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Does Vision Health Knowledge Matter? A Cross-Sectional Study of Primary School Students in Rural China

Zhaofeng Pang[1], Xiyuan Jia[2], Ming Zhou[2], Xinwu Zhang[3], Cindy Feng[3], Yue Ma[3]

[1]School of Politics and Public Administration, Northwest University of Political Science and Law, Xi'an, People's Republic of China; [2]School of Public Administration, Northwest University, Xi'an, People's Republic of China; [3]Stanford Center on China's Economy and Institutions, Stanford University, Palo Alto, CA, USA

Correspondence: Xinwu Zhang, Stanford Center on China's Economy and Institutions, Stanford University, 616 Jane Stanford Way, Palo Alto, CA, USA, Email zhangxinwuceee@126.com

Purpose: To estimate the prevalence, consequences of, and factors associated with poor vision health knowledge among students, parents, and teachers in rural China.

Methods: This cross-sectional study was conducted with 17,902 students among 251 primary schools in rural China. The primary outcomes were eyeglasses ownership and wear rates, measured by self-reported eyeglasses ownership and wear status. Descriptive and multivariable regression analyses were performed.

Results: Students, parents, and teachers had a high prevalence of poor vision health knowledge, with 90% of students, 86% of parents, and 56% of teachers scoring 4 or below on the study's vision knowledge test. Among 2,893 students needing eyeglasses, only 563 (19.46%) owned eyeglasses and 450 (15.55%) wore them. Both student and parental vision health knowledge were positively associated with eyeglasses ownership ($p < 0.001$ and $p < 0.001$, respectively). Parental vision health knowledge also showed a positive association with eyeglasses wear ($p=0.098$). Students with higher parental vision health knowledge and male students had higher vision health knowledge. Parents with higher education levels, at least one family member wearing eyeglasses, medium to high family wealth demonstrated higher levels of vision health knowledge.

Conclusion: We found that poor vision health knowledge is prevalent among children, parents, and teachers in rural western China, and that prevalent visual impairment among children is accompanied by low eyeglasses ownership and wear rates. We also found positive and significant correlations between students' and parental vision health knowledge and students' eyeglasses ownership, as well as between parental vision health knowledge and students' eyeglasses wear rates, suggesting that efforts are needed to improve vision health knowledge among students and parents in rural China.

Keywords: vision health knowledge, eyeglasses / spectacles ownership, eyeglasses / spectacles wear, primary students, rural China

Introduction

Visual impairment is the most common disability affecting school-aged children in the developing world.[1] More than 90% of visual impairment can be corrected with prescription eyeglasses, which have become increasingly available and affordable to children in the developing world.[2–5] But despite reduced accessibility and financial barriers, eyeglasses ownership and wear rates have remained low in less developed communities; in some areas, only 40% of the existing need has been met.[1,6–10] Moreover, previous intervention studies have reported that less than 30% of visually impaired school-aged children who received a pair of eyeglasses actually wear them.[9,11,12]

The poor vision health knowledge of school-aged children, their parents, and their teachers may be a primary reason behind the inadequate allocation of vision care and eyeglasses in low-resource areas. It may also worsen existing visual impairment in affected children. In fact, many studies have identified how poor vision health knowledge (ie, poor knowledge about the causes[2,3,13–15] or treatment[3–5,13,16–18] of visual impairment) among visually impaired children, their

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parents, and teachers negatively impacts eyeglasses purchase and wear rates in developing settings. Poor vision health knowledge in parents of visually impaired children has been found to determine such factors as if vision care is sought for the child, the child's age upon presentation of visual impairment, andthe treatment options available for the child.[14,19] Additionally, a common belief held by students, parents, and teachers with poor vision health knowledge is that wearing eyeglasses weakens or harms children's eyes, which discourages parents from obtaining corrective eyeglasses for their children.[3,13,16] Thus, evidence supports the theory that poor vision health knowledge held by visually impaired children, along with their parents and teachers, presents a significant barrier to eyeglasses ownership and wear in developing settings. To date, however, no study conducted in a developing setting has systematically examined the associations between eyeglasses ownership, eyeglasses wear, and vision health knowledge of school-aged children, their parents, and their teachers.

