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Barriers and facilitators to using ophthalmic clinical health services following school vision screening: a mixed-methods study

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ABSTRACT

Objective To identify determinants of the utilisation of ophthalmic clinical health services among students who failed school vision screening.

Methods This study employed a sequential explanatory mixed methods design, underpinned by Andersen's Behavioural Model of Health Service Utilisation. Data were initially gathered through interviews with 27 stakeholders—comprising 5 ophthalmologists, 7 community doctors, 7 public health professionals and 8 teachers. The qualitative insights informed the construction of a questionnaire, which subsequently garnered responses from 6215 participants. Qualitative data underwent thematic analysis with NVivo V.12, while quantitative data were analysed using multivariable multinomial logistic regression in SAS V.9.4. Data integration was performed using the Pillar Integration Process for a deductive, evidence-based synthesis of findings.

Results The research revealed that students attending vision demonstration schools and receiving encouragement from schools or communities to access clinical ophthalmic services demonstrated higher adherence to referral (OR=1.66, 95% CI 1.30 to 2.12; OR=1.54, 95% CI 1.33 to 1.80). Conversely, older students and those from higher-income families exhibited lower adherence rates (OR=0.31, 95% CI 0.23 to 0.44; OR=0.34, 95% CI 0.25 to 0.46). Moreover, students with less urgent medical needs were more likely to adhere to referrals compared with those needing immediate referrals (OR=1.24, 95% CI 1.06 to 1.45).

Four pillars emerged: (a) adherence decreased with age, (b) financial constraints did not pose an obstacle, (c) public health services played a critical role, (d) referral urgency did not linearly correlate with adherence.

Conclusion The utilisation of ophthalmic clinical health services following vision screening failure in students is significantly influenced by public health services provided by schools or communities, such as prompting those with abnormal screening results to access ophthalmic clinical health services.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Students who failed the school vision screening are mandated to pursue further assessment at a designated. Despite annual recommendations, adherence rate remains low.

WHAT THIS STUDY ADDS

⇒ Public health services were the primary determinants of referral adherence among students failing vision screenings, beyond sociodemographic characteristics such as age and family income, and perceived personal need.

⇒ Vision demonstration schools exhibited significantly higher adherence rates than other schools, and the active encouragement from schools or communities to adhere was a key factor in the utilisation of ophthalmic clinical health services.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The determinants of individual clinical health service utilisation were multifaceted, with prior research focusing predominantly on sociodemographic factors and the availability and accessibility of clinical medical resources, often overlooking the influence of public health entities and their services. Further investigation in this area was warranted.

⇒ Similar to other health service utilisation surveys, investigations into ophthalmic clinical health service use among students with failed school vision screenings lacked standardised questionnaires and methodologies. However, employing the Andersen's Model, incorporating mixed methods with both quantitative and qualitative analysis, and synthesising conclusions using the Pillar Integration Process were proven to be scientifically effective.

INTRODUCTION

An estimated 1 billion cases of impaired vision or blindness out of 2.2 billion individuals could have been prevented or ameliorated but not handled.[1] Vision impairment and blindness in children adversely impact their health, educational outcomes and future prospects.[2] The omission of early diagnosis and intervention in paediatric populations can result in irreversible vision loss or

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blindness.[3] Visual impairment manifests as a significant public health issue within developing nations, further compounded by insufficient healthcare services.[4] Nevertheless, school-based eye care initiatives hold promise for delivering high-quality, cost-effective visual health services.[5] The efficacy of vision screening programmes hinges on comprehensive follow-up care.[6]

In China, the lack of a standardised national protocol for vision screening and an established referral system has been noted.[7] Often, children identified in vision screenings are asymptomatic or in early stages, thus post-screening clinical follow-up rates are often low.[8] To improve compliance with clinical ophthalmic services post-screening, it is crucial to identify the underlying factors contributing to the persistently low adherence rates. Decision-making regarding medical consultations or treatments is intricate.[9] The Andersen's Model, established to elucidate healthcare access and utilisation,[10] suggests that a convergence of predisposing characteristics, enabling resources and need factors drives healthcare usage.[11] Contemporary research into post-vision screening compliance in children is limited,[12] with existing studies primarily focusing on parental[13] and healthcare system[14] determinants.

Health services research demands the examination of multifaceted and multilevel systems, often necessitating both quantitative and qualitative data.[15] Therefore, this study employs mixed methods to investigate the comprehensive determinants—spanning individual, familial, educational and healthcare-related factors—that influence the utilisation of ophthalmic services following school-based vision screenings, anchored by Andersen's Model as the theoretical underpinning.

