC. Students with higher monthly spending and more recent eye examinations showed higher eREC rates, with statistically significant differences.

**Conclusions:** The eREC rate among first-year medical students at Pham Ngoc Thach University of Medicine is relatively high, eREC is related to students' monthly spending and the timing of their most recent eye examination. However, the University still needs to promote periodic eye examination and implement eye screening programs for the remaining courses besides first-year students. In addition, the study suggests directions for research in the future with larger, more representative sample sizes and longitudinal designs to find more factors with causal relationships.

**Keywords:** refractive error, effective refractive error coverage, medical students.

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## 1. INTRODUCTION

Uncorrected refractive error (URE) is the leading cause of global visual impairment and results in significant economic loss—particularly due to uncorrected myopia, which is estimated to result in a loss of USD 244 billion annually[1]. The World Health Organization (WHO) recommends measuring the “effective refractive error coverage” (eREC) to monitor the coverage and quality of eye care services within healthcare systems. This indicator reflects the proportion of the population achieving “good vision” following refractive correction. However, many regions still fall below the recommended 60% coverage, such as Africa (5.7%), East Asia (9.0%), and Latin America (34.5%) [2,3].

The age of 18 is a critical period for the progression of refractive errors, particularly myopia, as visual acuity begins to stabilize. Assessing eREC in 18-year-old medical students helps determine the effectiveness of refractive correction and identify individuals with unstable refractive error. This study was conducted at Pham Ngoc Thach University of Medicine (PNTU), targeting first-year students—those without formal medical training—to objectively reflect the current state of eye care services.

The findings aim to identify socio-economic factors and eye care habits related to refractive error among medical students, thereby supporting the enhancement of eye care quality for the future healthcare workforce.

**Study Objective:** To determine the effective refractive error coverage (eREC) and associated factors among first-year medical students at Pham Ngoc Thach University of Medicine in the academic year 2023–2024.

## 2. SUBJECTS AND METHODS

**2.1 Study subjects:** First-year medical students at Pham Ngoc Thach University

of Medicine during the 2023–2024 academic year.

- Inclusion criteria: First-year medical students enrolled in the 2023–2024 academic year at PNTU.

- Exclusion criteria: Individuals with previously diagnosed ocular diseases (e.g., strabismus, ptosis, nystagmus, etc.).

**2.2 Study period:** From June 2024 to July 2024.

**2.3 Study location:** Pham Ngoc Thach University of Medicine.

**2.4 Study design:** Cross-sectional.

**2.5 Sample size**

The sample size was calculated using the formula for estimating a proportion:

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

Where:

- n: minimum required sample size
- $\alpha$ : Type I error probability ( $\alpha = 0.05$ )

- $Z_{1-\alpha/2}^2 = 1.96$ : corresponding to 95% confidence level

- $p=0.457$ : eREC rate among students at Hai Duong Medical Technical University in 2024

- $d=0.1$ : desired precision (chosen based on  $p = 0.3-0.7$  range)

Using this formula, the calculated sample size was 115. The actual number of participants recruited was 163 students.

**2.6 Sampling method**

This study employed total population sampling by sending email invitations to all 664 first-year medical students at PNTU. Among them, 182 students agreed to participate and attended the university’s general clinic for vision screening. After applying the inclusion and exclusion criteria, 179 students were eligible. Of these, 163 students provided complete data regarding eye care and vision correction habits.