In rural China, despite the high prevalence of visual impairment in school-aged children[1] (approximately 33% of whom reside in rural areas) and the relative ease of correcting a large majority of visual impairment with eyeglasses,[10,20] a significant number of children who would benefit from refractive correction do not appear to be receiving proper care. According to an analysis of 12 Chinese cohorts (N=83,273), visual impairment was detected in 32.8% of children aged 6 to 17 years, yet only 35.9% of the children in need of corrective eyeglasses owned a pair.[1] Moreover, Yi et al found that only 18% of the students with uncorrected visual acuity self-reported that they were actually wearing their eyeglasses.[12]

Research has determined that poor vision health knowledge might be a key factor behind low eyeglasses ownership and wear rates among school-aged children in rural China. Compared to the vision health knowledge of school-aged children attending urban schools, rural students have significantly lower levels of vision health knowledge.[3,21,22] For example, studies done in rural northwest China involving primary school students, their parents, and their teachers found that all three groups had low-to-moderate vision health knowledge.[21,23] Yet little is known about the correlation between vision health knowledge and eyeglasses ownership and wear rates. To our knowledge, only one study done in rural China has examined a potential correlation between teachers' vision health knowledge and their students' rates of purchasing or wearing eyeglasses;[24] this study, however, found no significant results. It therefore remains unclear how the vision health knowledge of rural, visually impaired primary school students, their parents, and their teachers correlates with these students' eyeglasses ownership and wear rates.

To address this gap, this paper explores the prevalence, potential consequences, and factors associated with poor vision health knowledge among primary school students in China's rural areas. We have three objectives. First, we document the prevalence of poor vision health knowledge among primary school students, their teachers, and their parents, and describe the rates of students' visual impairment, eyeglasses ownership, and eyeglasses wear. Second, we assess if the poor vision health knowledge of the students, their parents, and teachers adversely affects visually impaired students' eyeglasses ownership and wear rates. Finally, we examine the relationship between the level of vision health knowledge among students and parents and several sociodemographic characteristics.

Materials and Methods

Setting

This study was conducted in two areas of western China: prefectures A and B. Prefecture A is an economically-deprived area in one of China's lowest resource provinces, Gansu. Gansu was the second-poorest province in the country with an annual per capita GDP of USD 3,100 in 2012.[25] In contrast, prefecture B is a relatively affluent area located in Shaanxi province, a middle-income province. In 2012, Shaanxi's GDP per capita of USD 6,108 was ranked 14th among China's 31 provincial administrative regions and was very similar to the national average of USD 6,091.[25] This study's protocol[26] was approved by Institutional Review Boards at Stanford University (Palo Alto, USA) and the Zhongshan Ophthalmic Center (Guangzhou, China), with the principles of the Declaration of Helsinki followed throughout. The ethical committee approval for this study was obtained from the Stanford University Institutional Review Board (Registration number: ISRCTN03252665, registration site: http://isrctn.org) and Sun Yat-Sen University (Registration number: 2013MEK Y018). Permissions were also obtained from the local boards of education in each sample region and from from the principals of all participating schools. All sample children and teachers individually gave oral consent to their

participation in the study prior to data collection; Children's parents gave written informed consent to both their own and their children's involvement in the study.

Sampling

We selected sample schools using a five-step cluster sampling procedure. First, we obtained a list of all schools in prefectures A and B. Second, we selected all counties in the two prefectures except for one in prefecture B, which was excluded because of its smaller population compared to the average population of the other 11 counties in B (80,000 vs 300,000). The fixed costs associated with adding this small county prevented us from including it. In total, 18 counties were included in the sampling frame: 7 from A and 11 from B. Third, we obtained a list of all primary schools from each county's Bureau of Education, and after randomly selecting one school from each township in each county, we compiled a list of 435 rural schools. Then, we limited our sample to schools with between 50 and 150 students in fourth and fifth grade altogether. This range ensured both statistical power and efficient, consistent implementation to meet logistical constraints. To achieve statistical power, we needed an average of 15 students with poor vision per sample school. We drew on previous research to assume that 15% of all children in rural China had poor vision.[2] This meant that we needed each school to have 100 students in fourth and fifth grade to achieve statistical power. Due to logistical constraints, we could screen only one school per day. To ensure consistent, high-quality visual acuity measurement, a maximum of 150 fourth and fifthgraders could be screened at each school per day. Only 7% of the 435 schools had fewer than 50 students in fourth and fifth grade; Only 12% had more than 150 students. Fourth, from each school, we randomly selected one fourth- and one fifth-grade class. In total, our sample schools were representative of 81% of all the students in the prefectures. All students in each sample class were enrolled in the study, leading to a total of 17,902 fourth and fifth-grade students (9,310 students from A and 8,592 students from B) from 251 primary schools in northwestern China. We focused on these two grades because ophthalmologists have pointed out that the onset of myopia typically begins at age 8 to 10, which coincides with fourth and fifth grade in rural Chinese schools.[27]

Data Collection

Data were collected for this study in 2012. Three questionnaires were administered separately to students, their caregivers, and teachers by trained enumerators.