METHODS

Study design

This research was conducted using a mixed-methods framework, incorporating both qualitative (individual in-depth interviews and focus group discussions) and quantitative (survey) methodologies. Mixed methods research synergistically combines the empirical precision of quantitative data with the nuanced context of qualitative insights, offering a robust approach for investigating complex healthcare systems and deepening the analysis in health services research.[16]

This study used a two-phase sequential explanatory mixed-methods approach, beginning with qualitative interviews to guide the creation of a quantitative survey in the absence of a pre-existing instrument for post-vision screening ophthalmic service utilisation. Subsequently, the survey was deployed to test hypotheses and achieve research goals. This process effectively merges qualitative insights with quantitative rigour, achieving a comprehensive methodological integration.[17]

Our study employed the validated mixed-method joint display technique known as the Pillar Integration Process (PIP) to effectively integrate quantitative and qualitative data, which was pivotal in deriving conclusions. The PIP consists of four stages—Listing, Matching, Checking and Pillar Building—to systematically reveal emergent themes.[18]

Phase 1

The study employed purposive sampling to select interviewees, such as ophthalmologists, community and public health centre physicians, and educators.

All included participants play crucial roles in the school eye health programmes. Teachers inform students and parents before the screening, providing student details to community physicians who carry out vision screenings at the school. Subsequently, the physicians send results and referral notifications to the school. Teachers communicate results to students and parents, issuing referrals as necessary. Referred students and parents proceed to designated hospitals for further examinations, with ophthalmologists recording and notifying outcomes to community hospitals. Following this, community physicians input follow-up data into Shanghai child and adolescent visual development records while public health physicians oversee database management and workflow coordination.

Participants must have at least 3 years of experience in their field, be actively involved in the management of eye health, and voluntarily participate. Data collection would be stopped, and interviews would be ended once thematic saturation is achieved. Focus group sessions were hosted at Disease Prevention and Control Centres, while offline individual interviews took place at the informant's hospital. Online individual interviews were conducted via telephone. All participants provided informed consent prior to the interview, including the permission to be audio-recorded.

Phase 2

Teachers facilitated electronic questionnaires, which parents completed under supervision. This study has obtained consent from the guardians of the research subjects. Collected data were cross-referenced with the Minhang district's child and adolescent visual development records in Shanghai, encompassing comprehensive demographic and ophthalmological assessment outcomes and physician's advisement. Analysis identified students failing school vision screenings and recommended for referrals. Utilisation patterns of ophthalmic services among these students were investigated, differentiating between compliant and non-compliant groups. To discern factors influencing ophthalmic service usage, analytical variables were systematically categorised using the Andersen Model.

Study population

Figure 1 shows that in phase 1, the sample comprised 27 informants. In phase 2, a total of 15 615 students were surveyed by questionnaire, of whom 3535 were excluded due to the unavailability of screening records, while 210

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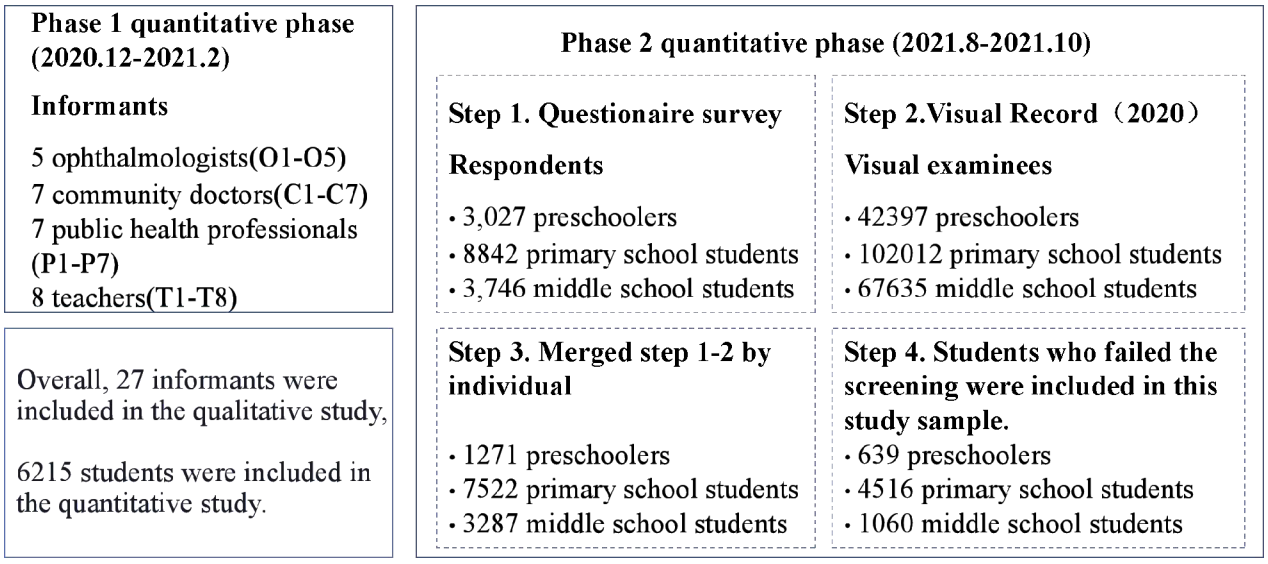


