Information for Vision: Experimental Evidence on Nudging Low-income Students to Wear Eyeglasses

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Abstract

This study uses a randomized experiment to examine the effectiveness of informational nudges about eyeglasses on middle-school students' decisions to purchase glasses after developing myopia. With a sample of 8,808 low-income middle school students in China, the experimental results show that the short-term impact of wearing glasses on academic achievement (vs. long-term impact, social norm, or cost) is the most effective information for students. We also find heterogeneity in baseline belief, peer effects, as well as in how students with different characteristics respond to various types of information. The cost-benefit analysis demonstrates the efficacy and cost-effectiveness of nudges in improving academic outcomes. Our results provide novel evidence of the importance of precise, personalized informational nudges in improving students' educational input and academic achievement.

Keywords: informational nudge, vision health, behavioral mechanism, decision-making

1 Introduction

Myopia is a leading cause of visual disability that can be corrected by wearing glasses. Despite this, studies reveal that a significant portion of low-income students with myopia do not wear glasses (Ma et al., 2014; Wang et al., 2015; Yi et al., 2015), which may affect their future development and compound social inequality. An emerging literature documents the effects of wearing eyeglasses on students' educational outcomes, suggesting that improving the availability and affordability of eyeglasses, such as providing free eyeglasses (Glewwe et al., 2016; Ma et al., 2014), vouchers(Guan et al., 2023), educational campaigns (Zhang et al., 2021), or a combination of these interventions (Sylvia et al., 2022), could significantly enhance the educational outcomes of low-income students. However, the effectiveness of those interventions is unexpectedly low due to the low take-up rates among students (Glewwe et al., 2016; Ma et al., 2014), as reported to be 53.11% by a meta-analysis (Wu et al., 2023). Few papers have

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identified the reasons for the low take-up, and it is worth investigating why students did not comply with the interventions in a favorable way as expected.

Considering the high returns to wearing glasses, there might be behavioral barriers contributing to the low take-up of eyeglasses. A vast literature in behavioral economics documents the negative effects of behavioral biases on individuals' decision-making. In particular, individuals with low socioeconomic status (SES) are more susceptible to behavioral biases (Lavecchia et al., 2016), which applies to the low-income students we focus on. These students, from less-educated or low-income families, often face limited access to accurate information and are surrounded by an environment with more stigma and redundant social norms, giving rise to their biased beliefs and other behavioral biases (Damgaard and Nielsen, 2018; Lavecchia et al., 2016). In our context, one important behavioral barrier might be loss aversion. That is, students may underestimate or be uncertain about the benefits of wearing glasses compared to the cost of wearing them, which leads to the low take-up. Another behavioral barrier is the concern with self- and social-image. Students value their self- and social-image and could have concerns about their appearance with eyeglasses, fearing teasing from their peers. Besides, students may also have information friction or incomplete information about the cost of a pair of standard eyeglasses and the prevalence of myopia among peers. Taken together, these behavioral barriers may play an important role in preventing students from wearing glasses.

Our study fills this gap by providing experimental evidence of the behavioral mechanism behind individuals' decision-making about the adoption of eyeglasses. We use informational nudges that target behavioral barriers and examine the effects of different information components on students' decisions regarding eyeglass usage. To this end, we conducted a large-scale survey experiment across 20 middle schools in a southwestern poor county in China in May 2022. A total of 8,808 7th and 8th graders in these schools participated in the study. During the experiment, we measured students' willingness to wear glasses in response to four pieces of information designed to address the four groups of behavioral barriers correspondingly. The first piece of information focused on the short-term impact of wearing glasses on students' academic performance. The second piece of information was about the long-term impact of wearing glasses on students' health and future career development. The third and fourth pieces of information targeted the price of a pair of standard eyeglasses and peer pressure associated with stigmatization (e.g. teasing), respectively.

The results show that information regarding the short-term impact of wearing glasses statistically significantly increased students' willingness to wear glasses after developing myopia by 7 percentage points. This was a 10.5 percent increase from the control group's mean of 66.8%. In contrast, the significant nudge effect of information about the long-term impact was only limited to myopic students who already wore glasses, which is probably a result of self-selection. Taken together, this suggests that students in our sample were subject to present bias that they valued more on the short-term impact than the long-term impact. Besides, information about the nationwide prevalence of myopia only significantly increased non-myopic students' willingness to wear glasses, due to their biased belief of the myopia prevalence in the school. We did not find a significant effect from information on the price of eyeglasses, suggesting it was not the key barrier to glasses adoption. Furthermore, we explore how students' heterogeneous backgrounds mediate their responses to the various kinds of information. We find clear evidence of treatment heterogeneity across student characteristics, peer groups, and baseline beliefs. The combination of the four informational nudges was more likely to adjust the decision-making of students who were (1) minority ethnic groups, (2) had good academic performance, (3) had more classmates wearing glasses, (4) had more classmates with good academic performance, and (5) held an uncertain baseline belief.

At last, we estimated the effect of wearing glasses on academic performance using our local sample combined with administrative test score data. We also compare the local results with the national representative results using a nationwide educational survey in China. The results show that wearing glasses significantly improved average test scores by 0.102 SDs for myopic students, which outweighs both the results of the national rural sample (0.026 SDs) and the national sample (0.034 SDs). Using this result, we conduct a cost-benefit analysis and conclude that this intervention yields a net benefit of $6.2 per capita, or a net benefit of $23,510.4 in total, demonstrating that our behavioral nudge is cost-effective.

Previous papers in the literature of vision health focus on how to maximize the intervention effects, ignoring the behavioral mechanisms behind individuals' decision-making regarding eyeglass adoption. In a meta-analysis by Wu et al. (2023), they reviewed seven studies that identified the factors contributing to eyeglasses adoption. These factors include the severity of the refractive error, and social and demographic factors, such as children's age, sex, family income, and so on. However, none of these studies examined the role of behavioral biases in understanding low eyeglasses adoption. Additionally, some studies employed informational intervention to improve eyeglasses adoption. Sylvia et al. (2022) and Zhang et al. (2021) both launched health education campaigns informing of the benefits of wearing eyeglasses, yet they focused on the overall effect of the information intervention rather than the effect of the specific information they provided. Zhang et al. (2022) and Guan et al. (2023) both took insights from behavioral economics, using message framing or voucher deadlines to enhance the intervention effectiveness, but also lack of perspectives from behavioral mechanisms.

Besides, the cost-effectiveness of the interventions designed to promote glasses-wearing holds significant policy implications. Most interventions in prior research take the form of providing free eyeglasses or vouchers, which is uneconomical and unsustainable due to the combination of substantial costs and low take-up rates among students. While Sylvia et al. (2022) and Guan et al. (2023) managed to improve the effectiveness of their interventions by increasing the take-up rates, their interventions required a relatively long duration and incurred considerable expenses, limiting their policy application.

This paper makes two primary contributions. First, since the issue of correcting myopia by wearing glasses is not properly valued in low-income regions and previous studies mainly focus on the effect of the interventions like the provision of free eyeglasses, little is known about the underlying behavioral mechanism behind individuals' decision-making about eyeglass adoption. We provide the first experimental evidence on the behavioral mechanism behind the low adoption of eyeglasses among low-income students. By conducting an intervention with targeted information, we find out the specific behavioral bias that prevents students from wearing glasses, and also the heterogeneity of biases by students' characteristics, peer effects, and baseline beliefs. Given all these findings, we can offer an effective type of intervention targeting a specific group of students.

Second, interventions to solve realistic problems need to meet the requirement of cost-effectiveness in the context of public policy. We provide evidence that even a light-touch informational nudge can significantly improve the willingness to wear glasses. We prove that our intervention, a light-touch informational nudge, is relatively economical and consumes a shorter time duration, compared to those offering free eyeglasses and vouchers. Our cost-benefit analysis shows that the economic benefits far outweigh the experimental costs.

The rest of the paper is organized as follows: Section 2 describes the background of the prevalence of myopia without wearing glasses and behavioral biases. Section 3 presents the interventions and the randomized experimental design. Section 4 reports the results and discusses the heterogeneous treatment effects. Section 5 provides the cost-benefit analysis. Section 5 concludes.

2 Background: low take-up of eyeglasses among low-income students

It is estimated that approximately 2.6 billion people have myopia of which 312 million are under the age of 19 (WHO, 2020). In China, about 52.7 percent of children and adolescents had poor vision in 2020, among which the proportions of primary, middle, and high school students were 35.6%, 71.1%, and 80.5%, respectively (Ministry of Education of China 2021)[1].

This visual disorder can significantly impact students' educational outcomes (WHO, 2020), including their development of motor skills (Warren, 1994), interaction with peers (Rainey et al., 2016), engagement in physical activities (Ethan and Basch, 2008), mental health (Yi et al., 2015), and personal identity (Oh et al., 2004). This visual problem is also a critical factor affecting education equity. The disorder has brought about a disproportionate burden on low so-

[1]Cited from an official press conference held by Ministry of Education of China in 2021 (see here).

cioeconomic status (SES) students with an estimated rate of unaddressed myopia 80% higher in low- and middle-income areas than in high-income areas (Fricke et al., 2018). However, about 38%–85% of rural students with visual impairment do not wear eyeglasses or even have taken a vision test (Glewwe et al., 2016).

Since myopia is irreversible, two types of treatments commonly used include eye surgery and eyeglasses, which can significantly improve refractive errors and slow the progression toward vision impairment (WHO, 2020). Several experimental studies have investigated the effects of the availability and affordability of eyeglasses for improving education outcomes (Fricke et al., 2012; Graham, 2017; Ma et al., 2014). For example, by offering 7th and 8th graders free eyeglasses in 16 schools in Yulin Prefecture, Shaanxi Province, China, Nie et al. (2020) found a 0.14 standard deviation increase in test scores and a two percentage point decrease in dropouts, compared to students who were only provided with myopic prescriptions. In Gansu Province, China, wearing eyeglasses increased test scores by 0.16 to 0.22 standard deviations for 4th, 5th, and 6th graders (Glewwe et al., 2016). Ma et al. (2014) found that providing children at 252 primary schools with free glasses increased test scores by 0.11 standard deviations compared to students in the control group.

Although significant effects of improving access to eyeglasses were found in these studies, two major limitations exist. First, in addition to the prevalent unaddressed myopic problem, low-SES areas often face other problems that are tied to educational outcomes in a condition of budget constraints, such as teacher shortages (Tran and Smith, 2021). Such constraints may lead to the financial investment in offering eyeglasses at scale to compete with other necessary educational supplies, causing a decrease in its priority. Second, even if eyeglasses are provided completely or partially by the public sector, students' actual take-ups may not be guaranteed, as found to be approximately 53.11% for overall take-up rate according to a meta-analysis (Wu et al., 2023). For example, in a study by Glewwe et al. (2016) on the Gansu Vision Intervention Project (GVIP), one-third of the free glasses offered to low-income primary schools were turned down, even though a large positive effect on test scores was found. In Oaxaca, Mexico, 34% of students aged 5 to 18 who were provided with free eyeglasses reported that they did not wear them (Yi et al., 2015). Moreover, Ma et al. (2014) found low compliance and an insignificant effect if free glasses were offered in the form of a voucher, with a standard deviation of 0.07 lower in test scores than providing eyeglasses in class.