The questionnaire for students collected information on students' characteristics (age, sex, grade, and whether they boarded at school), as well as vision health knowledge. To ensure students understood the items about vision health knowledge, we conducted a pilot survey among 4th and 5th graders, and trained enumerators explained terminology used in the items during survey administration. To measure academic performance, the research team administered age-appropriate printed mathematics tests for fourth and fifth graders. Local education officials assisted with selecting questions from items developed for the Trends in International Mathematics and Science Study (http://timss.bc.edu/home/pdf/TP_About.pdf). The examination was timed (25 minutes) and proctored by two study enumerators at each school. Consistent with previous studies,[1,10,12,20] we collected students' self-reported eyeglasses ownership and wear to assess compliance with eyeglasses prescription. Students were asked whether they owned eyeglasses. Those reporting that they owned eye-glasses were then asked to describe their eyeglasses wear as either "always", "only for studying", or "usually not worn". We defined self-reported eyeglasses wear as positive if the student reported to wear eyeglasses "always" or "only for studying".

The household questionnaire was handed out to all students' primary caregivers to measure demographic characteristics and parental knowledge of vision health. About 85.75% of all respondents were the students' parent (Appendix Table 1). Respondents reported parental education, migration status, whether at least one family member wore eyeglasses. To estimate the family assets, respondents reported whether their family had the following household items (based on the "National Household Income and Expenditure Survey" published by the China National Bureau of Statistics): a car, a van, a motorcycle, a tractor, agricultural equipment, a computer, access to the Internet, a television, a camera, a washing machine, an air conditioner, a water heater, a gas stove, a refrigerator, a kitchen ventilator, and a flush toilet. We assigned a numerical value to each item and then calculated a proxy variable for the value of the household asset by summing the value of all

items owned by the household. We measured assets ownership rather than family income because recent research found the former to be a more reliable indicator of household socioeconomic status.[28]

Additionally, all 501 homeroom teachers of the sample students completed a questionnaire in which they reported their demographic information and knowledge of vision health. As shown in Appendix Table 1, the average age of the teachers was 32.51 years; more than half (62.28%) of the teachers were female, and about 54.49% had a college degree or above.

Vision Health Knowledge Assessment

In this study, vision health knowledge is measured through individuals' knowledge about myopia and the effects of spectacles wear.[21] To assess vision health knowledge of students, parents, and teachers, we used a questionnaire with eight questions on vision health, developed by health experts from Shaanxi Normal University.[21] The questionnaire was reviewed by other specialists from Zhongshan Ophthalmic Center, an authoritative ophthalmology institution in China, and piloted on a sample of 4th and 5th grade children.[21] Each item had three possible answers: agree, disagree, and do not know. The first section measured knowledge about myopia and included the following items: (a) Myopia (nearsightedness) causes difficulty in seeing nearby objects, (b) Myopia is caused by deformed eyeballs, (c) Eye exercises can treat myopia, (d) Uncorrected nearsightedness will impact school performance. The second section measured knowledge about eyeglasses importance and included the following items: (a) Nearsightedness can be easily treated with eyeglasses, (b) It is not necessary to wear eyeglasses when near-sightedness is not severe, (c) Wearing eyeglasses will harm vision, (d) Elementary school students should not wear eyeglasses.

Visual Impairment Assessment

As part of the school survey, a two-step eye examination was administered to all sample students. First, two trained staff members administered visual acuity (VA) screenings using the Early Treatment Diabetic Retinopathy Study (ETDRS) eye charts. The ETDRS is accepted worldwide as the standard for accurate visual acuity measurement.[29] Students who were found visually impaired (defined as VA of less than or equal to 6/12, or 20/40, in either eye) in this first test were administered a second vision test within the following two days. This second test was conducted by a team of one optometrist, one nurse, and one staff assistant. The test involved cycloplegic automated refraction with subjective refinement to determine prescriptions for children needing glasses. Students were regarded as visually impaired and informed to wear eyeglasses if they had the following: uncorrected VA $\leq$ 6/12 in either eye; spherical equivalent refractive error of myopia ≤ -0.75 diopters (D), hyperopia $\geq +2.00$ D, or astigmatism ≥ 1.00 D, and VA could be improved to $\geq$ 6/7.5 in both eyes with eyeglasses.