Figure 1 Overview of study population and data integration.

were omitted due to duplication, incomplete or aberrant data entries. Hence, the dropout rate for this study was 24.0% (3745/15 615). Among those remaining, 6215 out of 11 870 (52.36%) were recommended for referral, and a total of 6215 students were finally included in the study.

Statistical analyses

Phase 1: qualitative thematic analysis

All the interviews were recorded and transcribed. A thematic analysis was used to systematically code and analyse transcribed interviews through NVivo V.12.

Analysis themes

The interviews adhered to a semi-structured format designed to meet the objectives of the project. The guiding framework included sections on: (a) existing practices in children's vision health, encompassing screening and referral processes; (b) regional adherence following school vision screening; (c) implications for health service demand; and (d) potential strategies to enhance adherence rate. The 21 items checklist from the Standards for Reporting Qualitative Research was used to inform the qualitative approach of the research.

Phase 2: quantitative variable analysis

Analysis was conducted using SAS software (V.9.4). We summarised descriptive statistics as counts (n) and proportions (%). Distributional disparities in compliance were evaluated using the χ^2 test or Fisher's exact test, as appropriate. Influencing factors were examined across three separate multivariate multinomial logistic regression models. Model 1 exclusively incorporated predisposing factors, while model 2 added an enabling factor. Model 3 was comprehensive, assimilating predisposing, enabling and an additional need factor for analysis. Results are presented as ORs with 95% CIs and associated p values. Statistical significance was set at $p<0.05$ with two-tailed tests.

Analysis variables

The quantitative survey data were analysed using Andersen's Behavioural Model, encompassing predisposing, enabling and need factors.[19]

Dependent variable

In this analysis, adherence to referral was the dependent variable classified into compliant and non-compliant groups. Compliance was defined as having sought ophthalmic evaluation at least once following a screening failure in 2020, with attendance records maintained in the database. Children lost to follow-up were considered non-compliant. The adherence rate was calculated as the number of patients for whom the conclusions of the ophthalmologist were received from the screening institution divided by the number of referred patients.

Independent variables

Predisposing factors encompass demographic characteristics and social structure elements relevant to healthcare utilisation.[20] In this study, predisposing factors included age, gender, ethnicity, indigenous habitats and parental occupations.

Enabling factors are conditions that facilitate the reduction of financial and structural obstacles to healthcare access.[20] In this investigation, the enabling factors encompassed the annual family income, vision demonstration school, and the public health services provided by schools or community hospitals. Family income (per year) was categorised into 'low income' (less than ¥100 000), 'lower middle income' (¥100 000–¥300 000), 'upper middle income' (¥300 000–¥500 000) and 'high income' (¥≥500 000) according to the local economic level.

Need factors pertain to individuals' subjective healthcare necessities and personal health perception.[21] As the questionnaire responses were provided by parents, direct

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Table 1 Baseline characteristics of the study participants