**2.7 Variable definitions**

- eREC based on WHO criteria:

$$eREC = \frac{\text{Cases corrected effectively}}{\text{Cases needed corrected}}$$

Cases needed corrected includes:

- *Uncorrected*: Visual acuity in the better eye < 6/12 without glasses and improves to ≥ 6/12 with correction.
- *Ineffectively corrected*: Wearing glasses with current VA < 6/12, but correctable to ≥ 6/12 with updated prescription or pinhole.
- *Effectively corrected*: VA < 6/12 without glasses, but ≥ 6/12 with current glasses.
- eREC based on IAPB criteria:

$$eREC = \frac{\text{Cases corrected effectively}}{\text{Cases needed corrected}}$$

Cases needed corrected includes:

- *Uncorrected*: VA < 6/9 in the better eye without glasses, improves to ≥ 6/9 with correction.
- *Ineffectively corrected*: Wearing glasses with VA < 6/9, but correctable to ≥ 6/9 with updated prescription or pinhole.
- *Effectively corrected*: VA < 6/9 without glasses, but ≥ 6/9 with current glasses.
- The outcome variable was coded as binary: “effective correction” or “not effective.” WHO’s 6/12 threshold represents the general population standard, while IAPB’s 6/9 is recommended for school screening.
- Monthly income was categorized based on Vietnam’s multidimensional poverty standards (2021–2025)[10].

## 2.8 Data collection tools

- The outcome variable (eREC) was assessed using standard visual acuity charts.
- Other variables were collected through a self-administered questionnaire based on eye care behavior frameworks from Rizyal (2019) and Shi (2018) [11,12].

## 2.9 Data processing and analysis

- eREC was presented in frequencies and proportions.
- Quantitative variables (e.g., time since last eye exam, time of first glasses use, residential area) were non-normally distributed and thus presented as median, interquartile range (IQR), and min–max.
- Logistic regression was used to explore associations between eREC and independent variables.
- Poisson regression was used to calculate prevalence ratios (PR) in multivariate analysis.

## 2.10 Ethics

The study was approved by the Institutional Review Board and Ethics Committee in Biomedical Research at PNT UMed (Approval No. 915/TĐHYKPNT–HĐĐĐ, dated November 14, 2023).

Students with poor visual acuity were given appropriate information and guidance on eye care after screening.

## 3. RESULTS

### 3.1 Characteristics of the study population

The demographic characteristics of the study population showed a fairly balanced gender distribution. However, there was a notable disparity in living areas, with the majority of students coming from rural regions. Most students’ parents had attained college/university/postgraduate education (63.2%). More than half of the students reported a monthly expenditure of 3 million VND or more.

Regarding eye care and usage habits, the study found that 137 students (84%) were currently correcting their refractive error with either glasses or refractive surgery. A majority (74.2%) had a family history of refractive error.

About 46% of students reported having their eyes examined once per year, while 39.3% had eye exams twice a year. Only 9.2% had not had an eye exam in the past year. These results are consistent with a

2021 study in Pakistan, which also found that medical students tend to undergo regular eye check-ups, with annual examinations being the most common [7].

3.2 Effective refractive error coverage (eREC)

- According to WHO’s 6/12 threshold [2]: Among the 163 participating students, 45 did not need refractive correction, 111 were effectively corrected, 3 were ineffectively corrected, and 4 were uncorrected. None fell into the visual impairment category. Therefore, the eREC rate based on the WHO’s 6/12 threshold was 94.1%.
- According to IAPB’s 6/9 threshold [2, 9]: Among the same 163 students, 42 did not need correction, 103 were effectively

corrected, 14 were ineffectively corrected, and 4 were uncorrected. No student had visual impairment. Thus, the eREC rate based on IAPB’s 6/9 threshold was 85.1%.

3.3 Factors associated with effective refractive error correction

- According to WHO’s 6/12 threshold: To examine the association between eREC and related factors, 45 students who did not require correction and 4 uncorrected students were excluded to simplify the grouping. Due to the small number of ineffectively corrected cases, no statistical test was conducted for associations under this threshold.
- According to IAPB’s 6/9 threshold:

**Table 1.** Association between monthly expenditure and effective refractive correction (N = 117)

Monthly expenditure	Effective correction				P	PR (95% CI)
	Yes (n = 113)		No (n = 14)			
	SL	%	SL	%		
Under 1.5 million VND	12	60.0	8	40.0	0.015	1
1.5 – 3 million VND	34	97.1	1	2.9		1.6(1.1-2.3)
Over 3 million VND	57	91.9	5	8.1		1.5(1.1-2.2)

These results show that students with higher monthly expenditures had a significantly higher rate of effective correction, particularly those spending 1.5 million VND or more. The difference was statistically significant (p = 0.015).