Statistical Analysis

We performed univariate and multiple analysis using STATA 16.0 (StataCorp, College Station, Texas, USA), calculating robust standard errors to adjust for clustering by school. Using responses from the students, parents, and teachers, we created an index of eight questions on vision health according to the generalized least squares (GLS) weighting procedure described in Appendix A of Anderson (2018).[30] Higher index numbers indicated higher levels of vision health knowledge. Eyeglasses ownership was defined as students owning a pair of eyeglasses. Eyeglasses wear was defined as students reporting wearing their eyeglasses "always" or "only for studying".

We used multiple linear regression to assess correlations between student, parent, and teacher vision health knowledge and eyeglasses ownership or wear, as well as correlations between student and parental vision health knowledge and sociodemographic characteristics. All sociodemographic variables were included in multiple models with $P \leq 0.20$ in the univariate analysis.

Results

Table 1 presents the descriptive statistics of the 17,902 primary school students. The average age of the students was 10.55 years old. More than half (52%) of the students were male. Only 18% boarded at school. The average standardized math score of the students was 0.04. About 9% of the students' mothers had attended school for 12 years or more. About

Table 1 Descriptive Statistics of Student Characteristics (N=17,902)

Variables	Full Sample	Prefecture A	Prefecture B	Difference
	(1)	(2)	(3)	(4) = (2) - (3)
Male students (n, %)	9,231	4,686	4,545	−0.07
	(51.56%)	(50.33%)	(52.90%)	(0.05)
Student's age in years, Mean (SD)	10.55	10.7	10.39	0.37
	(1.14)	(1.23)	(1.00)	(0.64)
Boarding at school (n, %)	3,257	200	3,057	−0.67***
	(18.19%)	(2.15%)	(35.58%)	(0.06)
Standardized math score	0.04	−0.02	0.10	0.65***
	(0.98)	(0.96)	(1.01)	(0.05)
Father completed senior high school and above (n, %)	2,372	1,198	1,174	0.04
	(13.25%)	(12.87%)	(13.66%)	(0.03)
Mother completed senior high school and above (n, %)	1,545	631	914	0.02
	(8.63%)	(6.78%)	(10.64%)	(0.06)
Both parents migrated out for work (n, %)	2,243	1,512	731	0.07*
	(12.53%)	(16.24%)	(8.51%)	(0.04)
At least one family member wears eyeglasses (n, %)	4,262	2,230	2,032	−0.03
	(23.81%)	(23.95%)	(23.65%)	(0.04)
Log(asset), Mean (SD)	9.66	9.35	10	−1.17***
	(0.96)	(0.77)	(1.02)	(0.16)
Observations	17,902	9,310	8,592	

Notes: Standard deviations or percentages are in parentheses; standard errors are in square parentheses. *p < 0.1. ***p < 0.01.

13% of the students' fathers had attended school for 12 years or more. In 13% of the students' households, the parents had migrated away for work. In 24% of the students' households, at least one family member wore eyeglasses. Finally, the logarithmic mean of the family property was 9.66. In addition, we also compared students from the two prefectures and had not found significant differences in characteristics except for boarding status, standardized math score, parental migrant status, and family assets.

Table 2 Descriptive Statistics of Vision Health Knowledge and Vision Outcomes (N=17,902)

		Students	Parents	Teachers
		(1)	(2)	(3)
Panel A: Vision Health Knowledge Questionnaire Correct Response, N (Percent)				
(1)	Myopia (nearsightedness) causes difficulty in seeing nearby objects.	6,659 (37.19)	7,280 (40.66)	354 (70.66%)
(2)	Myopia is caused by deformed eyeballs.	3,846 (21.48)	3,737 (20.87)	161 (32.14%)
(3)	Eye exercises can treat myopia.	2,253 (12.58)	2,886 (16.12)	189 (37.72%)
(4)	Uncorrected nearsightedness will impact school performance.	8,753 (48.89)	10,766 (60.13)	408 (81.44%)
(5)	Nearsightedness can be easily treated with eyeglasses.	3,315 (18.51)	5,686 (31.76)	187 (37.33%)
(6)	It is not necessary to wear eyeglasses when nearsightedness is not severe.	6,841 (38.21)	5,285 (29.52)	184 (36.73%)
(7)	Wearing eyeglasses will harm vision.	4,833 (26.99)	4,567 (25.51)	285 (56.89%)
(8)	Elementary school students should not wear eyeglasses.	5,956 (33.27)	6,173 (34.48)	341 (68.06%)
(9)	Vision health knowledge mean (SD)	2.37 (1.60)	2.59 (1.70)	4.20 (1.73)
Panel B: Outcomes, N (Percent)				
(1)	Visual impairment rate	2,893 (16.16)	–	–
(2)	Eyeglasses ownership	563 (19.46)	–	–
(3)	Eyeglasses usage	450 (15.55)	–	–

Note: Source: Authors' survey.