3 Methodology

3.1 Setting and sample

This information intervention was conducted in Yun Prefecture, a low-income county in Yunnan, China, previously designated as a national poor county [2]. This county is also home to a sizable population of the Yi ethnic minority. The research sample used in this study represents a population characterized by relatively disadvantaged socio-economic status, making it suitable for studying relevant issues about students from impoverished and ethnic minority regions.

The research was carried out across 20 middle schools, involving 8,808 participants comprising 7th and 8th graders who participated in the survey experiment. Figure 1 depicts the time students couldn't see the blackboard (likely myopic), became myopic, and started to wear glasses. It shows that the 7th grade experiences the peak of myopia and wearing glasses, indicating that it is an opportune time to nudge the 7th- and 8th-grade students in our sample to wear glasses by providing information.

3.2 Experimental design

Using the survey experiment methodology, this study explores what information effectively motivates students to purchase eyeglasses after developing myopia or recommend their use to peers. With this aim, we included three sections in the experiment: pre-intervention questions, information intervention, and post-intervention questions.

In the first section, the survey asks questions about myopia status, eyeglass-wearing status, student characteristics, time investment in learning, learning attitudes, personality traits, and beliefs about myopia and eyeglasses. The question for myopia status contains three answers: not myopic, likely myopic (not diagnosed as myopia but sometimes can't see blackboard clearly), and myopic (diagnosed as myopic), while the question for eyeglass-wearing status contains two answers: wearing glasses, not wearing glasses. For student characteristics, we collect information about their gender (female or male), minority status (minority or not), and school location (urban or rural). For study-related factors, we asks students the degrees of self-confidence, growth mindset, and whether they want to attend high school. In addition, the survey asks students about their beliefs regarding the effects of wearing glasses on learning, their estimation of the percentage of students who are myopic in their grade, and the estimated cost of purchasing a pair of eyeglasses.

After answering these pre-intervention questions, one in five types of information was randomly displayed on each student's computer screen, with each student only receiving one

[2] The county's per capita GDP in 2021 was 37,055 CNY, showing not only a disparity compared to Yunnan Province's per capita GDP of 57,686 CNY but also a notable deviation from the national average of 80,976 CNY.

type of information. The information was designed based on barriers and benefits related to accessing eyeglasses as highlighted in the literature.

First, we provided information about the short-term impacts of wearing glasses on academic achievement based on several research findings. Gomes-Neto et al. (1997) found that the poor vision of students in rural Northeast Brazil was associated with low school performance, including the high probability of dropping out and low probability of matriculation. Hannum and Zhang (2012) found that wearing glasses increased the math and literacy test scores of Chinese middle school students by 0.27 and 0.43 standard deviations, respectively. To examine this factor, the following information is provided: *"Myopia can cause you to not be able to see the blackboard clearly and not keep up with the pace of lectures, leading to a decline in academic performance. If you experience myopia, having a pair of glasses has a significant effect on improving your academic achievement."*

Second, we provided information about the long-term negative consequences of eye health and labor market opportunities. Specifically, unaddressed myopia can result in severe visual impairment, including glaucoma, macular degeneration, retinal detachment, and blindness (Verhoeven et al., 2015; WHO, 2019). Moreover, myopia negatively affects economic productivity. In a meta-analysis, Naidoo et al. (2019) estimated that the global productivity loss resulting from uncorrected myopia was approximately 24 billion USD in 2015. Boudreaux and Lipton (2021) found that Medicaid adult vision coverage in the U.S. that offered vision screening and eyeglasses to low-income parents of dependent children significantly improved their labor market activities. To test this factor, this study provides the following information: *"If you experience myopia, not wearing glasses will affect your academic performance and lead to the continued deterioration of your vision and cause amblyopia. These will eventually impact your labor market opportunities."*

Third, this study provides national statistics on the percentage of students having myopia in China. Including this information may allow students who are concerned about their social identity and peer pressure to have a better understanding of the disease's prevalence. WHO (2019) found that some people regard wearing eyeglasses as a disability. Odedra et al. (2008) found that some Tanzanian students refused to wear eyeglasses because they feared ridicule. A similar reason was noted by Gogate et al. (2013) who found that a common reason among Indian students for refusing eyeglasses was the "fear of being teased by other children." Thus, this study provides statistics on the high prevalence of myopia to examine whether this information is effective in reducing peer pressure and thus influencing students' decision-making. The information provided that corresponds to this factor is the following: *"Myopia is a very common problem in our country. The proportion of middle school students who experience myopia is 74%. Myopia can be improved by wearing eyeglasses."*

Fourth, students may overestimate the price of eyeglasses. Although research regarding this factor is scant, Glewwe et al. (2016) found that parents' perceived cost of glasses was negatively associated with purchasing glasses for their children. Additional research has found a negative relationship between the perceived cost of other educational investments, such as college tuition, and education decisions, such as attending college (Dynarski et al., 2022; Linos et al., 2021). This suggests that students' perceived cost of eyeglasses as an investment in their education might influence their decision-making. To examine the effects of information about the price of eyeglasses, this study provides the following: *"The average market price of a pair of glasses is 200 to 300 yuan. Having a pair of glasses is very cost-effective if you experience myopia."*

To estimate the causal effects of these four types of information, this study also includes a control group in which no information specific to myopia and eyeglasses is provided. The control group information applies to the hypothetical scenario where students directly made their decisions to wear glasses after developing myopia or to encourage myopic friends to wear glasses without additional information.

The grouping overview is as follows:

- **Control:** *"Have a 30-second rest and please click to continue."*
- **T1 (short-term impact):** "Myopia can cause you to not be able to see the blackboard clearly and not keep up with the pace of lectures, leading to a decline in academic performance. If you experience myopia, having a pair of glasses has a significant effect on improving your academic achievement."
- **T2 (long-term impact):** *"If you experience myopia, not wearing glasses will affect your academic performance and lead to the continued deterioration of your vision and cause amblyopia. These will eventually impact your labor market opportunities."*
- **T3 (nationwide prevalence of myopia):** *"Myopia is a very common problem in our country. The proportion of middle school students who experience myopia is 74%. Myopia can be improved by wearing eyeglasses."*
- **T4 (price of a pair of glasses):** *"The average market price of a pair of glasses is 200 to 300 yuan. Having a pair of glasses is very cost-effective if you experience myopia."*

The information mentioned above was displayed for 30 seconds before automatically transitioning to the post-intervention questions. During these 30 seconds, students in all five groups could not operate the computers. In the post-question section, students were asked two questions as the outcomes of interest in our study:

- **Outcome 1 (students who were not myopic or likely myopic answer):** *"Will you purchase eyeglasses after you develop myopia?"*
- **Outcome 2 (all students answer):** *"Will you recommend eyeglasses use to peers with myopia?"*

For the first question (outcome 1), only students who were not myopic or likely myopic were asked because they had not yet fully developed myopia and thus were suitable for this question.

At last, we illustrate the RCT design in Table 1 .

3.3 Balance test and descriptive statistics

Table 2 reports the balance check of our randomization. We conducted four t-tests across the different treatments for each observed variable and a multinomial logistic regression of the treatments on the observed variables. Both the individual tests and the joint test show no statistically significant differences in the students' characteristics across the groups. The joint F test p-value from a multinomial logistic regression is 0.6863, indicating that the observed students' characteristics cannot predict the treatment assignment.

Table 3 presents descriptive statistics derived from our survey sample. We also include reference data from a nationwide survey and official statistics in column (8) for comparison. Panel A shows that 68.1% students in our county-based sample have vision problems and 60.5% of them wear glasses, both figures comparable to the national average of 71.1% and 62.3%. While girls and high-achieving students have the highest myopia rates in our sample, their proportions of wearing glasses after developing myopia are also the highest. This pattern may be explained by their outstanding academic performance, as suggested by their average test scores in Panel C. In contrast, the proportion

Additionally, findings from Panel B also unveil a substantial belief bias among students in the county-based sample. The estimated myopia prevalence is significantly below the national average, while the estimated price for eyeglasses at 1680.4 yuan significantly exceeds the national average.

3.4 Empirical strategy

We estimate the average treatment effects of receiving informational nudges using the following linear regression:

$$Y_{ic} = \beta_0 + \sum_{n=1}^{4} \beta_n Nudge_{ic}^n + \gamma X_{ic} + \varphi_c + \varepsilon_{ic}$$

where Y_{ic} is the outcome of interest for student i in class c. $Nudge_{ic}^n$ is a dummy variable for receiving one of four types of informational nudges, where n is the specific type of information a student receives. β_n identifies the impact of each nudge group n. X_{ic} is a vector of controls which include student characteristics, personality traits, baseline beliefs about myopia and eyeglasses, and test scores. φ_c is a vector of school-class fixed effects. ε_{ic} is an error term, clustered by school-grade.

4 Results

4.1 Average treatment effects

Table 4 reports the estimation results of nudge effects on students' willingness to wear glasses after developing myopia. Columns (1) - (3) show the results for all students who have answered the question and are either non-myopic or likely myopic, and columns (4) and (5) report the results of students who are not myopic and likely myopic, respectively. Column (1) contains no covariates or fixed effects, while column (2) adds all covariates shown in Table 2, and column (3) further adds school-class fixed effects. The first row reports the control group's mean of the willingness to wear glasses after developing myopia, which represents the treated students' baseline willingness. Under no informational nudge, 66.8% of all students who were either not myopic or likely myopic decided to wear glasses after developing myopia. Interestingly, non-myopic students were notably more willing to wear glasses (72.3%) than likely myopic students (52.6%), which may be due to the fact that fewer likely myopic students believed that wearing glasses has a positive impact on their studies, as shown in column (10) in Table 3.

We found that providing information on the short-term impact of wearing glasses (T1) significantly improved students' willingness to wear glasses after developing myopia, which is consistent across every column in Table 4. After controlling for covariates and fixed effects, students who were nudged by the T1 were 7 percentage points more likely to decide to wear glasses than those in the control group, equivalent to a 10.5 percent increase from the control group's mean. This substantial treatment effect of T1 is noteworthy, considering the mild nature of the nudge information (DellaVigna and Linos, 2022). Specifically, the nudge effect of T1 had a greater impact on likely myopic students compared to non-myopic students, which may be attributed to the lower baseline willingness among likely myopic students, as suggested by their control mean.