Variable	Total (N=6215)	Non-compliant (N=5171, 83.20%)	Compliant (N=1044, 16.80%)	P value
Predisposing factors				
Age				<0.001
5–6	639 (10.3)	515 (80.6)	124 (19.4)	
7–11	4516 (72.7)	3680 (81.5)	836 (18.5)	
12–18	1060 (17.1)	976 (92.1)	84 (7.9)	
Sex				0.367
Girl	3008 (48.4)	2516 (83.6)	492 (16.4)	
Boy	3207 (51.6)	2655 (82.8)	552 (17.2)	
Ethnicity				0.416
Non-Han ethnicity	204 (3.3)	174 (85.3)	30 (14.7)	
Han ethnicity	6011 (96.7)	4997 (83.1)	1014 (16.9)	
Indigenous habitats				0.304
Non-indigenous	3631 (58.4)	3036 (83.6)	595 (16.4)	
Indigenous	2584 (41.6)	2135 (82.6)	449 (17.4)	
Father's occupation				0.029
Professional/managerial work	4101 (66.0)	3449 (84.1)	652 (15.9)	
Service/labour work	1307 (21.0)	1062 (81.3)	245 (18.7)	
Not working	807 (13.0)	660 (81.8)	147 (18.2)	
Mother's occupation				0.005
Professional/managerial work	3976 (64.0)	3332 (83.8)	644 (16.2)	
Service/labour work	972 (15.6)	774 (79.6)	198 (20.4)	
Not working	1267 (20.4)	1065 (84.1)	202 (15.9)	
Enabling factors				
Family annual income, ¥				<0.001
Low	1102 (17.7)	872 (79.1)	230 (20.9)	
Lower middle	3120 (50.2)	2531 (81.1)	589 (18.9)	
Upper middle	1214 (19.5)	1053 (86.7)	161 (13.3)	
High	779 (12.6)	715 (91.8)	64 (8.2)	
Enrolled in vision demonstration schools				0.006
No	5746 (92.5)	4802 (83.6)	944 (16.4)	
Yes	469 (7.5)	369 (78.7)	100 (21.3)	
Public health services provided by school/community				
Screening notification				0.041
No	283 (4.6)	248 (87.6)	35 (12.4)	
Yes	5932 (95.4)	4923 (83.0)	1009 (17.0)	
Health education				0.022
No	355 (5.7)	311 (87.6)	44 (12.4)	
Yes	5860 (94.3)	4860 (82.9)	1000 (17.1)	
Results disclosure				0.100
No	220 (3.5)	192 (87.3)	28 (12.7)	
Yes	5995 (96.5)	4979 (83.1)	1016 (16.9)	
Referral encouragement				<0.001
No	2457 (39.5)	2151 (87.5)	306 (12.5)	

Continued

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Table 1 Continued

Variable	Total (N=6215)	Non-compliant (N=5171, 83.20%)	Compliant (N=1044, 16.80%)	P value
Yes	3758 (60.5)	3020 (80.4)	738 (19.6)	
Need factor				
Referral urgency				<0.001
Immediate referral	603 (9.7)	520 (86.2)	83 (13.8)	
Emergency referral	2206 (35.5)	1829 (82.9)	377 (17.1)	
Urgent referral	328 (5.3)	259 (79.0)	69 (21.0)	
Routine referral	3078 (49.5)	2563 (83.3)	515 (16.7)	

assessment of students' self-evaluated referral needs and health perceptions was infeasible. Objectively, the study used referrals determined by community doctors, based on vision screening outcomes, as a proxy for evaluating students' referral requirements. Visual health status was stratified into four categories reflecting the urgency of impairment: (a) routine, (b) urgent, (c) emergency and (d) immediate referral. The specific criteria for these classifications are detailed in online supplemental table S1.

Data integration

In our study, the first column delineated discrete sections of the questionnaire under investigation. Subsequent questionnaire outcomes were enumerated in the second column. The Matching stage involved columns four and five, where qualitative insights and coding were synchronised with the quantitative data from column two. A comparative analysis of the data across columns two, four and five was then conducted to unveil patterns of congruence, culminating in the Pillar Building stage, where synthesised inferences were consolidated in the third column as foundational themes.[22]

RESULTS

Qualitative findings

Twenty-two informants engaged in two focus groups, two underwent face-to-face in-depth interviews at their respective hospitals, and another three were interviewed via telephone. The qualitative interviews predominantly featured female informants, comprising 85.2% (n=23) of participants. The predominant share of the cohort possesses senior professional designations.

Seven themes were identified, including referral criteria, adherence rates, workflow, recording and feedback of outcomes, medical resources, health service capacity and medical fees.

Quantitative findings

Characteristics of respondents

The overall screening yielded a referral rate of 52.4%. Among the students recommended for referral, only 16.8% used ophthalmic clinical health services. Table 1 details the demographic profiles of the respondents. A majority (72.7%) were enrolled in primary schools, ages 7–11. The gender distribution was nearly even, with boys constituting 51.6%, and a significant majority, 96.7% (n=6011), were of Han ethnicity, with 41.6% (n=2584) identifying as indigenous residents. Approximately half reported a family income within the 'lower-middle income' bracket. The parents of around two-thirds of the participants were in professional or managerial roles. Only a small fraction, 7.5%, attended vision demonstration schools. About 95% of respondents had received formal screening notification, eye health education and results disclosure provided by schools or community hospitals. Furthermore, 60.5% were notified to pursue referrals. Among those referred, 49.5% required routine referral, while 35.5% necessitated an emergency referral.

Sex, ethnicity and status as indigenous residents were not determinative factors in the utilisation of ophthalmic clinical health services. Students with parents employed in physical labour and those enrolled in vision demonstration schools exhibited higher adherence rates. As family annual income increased, the adherence rate decreased (p<0.001). Additionally, the public health services rendered by school or local communities, alongside the urgency of referrals, were influential parameters in the referral process.