Panel A of Table 2 shows the percentage of correct answers given by the participants for each of the eight vision health questions. Students, parents, and teachers all had low levels of vision health knowledge, averaging scores of only 2.37, 2.59, and 4.20 points out of 8, respectively. Moreover, for 90% of the students, 86% of parents, and 56% of teachers, their vision health knowledge was less than or equal to 4. Appendix Table 2 shows the percentile values for vision health knowledge of students, their parents, and teachers. The 5th, 25th, 50th, 75th, and 95th percentile score for students' vision health knowledge was 0, 1, 2, 3, and 5, respectively. The 5th, 25th, 50th, 75th, and 95th percentile score for parental vision health knowledge was 0, 1, 2, 4, and 5, respectively. The 5th, 25th, 50th, 75th, and 95th percentile score for teachers' vision health knowledge was 1, 3, 4, 6, and 7, respectively.

Panel B of Table 2 shows the uncorrected visual acuity rate, eyeglasses ownership rate, and eyeglasses wear rate. In our sample, among 2,893 students screened as having visual impairment and advised to wear eyeglasses for vision correction, 563 (19.46%) students self-reported owning eyeglasses, and only 450 (15.55%) of them reported wearing eyeglasses.

Table 3 reports the correlations between vision health knowledge and eyeglasses ownership among the students screened as having visual impairment. According to the multiple linear regression models, the factors of students' vision health knowledge, parental vision health knowledge, and if at least one family member wore eyeglasses were significantly associated with eyeglasses ownership (0.097, 95% CI 0.063 to 0.132, p<0.001; 0.092, 95% CI 0.060 to 0.125, p<0.001; 0.104, 95% CI 0.072 to 0.136, p<0.001, respectively).

Table 4 shows the relationship between vision health knowledge and eyeglasses wear among students needing eyeglasses and owning eyeglasses. According to the multiple linear regression models, parental vision health knowledge (0.063, 95% CI −0.011 to 0.137, p<0.1) and parental migration status (0.083, 95% CI −0.015 to 0.181, p<0.1) were positively and significantly associated with eyeglasses wear.

Table 3 OLS Estimation of Correlation Between Vision Health Knowledge and Eyeglasses Ownership Among Students Needing Eyeglasses

Dependent variable		Univariate Model Adjusted for Owning Eyeglasses (n = 2,893)		Full Model* (n = 2,893)	
		Regression Coefficient (95% CI)	P value	Regression Coefficient (95% CI)	P value
Vision health knowledge					
(1)	Students' vision health knowledge	0.131 (0.098, 0.164)	<0.001	0.097 (0.063, 0.132)	<0.001
(2)	Parents' vision health knowledge	0.127 (0.096, 0.159)	<0.001	0.092 (0.060, 0.125)	<0.001
(3)	Teachers' vision health knowledge	0.030 (−0.006, 0.066)	0.098	0.024 (−0.014, 0.062)	0.210
Individual characteristics					
(4)	Age (years)	0.006 (−0.008, 0.020)	0.401		
(5)	Male (1 = yes)	0.001 (−0.029, 0.031)	0.961		
(6)	Boarding at school (1 = yes)	0.002 (−0.037, 0.040)	0.933		
(7)	Standardized math score	0.009 (−0.005, 0.024)	0.210		
Parental and family characteristics					
(8)	Father has education of 12 years or more (1 = yes)	0.055 (0.009, 0.102)	0.020	0.016 (−0.032, 0.064)	0.515
(9)	Mother has education of 12 years or more (1 = yes)	0.069 (0.015, 0.122)	0.012	0.017 (−0.038, 0.072)	0.534
(10)	Parental migrant status (1 = both parents are migrants)	0.026 (−0.019, 0.071)	0.258		
(11)	At least one family member wears eyeglasses (1 = yes)	0.125 (0.093, 0.156)	<0.001	0.104 (0.072, 0.136)	<0.001
(12)	Medium wealth tercile (1 = yes)	0.002 (−0.036, 0.041)	0.911		
(13)	High wealth tercile (1 = yes)	0.036 (−0.002, 0.074)	0.060	0.024 (−0.014, 0.061)	0.211

Notes: Source: Authors' survey. *Including variables associated with eyeglasses ownership P ≤ 0.2 in the univariate model.