**Table 2.** Time since last eye exam and effective correction status (N = 117)

Time since last exam (months)	Median [IQR]	p
	5 [1;10]	0.003

Time since the last eye exam was significantly associated with eREC (p < 0.05).

Other variables did not show statistically significant associations.

Variables with p < 0.2 in chi-square, trend chi-square, Fisher’s exact, or Mann-Whitney U tests were included in multivariate logistic regression, including: parental education, monthly expenditure, and time since last eye exam.

After conducting multivariate logistic regression, parental education had some significant subcategories, but overall it did not consistently show a statistically meaningful association with the outcome (p = 0.118). Therefore, it was excluded from the final model to focus on more predictive variables.

Below are the adjusted prevalence ratios (PR) and p-values:

**Table 3.** Multivariate logistic regression analysis (N = 117)

Variables	PR (95% CI)	p
<b>Monthly expenditure</b>		
Under 1.5 million VND	1	
1.5 – 3 million VND	19.5(2.1-179.1)	<b>0.008</b>
Over 3 million VND	8.5(2.1-34.4)	<b>0.003</b>
<b>Last eye exam</b>	0.9 (0.8 – 1)	<b>0.013</b>

Predictive model for effective correction:

$$eREC = 1.2 + 2.9 \times (1.5 - <3 \text{ million VND}) + 2.1 \times (\geq 3 \text{ million VND}) - 0.1 \times (\text{months since last exam})$$

#### 4. DISCUSSION

##### 4.1 Effective Refractive Error Coverage (eREC)

The effective refractive error coverage among first-year medical students at Pham Ngoc Thach University of Medicine was 94.1% based on WHO’s 6/12 threshold and 85.1% using IAPB’s 6/9 threshold. These differences are due to the use of two different visual acuity cutoffs.

Compared with other studies, the WHO-based eREC rate of 94.1% found in this study is relatively high. For example, a global review by Bourne et al. (2022) found an average worldwide eREC rate of 35.7%, with Southeast Asia reaching 75.8%, and up to 79.1% in high-income countries [8]. This may be explained by the fact that community-level studies often include older adults, people with limited access to eye care, or low-income populations.

Therefore, to appropriately evaluate eREC among a specific group such as medical students, a higher threshold like IAPB’s 6/9 is more suitable, aligning with the vision expectations for future healthcare professionals.

This study found that 85.1% of first-year medical students had effective refractive correction under the IAPB threshold. This may be because students who enter medical school are generally more health-conscious, live mostly in urban areas with better access to eye care,

and are younger (aged 19–21) than participants in WHO-based population studies—factors that likely contribute to the high eREC rate.

##### 4.2 Factors related to eREC

The findings show a statistically significant association between monthly expenditure and eREC. Specifically, students spending 1.5–<3 million VND and  $\geq 3$  million VND per month had 1.6 and 1.5 times higher odds of effective correction, respectively, compared to those spending <1.5 million VND. This suggests that financial capacity influences access to and utilization of high-quality refractive services—consistent with findings from other international studies, such as Yekta et al. (2020) in Iran, which found that individuals with lower income were more likely to have unmet refractive error needs (OR = 2.3,  $p < 0.05$ ) [9].

The study also showed that students who had their eyes examined more recently (median: 6.2 months prior) had a significantly higher eREC rate than those whose last exam was further in the past (median: 14.1 months), with a statistically significant difference ( $p = 0.009$ ). This emphasizes the importance of regular eye examinations to ensure accurate and timely correction.

