Access to community-based eye services in Meru, Kenya: a cross-sectional equity analysis

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Summary

Background: Over 80% of blindness in Kenya is due to curable or preventable causes, with an estimated 7.5 million Kenyans in need of quality eye care services. Embedding sociodemographic data collection into the national eye screening programme could help identify the groups facing systematic barriers to care. We aimed to determine the sociodemographic characteristics that are associated with access among patients diagnosed with an eye problem and referred for treatment in the national eye screening programme.

Method: We used an embedded, pragmatic, cross-sectional study design. A list of sociodemographic questions was developed with input from researchers, community members, policymakers, and programme implementers. After five rounds of iteration, the final sociodemographic question set included the following domains: age, gender, religion, marital status, disability, education, occupation, income, housing, assets, and health insurance. These were integrated into an app that is used to screen, refer, and check-in (register) participants within a major eye screening programme. We gathered data from 4,240 people who screened positive during community screening and were referred to a local outreach treatment clinic in Meru County. We used logistic regression to identify groups for whom services were inaccessible.

Findings: Only 46% of those who were referred to local treatment outreach clinics were able to access care. In our fully adjusted model, at the 0.05 level there were no statistically significant differences in the odds of attendance within the domains of disability, health insurance, housing, income, or religion. Strong evidence ($p<0.001$) was found of an association between access and age, gender, and occupation, with males, younger adults, and those working in sales, services and manual jobs being the least likely to access care.

Conclusions: Less than half of those identified with an eye need and referred to free local clinics were able to access care in Meru. Younger people are being left behind, with less than a third of those aged 18-44 receiving care. Future work should explore the barriers and potential solutions to equitably improve access to care for this group.

Keywords

Equity; socioeconomic inequalities; access; primary care; eye care

Introduction

More than one billion people currently live with preventable or untreated visual impairment, and over 90% of these cases are easily treatable with highly cost-effective interventions like spectacles and cataract surgery.[7] The vast majority of people with untreated eye conditions live in low- or middle-income countries, and within these countries marginalised groups are often disproportionately affected.[7–9] Extending access to eye services is a global health priority that aligns with both the principles of proportionate universalism[1] and Primary Health Care: an approach to health that prioritises the worst-off and seeks to advance equity and *health for all*.[2]

An estimated 7.5 million people require eye health services in Kenya, but less than a quarter are able to access services.[3] In 2022 the government launched the 'Vision Impact Programme' (VIP) in which community-based teams use smartphones to administer 'tumbling E' visual acuity assessments, using an app developed by the social enterprise Peek Vision.[4] Those who screen positive - i.e. their visual acuity is found to fall below a predetermined threshold (<6/12 in either eye) are referred to a local outreach treatment clinic, commonly held in a primary care facility, where they receive free further assessment and care, including spectacles, eye drops, or onward referral for cataract surgery at a local hospital as required. Screeners also refer people who have a red eye or another issue upon basic visual inspection, and anyone who feels they have an eye problem, even if there are no clinical signs and their visual acuity is >6/60.

In the VIP programme's first year, over a million people were screened and more than 150,0000 were managed at free treatment outreach clinics.[5] Whilst this is a remarkable achievement, internal Peek data suggest that there are important issues with clinic accessibility, as less than half of those who were identified with an eye problem during community-based screening received care at their local clinic.

Access is determined by both patient and provider factors,[6] and evidence from other countries suggests that certain groups such as females, widows, and those in rural areas - may face unique structural barriers to accessing eye care services.[7] Currently, no sociodemographic data beyond age, gender, and language are being collected in the VIP screening programme, and these data are not currently being

used to perform equity analyses. As such, any sociodemographic inequities are invisible.

Acknowledging the risk that "poorer, less advantaged segments of the population could be left behind" as countries expand access to health services in pursuit of UHC, joint WHO and World Bank guidance recommends that health programmes routinely gather data on gender, wealth, and place of residence (urban/rural) to monitor equity in effective service coverage.[8] The recent UN Resolution on Vision, the Lancet Commission on Global Eye Health, and the Declaration of Astana all call on global health partners to analyse the equity impact of their programs across different sociodemographic populations.[9–11] This aligns with the 'central transformative promise' of the Sustainable Development Goals which is to 'leave no one behind' and the commitment to 'reach the furthest behind first'.[12]

Working with the Ministry of Health, a local community advisory board, the VIP programme implementing partner, and Peek Vision, we aimed to integrate a set of sociodemographic questions into the community-based screening process in Meru county and perform the first assessment of whether all sociodemographic groups are experiencing similar levels of access to primary eye care.

Methods

Population

The VIP programme has been designed to screen all residents aged over 18 years in ten of Kenya's 47 counties.[13] Working with the national director of eye services, we identified Meru county as the best place to conduct our study, based on the fact that it contains a mix of urban and rural areas, has a leadership engaged with equity-focused quality improvement, and had a screening schedule that aligned with our research timeline. Meru is a central high-altitude county on the slopes of Mount Kenya with a population of 1.55 million, most of whom live in Meru town, the seventh largest urban centre in the country. Agriculture is the main source of employment, with khat and tea being the most prevalent cash crops.

Sociodemographic domains

We started by performing a literature review and a secondary analysis of data from a systematic review to identify the sociodemographic domains that are being used by other programmes, agencies, and researchers around the world. Full details and results are available in our published protocol.[14] Briefly, we identified 11 broad domains that had been used or recommended in the peer-reviewed literature and UN agency reports: age, gender, residence (urban/rural), language, ethnicity/tribe/race/caste, refugee/immigrant status, marital status, religion, occupation, income, and wealth.[8–10,15–19] We drafted response options for each domain that aligned with those used in the widely-used USAID Demographic and Health Survey (DHS) that has been used to complete more than 400 surveys in 90 countries[20,21] and the Rapid Assessment of Avoidable Blindness (RAAB) instrument that has been used for over 300 surveys in 80 countries.[22] This was to ensure that all ensuing data complied with international norms and were maximally useful for domestic policymakers.

Next, we set up a multi-stakeholder workshop that included representatives from Peek Vision, the implementing partner organisation (Christian Blind Mission), the Ministry of Health, and local academics with experience and expertise in sociodemographic data collection. This group adapted each of the draft domains to the Kenyan context, and adding in a housing question as an indicator of wealth.

Over the course of four hybrid workshops, we iteratively refined the list of domains and questions stems, seeking to align them with pre-existing locally collected data and ensuring that the wording accorded with cultural norms. We removed the question on tribe/ethnicity as this was considered to be potentially inflammatory. Supplementary tables 1-4 present further detail on the decisions made at each stage.

All decisions were made by consensus, and after five rounds of iteration the final list included 11 domains with between 2-8 individual response options (Table 1). Every domain also included ‘don’t know’ and ‘do not want to answer’. The draft survey instrument was translated into Kiswahili and back-translated into English to check that meaning had not been lost. The survey was piloted with laypeople using a ‘think aloud’ approach,[23] and then in the actual screening programme with approximately 100 service users. No changes were indicated during piloting.