Table 4 OLS Estimation of Correlation Between Vision Health Knowledge and Eyeglasses Wear Among Students Needing Eyeglasses

Dependent variable		Univariate Model Adjusted for Eyeglasses Wear (n = 546)		Full Model* (n = 546)	
		Regression Coefficient (95% CI)	P value	Regression Coefficient (95% CI)	P value
Vision health knowledge					
(1)	Students' vision health knowledge	0.006 (−0.062, 0.075)	0.855		
(2)	Parents' vision health knowledge	0.062 (−0.010, 0.134)	0.092	0.063 (−0.011, 0.137)	0.092
(3)	Teachers' vision health knowledge	0.038 (−0.024, 0.097)	0.233		
Individual characteristics					
(4)	Age (years)	−0.012 (−0.047, 0.023)	0.491		
(5)	Male (1 = yes)	−0.038(−0.116, 0.040)	0.338		
(6)	Boarding at school (1 = yes)	−0.058 (−0.140, 0.025)	0.171	−0.057 (−0.140, 0.025)	0.172
(7)	Standardized math score	0.027 (−0.009, 0.062)	0.142	0.025 (−0.011, 0.061)	0.174
Parental and family characteristics					
(8)	Father has education of 12 years or more (1 = yes)	0.021 (−0.074, 0.116)	0.663		
(9)	Mother has education of 12 years or more (1 = yes)	0.019 (−0.071, 0.109)	0.674		
(10)	Parental migrant status (1 = both parents are migrants)	0.091 (−0.006, 0.188)	0.065	0.083 (−0.015, 0.181)	0.098
(11)	At least one family member wears eyeglasses (1 = yes)	0.023 (−0.040, 0.086)	0.475		
(12)	Medium wealth tercile (1 = yes)	−0.068 (−0.151, 0.014)	0.104	−0.064 (−0.147, 0.018)	0.127
(13)	High wealth tercile (1 = yes)	−0.041 (−0.120, 0.038)	0.306		

Notes: Source: Authors' survey. In this study, 563 students needing eyeglasses had a pair of eyeglasses, but among these eyeglasses wear status of 17 students were missing, thus observation here is 546. *Including variables associated with eyeglasses wear P ≤ 0.2 in the univariate model.

Table 5 Results from OLS Estimates of the Correlates of Students' Vision Health Knowledge

Variables		Univariate Model Adjusted for Students' Vision Health Knowledge (n = 17,902)		Full Model* (n = 17,902)	
		Regression Coefficient (95% CI)	P value	Regression Coefficient (95% CI)	P value
Vision health knowledge					
(1)	Parents' vision health knowledge	0.196 (0.180, 0.212)	<0.001	0.194 (0.179, 0.210)	<0.001
(2)	Teachers' vision health knowledge	−0.014 (−0.041, 0.014)	0.330		
Individual characteristics					
(3)	Age (years)	0.001 (−0.007, 0.009)	0.833		
(4)	Male (1 = yes)	0.035 (0.022, 0.048)	<0.001	0.034 (0.021, 0.047)	<0.001
(5)	Boarding at school (1 = yes)	−0.001 (−0.024, 0.021)	0.904		
Parental and family characteristics					
(6)	Father has education of 12 years or more (1 = yes)	0.010 (−0.011, 0.030)	0.372		
(7)	Mother has education of 12 years or more (1 = yes)	0.035 (0.009, 0.062)	0.008	0.019 (−0.007, 0.044)	0.154
(8)	Parental migrant status (1 = both parents are migrants)	−0.005 (−0.026, 0.017)	0.677		
(9)	At least one family member wears eyeglasses (1 = yes)	0.026 (0.010, 0.041)	0.002	0.013 (−0.003, 0.028)	0.103
(10)	Medium wealth tercile (1 = yes)	0.006 (−0.011, 0.022)	0.506		
(11)	High wealth tercile (1 = yes)	0.027 (0.009, 0.045)	0.004	0.014 (−0.003, 0.032)	0.110

Notes: Source: Authors' survey. *Including variables associated with students' vision health knowledge P ≤ 0.2 in the univariate model.