Factors associated with compliance

Table 2 delineates the ORs ascertained from both bivariate and multivariate logistic regression analyses. The results demonstrated a negative correlation between age and service adherence. The likelihood of adherence was higher among students whose parents were engaged in service/labour sectors relative. Enrolment in vision demonstration schools significantly increased the likelihood of adherence to referrals. Interestingly, adherence was inversely related to family annual income. Notification of vision screening from schools or communities, along with health education and adherence reminders, significantly influenced the likelihood of referral compliance. Compared with students requiring emergency referrals, those necessitating urgent referrals exhibited an increased likelihood of attending clinical visits.

The comprehensive model demonstrated that students enrolled in vision demonstration schools and who

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Table 2 Multivariable logistic regression analyses of factors associated with adherence

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)		
		Predisposing variables	Predisposing+enabling variables	Predisposing+enabling+need variables
Predisposing factors				
Age/referring to 5–6				
7–11	0.94 (0.77 to 1.16)	0.95 (0.77 to 1.17)	0.87 (0.70 to 1.08)	0.86 (0.69 to 1.07)
12–18	0.36 (0.27 to 0.48)**	0.36 (0.27 to 0.49)**	0.35 (0.26 to 0.48)**	0.31 (0.23 to 0.44)**
Sex/referring to girl				
Boy	1.06 (0.93 to 1.22)	1.04 (0.91 to 1.19)	1.05 (0.92 to 1.21)	1.06 (0.92 to 1.21)
Ethnicity/referring to non-Han ethnicity				
Han ethnicity	1.18 (0.79 to 1.74)	1.18 (0.79 to 1.75)	1.10 (0.74 to 1.65)	1.10 (0.74 to 1.65)
Indigenous habitats/referring to non-indigenous				
Indigenous	1.07 (0.94 to 1.23)	1.16 (1.01 to 1.34)*	1.13 (0.98 to 1.31)	1.12 (0.97 to 1.30)
Father's occupation/referring to professional/managerial work				
Service/labour work	1.22 (1.04 to 1.44)*	1.05 (0.84 to 1.32)	0.99 (0.79 to 1.24)	0.99 (0.79 to 1.25)
Not working	1.18 (0.97 to 1.44)	1.20 (0.97 to 1.48)	1.11 (0.89 to 1.37)	1.11 (0.89 to 1.37)
Mother's occupation/referring to professional/managerial work				
Service/labour work	1.32 (1.11 to 1.58)**	1.25 (0.98 to 1.60)	1.21 (0.94 to 1.55)	1.22 (0.95 to 1.57)
Not working	0.98 (0.83 to 1.17)	0.95 (0.79 to 1.15)	0.93 (0.77 to 1.12)	0.93 (0.77 to 1.12)
Enabling factors				
Family annual income/referring to low level				
Lower middle	0.88 (0.74 to 1.05)		0.86 (0.72 to 1.04)	0.87 (0.72 to 1.04)
Upper middle	0.58 (0.47 to 0.72)**		0.57 (0.45 to 0.73)**	0.58 (0.46 to 0.73)**
High	0.34 (0.25 to 0.46)**		0.33 (0.25 to 0.45)**	0.34 (0.25 to 0.46)**
Enrolled in vision demonstration schools/referring to no				
Yes	1.38 (1.09 to 1.74)*		1.68 (1.32 to 2.15)**	1.66 (1.30 to 2.12)**
Screening notification/referring to no				
Yes	1.45 (1.01 to 2.08)*		1.21 (0.76 to 1.93)	1.21 (0.76 to 1.94)
Health education/referring to no				
Yes	1.45 (1.05 to 2.01)*		1.08 (0.71 to 1.63)	1.07 (0.71 to 1.63)
Results disclosure/referring to no				
Yes	1.40 (0.94 to 2.09)		0.90 (0.54 to 1.50)	0.91 (0.55 to 1.52)
Referral encouragement/referring to no				
Yes	1.72 (1.49 to 1.98)**		1.60 (1.37 to 1.85)**	1.54 (1.33 to 1.80)**
Need-for-care factor				
Referral need level/referring to immediate referral				
Emergency referral	1.29 (1.00 to 1.67)			1.31 (0.98 to 1.75)
Urgent referral	1.67 (1.17 to 2.37)*			1.24 (1.06 to 1.45)*
Routine referral	1.26 (0.98 to 1.62)			1.13 (0.86 to 1.49)

*p<0.05, **p<0.01.

received encouragement from their schools or local communities showed increased adherence to referral (OR=1.66, 95% CI 1.30 to 2.12; OR=1.54, 95% CI 1.33 to 1.80). Additionally, older students and students from higher-income families showed lower rates of adherence (OR=0.31, 95% CI 0.23 to 0.44; OR=0.34, 95% CI 0.25 to 0.46). Finally, students with less urgent medical needs were more likely to adhere to referrals compared with those requiring immediate referrals (OR=1.24, 95% CI 1.06 to 1.45).