We also found that providing information about the nationwide prevalence of myopia (T3) significantly increased students' willingness to wear glasses after developing myopia. However, the nudge effect was only observed among non-myopic students who received the T3, probably because non-myopic students were initially more concerned about the associated stigma of wearing glasses, as suggested by their relatively low estimated rate in the grade in Table 3.

Table 5 reports the estimation results of nudge effects on students' willingness to encourage myopic friends to wear glasses. We show the result of all students and divided it into four subgroups: non-myopic students, likely myopic students, myopic students not wearing glasses, and myopic students wearing glasses. Compared to the willingness to wear glasses by oneself, the willingness to encourage others to do the same may be stronger given that encouraging others takes less effort than taking action by oneself, which can be supported by the higher baseline willingness of non-myopic or likely myopic students shown in Table 5 than that of the same people in Table 4.

The estimation result of column (1) shows that providing information on the short-term impact (T1) significantly increased the willingness of all students who received the information by 5.5 percentage points, equivalent to a 7.8 percent increase from the control group's mean. Specifically, T1 somehow did not significantly increase non-myopic or likely myopic students' willingness to encourage myopic friends to wear glasses, which contrasts with the results in Table 4. A plausible reason is that these students' baseline willingness to encourage friends was higher than their willingness to wear glasses themselves as mentioned above, which limits the nudge effects in Table 5. While non-myopic or likey myopic students were not significantly nudged by T1, myopic students who wore or did not wear glasses were significantly nudged by T1 even though their baseline willingness was relatively high. This pattern shows that myopic students were more easily nudged by information on the short-term impact than non-myopic or likely myopic students.

We also found that myopic students who already wore glasses were the only ones significantly nudged by information about the long-term impact (T2), namely the positive impacts of wearing glasses on health and career development. This can not be attributed to the low baseline willingness considering their relatively high baseline willingness compared to others. Given the fact that they already wore glasses before the intervention, this might suggest that they had long been valuing the long-term benefits of wearing glasses, which reveals self-selection in the significant nudge effect of T2.

Taken together, we did not find statistically significant impacts of the information on the price of eyeglasses (T4) throughout the two types of willingness. This shows that the overestimated price of glasses was not the key behavioral barrier to eyeglass adoption. Comparing the effects of T4 to those of T1, the benefits of wearing glasses outweigh the cost of wearing them when these students were making decisions on whether to wear glasses after developing myopia. This might suggest that the low take-up of glasses was caused by students' uncertainty or underestimation of the benefits of wearing glasses if loss aversion was one of the behavior barriers for these students. Besides, the contrast between the effects of T1 and T2 reveals that students generally focus more on the short-term impacts. This pattern is consistent with the *present bias* discussed in Ericson and Laibson (2019), which argues that people have the tendency to focus more on the present situation than the future when making decisions.

Last but not least, the issue of multiple hypothesis testing poses threats to our results. The combination of five regressions and four treatments (20 tests in total, 4 coefficients by 5 regressions) in both tables could potentially lead to false rejections of null hypotheses. Thereby, we conduct multiple hypothesis testing to provide more robust p-values (or q-values) of the nudge effects[3]. After adjustment, previously significant nudge effects remain significant, which

[3]We use Michael Anderson's code to compute sharpened False Discovery Rate (FDR) q-values, which is based on

validates our findings.

4.2 Heterogeneity in the nudge effects

We next examined how different students responded to the informational nudges based on three dimension: (1) student characteristics and academic performance, (2) peer group, and (3) baseline beliefs. Table 6-8 summarize the main results for these dimensions. For the sake of better comparison, we estimate the overall nudge effects by combining the four treatments as a single treatment and report them in the first row of each table[4].

Student characteristics and academic performance. Table 6 presents the sample split into three pairs of subgroups based on race, gender, and test scores, respectively. The overall nudge effects show that minority students, compared with Han students, are more compliant with the nudges in both outcomes. In contrast, the nudge interventions hardly adjust Han students' decision-making in both outcomes. This disparity may be attributed to the relatively low baseline willingness of minority students as shown in the control group mean. According to the second row in panel B in Table 3, fewer minority students believe that glasses-wearing helps their studies compared to Han students and the sample average, and therefore they are more likely to update their beliefs after the intervention.

As mentioned in the survey background, minority students constitute the majority of the entire sample. This result suggests that informational nudges may serve as a potent tool to enhance eyeglasses uptake among low-income minority students.

Gender is another characteristic worth noting. For the decision to wear glasses, girls show more willingness after being nudged by the information on the short-term impacts (T1), while boys show no such response. A plausible reason is that few girls initially believed that wearing glasses has a positive impact on their studies, as shown in Panel B in Table 3, making them more likely to update belief. On the other hand, Table 6 shows that only boys exhibit more willingness to wear glasses after being nudged by the information on the nationwide prevalence of myopia (T3). They may have greater concerns for peer pressure associated with wearing glasses, which can be inferred by their relatively low estimated rate of myopia in the grade (see Table 3). Additionally, those boys were probably more subject to stigma connected with glasses-wearing, which is supported by the lower rate of glasses-wearing among boys with vision problems (also see Table 3).

This pattern suggests that policymakers should provide girls with information about short-term impacts, such as academic performance, to aid their decision-making. For boys, it's important to consider the role of peer pressure in designing nudges, particularly regarding stigmatization.

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the theory from Thomas (1994).

[4]To measure the overall nudge effect, we use the specification $Y_{ic} = \alpha_0 + \alpha_1 Nudge^n_{ic} + \gamma X_{ic} + \varphi_c + \varepsilon_{ic}$, where α_1 measures the overall nudge effect and n is the one from 1 to 4

Table 6 also reports the heterogeneity in student's academic performance. We calculate the median of all students' total test scores and subsequently divide the students into two subgroups based on this median. Similar to minority students, high-achieving students are also more compliant with the nudges in both outcomes, especially in terms of persuading friends to wear glasses. This may be attributed to the strong complementarity between information and education (Duflo et al., 2015; Dupas and Miguel, 2017; Godlonton et al., 2016). High-achieving students are more likely to adopt beneficial information and adjust their behavior due to higher self-efficacy (Schwarzer, 1992; Schwarzer and Fuchs, 1996). This tendency is supported by the higher values in confidence factor and growth mindset observed among high-achievers (see panel B inTable 3). Those high-achieving students are also more likely to value long-term benefits than lower-achieving peers.

Peer group. Apart from personal characteristics, the nudge effects may also vary based on one's peer group and the extent of their exposure. Table 7 presents heterogeneity across two dimensions of peer effects: the ratio of classmates wearing glasses, and the average test scores of classmates.[5] A cross-column comparison shows that students being nudged are more likely to choose to wear glasses or persuade friends when most of their classmates already wear glasses. A plausible explanation is the demonstration effect that students are more inclined to heed the information about glasses and update their beliefs when they observe many of their classmates already wearing them.

Additionally, for students whose classmates are mostly high-achievers, the nudge intervention works more effectively, than in the first dimension, to enhance the willingness to wear glasses or persuade friends by 7.0 percentage points ($p < 0.003$, 11% of the control group mean) and 7.3 percentage points ($p < 0.001$, 11% of the control mean), respectively. Besides, it is worth noting that, even after adjusting p-values, almost all nudge information significantly helps improve students' willingness except for the one about price in the first outcome. In contrast, in classes where the average test score is below the median, nudge information has minimal impact on students' decision-making. The pattern is consistent with the heterogeneity in academic performance analyzed above, indicating that high-achieving classmates' self-efficacy might influence and motivate their peers to embrace useful information and modify their decisions.

Baseline beliefs. When trying to nudge people towards certain decisions or behaviors, prior beliefs play a crucial role (Thaler and Sunstein, 2008). We investigate how an individual's baseline belief influences the nudge effect.

In the pre-intervention survey, we gathered data on students' baseline beliefs about glasses-wearing, which is designed to help us measure the extent of students' belief biases. Firstly, we

[5]To measure the ratio of classmates wearing glasses, we use the leave-one-out method, which divides the number of one's classmates who wear glasses by the total number of one's classmates in the class. The same method is applied to measure the average test scores of classmates.

asked about students' perceived prices of eyeglasses as the belief bias of costing. If a student significantly overestimates the price, it may indicate a strong bias in their perception of the cost of wearing glasses. Secondly, we surveyed students on their perceptions of how wearing glasses affects studying in order to identify the belief bias on the short-term impact. Negative or skeptical attitudes would reflect a cognitive bias. Lastly, we asked each student's estimate of the proportion of myopic students in their grade as an indicator of their perception of wearing glasses as humiliating. If the proportion is underestimated by a student, they may view having vision problems as unusual at school and, as a result, fear discrimination if they are myopic.

Each baseline belief we surveyed corresponds to specific nudge information except for the one about the long-term impact (T2). We did not ask students questions about their long-term benefit preferences since their test scores can already indicate such preferences. A higher score shows a student's commitment to studying over short-term pleasures like instant entertainment, suggesting that a student values long-term benefits.

We start the analysis by simply examining the baseline belief regarding how wearing glasses affects studying. The corresponding question offers three options: "positive", "negative" and "not sure", which allows us to divide the sample into three subgroups, each representing a different degree of belief bias. Table 8 compares the regression results across three degrees of belief bias. Notably, the "not sure" group is most effectively nudged by nearly all four information, whereas the other two barely show significant nudge effects. This result may suggest that individuals without a strong prior belief are more susceptible to nudges. However, we cannot take this result as conclusive evidence of a general behavioral pattern because the "not sure" group only represents individuals with a mild belief bias about the impact of wearing glasses on studying and may not capture other three types of baseline beliefs.

To measure the overall belief bias capturing all four baseline beliefs, we predict the counterfactual or pre-intervention willingness of all the treated samples as the alternative method[6]. We employ machine learning to predict the willingness and use five models controlling for full covariates and fixed effects, and then compare their predictive accuracies. Specifically, we utilize the control group to train these models by splitting it into a training sample (80%, N=1321) and a testing sample (20%, N=330), and then predict the outcome using well-trained models and samples from all treated groups. Table 9 exhibits the predicted probabilities, classification accuracies, and classification error rates across five models in two outcomes. Comparing classification accuracy and classification error rate in two outcomes, Random Forest tends to have a slightly better performance in in-sample and out-of-sample predictions. Hence, we use the predicted probability from Random Forest as the counterfactual willingness.

If the predicted willingness indeed captures the overall belief bias, then students with deeper belief biases would exhibit lower willingness in the absence of any intervention. Fig-

[6]Given that the two outcomes in this paper are dummy variables, the predictions are doing classifications.

ure 2 and Figure 3 depict the correlations between the predicted willingness and the four baseline beliefs, in which our predicted willingness decreases as belief bias increases. Thereby, the consistently correlative patterns shown in both figures validate our prediction of the pre-intervention willingness.