Table 6 Results from OLS Estimates of the Correlates of Parents' Vision Health Knowledge

Variables		Univariate Model Adjusted for Students' Vision Health Knowledge (n = 17,902)		Full Model* (n = 17,902)	
		Regression Coefficient (95% CI)	P value	Regression Coefficient (95% CI)	P value
Students' parental and family characteristics					
(1)	Father has education of 12 years or more (1 = yes)	0.048 (0.025, 0.071)	<0.001	0.026 (0.003, 0.049)	0.028
(2)	Mother has education of 12 years or more (1 = yes)	0.073 (0.047, 0.099)	<0.001	0.056 (0.029, 0.082)	<0.001
(3)	Parental migrant status (1 = both parents are migrants)	−0.006 (−0.028, 0.016)	0.613		
(4)	At least one family member wears eyeglasses (1 = yes)	0.055 (0.037, 0.073)	<0.001	0.050 (0.033, 0.068)	<0.001
(5)	Medium wealth tercile (1 = yes)	0.023 (0.007, 0.040)	0.007	0.023 (0.006, 0.040)	0.007
(6)	High wealth tercile (1 = yes)	0.056 (0.037, 0.075)	<0.001	0.052 (0.033, 0.071)	<0.001

Notes: Source: Authors' survey. *Including variables associated with parents' vision health knowledge P ≤ 0.2 in the univariate model.

Table 5 presents the factors correlated with student vision health knowledge. In the multiple linear regression models, students with higher parental vision health knowledge and male students had greater vision health knowledge (0.194, 95% CI 0.179 to 0.210, p<0.001; 0.034, 95% CI 0.021 to 0.047, p<0.001, respectively).

Table 6 presents the factors correlated with parental vision health. In the multiple linear regression models, factors positively and significantly associated with parental vision health knowledge included paternal education (0.026, 95% CI 0.003 to 0.049, p=0.028); maternal education (0.056, 95% CI 0.029 to 0.082, p<0.001); if at least one family member wore eyeglasses (0.050, 95% CI 0.033 to 0.068, p<0.001); and families with medium wealth (0.023, 95% CI 0.006 to 0.040, p=0.007) or high wealth (0.052, 95% CI 0.033 to 0.071, p<0.001).

Discussion

This is the first study conducted in rural western China that systematically explores the associations between eyeglasses ownership and wear rates among 17,902 fourth- and fifth-grade students, and vision health knowledge among the students, their parents, and their teachers. First, our results showed that the students, parents, and teachers were all highly likely to have poor vision health knowledge. In addition, among visually impaired students, few (19.46%) self-reported owning eyeglasses and even fewer (15.55%) self-reported wearing eyeglasses. Second, better vision health knowledge among students and parents was linked to higher eyeglasses ownership in students; we also found a positive and significant correlation between parental vision health knowledge and students' eyeglasses wear rate, but did not find any significant correlation between teachers' vision health knowledge and students' eyeglasses ownership or wear rates. Finally, we identified several factors significantly correlated with student and parental vision health knowledge.

Our results indicate that children, parents, and teachers in rural western China often have poor vision health knowledge, and that the prevalent visual impairment among children is accompanied by low eyeglasses ownership and wear rates. About 90% of students, 86% of parents, and 56% of teachers scored less than 4 points (out of 8 points) on the vision health knowledge test. In addition, the students, parents, and teachers averaged a correct response rate of 30%, 32%, and 53% for each question on the test, respectively. We found that 16.16% of the sample children had visual impairment, a rate lower than those found in previous studies conducted in primary schools in urban China.[31,32] In our study, only 19.46% of students needing eyeglasses owned them, consistent with findings from previous studies conducted in primary schools in rural China[1] and in other LMICs.[33,34] For example, Wang et al found that 23% of urban migrant Chinese school children (mean age 11 years) who needed eyeglasses owned them.[35] Finally, only 15.55% of the students needing eyeglasses in our study reported wearing them, a rate consistent with findings from migrant-majority primary schools in urban China[10] and in other LMICs,[6,7] but lower than that found among students from urban China.[32] For instance, Zhang et al found that 17.9% of the urban migrant children (mean age 10.9 years) who owned eyeglasses reported wearing them.[32] In urban primary schools, 26% of the fourth and fifth students who owned eyeglasses reported

wearing them.[32] Although our findings suggest a promising reduction in the rural-urban gap in eyeglasses compliance, the low level of vision health knowledge among children in rural China, their parents, and teachers remains a concern.