Integration of qualitative and quantitative findings

Four pillars emerged from the integrated qualitative and quantitative results of the PIP. These were: (a) adherence decreased with age, (b) financial constraints did not pose an obstacle, (c) public health services played a critical

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Table 3 A joint display of the connections between the quantitative and qualitative data arising from the study

Quantitative findings		Pillar	Qualitative findings	
Data	**Categories**	**Themes**	**Categories**	**Illustrative quotations**
Adherence rates for children aged 5–6 years stood at 19.4%, while those for middle school students aged 12–18 years were at 7.9%, representing a significant decrease (OR=0.31; 95% CI 0.23 to 0.44)	Disparities in adherence rates across different student age groups	Adherence decreased with age	The influence of students' demographic characteristics on adherence rates	'Young children predominate in outpatient clinic visits, with high school students being a rarity'. (O1) 'Middle school students, experiencing stable visual development and heavier academic demands, receive less parental attention for vision issues due to a prevalent belief in the inevitability of nearsightedness'. (P3)
Family annual income was inversely related to student adherence rates (p<0.001). Students from families earning 300 000–500 000 and ≥500 000 annually were less inclined to follow referral recommendations compared with those from families earning under 100 000, with ORs of 0.58 (95% CI 0.46 to 0.73) and 0.34 (95% CI 0.25 to 0.46), respectively	Impact of family income on adherence	Financial constraints did not pose an obstacle	The effect of medical costs on adherence	'Students referred to our hospital following unsuccessful school vision screenings incur costs of approximately 100 ¥'. (O3) 'The medical expenses are affordable, typically not surpassing 300 ¥'. (O1) 'Treatment costs do not deter parents from hospital visits, as the financial burden is generally not substantial'. (T3)
a. Greater adherence to referral among vision demonstration schools students compared with peers (OR=1.66; 95% CI 1.30 to 2.12) b. Encouraged students showed heightened referral adherence compared with unprompted peers, following school/community hospital interventions (OR=1.54; 95% CI 1.33 to 1.80)	Impact of vision demonstration schools and school/community hospital health services on adherence	Public health services played a critical role	School or community hospital-delivered public health services bolster clinical health service utilisation	'We will enlist vision health experts to provide health education lectures at vision demonstration schools and offer specialized eye care training for teachers to augment their health literacy'. (P4) 'Community hospitals generate and provide schools with referral lists from screening outcomes and printed appointment notices; however, the responsibility for subsequent follow-up reminders resides with the schools'. (C7) Interviewed teachers commonly perceived a lack of school concern regarding parental compliance with children's follow-up appointments and absence of mandatory feedback on follow-up outcomes
Referral urgency was found to be a significant determinant of student adherence rates (p<0.001); however, the relationship was not linear. The adherence rate for immediate referral was the lowest at 13.8%. Students who required urgent demonstrated higher adherence compared with those with emergency referrals (OR=1.67, 95% CI 1.17 to 2.37)	The impact of referral urgency on adherence	Referral urgency did not linearly correlate with adherence	Differential referral urgency exerts a distinct impact on adherence, necessitating nuanced patient management strategies	'Nearly half of the attending students were routine referrals, presenting with normal uncorrected visual acuity yet having a refractive error less than 0.00D'. (O4) 'In practice, there appears to be no distinct stratified management for students based on referral urgency'. (C5)

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role, (d) referral urgency did not linearly correlate with adherence. Table 3 illustrates the integration of the findings and the resulting pillars.

DISCUSSION

This study employed Andersen's Model to investigate the characteristics of students who adhere to referral posting school vision screening. The study disclosed an overall adherence rate of 16.80%. The prevalence of visual impairment among students in Shanghai is on a continuous rise.[23] Our study's referral rate was high at 60%, surpassing rates observed in Australia (10%),[24] Canada (32.2%),[25] Germany (27%),[26] New Zealand (14%).[27] However, the adherence rate in our setting was markedly lower than in Israel (54.3%),[13] Canada (69.9%)[25] and Yunnan Province, China (37.4%).[7] Vision screening, a pivotal public health intervention, is aimed at the early detection of high-risk individuals and early-stage diseases. Ensuring timely and adequate follow-up is critical for the success of disease prevention and control efforts. To bolster referral adherence, the study identified critical factors, including age, family annual income, public health services and referral urgency based on the student's individual condition.