Using the predicted willingness, we estimated the nudge effect within each predicted willingness quartile. Figure 4 and Figure 5 show significant variations and similar patterns across each frame represented by a nudge effect. Specifically, information interventions have consistently affected students with a medium predicted willingness (Q2 or Q3), but in most cases have minimal effects on those with either a low or a high willingness (Q1 or Q4). This finding is consistent with the pattern in Table 8 and also the findings in Thaler and Sunstein (2008) that a human decision can be most effectively influenced by a behavioral nudge if there is no strong prior belief that goes for or against it.

5 Cost-benefit analysis

Having established the effectiveness of our informational nudge, we now examine the efficiency of our intervention in nudging students with vision problems to wear glasses. In this section, we conduct a cost-benefit analysis to assess the cost-effectiveness of this intervention project from a broader policy standpoint.

Students' test scores, a measure of academic performance, is used to evaluate the short-term benefits students with vision problems can acquire from wearing glasses. We use administrative data on students' test scores, standardized at the school level, to examine the impact of myopia and wearing glasses on these scores. Specifically, in our regressions, we control the time and effort students spend studying to mitigate the selection bias associated with myopia[7]. Panel A in Table 10 shows that myopia consistently reduces students' scores in every subject, while wearing glasses significantly and consistently improves students' test scores. To alleviate the biases in OLS estimations, we employ double machine learning (DML) to estimate the effects on average test scores in column (5). Developing myopia decreases students' average test scores by 0.052 SDs, whereas wearing glasses significantly increases students' average test scores by 0.102 SDs, outweighing the negative impact of myopia. This finding is approximate to Glewwe et al. (2016), who discovered that poor vision resulted in a 0.023 SDs decrease in students' average test scores while having eyeglasses led to a 0.156 SDs increase. Given the fact that their estimates are derived from an IV estimation (the instrumental variable is giving free eyeglasses), the effect of wearing glasses in their result reasonably outperforms ours.

Additionally, we compare this local result to the nationwide result to further underscore the benefits of wearing glasses for students with vision problems in our study. We utilize the

[7]This bias stems from the notion that the harder a student works, the more likely they are to have vision problems.

China Education Panel Survey (CEPS), a nationwide panel survey in China that provides educational outcome data for students in grades 7 through 9, and select students from grades 7 and 8 (same with our sample) to provide comparable results. To be specific, students from grades 7 and 8 represent the same individuals surveyed at different times, forming a panel data set. In our regressions, test scores from grade 8 are the outcomes, while grade 7 test scores are included as a lagged variable. Besides, our variables of interests, being myopic and wearing glasses, were surveyed in grade 7 instead of the ones surveyed in grade 8 because the former ones precede the grade 8 test scores and thus have causal effects on them[8]. Lastly, we also control the efforts students invest in their studies to mitigate the selection bias associated with developing myopia.

Panels B and C in Table 10 present the results from rural samples and nationwide samples, respectively. We find that wearing glasses after developing myopia leads to a greater improvement in students' average test scores in our sample, compared to the rural and nationwide samples in CEPS. This result indicates substantial returns to wearing eyeglasses for students in ultra-poor regions and further reveals the effectiveness of our intervention.

According to a meta-analysis in Jackson and Mackevicius (2021), a 0.0352 SDs improvement in average test scores amounts to a $1000 annual increase in per-pupil public school spending. In our results, we observe an increase of 0.102 SDs in average test scores by wearing glasses for those who are already myopic, which amounts to approximately $2898 worth of per-pupil educational input. Assuming conservatively that 10% myopic students who decide to wear glasses after being successfully nudged by T1 will indeed wear glasses afterwards[9], there would be a 0.7 percentage point $(10\% \times 7pp. = 0.7pp.)$ increase in eyeglass adoption in the real world[10]. A 0.7 pp. increase in eyeglasses adoption among myopic students is equivalent to an educational input of $20.3 per student $(0.7\% \times \$2898 = \$20.3)$. Considering that our survey experiment has a per capita cost of approximately $0.1 for digital delivery, and the average price of a pair of standard eyeglasses is about $14 in China, we can conclude that this intervention yields a net benefit of $6.2 per capita for non-myopic or likely myopic students, or a net benefit of $23,510.4 in total $(\$6.2 \times 3792 = \$23510.4)$ [11], which is obviously cost-effective.

[8] It is worth noting that CEPS did not survey whether students wore glasses when they were in grade 7, but we can infer who did not wear glasses based on the information about myopia in grade 7 and information about glasses-wearing in grade 8. Then we have 1969 myopic students we are not sure whether wore glasses in the grade 7. According to the literature, wearing glasses consistently improves the test scores of students with vision problems. Therefore, to obtain a lower-bound effect of wearing glasses on test scores, we regard these 1969 students as wearing glasses.

[9] Zhang et al. (2022) found that the informational nudges using message framing led to at least a 12 pp. increase of students' eyeglasses ownership.

[10] 7 pp. is the nudge effect of T1 on the willingness to wear glasses, shown in Table 4

[11] In our sample, there are 3453 non-myopic or likely myopic students.

6 Conclusion

Vision problems are among the most common factors detrimental to students' educational outcomes, with many of them often left untreated among students in low-income regions. While previous studies have emphasized the benefits of vision correction for academic performance, the role of behavioral bias in preventing myopic students from wearing glasses remains to be explored. The central aim of this study is to identify which types of information can significantly increase students' motivation to purchase glasses or encourage other students to do so.

Using a survey experiment conducted in an ultra-poor region of China, this study finds that the information about the short-term impacts of wearing glasses on academic achievement is the most effective for most students to increase such motivation. Whereas information about the long-term impact results in a slight increase in the willingness to encourage myopic friends to wear glasses, this effect is particularly pronounced among individuals who already wear glasses. These results have the following policy implication: emphasizing the short-term impacts or benefits is effective for motivating individuals to adjust their decision-making in policy interventions.

While the baseline estimation results showed encouraging evidence regarding the effectiveness of specific nudge information, we also uncovered large heterogeneity in treatment effects in three dimensions. Firstly, we find the significant role of targeted information combined with personal characteristics—like race, gender, and academic performance—in influencing individuals' decisions to follow the intervention. Specifically, minority students and high-achieving students are the ones more inclined to follow the nudge information. Secondly, peer effects are also considered. We find that students are more influenced by nudges when their peers already wear glasses or are high-achieving students. Lastly, the study also explores how prior beliefs affect nudge efficacy, showing that uncertain baseline beliefs amplify the responsiveness to informational nudges. These patterns suggest that, in policy practice, information content should be designed to target different student populations, while paying attention to the interactive effects of students' academic performance and original beliefs on the outcomes of interventions.

Our cost-benefit analysis establishes the cost-effectiveness of such low-cost informational nudge. This suggests that even modest interventions like informational nudges can yield meaningful outcomes. Given the substantial benefits of wearing eyeglasses identified in the literature, leveraging the targeted information to encourage eyeglasses usage among myopic students can be highly promising to improve their academic achievement.

References

Boudreaux, M. H. and Lipton, B. J. (2021). Medicaid benefit generosity and labor market outcomes evidence from medicaid adult vision benefits. *Journal of Human Resources*, 56(2):539–569.

Damgaard, M. T. and Nielsen, H. S. (2018). Nudging in education. *Economics of Education Review*, 64:313–342.

DellaVigna, S. and Linos, E. (2022). RCTs to Scale: Comprehensive Evidence From Two Nudge Units. *Econometrica*, 90(1):81–116.

Duflo, E., Dupas, P., and Kremer, M. (2015). Education, HIV, and Early Fertility: Experimental Evidence from Kenya. *American Economic Review*, 105(9):2757–2797.

Dupas, P. and Miguel, E. (2017). Chapter 1 - Impacts and Determinants of Health Levels in Low-Income Countries. In Banerjee, A. V. and Duflo, E., editors, *Handbook of Economic Field Experiments*, volume 2 of *Handbook of Economic Field Experiments*, pages 3–93. North-Holland.

Dynarski, S., Page, L. C., and Scott-Clayton, J. (2022). College costs, financial aid, and student decisions. Technical report, National Bureau of Economic Research.

Ericson, K. M. and Laibson, D. (2019). Handbook of Behavioral Economics: Applications and Foundations 1. volume 2 of *Handbook of Behavioral Economics - Foundations and Applications 2*, pages 1–67. North-Holland.

Ethan, D. and Basch, C. E. (2008). Promoting healthy vision in students: Progress and challenges in policy, programs, and research. *The Journal of School Health*, 78(8):411–416.

Fricke, T. R., Holden, B. A., Wilson, D. A., Schlenther, G., Naidoo, K. S., Resnikoff, S., and Frick, K. D. (2012). Global cost of correcting vision impairment from uncorrected refractive error. *Bulletin of the World Health Organization*, 90(10):728–738.

Fricke, T. R., Tahhan, N., Resnikoff, S., Papas, E., Burnett, A., Ho, S. M., Naduvilath, T., and Naidoo, K. S. (2018). Global Prevalence of Presbyopia and Vision Impairment from Uncorrected Presbyopia: Systematic Review, Meta-analysis, and Modelling. *Ophthalmology*, 125(10):1492–1499.

Glewwe, P., Park, A., and Zhao, M. (2016). A better vision for development: Eyeglasses and academic performance in rural primary schools in China. *Journal of Development Economics*, 122:170–182.

Godlonton, S., Munthali, A., and Thornton, R. (2016). Responding to Risk: Circumcision, Information, and HIV Prevention. *The Review of Economics and Statistics*, 98(2):333–349.

Gogate, P., Mukhopadhyaya, D., Mahadik, A., Naduvilath, T. J., Sane, S., Shinde, A., and Holden, B. (2013). Spectacle compliance amongst rural secondary school children in Pune district, India. *Indian Journal of Ophthalmology*, 61(1):8–12.

Gomes-Neto, J. B., Hanushek, E. A., Leite, R. H., and Frota-Bezzera, R. C. (1997). Health and schooling: Evidence and policy implications for developing countries. *Economics of Education Review*, 16(3):271–282.

Graham, R. (2017). Facing the crisis in human resources for eye health in sub-Saharan Africa. *Community Eye Health*, 30(100):85–87.

Guan, H., Yang, T., Zhang, Y., and Shi, Y. (2023). Time's ticking! Effects of deadline on the utilization of health services: Evidence from a cluster-randomized controlled trial. *Social Science & Medicine*, page 116331.

Hannum, E. and Zhang, Y. (2012). Poverty and proximate barriers to learning: vision deficiencies, vision correction and educational outcomes in rural northwest china. *World development*, 40(9):1921–1931.

Jackson, C. K. and Mackevicius, C. (2021). The Distribution of School Spending Impacts.

Lavecchia, A. M., Liu, H., and Oreopoulos, P. (2016). Behavioral economics of education: Progress and possibilities. In *Handbook of the Economics of Education*, volume 5, pages 1–74. Elsevier.