Table 1: Sociodemographic domains and response options

Domain	Question stem	Response options
Gender	What is your gender?	Female
		Male
		Other
Age	What is your age?	18-24
		25-34
		35-44
		45-54
		55-64
		65+
Language	What is your preferred language?	Kiswahili
		English
Marital status	What is your marital status?	Single
		Married
		Divorced/separated
		Widowed
Assets	Does your household own a bicycle, motorbike, scooter, car, or truck?	None
		Bike or Moto or Scooter
		Car or Tuck
Disability	Do you have any difficulty with hearing, walking, climbing steps or communicating?	No
		Yes (one or more)
Education	What is your highest level of education?	None
		Primary
		Secondary
		Post-secondary
Health insurance	Do you have health insurance?	No
		Yes, active
		Yes, not active
Housing	Do you have Electricity, Solar, or a Generator at home?	No
		Yes
Income	In the last month, what was your approximate income?	KES <24,000
		KES 24,000-32,333
		KES >32,333
Occupation	What is your occupation?	Not employed
		Farming
		Domestic service
		Professional*
		Sales & services
		Skilled manual
		Unskilled manual

		Student/pupil
Religion	What is your religion?	Christian
		Islam
		Hindu
		Other

*Note: Includes professional or manager or technician or clerical

Screening approach

In the VIP programme, community health workers go house-to-house and assess the vision of all residents. For each participant, they enter the following demographic details into the Peek app:[24] name, contact phone number, age, and gender. Next, they perform a 'tumbling E' visual acuity assessment using a smartphone. As stated above, if the participant's vision falls below a pre-specified acuity threshold, or if they have a visible or reported subjective eye complaint (e.g. a red or painful eye), then the participant is referred to the local clinic for further assessment and treatment. At this point their preferred language is recorded. The participant is given an appointment date and is sent a follow-up reminder text message. On the day of assessment, participants are checked-in (registered) by staff using the same Peek app at the clinic. This means that Peek hold a record of all those referred and can generate a complete list of all those who have and have not been checked-in on their appointed date.

We added the extended list of sociodemographic questions to the Peek app. These questions were asked of every person who was found to have an eye problem and referred to their local treatment outreach clinic. Informed written consent to gather these additional sociodemographic data was obtained by the community health workers who performed the screening, using paper consent forms.

Sample size

Our aim was to compare the odds of attendance between different sociodemographic subgroups (e.g. males vs females). Our community advisory group suggested that we would want to detect differences in attendance of 5-10% or more between subgroups. With a 95% confidence level and a maximally conservative proportion of 50% attendance, we calculated that we would need to have at least 1,566 people in each subgroup to have 80% power to detect a 5%

difference between subgroups, or 385 people in each subgroup to detect a difference of 10%. We decided to set our sample size at 3,850 which would provide 80% power to detect differences of 10% between groups that contain at least 10% of the overall population, while still providing power to detect a difference of 5% in subgroups that make up 40% of the population. We deemed that this would enable robust comparisons between most subgroups, and accepted that we would only be able to identify large differences between subgroups that contained very few people e.g. those in the highest income category or those reporting a religion other than Christianity or Islam.

We reviewed the number of people who had been recruited on a weekly basis and stopped data collection on the day that the sample exceeded 3,850.

Statistical analysis

We used logistic regression to calculate the adjusted odds of non-attendance for each sociodemographic subgroup. Our statistical approach is outlined below:

1. Perform simple logistic regression with attendance as the outcome. Separately add each sociodemographic domain as an exposure. (Unadjusted model)
2. Adjust each model for age and gender. (Minimally adjusted model)
3. Adjust each model for all other sociodemographic variables. (Fully adjusted model)
4. Test an interaction between each sociodemographic variable and age category (Effect modification by age)
5. Test an interaction between each sociodemographic variable and gender (Effect modification by gender)

Post-hoc sensitivity analyses

To quantify the impact of intersectionality,[25,26] we estimated the probability of attendance for people with different combinations of sociodemographic characteristics that were found to be the strongest predictors for poor access.

After completing our analysis, our Kenyan Ministry of Health collaborators sensibly hypothesized that severity of eye condition could explain differences in attendance by age and other sociodemographic domains, reasoning that those with painful or

severe conditions would be more likely to seek care than those with mild or painless conditions. Data on eye conditions had already been collected during screening. We categorised these diagnostic codes into five categories that grouped conditions based on their likely acuity and impact (below). Then we re-ran the regression models with and without this new eye condition data.

- Normal vision
- Loss of vision (visual acuity <6/12 vision in either eye)
- Chronic problem: Growth on eyeball, Lump on lids, White pupil, Strabismus
- Acute problem: Conjunctivitis, Redness, Redness with discharge, Red and watery itchy eye
- Urgent problem: Eye injury, Pain, Whole eyeball swollen

Bias

To reduce the risk of selection bias the sociodemographic questions were asked of every consecutive person who was referred until we had collected data from at least 3,850 people. We developed a robust set of questions to minimise the risk of recall bias, grounded in the literature and tailored to the local context by a group of experts and community representatives. We delivered standardised training to the data collectors in order to minimise the risk of measurement bias. We also performed unannounced observations of screeners to check that the questions were being asked as intended. We found no issues.

Ethics

This study was approved by LSHTM and KEMRI ethics committee and the National Commission for Science, Technology & Innovation. Written informed consent was obtained from every participant.

Findings

Between April and July 2023, 136,912 people aged >18 years old were screened in Meru county and 32,835 people were found to have an eye problem that required referral to a local treatment outreach clinic (24.0%). We gathered and analysed data

from the first 4,240 of these referred people who consented to provide their sociodemographic information. As several hundred people were screened every week, our final sample exceeded 3,850.

Of these 4,240 people, just under half were able to access their appointment (46.0%). In our fully adjusted model, we found very strong evidence ($p<0.001$) of an association between three variables and access: gender, with men found to be less likely to access care than women; age, with younger people less likely to access care than older people; and occupation, where those in skilled/unskilled manual labour and sales & services occupations had the lowest access. Younger people had the worst access overall, with only 32% of those aged 18-44 years being checked-in at clinics compared to 54% of those aged ≥45 years old.