##### 4.3 Study limitations

This study has several limitations related to its scope and design. First, the recruitment method (via email invitation) may introduce selection bias, potentially favoring students with better vision or those more confident in their current correction. Second, the sample represents less than 30% of the target population, limiting generalizability. Additionally,

self-reported monthly expenditure may introduce measurement bias, affecting the reliability of related findings.

## 5. CONCLUSION

This study successfully identified the effective refractive error coverage (eREC) and its associated factors among first-year medical students at Pham Ngoc Thach University of Medicine, using both WHO and IAPB criteria. The eREC rates were 94.1% and 85.1%, respectively. Monthly expenditure and the time since the last eye examination were found to significantly affect the effectiveness of refractive correction.

Based on these findings, the study recommends strengthening collaboration between optometry professionals and the university to implement eye health education programs and promote regular eye screenings. Furthermore, the study suggests future research directions involving larger and more representative sample sizes and longitudinal study designs to identify additional factors with potential causal relationships.

## REFERENCES

1. Naidoo KS, Fricke TR, Frick KD, et al. Potential Lost Productivity Resulting from the Global Burden of Myopia: Systematic Review, Meta-analysis, and Modeling. *Ophthalmology*. 2019;126(3):338-346. doi:10.1016/j.ophtha.2018.10.029
2. World Health Organization. Report of the 2030 Targets on Effective Coverage of Eye Care.; 2022. <http://apps.who.int/>
3. Bourne RRA, Cicinelli MV, Sedighi T, et al. Effective refractive error coverage in adults aged 50 years and older: estimates from population-based surveys in 61 countries. *Lancet Glob Health*. 2022;10(12):e1754-e1763. doi:10.1016/S2214-109X(22)00433-8
4. Tiên Sơn Đ, Khắc Trường N, Phi Long H, et al. Khảo sát đặc điểm tật khúc xạ của sinh viên năm nhất Trường Đại học Kỹ thuật Y tế Hải Dương. *Tạp chí Y học Việt Nam*. 2024;540:113-116.
5. Naing L, Winn T, Rusli BN. Practical Issues in Calculating the Sample Size for Prevalence Studies. Vol 1.; 2006.
6. Shin HM, Shin HU, Jung JH. Prevalence of Refractive Error in Adults in Phnom Penh, Cambodia. *Journal of Korean Ophthalmic Optics Society*. 2018;23(4):301-307. doi:10.14479/jkoos.2018.23.4.301
7. Shah SP, Jadoon MZ, Dineen B, et al. Refractive errors in the adult Pakistani population: The national blindness and visual impairment survey. *Ophthalmic Epidemiol*. 2008;15(3):183-190. doi:10.1080/09286580802105822
8. Bourne RRA, Dineen BP, Noorul Huq DM, Ali SM, Johnson GJ. Correction of Refractive Error in the Adult Population of Bangladesh: Meeting the Unmet Need. *Invest Ophthalmol Vis Sci*. 2004;45(2):410-417. doi:10.1167/iovs.03-0129
9. Yekta A, Hashemi H, Pakzad R, et al. Economic inequality in unmet refractive error need in deprived rural population of Iran. *J Curr Ophthalmol*. 2020;32(2):189-194. doi:10.4103/JOCO.JOCO\_100\_20
10. Chính phủ Việt Nam. Nghị định số 07/2021/NĐ-C. Nghị định quy định chuẩn nghèo đa chiều giai đoạn 2021-2025, 2021.
11. Rizyal A. Nepal Medical College Journal 26 NMCJ Refractive Errors and Its Associated Factors among Undergraduate Medical Students in Kathmandu. Vol 21.; 2019.
12. Shi XY, Ke YF, Jin N, Zhang HM, Wei RH, Li XR. The prevalence of vision impairment and refractive error in 3654 first year students at Tianjin Medical University. *Int J Ophthalmol*. 2018;11(10):1698-1703. doi:10.18240/ijo.2018.10.19