Linos, E., Reddy, V., and Rothstein, J. (2021). Demystifying college costs: how nudges can and can't help. *Behavioural Public Policy*, pages 1–22.

Ma, X., Zhou, Z., Yi, H., Pang, X., Shi, Y., Chen, Q., Meltzer, M. E., le Cessie, S., He, M., Rozelle, S., Liu, Y., and Congdon, N. (2014). Effect of providing free glasses on children's educational outcomes in China: Cluster randomized controlled trial. *BMJ*, 349:g5740.

Naidoo, K. S., Fricke, T. R., Frick, K. D., Jong, M., Naduvilath, T. J., Resnikoff, S., and Sankaridurg, P. (2019). Potential Lost Productivity Resulting from the Global Burden of Myopia: Systematic Review, Meta-analysis, and Modeling. *Ophthalmology*, 126(3):338–346.

Nie, J., Pang, X., Wang, L., Rozelle, S., and Sylvia, S. (2020). Seeing is believing: experimental evidence on the impact of eyeglasses on academic performance, aspirations, and dropout among junior high school students in rural china. *Economic Development and Cultural Change*, 68(2):335–355.

Odedra, N., Wedner, S. H., Shigongo, Z. S., Nyalali, K., and Gilbert, C. (2008). Barriers to spectacle use in Tanzanian secondary school students. *Ophthalmic Epidemiology*, 15(6):410–417.

Oh, H.-K., Ozturk, M. A., and Kozub, F. M. (2004). Physical activity and social engagement patterns during physical education of youth with visual impairments. *Re:view*, 36(1):39–49.

Rainey, L., Elsman, E. B. M., van Nispen, R. M. A., van Leeuwen, L. M., and van Rens, G. H. M. B. (2016). Comprehending the impact of low vision on the lives of children and adolescents: A qualitative approach. *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, 25(10):2633–2643.

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In *Self-Efficacy: Thought Control of Action*, pages 217–243. Hemisphere Publishing Corp, Washington, DC, US.

Schwarzer, R. and Fuchs, R. (1996). Self-efficacy and health behaviours. In *Predicting Health Behaviour: Research and Practice with Social Cognition Models*, pages 163–196. Open University Press, Maidenhead, BRK, England.

Sylvia, S., Ma, X., Shi, Y., and Rozelle, S. (2022). Ordeal mechanisms, information, and the cost-effectiveness of strategies to provide subsidized eyeglasses. *Journal of Health Economics*, 82:102594.

Thaler, R. H. and Sunstein, C. R. (2008). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Nudge: Improving Decisions about Health, Wealth, and Happiness. Yale University Press, New Haven, CT, US.

Thomas, G. E. (1994). Resampling-Based Multiple Testing: Examples and Methods for p-Value Adjustment. *Journal of the Royal Statistical Society Series D: The Statistician*, 43(2):347–348.

Tran, H. and Smith, D. A. (2021). How Hard-to-Staff Rural School Districts Use State Funds to Address Teacher Shortages. *Journal of Education Finance*, 47(2):130–156.

Verhoeven, V. J. M., Wong, K. T., Buitendijk, G. H. S., Hofman, A., Vingerling, J. R., and Klaver, C. C. W. (2015). Visual consequences of refractive errors in the general population. *Ophthalmology*, 122(1):101–109.

Wang, X., Yi, H., Lu, L., Zhang, L., Ma, X., Jin, L., Zhang, H., Naidoo, K. S., Minto, H., Zou, H., Rozelle, S., and Congdon, N. (2015). Population Prevalence of Need for Spectacles and Spectacle Ownership Among Urban Migrant Children in Eastern China. *JAMA Ophthalmology*, 133(12):1399–1406.

WHO (2019). World report on vision.

Wu, L., Feng, J., and Zhang, M. (2023). Implementing interventions to promote spectacle wearing among children with refractive errors: A systematic review and meta-analysis. *Frontiers in Public Health*, 11.

Yi, H., Zhang, L., Ma, X., Congdon, N., Shi, Y., Pang, X., Zeng, J., Wang, L., Boswell, M., and Rozelle, S. (2015). Poor vision among China's rural primary school students: Prevalence, correlates and consequences. *China Economic Review*, 33:247–262.

Zhang, Y., Guan, H., Du, K., and Huang, J. (2022). The impact of message framing on uptake of vision health services for rural students in China: A randomized control trial. *China Economic Review*, 76:101855.

Zhang, Y., Guan, H., Du, K., Zhao, J., Shi, Y., Wang, H., and Wang, D. (2021). Effects of Vision Health Education and Free Eyeglasses on Knowledge of Vision and Usage of Spectacles Among Primary School Students: Evidence from Gansu and Shaanxi Provinces in China. *Risk Management and Healthcare Policy*, 14:1449–1464.