Three other variables showed some weaker evidence of an association with the outcome; education ($p=0.03$), marital status ($p=0.03$), and vehicle ownership ($p=0.03$). (Table 2)

Table 2: Attendance by sociodemographic group

		N	N Attended	% Attended	Unadjusted OR	p-value	Adjusted for age and gender	p-value	Adjusted for everything	p-value
Gender	Female	2700	1317	49%	Ref	<0.001	Ref	<0.001	Ref	<0.001
	Male	1540	634	41%	0.73 (0.65-0.83)		0.67 (0.59-0.76)		0.72 (0.63-0.83)	
Age	18-24	271	78	29%	0.42 (0.32-0.57)	<0.001	0.41 (0.31-0.55)	<0.001	0.49 (0.35-0.69)	<0.001
	25-34	615	189	31%	0.46 (0.38-0.57)		0.45 (0.36-0.55)		0.51 (0.41-0.63)	
	35-44	730	256	35%	0.57 (0.47-0.69)		0.55 (0.46-0.67)		0.59 (0.48-0.72)	
	45-54	1048	512	49%	Ref		Ref		Ref	
	55-64	786	429	55%	1.26 (1.05-1.51)		1.27 (1.05-1.53)		1.21 (1.00-1.46)	
	65+	790	487	62%	1.68 (1.39-2.03)		1.71 (1.42-2.07)		1.61 (1.31-1.99)	
Transport assets	None	3644	1726	47%	Ref	0.0001	Ref	0.002	Ref	0.03
	Bike/Moto/scooter	328	125	38%	0.68 (0.54-0.86)		0.86 (0.68-1.10)		0.87 (0.68-1.12)	
	Car	268	100	37%	0.66 (0.51-0.85)		0.64 (0.49-0.83)		0.69 (0.52-0.92)	
Disability	No	3637	1629	45%	Ref	<0.001	Ref	0.87	Ref	0.99
	Yes	603	322	53%	1.41 (1.19-1.68)		0.98 (0.82-1.18)		1.00 (0.83-1.20)	
Education	None	284	149	52%	Ref	<0.001	Ref	0.002	Ref	0.03
	Primary	1787	906	51%	0.93 (0.73-1.20)		1.43 (1.09-1.87)		1.42 (1.07-1.87)	
	Secondary	1538	666	43%	0.69 (0.54-0.89)		1.28 (0.97-1.69)		1.30 (0.97-1.73)	
	Post-secondary	631	230	36%	0.52 (0.39-0.69)		1.03 (0.76-1.40)		1.12 (0.81-1.56)	
Health insurance	No	2530	1154	46%	Ref	0.35	Ref	0.77	Ref	0.12
	Yes, active	909	437	48%	1.10 (0.95-1.28)		1.02 (0.87-1.19)		1.20 (1.01-1.43)	
	Yes, not active	801	360	45%	0.97 (0.83-1.14)		0.95 (0.80-1.12)		1.04 (0.88-1.24)	
Cement floor	No	703	353	50%	Ref	0.015	Ref	0.21	Ref	0.48
	Yes	3537	1598	45%	0.82 (0.69-0.96)		0.90 (0.76-1.06)		0.94 (0.79-1.12)	
Income	No response	1984	935	47%	Ref	<0.001	Ref	0.007	Ref	0.11
	<24,000	2050	939	46%	0.94 (0.84-1.07)		0.92 (0.81-1.04)		0.91 (0.80-1.04)	
	24,000-32,333	132	56	42%	0.83 (0.58-1.18)		0.84 (0.59-1.22)		0.98 (0.67-1.45)	

	>32,333	74	21	28%	0.44 (0.27-0.74)		0.41 (0.24-0.69)		0.54 (0.30-0.95)	
Marital status	Single	904	320	35%	Ref		Ref		Ref	
	Married	2977	1435	48%	1.96 (1.64-2.33)		1.37 (1.12-1.66)		1.29 (1.05-1.59)	
	Divorced/separated	200	93	47%	1.83 (1.33-2.51)	<0.001	1.12 (0.79-1.57)	0.005	1.10 (0.77-1.55)	0.03
	Widowed	333	185	56%	2.63 (2.01-3.41)		1.05 (0.77-1.42)		1.03 (0.76-1.42)	
	Other	26	11	42%	1.54 (0.70-3.41)		0.87 (0.38-1.97)		0.89 (0.38-2.00)	
Occupation	Not employed	801	367	46%	Ref		Ref		Ref	
	Farming	1593	892	56%	1.50 (1.27-1.78)		1.29 (1.08-1.54)		1.24 (1.03-1.49)	
	Domestic service	297	162	55%	1.42 (1.09-1.85)		1.45 (1.10-1.91)		1.44 (1.09-1.90)	
	Professional	202	79	39%	0.76 (0.55-1.04)	<0.001	0.86 (0.62-1.19)	<0.001	1.05 (0.73-1.52)	<0.001
	Sales & services	449	151	34%	0.60 (0.47-0.76)		0.73 (0.56-0.93)		0.76 (0.58-0.98)	
	Skilled manual	400	138	35%	0.62 (0.49-0.80)		0.78 (0.60-1.01)		0.79 (0.60-1.04)	
	Unskilled manual	417	140	34%	0.60 (0.47-0.76)		0.72 (0.56-0.93)		0.72 (0.55-0.93)	
	Student/pupil	81	22	27%	0.44 (0.27-0.73)		0.86 (0.49-1.51)		1.00 (0.56-1.77)	
Religion	Christian	4129	1907	46%	Ref		Ref		Ref	
	Islam	81	36	44%	0.93 (0.60-1.45)	0.09	0.95 (0.60-1.50)	0.15	1.07 (0.67-1.69)	0.24
	Other	30	8	27%	0.42 (0.19-0.95)		0.44 (0.19-1.00)		0.49 (0.21-1.14)	

Figures 1 and 2 plot the adjusted odds ratios of attendance for the demographic and economic factors.