The results also suggest that the vision health knowledge of students, parents, and teachers plays a critical role in shaping the vision health behavior of school-aged children in rural China. First, students' vision health knowledge was positively and significantly correlated with their eyeglasses ownership rates, which is consistent with findings from previous studies.[23] Second, parental vision health knowledge was positively and significantly correlated with both students' eyeglasses ownership and wear rates. According to studies conducted in China[18] and other LMICs,[13,36] a major explanation for the low rates of eyeglasses ownership and wear observed in LMICs is that many parents living in low-resource areas hold the misconception that eyeglasses harm rather than improve their child's vision, which discourages eyeglasses ownership and wear among visually impaired children. However, we note that none of these studies established quantitative correlations to support their reasoning. Third, although the vision health knowledge of teachers was positively correlated with students' eyeglasses ownership and wear rates, these correlations were not statistically significant, consistent with previous findings.[24] One possible interpretation is that vision health knowledge and students' vision health are not major benchmarks for evaluating educators in rural China, which potentially demotivates teachers from monitoring their students' vision health.[37]

This study found several significant correlations between household characteristics and the vision health knowledge of students, including students' gender and parental vision health knowledge. We believe that household bias based on the child's gender (ie, the bias against girls at home) leads to an unequal allocation of household resources,[38] with girls often receiving less investment in health education from their parents than boys. We also believe that parental vision health knowledge affects student vision health knowledge because children spend most of their time at home and are likely to be influenced by their parents' knowledge;[39,40] Therefore, if parents have low vision health knowledge, their children are likely to have similarly low levels of vision health knowledge.

We observed several significant correlations between household characteristics and parental vision health knowledge, including parental education level, family wealth, and if a family member wore eyeglasses. Higher parental education level predicted a higher likelihood that parents will encounter information about vision health, as supported by Shrestha et al.[41] In terms of family wealth, wealthier parents are generally better positioned to invest in their children's health, along with being more likely to have better education.[34] Finally, to the best of our knowledge, no previous study besides the current study has established a positive and significant correlation between a family member wearing eyeglasses and parental vision health knowledge.

This study has several strengths. First, it has a large sample size of 17,902 fourth- and fifth-grade students from 251 rural schools in 18 different counties. Second, it systematically examines the prevalence, consequences, and correlates of vision health knowledge among sampled students, their parents, and their teachers in a low-resource setting — China's rural areas. Despite these strengths, we acknowledge limitations. First, our research identifies correlations between vision health knowledge and vision health behavior but does not establish causality. Second, open-ended responses from children revealed that visually impaired children may not wear glasses due to low eye-glasses wear rate in the community, concerns about appearance, inconvenience, discomfort, and fear of being teased. Thus, the social-psychological factors influencing eyeglasses wear remain underexplored due to the cross-sectional nature of the study. Third, students with low myopia or astigmatism may be less likely to wear eyeglasses than those with high myopia or astigmatism. Finally, while these results may be broadly applicable to China's rural communities, caution is necessary when applying them to other countries and contexts.

This study highlights the importance of improving vision health knowledge among students and parents to increase the eyeglasses ownership and wear rates of visually impaired students living in low-resource areas. Recent studies have shown that school-based vision health campaigns can improve students' vision knowledge as well as eyeglasses ownership and wear rates.[21,23,42] Based on findings from this and previous studies, at the time of writing, the research team had implemented a series of interventions to improve vision health knowledge and to encourage use of eyeglasses among rural Chinese children.[21,23,43] One of them was a health information campaign that consisted of lectures, distribution of cartoon-based pamphlets, and screenings of short documentary-type films that introduce vision health knowledge to students, parents, and teachers;[23] another involved distribution of vouchers for eyeglasses;[43] the third combined the

health information campaign with provision of free eyeglasses.[21] In less developed communities, promoting accurate and reliable information on vision health could not only improve the overall health and well-being of school-aged children, but also increase vision health knowledge among students and parents, thereby encouraging students with visual impairment to own and wear corrective eyeglasses.

Data Sharing Statement

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the institutional review boards at Stanford University Institutional Review Board (Registration number: ISRCTN03252665, registration site: http://isrctn.org) and Sun Yat-Sen University (Registration number: 2013MEK Y018). Permission was received from local boards of education in each region and the principals of all schools. The presented data are anonymized and the risk of identification is low. The principles of the Declaration of Helsinki were followed throughout. Trained members of the field survey team received informed oral consent from all sample students. Students were aware that their information would be collected and used for the purposes of this study. All participating children gave oral consent before data collection; their parents gave written informed consent for their children's involvement in the study. All methods were carried out in accordance with relevant guidelines and regulations.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest.

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