Figures and Tables

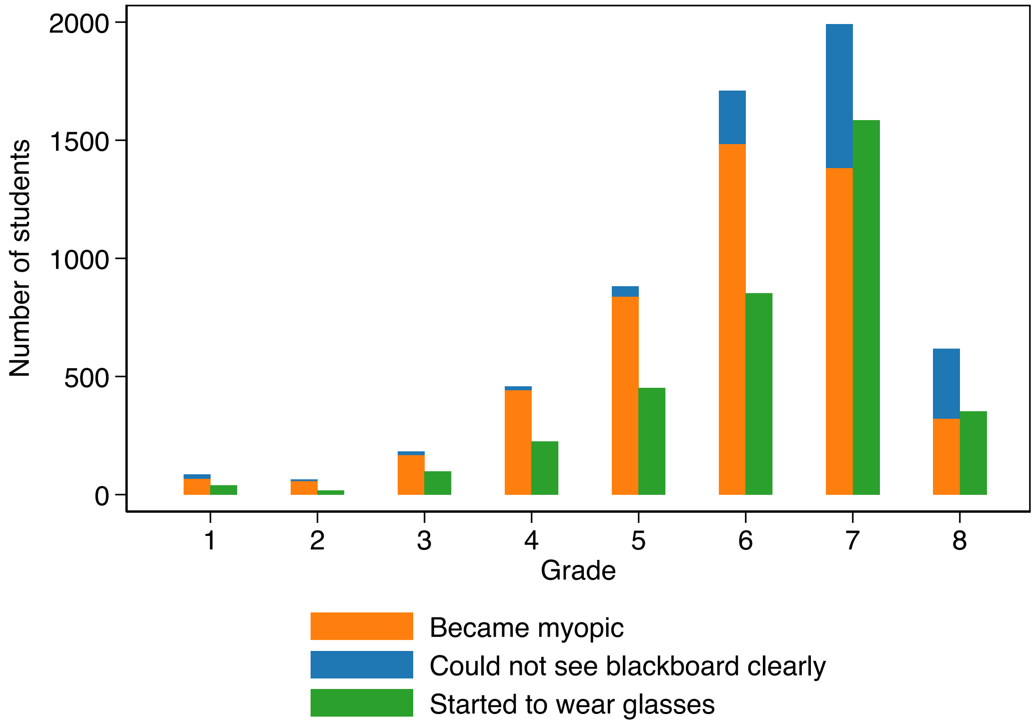

Figure 1: Time gaps between becoming myopic and wearing eyeglasses

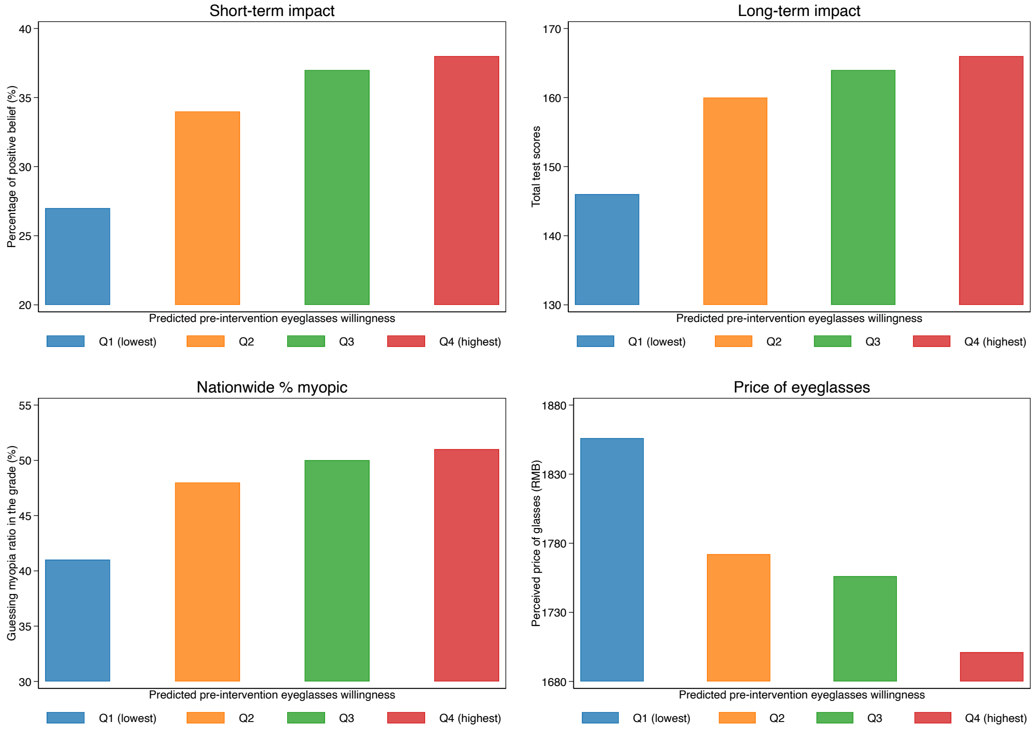

Figure 2: Baseline beliefs and predicted willingness to wear glasses

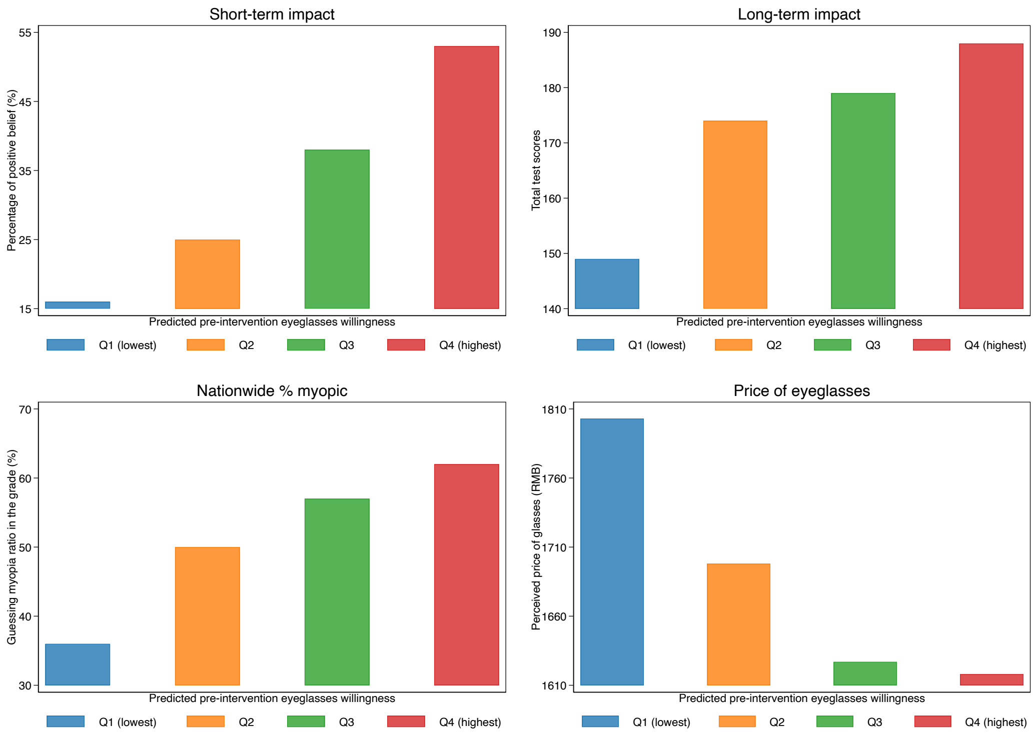

Figure 3: Baseline beliefs and predicted persuading willingness

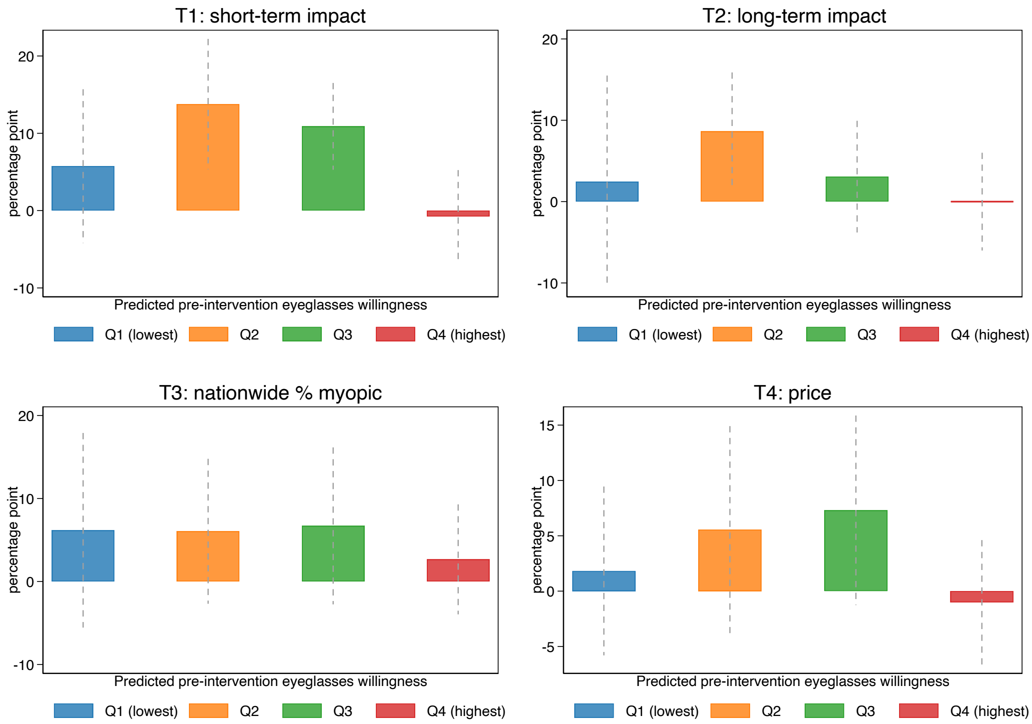

Figure 4: Heterogeneous effects on wearing eyeglasses

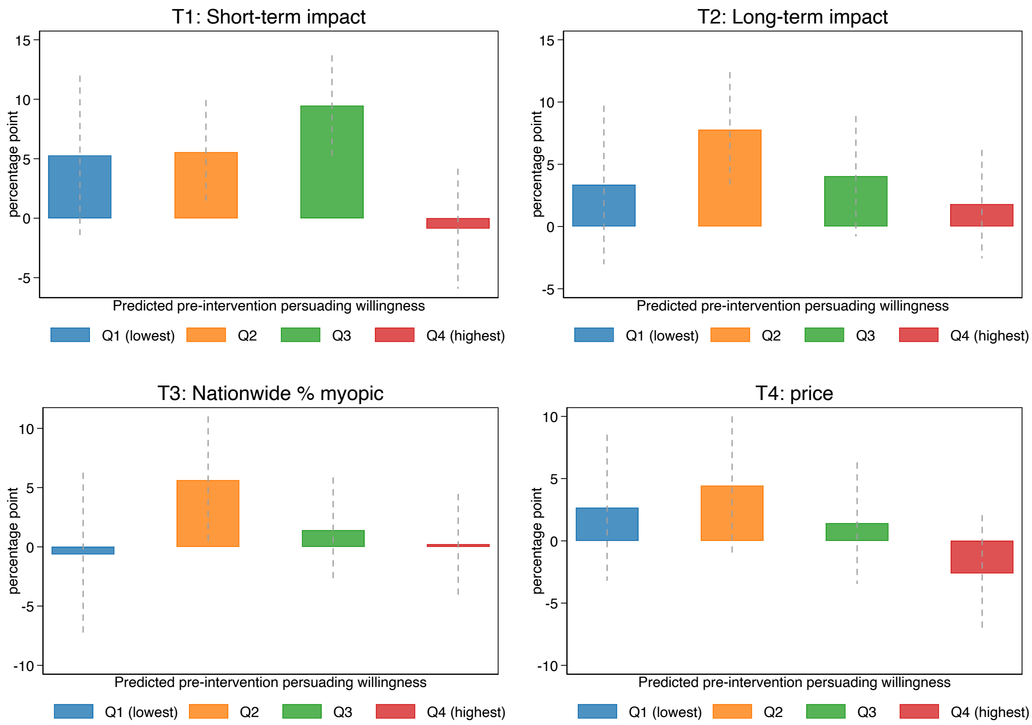

Figure 5: Heterogeneous effects on persuading willingness

Table 1: Experimental design

2022	**Online survey experiment with a county random sample of 7th and 8th grade students**
	Surveying students' background information
Control	No information *(N=1651)*
Treatment 1	Short-term impact *(N=1648)*
	"Myopia can cause you to not be able to see the blackboard clearly and not keep up with the pace of lectures, leading to a decline in academic performance. If you experience myopia, having a pair of glasses has significant effect on improving your academic achievement."
Treatment 2	Long-term impact *(N=1644)*
	"If you experience myopia, not wearing glasses will affect your academic performance and lead to the continued deterioration of your vision and cause amblyopia. These will eventually impact your labor market opportunities."
Treatment 3	Nationwide % myopic *(N=1653)*
	"Myopia is a very common problem in our country. The proportion of middle school students who experience myopia is 74%. Myopia can be improved by wearing eyeglasses."
Treatment 4	Price *(N=1666)*
	"The average market price of a pair of glasses is 200 to 300 yuan. Having a pair of glasses is very cost-effective if you experience myopia."
Outcome 1	Will wear glasses after developing myopia ? (Students not diagnosed as myopia answer the question)
Outcome 2	Will encourage myopic friends to wear glasses ? (All students answer the question)

Notes: This table shows the experimental design of eyeglass information intervention in 2022. Randomization was independently conducted at the student level.

Table 2: Balance checks

	(1) Control	(2) T1	(3) T2	(4) T3	(5) T4	Diff (1)-(2)	Diff (1)-(3)	Diff (1)-(4)	Diff (1)-(5)
Panel A. Myopia & wearing glasses									
Myopia (=1)	0.545	0.534	0.538	0.536	0.552	0.011	0.006	0.009	-0.008
	[0.024]	[0.024]	[0.025]	[0.024]	[0.025]				
Likely myopia (=1)	0.131	0.152	0.141	0.147	0.143	-0.021	-0.010	-0.016	-0.012
	[0.009]	[0.014]	[0.012]	[0.010]	[0.008]				
Wear glasses (=1)	0.411	0.419	0.413	0.405	0.422	-0.009	-0.002	0.006	-0.011
	[0.030]	[0.027]	[0.031]	[0.026]	[0.031]				
Panel B. Student's beliefs									
Estimated myopia % in the grade	51.815	52.854	52.103	52.140	52.348	-1.040	-0.288	-0.326	-0.533
	[1.970]	[1.986]	[1.746]	[1.775]	[1.964]				
Positive impact of wearing glasses (=1)	0.315	0.339	0.339	0.339	0.337	-0.024	-0.024	-0.024	-0.022
	[0.016]	[0.018]	[0.016]	[0.015]	[0.015]				
Log(perceived price of glasses)	7.210	7.182	7.169	7.187	7.162	0.029	0.042	0.023	0.049
	[0.035]	[0.053]	[0.063]	[0.031]	[0.040]				
Panel C. Student characteristics									
Female (=1)	0.494	0.498	0.511	0.483	0.517	-0.004	-0.017	0.011	-0.023
	[0.017]	[0.014]	[0.016]	[0.017]	[0.017]				
Minority (Yi = 1)	0.438	0.448	0.443	0.453	0.466	-0.011	-0.005	-0.015	-0.028
	[0.034]	[0.037]	[0.038]	[0.037]	[0.034]				
Minority (other groups=1)	0.153	0.150	0.161	0.145	0.160	0.003	-0.007	0.008	-0.007
	[0.012]	[0.010]	[0.013]	[0.010]	[0.012]				
Panel D. Study-related factors									
Want to attend high school (=1)	0.807	0.823	0.832	0.805	0.822	-0.016	-0.025	0.002	-0.014
	[0.021]	[0.022]	[0.020]	[0.020]	[0.017]				
Self-confidence (s.d.)	0.016	0.038	-0.002	-0.012	0.006	-0.023	0.018	0.027	0.010
	[0.035]	[0.037]	[0.038]	[0.042]	[0.043]				
Growth mindset (optimistic=1)	0.293	0.295	0.298	0.270	0.300	-0.002	-0.006	0.022	-0.007
	[0.013]	[0.016]	[0.013]	[0.017]	[0.012]				
Math is a difficult subject (=1)	0.568	0.579	0.574	0.603	0.582	-0.012	-0.007	-0.036*	-0.014
	[0.020]	[0.024]	[0.020]	[0.021]	[0.020]				
English is a difficult subject (=1)	0.632	0.630	0.646	0.658	0.622	0.002	-0.014	-0.026	0.010
	[0.029]	[0.029]	[0.028]	[0.029]	[0.032]				
Panel E. Student's test scores									
Chinese	65.697	66.551	65.869	65.012	66.304	-0.854	-0.173	0.685	-0.607
	[1.715]	[1.677]	[1.604]	[1.510]	[1.575]				
English	52.059	53.318	51.450	50.895	52.993	-1.259	0.609	1.164	-0.934
	[3.964]	[4.143]	[3.827]	[3.621]	[3.798]				
Math	54.080	55.257	53.227	52.146	54.695	-1.177	0.853	1.934	-0.615
	[3.728]	[3.741]	[3.382]	[3.268]	[3.495]				
Observations	1651	1648	1644	1653	1666				

Notes: (1) The table reports the mean and standard deviation (in square brackets) of each variable. (2) The columns after column (5) report the control-treamtment differences. ***, **, and * indicate the significance of the differences at the 1, 5, and 10 percent critical level based on robust standard errors clustered by school-grade. (3) The joint F test p-value from a multinomial logit model using all the covariates and school-class fixed effects to predict treatment assignment status is 0.6863.