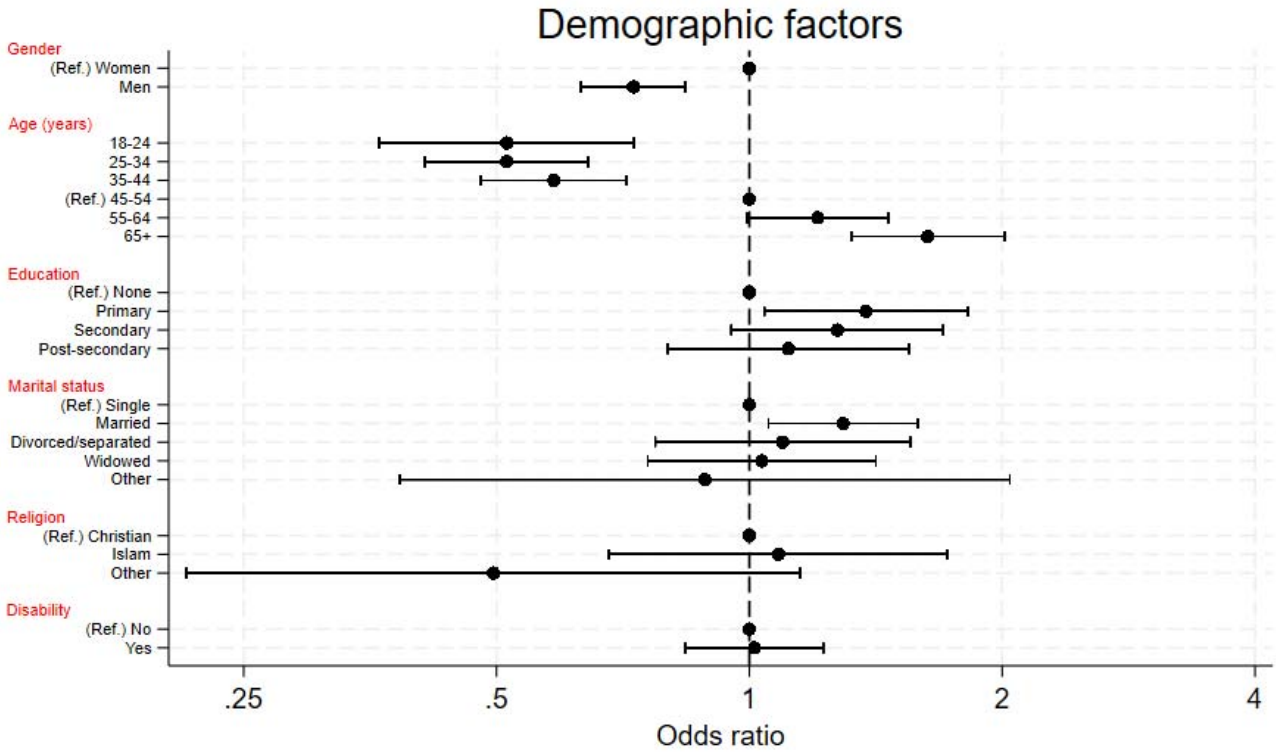

Figure 1: Plot of fully adjusted odds ratios of attendance according to demographic factors

Ref. = Reference group, disability = yes means the participant responded that they had difficulty with at least one of hearing, walking, climbing steps or communicating

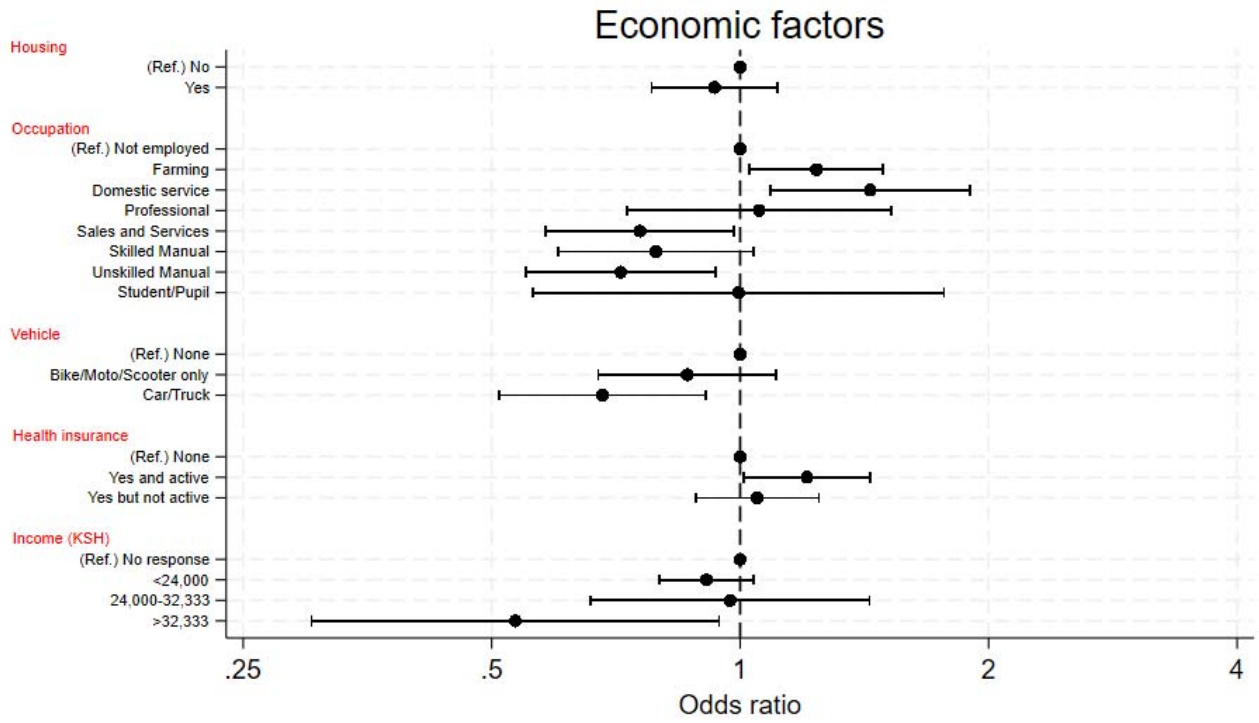

Figure 2: Plot of fully adjusted odds ratios of attendance according to economic factors

Ref. = Reference group

We tested for effect modification and identified some weak evidence (p=0.05) of an interaction between age and gender, suggesting that the difference in attendance between men and women is greater at younger ages than in older (Figure 3 and Supplementary Table 5).

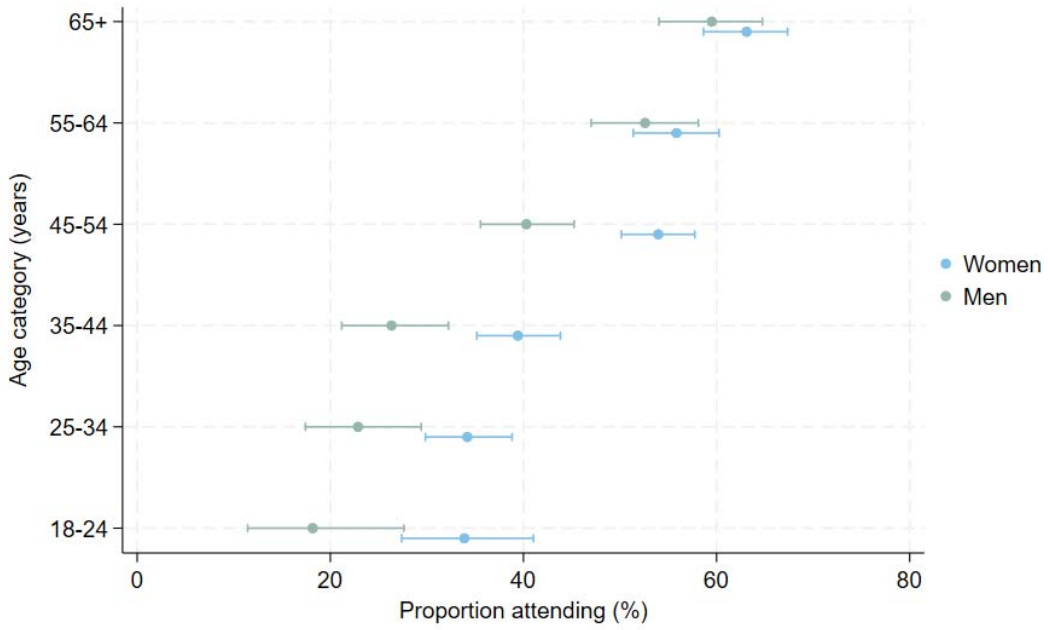

Figure 3: Clinic attendance within each age and gender group

Sensitivity analyses

To quantify the impact of intersectionality, we estimated the probability of attendance for people with different combinations of age, gender (including the interaction between age and gender), and occupation – the three strongest predictors of access. Age and gender were already categorical variables. For simplicity, we dichotomised occupation into a binary variable, grouping together the three categories of occupation that had the lowest attendance (skilled/unskilled manual and sales & services).