Adherence rate decreases with age

The adherence rate shows a marked decrease from preschoolers at 19.4%–18.5% in primary school students, and further to 7.9% in middle school students. Eye diseases such as myopia were considered untreatable and irreversible,[28] and it is commonly believed that intervention is effective only prior to the onset of a disease, which leads to a gradual neglect of eye health as individuals age. However, visual development is a dynamic process, and the stage of young adulthood remains a crucial period for visual development.[29]

Poverty is not a deterrent to referral adherence

Hemptinne *et al* suggest that the expense is a crucial determinant for parental compliance.[30] This study found an inverse relationship between family annual income and adherence rates. Although vision screening is state-funded in China, further ophthalmological evaluations carry additional costs. The study revealed that the expense of a single referral ranged from ¥100 to ¥300, an amount not prohibitive in the study's regional context. Consequently, economic hardship does not account for low adherence rates; in fact, families facing financial constraints may prioritise their children's vision health.

Public health services are crucial

Students attending vision demonstration schools or those encouraged to seek referrals by school or community hospitals exhibited notably higher adherence rates. Moreover, encouragement from teachers or community physicians significantly influenced student follow-up post-screening. This highlights the importance of public health to enhance adherence following school vision screenings.

Adherence does not linearly correlate with referral urgency

The adherence rate for immediate referrals was 13.8%, surprisingly lower than for emergency (17.1%), urgent (21.0%) and routine referrals (16.7%). Community doctors interviewed indicated that in practice, stratified management of students according to referral urgency is lacking. Students with rapidly deteriorating vision needing immediate referrals often are less aware than those with better vision, underscoring the importance of tiered management in student eye health.

The study findings indicate that adherence to referral is independent of gender, ethnicity and indigenous status. Likewise, familial financial standing and visual health status does not predict compliance. Consistent with other existing research,[31] enhanced governmental, community or school vision health services are pivotal in improving adherence. These results underscore the critical role of public health in advancing vision health among children and adolescents. The public health services, including offering dedicated appointments,[32] strengthening health education, conducting follow-up phone calls and involving school nurses in screening programmes, have been shown to boost post-screening referral adherence.[7]

This study has several limitations. In Shanghai's school eye health programmes, community doctors refer children to designated hospitals. Only follow-up results from these hospitals are recorded in the database. Medical records from non-designated hospitals are not included. Survey results show that over 80% of revisits occur at designated hospitals, suggesting a 20% follow-up loss. Designated hospitals are public with lower costs, while non-designated hospitals are mostly private with higher expenses. This underlines the study's conclusion that poverty does not hinder referral adherence. Therefore, despite some loss to follow-up, it does not affect the final conclusion of this study. Additionally, reliance on parental questionnaires may not accurately reflect children's viewpoints, and a direct appraisal of the students' self-assessed needs for referral and health perceptions was not possible. Instead, doctor's recommendations were used to estimate the students' actual referral needs.

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Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

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Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants and was approved by the Ethics Committee of the School of Public Health, Fudan University, approved this study (approval number IRB#2020-07-0836). Participants gave informed consent to participate in the study before taking part.