Table 3: Descriptive statistics

	(1) All samples	(2) Boys	(3) Girls	(4) Minority	(5) Han	(6) High-achiever	(7) Low-achiever	(8) Reference data
Panel A. Status quo of vision health								
Had vision problems (=1)	0.684	0.599	0.768	0.691	0.673	0.754	0.602	0.711
	(0.465)	(0.490)	(0.422)	(0.462)	(0.469)	(0.431)	(0.490)	
Myopic (=1)	0.541	0.459	0.623	0.550	0.527	0.610	0.461	
	(0.498)	(0.498)	(0.485)	(0.498)	(0.499)	(0.488)	(0.499)	
Likely myopic (=1)	0.143	0.140	0.145	0.141	0.146	0.144	0.141	
	(0.350)	(0.348)	(0.352)	(0.348)	(0.353)	(0.351)	(0.348)	
Among "Had vision problems":								
Wear glasses	60.5%	52.3%	67.1%	59.3%	62.5%	68.2%	49.3%	62.3%
Panel B. Students' baseline beliefs								
Estimated myopia % in the grade	52.09	47.85	56.39	49.18	51.95	58.29	45.18	-
	(23.02)	(23.51)	(21.68)	(22.89)	(23.21)	(21.59)	(22.49)	
Positive impact of glasses (=1)	0.334	0.350	0.319	0.331	0.340	0.325	0.343	-
	(0.472)	(0.477)	(0.466)	(0.471)	(0.474)	(0.469)	(0.475)	
Perceived price of glasses (RMB)	1681.4	1743.3	1618.6	1640.4	1743.7	1664.5	1699.1	200-300
	(1061.1)	(1173.7)	(928.9)	(1030.7)	(1102.9)	(987.6)	(1126.8)	
Panel C. Self-efficacy and test score								
Confidence factor (s.d.)	0.009	0.047	-0.029	-0.001	0.025	0.113	-0.113	-
	(0.999)	(1.027)	(0.970)	(0.983)	(1.023)	(1.029)	(0.949)	
Growth mindset (optimistic=1)	0.291	0.316	0.267	0.289	0.294	0.299	0.282	-
	(0.454)	(0.465)	(0.442)	(0.453)	(0.456)	(0.458)	(0.450)	
Average test score	57.33	52.61	62.00	58.02	56.22	74.72	40.07	-
	(20.10)	(20.32)	(18.74)	(19.95)	(20.28)	(11.02)	(9.284)	
Observations	8,262	4,126	4,136	4,987	3,275	4,459	3,803	

	(9) Not myopic	(10) Likely myopic	(11) Myopic & w/o glasses	(12) Myopic & w/ glasses
Wear glasses	0	0	0	100%
Panel A. Students' baseline beliefs				
Estimated myopia % in the grade	45.78	52.12	50.32	57.84
	(22.99)	(22.55)	(22.99)	(21.63)
Positive impact of glasses (=1)	0.374	0.271	0.334	0.324
	(0.484)	(0.444)	(0.472)	(0.468)
Perceived price of glasses (RMB)	1753.1	1787.3	1768.1	1561.1
	(1203.4)	(1119.9)	(1126.4)	(855.6)
Panel B. Self-efficacy and test score				
Confidence factor (s.d.)	0.0438	0.0147	-0.103	0.0153
	(1.009)	(1.021)	(0.933)	(1.002)
Growth mindset (optimistic=1)	0.320	0.289	0.285	0.272
	(0.467)	(0.454)	(0.452)	(0.445)
Average test score	51.07	57.41	50.78	64.10
	(18.55)	(19.52)	(17.90)	(19.87)
Observations	2613	1179	1050	3420

Notes: (1) Standard deviations are reported in parentheses. (2) " Estimated myopic % in the grade" refers to the question about the estimated proportion of myopic students in the grade; "Positive impact of wearing glasses" refers to those who initially believed that wearing glasses after developing myopia has a positive effect on study; "Guessing glasses price (RMB)" refers to the question about the guessing price of a pair of glasses. (3) In column (8), "Reference data" refers to the nationwide statistics, where "Had vision problems" contains the nationwide myopia rate among junior high school students cited from an official press conference (see here), while "Wear glasses" and "Guessing myopic % in the grade" are derived from the CEPS (during 2014-2015, students from grade 7-8).

Table 4: Nudge effects on students' willingness to wear glasses after developing myopia

	(1)	(2)	(3)	(4)	(5)
Sample	Not myopic + Likely myopic			Not myopic	Likely myopic
Control group mean	0.668	0.668	0.668	0.723	0.526
T1 (Short-term impact)	0.074***	0.078***	0.070***	0.054**	0.096**
	(0.018)	(0.018)	(0.019)	(0.025)	(0.040)
T2 (Long-term impact)	0.030	0.033	0.037*	0.030	0.017
	(0.023)	(0.022)	(0.021)	(0.023)	(0.043)
T3 (Nationwide % myopic)	0.051**	0.055**	0.062**	0.064**	0.007
	(0.022)	(0.023)	(0.025)	(0.029)	(0.046)
T4 (Price)	0.029	0.033	0.029	0.005	0.055
	(0.021)	(0.022)	(0.024)	(0.032)	(0.040)
Q-value: T1	0.001	0.001	0.007	0.071	0.067
Q-value: T2	0.159	0.159	0.109	0.159	0.332
Q-value: T3	0.071	0.067	0.067	0.071	0.332
Q-value: T4	0.159	0.159	0.180	0.332	0.159
Observations	3,792	3,454	3,453	2,607	1,170
R-squared	0.003	0.089	0.154	0.133	0.233
Covariates	No	Yes	Yes	Yes	Yes
School-Class FE	No	No	Yes	Yes	Yes

Notes: (1) "Students not diagnosed with myopia" include students who reported to be not myopic and students who did not know whether they were myopic but could not see the blackboard clearly. (2) Covariates include all the pre-intervention variables as summarized in Table 1. (3) False Discovery Rate (FDR) adjusted p-values, or *q-values*, are reported in square brackets as the results of multiple hypothesis testing. (4) Robust standard errors clustered by school-class are reported in parentheses; ***, **, and * reflect unadjusted p-values, indicating significance at the 1, 5, and 10 percent critical level. (5) "Control group mean" stands for the average outcome of control group.

Table 5: Nudge effects on students' willingness to encourage myopic friends to wear glasses

	(1)	(2)	(3)	(4)	(5)
Sample	All students	Not myopic	Likely myopic	Myopic & w/o glasses	Myopic & w/ glasses
Control group mean	0.702	0.738	0.577	0.623	0.738
T1 (Short-term impact)	0.055***	0.025	0.060	0.113**	0.055**
	(0.016)	(0.023)	(0.057)	(0.043)	(0.023)
T2 (Long-term impact)	0.041**	0.013	0.043	0.032	0.059***
	(0.017)	(0.029)	(0.036)	(0.056)	(0.020)
T3 (Nationwide % myopic)	0.016	0.004	0.001	0.023	0.015
	(0.014)	(0.024)	(0.037)	(0.042)	(0.019)
T4 (Price)	0.018	-0.016	0.063	0.058	0.012
	(0.016)	(0.029)	(0.042)	(0.051)	(0.022)
Q-value: T1	0.021	0.588	0.588	0.074	0.074
Q-value: T2	0.074	0.974	0.588	0.961	0.050
Q-value: T3	0.588	0.974	0.974	0.961	0.911
Q-value: T4	0.588	0.961	0.557	0.588	0.961
Observations	8,254	2,607	1,170	1,025	3,412
R-squared	0.089	0.128	0.251	0.244	0.109
Covariates	Yes	Yes	Yes	Yes	Yes
School-Class FE	Yes	Yes	Yes	Yes	Yes

Notes: (1) All regressions include the same control variables as those in Table 4. (2) Robust standard errors clustered by school-class are reported in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 6: Heterogeneity by personal characteristics and academic performance

Sample	(1) Minority	(2) Han	(3) Girls	(4) Boys	(5) Test Scores > Mdn	(6) Test Scores < Mdn
Panel A.	**Dependent Variable: Will wear glasses after developing myopia (0/1)**					
Overall effect	0.067**	-0.012	0.036	0.048	0.050*	0.023
	(0.026)	(0.033)	(0.023)	(0.031)	(0.028)	(0.030)
T1 (Short-term impact)	0.066**	0.024	0.101***	0.044	0.079**	0.031
	(0.031)	(0.032)	(0.035)	(0.031)	(0.032)	(0.037)
T2 (Long-term impact)	0.068**	-0.039	0.006	0.043	0.070*	-0.021
	(0.025)	(0.048)	(0.030)	(0.036)	(0.035)	(0.028)
T3 (Nationwide % myopic)	0.083**	0.013	0.001	0.091**	0.04	0.059
	(0.033)	(0.039)	(0.032)	(0.037)	(0.033)	(0.037)
T4 (Price)	0.049	-0.041	0.038	0.018	0.018	0.029
	(0.038)	(0.037)	(0.027)	(0.038)	(0.039)	(0.040)
Q-value: T1	0.116	0.665	0.049	0.404	0.098	0.665
Q-value: T2	0.098	0.665	0.806	0.478	0.165	0.665
Q-value: T3	0.098	0.783	0.839	0.098	0.462	0.320
Q-value: T4	0.438	0.505	0.404	0.754	0.754	0.665
Observations	2,079	1,348	1,408	2,037	1,713	1,730
R-squared	0.182	0.241	0.229	0.194	0.191	0.173
Control group mean	0.645	0.721	0.709	0.656	0.675	0.676
Panel B.	**Dependent Variable: Will encourage myopic friends to wear glasses (0/1)**					
Overall effect	0.034**	0.027	0.042**	0.020	0.060***	0.007
	(0.015)	(0.027)	(0.019)	(0.019)	(0.015)	(0.015)
T1 (Short-term impact)	0.058***	0.051	0.066**	0.039*	0.078***	0.042**
	(0.015)	(0.031)	(0.028)	(0.022)	(0.021)	(0.019)
T2 (Long-term impact)	0.049*	0.021	0.053**	0.035	0.096***	-0.008
	(0.025)	(0.033)	(0.023)	(0.022)	(0.022)	(0.019)
T3 (Nationwide % myopic)	0.015	0.019	0.013	0.017	0.032*	-0.001
	(0.018)	(0.03)	(0.02)	(0.025)	(0.017)	(0.020)
T4 (Price)	0.012	0.018	0.036	-0.012	0.039**	-0.005
	(0.021)	(0.032)	(0.025)	(0.025)	(0.019)	(0.026)
Q-value: T1	0.002	0.194	0.101	0.164	0.008	0.127
Q-value: T2	0.147	0.472	0.101	0.199	0.002	0.517
Q-value: T3	0.436	0.472	0.472	0.472	0.155	0.808
Q-value: T4	0.472	0.472	0.222	0.479	0.101	0.680
Observations	4,658	2,914	3,805	3,770	3,768	3,791
R-squared	0.103	0.115	0.106	0.114	0.108	0.092
Control group mean	0.703	0.696	0.705	0.696	0.708	0.693

Notes: (1) The “Overall effect" indicates the overall treatment effect from the 4 treatment groups compared to the control group. (2) Regressions include covariates and school-class fixed effects. (3) ***, **, and * indicate significance at the 1, 5, and 10 percent critical level based on robust standard errors clustered by school-class.