We found that the expected lowest attending group is 18-24-year-old males who work in sales/service/manual jobs, where we estimate that only 14% of people with these three characteristics would be able to access care (95% CI: 8-22%). The highest estimated access rate was 64%, found among females aged 65+ not working in those occupations (95% CI: 59-68%).

In our second sensitivity analysis we adjusted for severity of eye condition. We found that eye condition did not affect the effect estimates, suggesting that this variable

was not driving greater attendance in older people. Supplementary table 6 presents the full results.

Discussion

The growing emphasis on extending Universal Health Coverage and 'leaving no-one behind' means that programme managers around the world are increasingly being expected to identify populations that face unique barriers to care. Aligning with findings from previous research in Kenya,[27] we found that less than half of all people who screened positive in Meru's VIP project were able to access care. This resonates with a 2018 systematic review that found that 43% of all African outpatient appointments are not attended, with younger adults and those from lower socioeconomic groups being the least likely to attend.[28]

We found that younger men working in sales, services, or manual jobs were the least likely to attend. This stands in stark contrast to existing research on access to eye services which has shown older age, female gender, and widowhood to be the strongest predictors of poor access.[7,10] However, these studies focused on cataract care which affects people later on in life, whereas the VIP programme manages all eye conditions in all ages.

Given that Kenya ranks 110th out of 144 countries in the UN's gender equality ranking,[29] we were surprised that men were 30% less likely to attend than women in the fully adjusted model. However, this is not an unusual finding: despite having greater power, privileges, and opportunities than women in virtually all societies, men almost universally experience higher rates of poor health, lower rates of health care access, and lower overall life expectancy.[30,31] Differences in healthcare-seeking behaviour are thought to drive much of the gender gap in access rates, related to differences in perception of risk and pervasive social ideals of masculinity.[32] Whilst younger men were the least likely to attend in Meru, younger women were less likely to attend than older women, suggesting that youth is an independent predictor. Overall, age was by far the strongest predictor, with the youngest cohort (18-24y) three times less likely to have been checked-in than the oldest (65+), even after adjusting for occupation and severity of eye condition.

We hypothesise that younger adults may be more likely to be 'hustling' than older people – i.e. working in informal jobs with no fixed salary or paid sick leave, and therefore facing higher financial opportunity costs when taking time out to attend a clinic. The fact that people working in (often informal) sales, services, and manual labour were also less likely to attend than those working in other areas seems to corroborate this hypothesis.

To a lesser extent, car/truck ownership and high level of income were also associated with poor access. We hypothesise that this is because richer people who are told they have an eye problem at screening may be seeking private care rather than attending the VIP clinics. We plan to conduct a further set of interviews with people from this group to explore this issue further.

Our study had a number of limitations. We did not include questions on religion, tribe/ethnicity, or sexuality due to concerns about cultural sensitivities, but these are all important markers of potential access challenges.[17,18] With a larger sample we would have been able to detect smaller differences between groups, however it would have taken longer to conduct the study and the embedded nature of this research comes with pressure to deliver rapid and timely findings. Finally, we have not yet validated our sociodemographic questions. This work is currently underway, however the process of selecting the items and response options was based on extensive literature review and wide stakeholder engagement to ensure that we were using previously-validated questions with strong external validity.

Conclusion

Less than half of those referred to local eye clinics received treatment. We found evidence of large sociodemographic inequalities, with younger people, males, and those working in sales, services, and manual jobs facing the highest barriers. Overall, age was the strongest predictor. Future work should focus on exploring the specific barriers faced by younger adults and their ideas for how services could be modified to improve access to essential eye care.

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Appendix

1. Supplementary Tables 1-4: Sociodemographic variable section process

Supplementary Table 1: Sociodemographic variables from the first multi-stakeholder workshop

Domain (Data type)	Adult response options	Notes
Age (years) (Discrete)	Any integer >18	Already routinely collected in all Peek programmes
Gender (Categorical)	• Female • Male • Other	Already routinely collected in all Peek programmes The DHS and RAAB7 surveys only include female/male. We have added 'other'
Phone ownership (Ordinal)	Do you need someone else to receive your text message reminders? • Yes, my mother or father • Yes, my spouse • Yes, my daughter or son • Yes, other • No (= phone ownership)	Already routinely collected in all Peek programmes
Place of residence (Categorical)	N/A	Urban/rural location automatically inferred from screening location
Distance from screening location to clinic (km) (Discrete)	N/A	Distance between screening location and clinic location has been found to be a predictor of outcomes This is automatically calculated by the Peek software.
Language (Categorical)	• [list languages]	Country-specific lists will be derived from the latest Demographic and Health Survey
Relationships (Categorical)	• Married or living together • Divorced/separated	Options may need tailoring depending on the context.

	• Widowed • Never married or lived together	
Ethnicity (Categorical)	• [List ethnic groups] • Other	Country-specific lists will be derived from the latest Demographic and Health Survey
Migrant/refugee (binary)	Are you a migrant or refugee? • Yes • No	May be inflammatory depending on the setting
Religion (Categorical)	• [List main religions] • Other not listed • None	Country-specific lists will be derived from the latest Demographic and Health Survey
Education (Ordinal)	• None/pre-school only • Non-formal (included Quranic) • Some primary • Completed primary • Some secondary • Completed secondary • University	Options taken from the RAAB7 survey as it offers more detail than the DHS model questionnaire (early childhood education programme/Primary/Secondary/Higher) Non-formal/Quranic options may not be appropriate in settings where the prevalence of these forms is negligible
Occupation (Ordinal)	• Unemployed • Unskilled manual • Skilled manual • Professional • Homemaker	For children, programme implementers will ask what their parent's do for work and then code the highest occupational category on their behalf
Income (proxy) (Ordinal)	When you think about the food in your household would you say you have: • Less than adequate food for the needs of the household • Just adequate • More than adequate	This question is being used in the RAAB7 eye health survey as a proxy for income The survey is designed for >50y olds, so the response options may not be appropriate for children
Income adequacy (Ordinal)	When you think about the income in your household would you say it is: • Not enough to cover our needs, we must borrow, • Not enough to cover our needs, we use savings,	This question is being used in the RAAB7 eye health survey as a proxy for income The survey is designed for >50y olds, so the response options may not be appropriate for children

	• Just enough to cover our needs, • Enough to cover our needs, we are able to save a little • Enough to cover our needs, we are building savings	
Wealth (Binary)	Is your house's floor made out of cement? • Yes • No	The specific indicator used here will depend on the location
Assets (Binary)	Does your household own: • [List assets from DHS]	Shortest possible list of assets to be selected by country working groups

Note: Every question will have the additional options: 'Do not want to answer' and 'Don't know'.