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REFERENCES

1 Ferede AT, Alemu DS, Gudeta AD, *et al*. Visual impairment among primary school children in Gondar town, Northwest Ethiopia. *J Ophthalmol* 2020;2020:6934013.
2 Rainey L, Elsman EBM, van Nispen RMA, *et al*. Comprehending the impact of low vision on the lives of children and adolescents: a qualitative approach. *Qual Life Res* 2016;25:2633–43.
3 Wallace DK, Morse CL, Melia M, *et al*. Pediatric eye evaluations preferred practice pattern®: I. Vision screening in the primary care and community setting; II. *Ophthalmology* 2018;125:184–227.
4 Anley DT, Anteneh RM, Tegegne YS, *et al*. Prevalence of visual impairment and associated factors among children in Ethiopia: systematic review and meta-analysis. *PLoS One* 2022;17:e0271433.
5 Lester BA. Comparing the cost-effectiveness of school eye screening versus a primary eye care model to provide refractive error services for children in India. *Community Eye Health* 2007;20:15.
6 Nishimura M, Wong A, Dimaras H, *et al*. Feasibility of a school-based vision screening program to detect undiagnosed visual problems in kindergarten children in Ontario. *CMAJ* 2020;192:E822–31.
7 Zeng Y, Han X, Wang D, *et al*. Effect of a complex intervention to improve post-vision screening referral compliance among pre-school children in China: a cluster randomized clinical trial. *EClinicalMedicine* 2020;19:100258.
8 Rodriguez E, Srivastava A, Landau M. Increasing screening follow-up for vulnerable children: a partnership with school nurses. *Int J Environ Res Public Health* 2018;15:1572.
9 Andersen RM. Revisiting the behavioral model and access to medical care: does it matter *J Health Soc Behav* 1995;36:1–10.
10 Jin SW, Yun Lee H, Lee J. Analyzing factors enabling colorectal cancer screening adherence in Korean Americans using the andersen's behavioral model of health services utilization. *J Psychosoc Oncol* 2019;37:729–45.
11 Andersen RM. National health surveys and the behavioral model of health services use. *Med Care* 2008;46:647–53.
12 Messer DH, Mitchell GL, Twelker JD, *et al*. Spectacle wear in children given spectacles through a school-based program. *Optometry and Vision Science* 2012;89:19–26.
13 Gordon-Shaag A, Ben-Eli H, Sztrigler Cohen O, *et al*. Adherence to referrals from preschool vision screening and identification of barriers for non-adherence in Israel. *Clin Exp Optom* 2023;106:202–10.
14 Olthof M, Groenhof F, Berger MY. Continuity of care and referral rate: challenges for the future of health care. *Fam Pract* 2019;36:162–5.
15 Curry LA, Krumholz HM, O'Cathain A, *et al*. Mixed methods in BIOMEDICAL and health services research. *Circ Cardiovasc Qual Outcomes* 2013;6:119–23.
16 Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs-principles and practices. *Health Serv Res* 2013;48:2134–56.
17 O'Cathain A, Murphy E, Nicholl J. Three techniques for integrating data in mixed methods studies. *BMJ* 2010;341:c4587.
18 Nessle CN, Ghazal LV, Choi SW, *et al*. Joint display of integrated data collection for mixed methods research: an illustration from a pediatric oncology quality improvement study. *Ann Fam Med* 2023;21:347–57.
19 Andersen RM, Davidson PL, Ganz PA. Symbiotic relationships of quality of life, health services research and other health research. *Qual Life Res* 1994;3:365–71.
20 Walter F, Webster A, Scott S, *et al*. The andersen model of total patient delay: a systematic review of its application in cancer diagnosis. *J Health Serv Res Policy* 2012;17:110–8.
21 Lee Y-S, Hofstetter CR, Irvin VL, *et al*. Korean American women's preventive health care practices: stratified samples in California, USA. *Health Care Women Int* 2012;33:422–39.
22 Flanagan P, Dowling M, Gethin G. Barriers and facilitators to seasonal influenza vaccination uptake among nurses: a mixed methods study. *J Adv Nurs* 2020;76:1746–64.
23 Xu W, Wang X, Xiong J, *et al*. Status quo investigation on low-grade pupils vision in Zhabei District of Shanghai city. *Shanghai J Prev Med* 2013;25:629–31.
24 Blows SJ, Murphy EP, Martin FJ, *et al*. Vision screening in preschoolers: the new South Wales statewide eyesight preschooler screening program. *Med J Aust* 2014;200:222–5.
25 Wang P, Bianchet S, Carter M, *et al*. Utilization and barriers to eye care following school-wide pediatric vision screening. *Can J Ophthalmol* 2023;58:465–71.
26 Käsmann-Kellner BW, Ruprecht KW. Vision screening survey of all children starting primary school in 1998 in the federal state of saarland, Germany. *Strabismus* 2000;8:201–7.
27 Langeslag-Smith MA, Vandal AC, Briane V, *et al*. Preschool children's vision screening in New Zealand: a retrospective evaluation of referral accuracy. *BMJ Open* 2015;5:e009207.
28 Poonam G, Manjusha R, Vaghela DB, *et al*. A clinical study on the role of Akshi Tarpana with Jeevantyadi Ghrita in Timira (myopia). *Ayu* 2011;32:540–5.
29 Lee SS-Y, Alonso-Caneiro D, Lingham G, *et al*. Choroidal thickening during young adulthood and baseline choroidal thickness predicts refractive error change. *Invest Ophthalmol Vis Sci* 2022;63:34.
30 Hemptinne C, La Grange N, Yüksel D. Vision screening in belgian children: too much or not enough? *Ophthalmic Epidemiol* 2020;27:364–75.
31 Burnett AM, Yashadhana A, Lee L, *et al*. Interventions to improve school-based eye-care services in low- and middle-income countries: a systematic review. *Bull World Health Organ* 2018;96:682–694D.
32 Lee L, Moo E, Angelopoulos T, *et al*. Integrated people-centered eye care: a scoping review on engaging communities in eye care in low- and middle-income settings. *PLoS One* 2023;18:e0278969.

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