Table 7: Heterogeneity by peer groups

Sample	(1) % Glasses wearing > Mdn	(2) % Glasses wearing < Mdn	(3) Average scores > Mdn	(4) Average scores < Mdn
Panel A.	**Dependent Variable: Will wear glasses after developing myopia (0/1)**			
Overall effect	0.048*	0.027	0.070***	0.002
	(0.028)	(0.029)	(0.022)	(0.027)
T1 (Short-term impact)	0.053	0.051	0.069**	0.031
	(0.032)	(0.032)	(0.027)	(0.034)
T2 (Long-term impact)	0.072**	-0.015	0.091***	-0.034
	(0.032)	(0.033)	(0.028)	(0.032)
T3 (Nationwide % myopic)	0.041	0.058	0.081**	0.015
	(0.032)	(0.039)	(0.035)	(0.033)
T4 (Price)	0.026	0.014	0.040	-0.001
	(0.035)	(0.032)	(0.033)	(0.026)
Q-value: T1	0.306	0.306	0.090	0.496
Q-value: T2	0.010	0.678	0.049	0.454
Q-value: T3	0.445	0.331	0.098	0.678
Q-value: T4	0.536	0.678	0.454	0.729
Observations	1,679	1,774	1,727	1,726
R-squared	0.176	0.146	0.154	0.178
Control group mean	0.680	0.713	0.657	0.733
Panel B.	**Dependent Variable: Will encourage myopic friends to wear glasses (0/1)**			
Overall effect	0.045***	0.020	0.073***	-0.008
	(0.015)	(0.020)	(0.016)	(0.016)
T1 (Short-term impact)	0.064***	0.048**	0.101***	0.013
	(0.022)	(0.023)	(0.021)	(0.020)
T2 (Long-term impact)	0.062***	0.025	0.096***	-0.012
	(0.021)	(0.026)	(0.025)	(0.020)
T3 (Nationwide % myopic)	0.016	0.015	0.046**	-0.013
	(0.019)	(0.026)	(0.018)	(0.021)
T4 (Price)	0.038**	-0.009	0.050**	-0.020
	(0.017)	(0.024)	(0.020)	(0.025)
Q-value: T1	0.022	0.059	0.002	0.418
Q-value: T2	0.022	0.418	0.008	0.418
Q-value: T3	0.418	0.418	0.038	0.418
Q-value: T4	0.055	0.568	0.042	0.399
Observations	3,709	3,867	3,788	3,788
R-squared	0.09	0.078	0.085	0.086
Control group mean	0.704	0.696	0.687	0.714

Notes: (1) Columns 1 and 2 show the peer effects in the ratio of wearing glasses in the class, while columns 3 and 4 show the peer effects in the average test scores in the class. (2) The “Overall effect" indicates the overall treatment effect from the 4 treatment groups compared to the control group. (3) Regressions include covariates and school-class fixed effects. (4) ***, **, and * indicate significance at the 1, 5, and 10 percent critical level based on robust standard errors clustered by school-class.

Table 8: Heterogeneity by baseline beliefs

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Will wear glasses after developing myopia (0/1)			Will encourage myopic friends to wear glasses (0/1)		
Sample	Positive	Negative	Not sure	Positive	Negative	Not sure
Overall effect	0.018	0.032	0.074**	-0.002	-0.002	0.120***
	(0.039)	(0.028)	(0.029)	(0.021)	(0.019)	(0.029)
T1 (Short-term impact)	0.025	0.044	0.117**	-0.016	0.037*	0.152***
	(0.041)	(0.031)	(0.044)	(0.027)	(0.019)	(0.038)
T2 (Long-term impact)	-0.008	0.020	0.064*	0.026	-0.016	0.139***
	(0.042)	(0.039)	(0.036)	(0.026)	(0.032)	(0.034)
T3 (Nationwide % myopic)	0.047	0.082*	0.045	-0.003	-0.008	0.077**
	(0.055)	(0.043)	(0.035)	(0.024)	(0.026)	(0.033)
T4 (Price)	0.005	-0.018	0.072*	-0.016	-0.025	0.115***
	(0.045)	(0.042)	(0.042)	(0.026)	(0.025)	(0.037)
Q-value: T1	0.803	0.316	0.062	0.803	0.211	0.002
Q-value: T2	0.994	0.803	0.235	0.593	0.803	0.002
Q-value: T3	0.659	0.211	0.386	0.994	0.918	0.098
Q-value: T4	0.994	0.803	0.235	0.803	0.593	0.023
Observations	1,191	1,115	1,104	2,543	2,869	2,157
R-squared	0.271	0.269	0.263	0.121	0.133	0.166
Control group mean	0.714	0.689	0.624	0.761	0.751	0.559
All covariates	Yes	Yes	Yes	Yes	Yes	Yes
School-Class FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: (1) The "Overall effect" indicates the overall treatment effect from the 4 treatment groups compared to the control group. (2) ***, **, and * indicate significance at the 1, 5, and 10 percent critical level based on robust standard errors clustered by school-class.

Table 9: Predicting pre-intervention eyeglasses willingness: Model comparison

	(1)	(2)	(3)	(4)	(5)
Model	Tree	Random Forest	Boosting	LASSO	Logit
Panel A.	**Outcome: Will wear glasses after developing myopia (0/1)**				
Predicted probability					
Min	0.4141	0.4037	0.4586	0.4205	0.4059
Mean	0.6782	0.6806	0.6786	0.679	0.6793
Median	0.7811	0.6879	0.7036	0.6833	0.6843
Max	0.7811	0.7899	0.7470	0.8476	0.8574
Classification accuracy					
Training	71.00%	96.68%	71.23%	66.95%	67.09%
Testing	67.82%	70.18%	70.18%	66.18%	66.18%
Classification error rate					
Training	29.27%	9.27%	28.91%	32.91%	33.09%
Testing	40.15%	35.04%	35.77%	28.47%	29.20%
Panel B.	**Outcome: Will encourage myopic friends to wear glasses (0/1)**				
Predicted probability					
Min	0.1111	0.6846	0.6715	0.5382	0.5509
Mean	0.7009	0.7018	0.7003	0.7023	0.7029
Median	0.7038	0.7020	0.7004	0.703	0.7035
Max	0.7038	0.7159	0.7004	0.8062	0.8227
Classification accuracy					
Training	70.69%	74.13%	70.07%	70.07%	70.07%
Testing	69.01%	70.24%	70.07%	70.07%	70.07%
Classification error rate					
Training	29.93%	29.03%	29.93%	29.93%	29.93%
Testing	27.80%	27.80%	27.80%	27.80%	27.80%

Notes: (1) The training and testing datasets are obtained by dividing the control group sample in an 8:2 ratio, resulting in 1321 observations in the training dataset and 330 observations in the testing dataset. (2) All models use the same set of covariates (including their interactions) and fixed effects. (3) The λ values in the LASSO model are 0.1 and 0.001 respectively in two outcomes' context. (4) In the first outcome, the top 5 important predictors in the Random Forest model are guessing myopia rate in the grade, log(perceived price of glasses), self-confidence factors, English test score, and Chinese test scores.In the second outcome, the top 5 important predictors are school-class fixed effects, desire for attending high school, Chinese test score, currently wearing glasses, and believing positive impact on the study by wearing glasses.

Table 10: Effects of myopia and wearing glasses on academic performance (standardized test scores)

	(1)	(2)	(3)	(4)	(5)
Outcome	Chinese	Math	English	Average	Average
Method	OLS	OLS	OLS	OLS	DML
Panel A: Sample from this program					
Myopic (=1)	-0.061	-0.061**	-0.025	-0.051*	-0.052*
	(0.036)	(0.030)	(0.028)	(0.028)	(0.028)
Wear glasses (=1)	0.122***	0.131***	0.078**	0.111***	0.102***
	(0.037)	(0.038)	(0.034)	(0.032)	(0.034)
Observations	7,591	7,577	7,588	7,576	7,578
R-squared	0.365	0.369	0.438	0.455	
Panel B: Rural samples from CEPS					
Myopic (=1)	-0.036	-0.042	-0.062**	-0.041**	-0.035*
	(0.028)	(0.031)	(0.026)	(0.020)	(0.019)
Wear glasses (=1)	0.048	-0.001	0.025	0.028	0.026
	(0.033)	(0.033)	(0.036)	(0.023)	(0.024)
Observations	4,472	4,468	4,467	4,454	4,459
R-squared	0.567	0.600	0.658	0.752	
Panel C: Nationwide samples from CEPS					
Myopic (=1)	-0.045**	-0.035	-0.033*	-0.037***	-0.030**
	(0.019)	(0.023)	(0.017)	(0.013)	(0.013)
Wear glasses (=1)	0.057**	0.013	0.042*	0.037**	0.034**
	(0.023)	(0.023)	(0.022)	(0.016)	(0.015)
Observations	9,318	9,316	9,309	9,291	9,291
R-squared	0.55	0.577	0.663	0.748	

Notes: (1) All test scores are standardized within schools. (2) CEPS is a nationwide survey in China that provides educational outcome data for students in grades 7 through 9. We utilize samples from grades 7 and 8. (3) Variable "Wear glasses" in Panel C shows the minimum effect of wearing glasses on test scores (4) Regressions include covariates and school-class fixed effects. (5) ***, **, and * indicate significance at the 1, 5, and 10 percent critical level based on robust standard errors clustered by school-class.