Supplementary Table 2: Sociodemographic variables from the second multi-stakeholder workshop

Domain	Adult response options	Notes
Age	Any integer >18	Already routinely gathered
Gender	•Female •Male •Other	Already routinely gathered
Phone ownership	Do you need someone else to receive your text? message reminders? • Mother or father • Spouse • Daughter or son • Other • No (=phone ownership)	Already routinely gathered
Place of residence	N/A	Urban/rural automatically inferred
Distance to clinic	N/A	Automatically calculated by Peek
Language	What language do you speak most often at home? •English •Swahili •Borana •Embu •Kalenjin •Kamba •Kikuyu •Kisii •Luhya •Maragoli •Luo	Workshop participants felt that it would be inflammatory to ask about tribe/ethnicity. Language will be used as a Proxy

	•Maasai •Meru •Mijikenda •Pokot •Somali •Turkana •Other	
Relationships	•Never married •Married •Living together •Single •Divorced/separated •Widowed	
Migrant status	Were you born in Kenya? •Yes •No •Don't want to answer	This question may be redundant. Kenya is currently home to 500,000 refugees, however, they mainly live in camps and this information will already be collected under 'Place of residence'. Outside of Nairobi, the migrant population that does not live in camps is negligible.

Religion	What is your religion? •Roman Catholic •Protestant/other Christian •Islam •Other •No religion	Responses taken from the 2014 DHS
Education	What is you highest level of completed schooling? •No education •Some primary •Primary complete •Some secondary •Secondary complete •More than secondary	Adult responses aligned with the 2014 DHS
Occupation	What is your occupation? •Unemployed •Agriculture •Unskilled manual •Skilled manual •Sales and services •Clerical •Professional/technical/managerial •Homemaker	Interviewer to categorise and code the highest

Food adequacy	When you think about the food in your household would you say you have: • Less than adequate food for the needs of the household •Just adequate •More than adequate	Question taken from RAAB7 – may remove due to poor face validity
Income adequacy	When you think about the income in your household would you say it is: • Not enough to cover our needs, we must borrow, • Not enough to cover our needs, we use savings, • Just enough to cover our needs, • Enough to cover our needs, we are able to save a little • Enough to cover our needs, we are building savings	From RAAB7, but poor face validity.
Housing	Is your house's floor made of earth, sand, or dung? •Yes •No Do you have water piped into your own house or yard? •Yes •No Does your household have electricity? •Yes •No What kind of toilet does your household you use? •Own toilet/latrine •Shared toilet/latrine •None (bush/field)	All options taken from the 2014 DHS

Assets	Do you own a smartphone? •Yes •No Does your household own a: •Bicycle •Motorcycle/scooter •Car or truck Do you own your dwelling? •Yes •No	

Supplementary Table 3: Sociodemographic variables from the third multi-stakeholder workshop

Domain	Adult response options	Child response options	Notes
Age	Any integer >18	Any integer 5 - 17	Already routinely gathered
Gender	•Female •Male •Other	•Female •Male •Other	Already routinely gathered
Phone ownership	Do you need someone else to receive your text? message reminders? • Mother or father • Spouse • Daughter or son • Other • No (=phone ownership)	Provided contact number: • Mother or father • Guardian • Teacher • Other	Already routinely gathered
Place of residence	N/A	N/A	Urban/rural automatically inferred
Distance to clinic	N/A	N/A	Automatically calculated by Peek
Language	What language do you speak most often at home? •English •Swahili •Borana •Embu •Kalenjin •Kamba •Kikuyu •Kisii •Luhya •Maragoli •Luo	What language do you speak most often at home? •English •Swahili •Borana •Embu •Kalenjin •Kamba •Kikuyu •Kisii •Luhya •Maragoli	Used instead of ethnicity

	•Maasai •Meru •Mijikenda •Pokot •Somali •Turkana •Other	•Luo •Maasai •Meru •Mijikenda •Pokot •Somali •Turkana •Other	
Relationships	•Never married •Married •Living together •Single •Divorced/separated •Widowed	*Do you live with:* • Both parents • Just one parent • Another relative • Guardian (non-relative) • Orphanage	
Religion	What is your religion? •Roman Catholic •Protestant/other Christian •Islam •Other •No religion	What is your religion? •Roman Catholic •Protestant/other Christian •Islam •Other •No religion	Responses taken from the 2014 DHS

Education	What is you highest level of completed schooling? •No education •Some primary •Primary complete •Some secondary •Secondary complete •More than secondary	N/A	Adult responses aligned with the 2014 DHS
Occupation	What is your occupation? •Unemployed •Agriculture •Unskilled manual •Skilled manual •Sales and services •Clerical •Professional/technical/managerial •Homemaker	What are your parents' jobs? •No parents •Unemployed •Agriculture •Unskilled manual •Skilled manual •Sales and services •Clerical •Professional/technical/managerial •Homemaker	Interviewer to categorise and code the highest
Income adequacy	When you think about the income in your household would you say it is: • Not enough to cover our needs, we must borrow, • Not enough to cover our needs, we use savings, • Just enough to cover our needs, • Enough to cover our needs, we are able to save a little • Enough to cover our needs, we are building savings	N/A	From RAAB7, but poor face validity.

Housing	Is your house's floor made of earth, sand, or dung? •Yes •No Do you have water piped into your own house or yard? •Yes •No Does your household have electricity? •Yes •No What kind of toilet does your household you use? •Own toilet/latrine •Shared toilet/latrine •None (bush/field)	Is your house's floor made of earth, sand, or dung? •Yes •No Do you have water piped into your own house or yard? •Yes •No Does your household have electricity? •Yes •No What kind of toilet does your household you use? •Own toilet/latrine •Shared toilet/latrine •None (bush/field)	All options taken from the 2014 DHS
Assets	Do you own a smartphone? •Yes •No Does your household own a: •Bicycle •Motorcycle/scooter •Car or truck Do you own your dwelling? •Yes •No	Does your household own a smartphone? •Yes •No Does your household own a: •Bicycle •Motorcycle/scooter •Car or truck	

Supplementary Table 4: Sociodemographic variables from the fourth multi-stakeholder workshop

Domain	Adult response options (>18y)	Child response options	Notes
Age	How old are you?	How old are you	Already routinely gathered
Gender	•Female •Male •Other	•Female •Male •Other	Already routinely gathered
Phone ownership	Do you need someone else to receive your text message reminders? •Mother or father •Spouse •Daughter or son •Other • No (= phone ownership)	Provided contact number: •Mother or father •Guardian •Teacher •Other	Already routinely gathered
Place of residence	N/A	N/A	Urban/rural automatically inferred
Distance to clinic	N/A	N/A	Automatically calculated by Peek
Language	What is your mother tongue? •English •Swahili •Borana •Embu •Kalenjin •Kamba •Kikuyu •Kisii	What is your mother tongue? •English •Swahili •Borana •Embu •Kalenjin •Kamba •Kikuyu •Kisii	

	•Luhya •Maragoli •Luo •Maasai •Meru •Mijikenda •Pokot •Somali •Turkana •Other	•Luhya •Maragoli •Luo •Maasai •Meru •Mijikenda •Pokot •Somali •Turkana •Other	
Relationships	•Married •Single •Divorced/separated •Widowed •Other	*Do you live with:* •Both parents •Just one parent •Another relative •Guardian (non-relative) •Orphanage	We removed 'never married' because this is the same as single We removed 'living together' because this question is loaded with social stigma Ideally, we would ask children if one or more parent had died, but we don't want to cause distress. In the future we could consider asking teachers for this information

Religion	What is your religion? •Christian •Islam •Hindu •Other	What is your religion? •Christian •Islam •Hindu •Other	We removed 'no religion' as this group is negligible Christian denominations were aggregated, and we added 'Hindu'
Education	What is you highest completed level of schooling? •No education •Primary •Secondary •Post-secondary	N/A	We reworded the question and removed 'completed' and 'some' options to simplify the list
Disability	Do you have difficulty **hearing**, even if using a hearing aid(s)? • No difficulty • Some difficulty • A lot of difficulty • Cannot do at all • Don't know Do you have difficulty **walking or climbing steps**? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all	Do you have difficulty **hearing**, even if using a hearing aid(s)? • No difficulty • Some difficulty • A lot of difficulty • Cannot do at all • Don't know Do you have difficulty **walking or climbing steps**? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all	New question added at the request of implementing partners Response options taken from the Washington Group Short Set on Functioning: https://www.washingtongroup-disability.com/question-sets/wg-short-set-on-functioning-wg-ss/ The same options will be used for adults and children. UNICEF does have a child-specific question set, but it is more than double the length.

	•Don't know Do you have difficulty **remembering or concentrating?** • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know Do you have difficulty with **self-care**, such as washing all over or dressing? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know Using your language, do you have difficulty **communicating,** for example understanding or being understood? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know	•Don't know Do you have difficulty **remembering or concentrating?** • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know Do you have difficulty with **self-care**, such as washing all over or dressing? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know Using your language, do you have difficulty **communicating,** for example understanding or being understood? • No difficulty • Some difficulty •A lot of difficulty •Cannot do at all •Don't know	

Occupation	What is your occupation? •Not employed •Agriculture •Domestic service •Unskilled manual •Skilled manual •Sales and services •Clerical •Professional/technical/managerial	What are your parents' jobs? [staff to categorise & code only the highest] •No parents •Not employed •Agriculture •Domestic services •Unskilled manual •Skilled manual •Sales and services •Clerical •Professional/technical/managerial	We aligned the occupation categories with the 2014 DHS, adding domestic services
Income	What income band are you in? •Less than 24,000 KSh/month (288,000/yr, 10% Tax band) •Between 24,000 - 32,333 KSh/ month (288,000 - 100,000/yr, 25% Tax band) •More than 32,333 KSh/month (388,000/yr, 30% Tax band)	N/A	We removed the question on food adequacy as we felt it was not likely to render robust information. We also dropped the subjective question on income adequacy due to concerns about face validity. We replaced these income questions with a more direct item on income categories, based on the Kenya Revenue Authority tax bands
Housing	What is your floor made of in your house? •Cement •Other Do you have a source of water within your compound? • Yes • No Does your household have electricity, solar, or a generator?	What is your floor made of in your house? •Cement •Other Do you have a source of water within your compound? • Yes • No Does your household have electricity,	We switched from 'earth, sand or dung' to 'cement'. This is the reciprocal question and is faster to ask. We switched from 'do you have water piped into your own house or yard?' to 'do you have a source of water within your compound' because some rich people use boreholes We revised the wording of the toilet

	•Yes •No What type of toilet facility do members of your households usually use? • Own toilet/latrine •Communal toilet/latrine •None (bush/field)	solar, or a generator? •Yes •No What type of toilet facility do members of your households usually use? • Own toilet/latrine •Communal toilet/latrine •None (bush/field)	question changed to add greater clarity All options are aligned with the 2014 DHS
Assets	Do you own a smartphone? •Yes •No Does your household own a: •Bicycle •Motorcycle/scooter •Car or truck •None •Other	Does your household own a smart phone (with a touch screen)? •Yes •No Does your household own a: •Bicycle •Motorcycle/scooter •Car or truck •None •Other	We noted that smartphone ownership is so prevalent that it is only a sensible proxy for wealth in rural areas

2. Supplementary table 5: stratum specific effect estimates of association between attendance and age and gender

Strata	Category	Unadjusted OR	p-value
18-24 years	Female	Ref	
	Male	0.43 (0.23-0.81)	0.008
25-34 years	Female	Ref	
	Male	0.57 (0.38-0.85)	0.005
35-44 years	Female	Ref	
	Male	0.55 (0.39-0.77)	0.001
45-54 years	Female	Ref	
	Male	0.58 (0.45-0.74)	<0.001
55-64 years	Female	Ref	
	Male	0.88 (0.66-1.17)	0.37
65+ years	Female	Ref	
	Male	0.86 (0.64-1.15)	0.305
Women	18-24y	0.44 (0.31-0.62)	
	25-34y	0.44 (0.34-0.57)	
	35-44y	0.56 (0.44-0.70)	
	45-54y	Ref	
	55-64y	1.08 (0.85-1.37)	
	65+y	1.46 (1.15-1.86)	<0.001
Men	18-24y	0.33 (0.18-0.59)	
	25-34y	0.44 (0.30-0.65)	
	35-44y	0.53 (0.37-0.75)	
	45-54y	Ref	
	55-64y	1.64 (1.22-2.22)	
	65+y	2.17 (1.61-2.94)	<0.001

Note: The p-value for the interaction term was 0.048

3. Supplementary table 6: Regression with additional adjustment for eye condition

		N	N Attended	% Attended	Unadjusted	p	Adjusted for age & sex	p	Adjusted for everything	p	Additionally adjusted for eye condition	p
Gender	F	2700	1317	49%	Ref	<0.001	Ref	<0.001			Ref	<0.001
	M	1540	634	41%	0.73 (0.65-0.83)		0.67 (0.59-0.76)		0.72 (0.63-0.83)	<0.001	0.71 (0.62-0.83)	
Age cat	18-24	271	78	29%	0.42 (0.32-0.57)		0.41 (0.31-0.55)		0.49 (0.35-0.69)		0.54 (0.38-0.77)	<0.001
	25-34	615	189	31%	0.46 (0.38-0.57)		0.45 (0.36-0.55)		0.51 (0.41-0.63)		0.55 (0.43-0.69)	
	35-44	730	256	35%	0.57 (0.47-0.69)		0.55 (0.46-0.67)		0.59 (0.48-0.72)		0.61 (0.49-0.74)	
	45-54	1048	512	49%	Ref	<0.001	Ref	<0.001	Ref	<0.001	Ref	
	55-64	786	429	55%	1.26 (1.05-1.51)		1.27 (1.05-1.53)		1.21 (1.00-1.46)		1.20 (0.99-1.45)	
	65+	790	487	62%	1.68 (1.39-2.03)		1.71 (1.42-2.07)		1.61 (1.31-1.99)		1.65 (1.33-2.04)	
Asset	None	3644	1726	47%	Ref	0.0001	Ref	0.002	Ref	0.03	Ref	0.02
	Bike/Moto/scooter	328	125	38%	0.68 (0.54-0.86)		0.86 (0.68-1.10)		0.87 (0.68-1.12)		0.86 (0.67-1.10)	
	Car	268	100	37%	0.66 (0.51-0.85)		0.64 (0.49-0.83)		0.69 (0.52-0.92)		0.68 (0.51-0.91)	
Disability	No	3637	1629	45%	Ref		Ref		Ref	0.99	Ref	0.86
	Yes	603	322	53%	1.41 (1.19-1.68)	<0.001	0.98 (0.82-1.18)	0.87	1.00 (0.83-1.20)		1.02 (0.84-1.23)	
Education	None	284	149	52%	Ref	<0.001	Ref	0.002	Ref	0.03	Ref	0.05
	Primary	1787	906	51%	0.93 (0.73-1.20)		1.43 (1.09-1.87)		1.42 (1.07-1.87)		1.37 (1.04-1.82)	
	Secondary	1538	666	43%	0.69 (0.54-0.89)		1.28 (0.97-1.69)		1.30 (0.97-1.73)		1.27 (0.95-1.70)	
	Post-secondary	631	230	36%	0.52 (0.39-0.69)		1.03 (0.76-1.40)		1.12 (0.81-1.56)		1.10 (0.79-1.53)	
Health insurance	No	2530	1154	46%	Ref	0.35	Ref	0.77	Ref	0.12	Ref	0.13
	Yes active	909	437	48%	1.10 (0.95-1.28)		1.02 (0.87-1.19)		1.20 (1.01-1.43)		1.20 (1.01-1.43)	
	Yes not active	801	360	45%	0.97 (0.83-1.14)		0.95 (0.80-1.12)		1.04 (0.88-1.24)		1.04 (0.88-1.23)	
Housing	No	703	353	50%	Ref	0.015	Ref	0.21	Ref	0.48	Ref	0.43
	Yes	3537	1598	45%	0.82 (0.69-0.96)		0.90 (0.76-1.06)		0.94 (0.79-1.12)		0.93 (0.78-1.11)	
Income	No response	1984	935	47%	Ref	<0.001	Ref	0.007	Ref	0.11	Ref	0.11
	<24,000	2050	939	46%	0.94 (0.84-1.07)		0.92 (0.81-1.04)		0.91 (0.80-1.04)		0.91 (0.80-1.04)	
	24,000-32,333	132	56	42%	0.83 (0.58-1.18)		0.84 (0.59-1.22)		0.98 (0.67-1.45)		1.00 (0.67-1.47)	
	>32,333	74	21	28%	0.44 (0.27-0.74)		0.41 (0.24-0.69)		0.54 (0.30-0.95)		0.53 (0.30-0.94)	
Marital	Single	904	320	35%	Ref	<0.001	Ref	0.005	Ref	0.03	Ref	0.05
	Married	2977	1435	48%	1.96 (1.64-2.33)		1.37 (1.12-1.66)		1.29 (1.05-1.59)		1.30 (1.06-1.59)	
	Divorced/separate	200	93	47%	1.83 (1.33-2.51)		1.12 (0.79-1.57)		1.10 (0.77-1.55)		1.11 (0.78-1.58)	
	Widowed	333	185	56%	2.63 (2.01-3.41)		1.05 (0.77-1.42)		1.03 (0.76-1.42)		1.04 (0.76-1.43)	
	Other	26	11	42%	1.54 (0.70-3.41)		0.87 (0.38-1.97)		0.89 (0.38-2.00)		0.88 (0.38-2.03)	
Occupation	Not employed	801	367	46%	Ref	<0.001	Ref	<0.001	Ref	<0.001	Ref	<0.001
	Farming	1593	892	56%	1.50 (1.27-1.78)		1.29 (1.08-1.54)		1.24 (1.03-1.49)		1.25 (1.04-1.51)	
	Domestic service	297	162	55%	1.42 (1.09-1.85)		1.45 (1.10-1.91)		1.44 (1.09-1.90)		1.41 (1.06-1.86)	
	Prof/tech/man/Cle	202	79	39%	0.76 (0.55-1.04)		0.86 (0.62-1.19)		1.05 (0.73-1.52)		1.07 (0.74-1.54)	
	Sales & services	449	151	34%	0.60 (0.47-0.76)		0.73 (0.56-0.93)		0.76 (0.58-0.98)		0.76 (0.58-0.98)	
	Skilled manual	400	138	35%	0.62 (0.49-0.80)		0.78 (0.60-1.01)		0.79 (0.60-1.04)		0.79 (0.60-1.04)	
	Unskilled manual	417	140	34%	0.60 (0.47-0.76)		0.72 (0.56-0.93)		0.72 (0.55-0.93)		0.72 (0.55-0.94)	
	Student/pupil	81	22	27%	0.44 (0.27-0.73)		0.86 (0.49-1.51)		1.00 (0.56-1.77)		0.99 (0.55-1.75)	
Religion	Christian	4129	1907	46%	Ref	0.09	Ref	0.15	Ref	0.24	Ref	0.22
	Islam	81	36	44%	0.93 (0.60-1.45)		0.95 (0.60-1.50)		1.07 (0.67-1.69)		1.06 (0.67-1.69)	
	Other	30	8	27%	0.42 (0.19-0.95)		0.44 (0.19-1.00)		0.49 (0.21-1.14)		0.48 (0.20-1.11)	

		N	N Attended	% Attended	Unadjusted	p-value	Adjusted for age & sex	p	Adjusted for everything	p
Eye condition	Normal	209	86	41%	0.68 (0.51-0.91)	<0.001	0.64 (0.47-0.86)	0.012	0.66 (0.49-0.89)	0.008
	Loss of vision	1878	954	51%	Ref		Ref		Ref	
	Chronic	336	158	47%	0.86 (0.68-1.08)		0.85 (0.67-1.08)		0.84 (0.66-1.07)	
	Acute	1368	563	41%	0.68 (0.59-0.78)		0.83 (0.71-0.96)		0.80 (0.68-0.93)	
	Urgent	449	190	42%	0.71 (0.58-0.87)		0.93 (0.75-1.16)		0.88 (0.71-1.11)	