Project Report

Rapid Assessment Refractive Errors (RARE) in Koshi Province in Nepal

(A collaborative project by L V Prasad Eye Institute, Nepal Netra Jyoti Sangh and OneSight)

Submitted by:
Srinivas Marmamula, PhD,
Gullapalli Pratibha Rao International Centre for Advancement of Rural Eye care, L V Prasad Eye Institite,
Hyderabad, India
Email : sri.marmamula@lvpei.org

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Rapid Assessment Refractive Error (RARE) in Koshi Province in Nepal

Background

Vision loss affects over a billion people worldwide.[1] It adversely affects the social, economic, and emotional well-being of an individual. However, over 75% of vision loss is avoidable with timely interventions, such as cataract surgery and spectacles, improving the quality of life of individuals with vision loss. Among them, Uncorrected Refractive Errors (URE) are the leading cause of vision loss.[2] Most URE can be corrected by providing spectacles.

Reliable epidemiological data is essential for planning and monitoring eye care services in any region. The data is also required to evaluate and assess the impact of the services delivered in a region over time. Although population-based cross-sectional studies provide reliable information for setting priorities and starting services, they are resource-intensive and cannot be repeated at regular intervals.

Rapid assessments have proven to be invaluable tools in this aspect.[3] Rapid data collection at low cost, using local resources, and high repeatability at regular intervals to study trends have been the strengths of rapid assessment methods.[3] Rapid Assessment of Refractive Errors (RARE) in a methodology that focuses on younger age groups. It is used to assess the prevalence of uncorrected refractive errors.[4] RARE was developed and used in Andhra Pradesh and Telangana, India, resulting in publications in peer-reviewed journals.[4] This methodology is also used in several regions of the world.[4-11] However, no such study has been conducted in Nepal. Therefore, we conducted a cross-sectional study in the Koshi province of Nepal using the RARE methodology.

Objectives

- To estimate the prevalence and causes of visual impairment in the adult population in Koshi province in Nepal.
- To assess the prevalence of presbyopia, spectacles use, and effective refractive error coverage in Koshi province in Nepal.
- To assess the barriers to the uptake of eye care services among those with visual impairment and presbyopia
- To assess the ‘willingness to pay’ for spectacles in Koshi province in Nepal.

Methods

The study was conducted using the RARE methodology, which was used in Telangana and Andhra Pradesh, India.[4] The Institutional Review Board of Nepal Health Research Council (NHRC) reviewed and approved the study protocol. The study adhered to the Declaration of Helsinki. Written informed consent was obtained from each participant (or a guardian for those under 18 years) before the eye

examination. All the relevant approvals from local agencies were obtained before the study.

Study participants

Individuals aged 15 to 50 years, residing in the study area for more than three months, and willing to provide consent to participate in the study were included.

Study location

The study was carried out in the Koshi province of Nepal, which has an area of 25,905 square kilometers. The Koshi province covers 18% of the total area of Nepal. It has a diverse geographical terrain, comprising plains, hills, and mountain regions (Figure 1). It has six districts, with a population of 4.6 million, as of 2021. (https://en.wikipedia.org/wiki/Koshi_Province).

Figure 1: Map of Nepal showing Koshi Province where the study was conducted.

Sample size estimation

The minimum sample size required in each province was 4,500 (75 clusters), based on an estimate of 4% prevalence of visual impairment (presenting visual acuity worse than 6/12), allowing for a 95% confidence interval, a precision of 20%, design effect of 1.6 for a predetermined cluster size of 60 subjects, and 15% non-response rate. The study used a multi-stage cluster random sampling procedure with a compact segment sampling method. Three field teams were involved in data collection. Each team comprised an experienced ophthalmic assistant/optometrist and two community eye health workers. The participants were visited in their homes by the study team.

Eye Examination protocol

The study protocol is published.[4, 12] In brief, unaided (and aided) visual acuity (VA) in each eye was measured using a Snellen chart with tumbling ‘‘E’’ optotypes at a distance of 6 meters. Participants with VA less than 6/9 in either eye was re-assessed using a multiple pinhole occluder. Near vision was assessed binocularly using the N notation chart at a fixed distance of 40 cm for each individual. Torchlight examination was performed to assess the anterior segment of the eye. Lens status was assessed by using torchlight and distant direct ophthalmoscopy in a shaded environment without pupillary dilatation.

Demographic information, including education level, occupation, and current and previous use of spectacles, was collected through a brief personal interview. A question on barriers to the uptake of eye care services was administered to all participants with visual impairment. Among those who needed the services, willingness to pay for spectacles and eye care services was assessed.

Definitions

a. **Visual Impairment (VI)** was defined as presenting visual acuity worse than 6/12 in the better eye. VI was subdivided into blindness (worse than 3/60), severe visual impairment (worse than 6/60 to 3/60), moderate visual impairment (worse than 6/18 to 6/60), and mild visual impairment (worse than 6/18 to 6/12).
b. **Uncorrected Refractive Error (URE)** was defined as presenting visual acuity worse than 6/12 that has improved to 6/12 or better on the pinhole.

c. **Presbyopia** was defined as binocular, near vision <N8 at the participant's customary working distance for participants aged over 35 years and those who had binocular distance visual acuity of 6/12 or better.
d. **Refractive Error Coverage (%)** was defined according to McCormick and colleagues.[13-15] 'Met need' was defined as unaided VA worse than 6/12 that improved to 6/12 or better with their current spectacles. 'Unmet need' was defined as unaided VA worse than 6/12 that improved to 6/12 with pinhole among those without spectacles. 'Under-met need' was defined as aided VA worse than 6/12 that improved with pinhole to 6/12 or better. The sum of 'met need,' 'unmet need,' and 'under-met need' was considered as 'total need.'
e. **Effective Refractive Error Coverage (e-REC)** is calculated as follows: e-REC (%) = ((met need)/(total need)) X100.
f. **Refractive Error Coverage (%)** was calculated as: REC (%) = (met need + under-met need)/(total need) X100. REC (%) is similar to Spectacle Coverage (%) reported in other studies.
g. **Relative gap between REC (%) and e-REC (%)** was calculated as follows: Relative Quality gap (%) = 1-(e-REC/REC) X100.

All participants with uncorrected presbyopia were provided with spectacles. Those with VI due to URE or other causes such as cataract and those who needed further care were referred to the higher centres for management. All services and spectacles were provided at no cost to the participants.

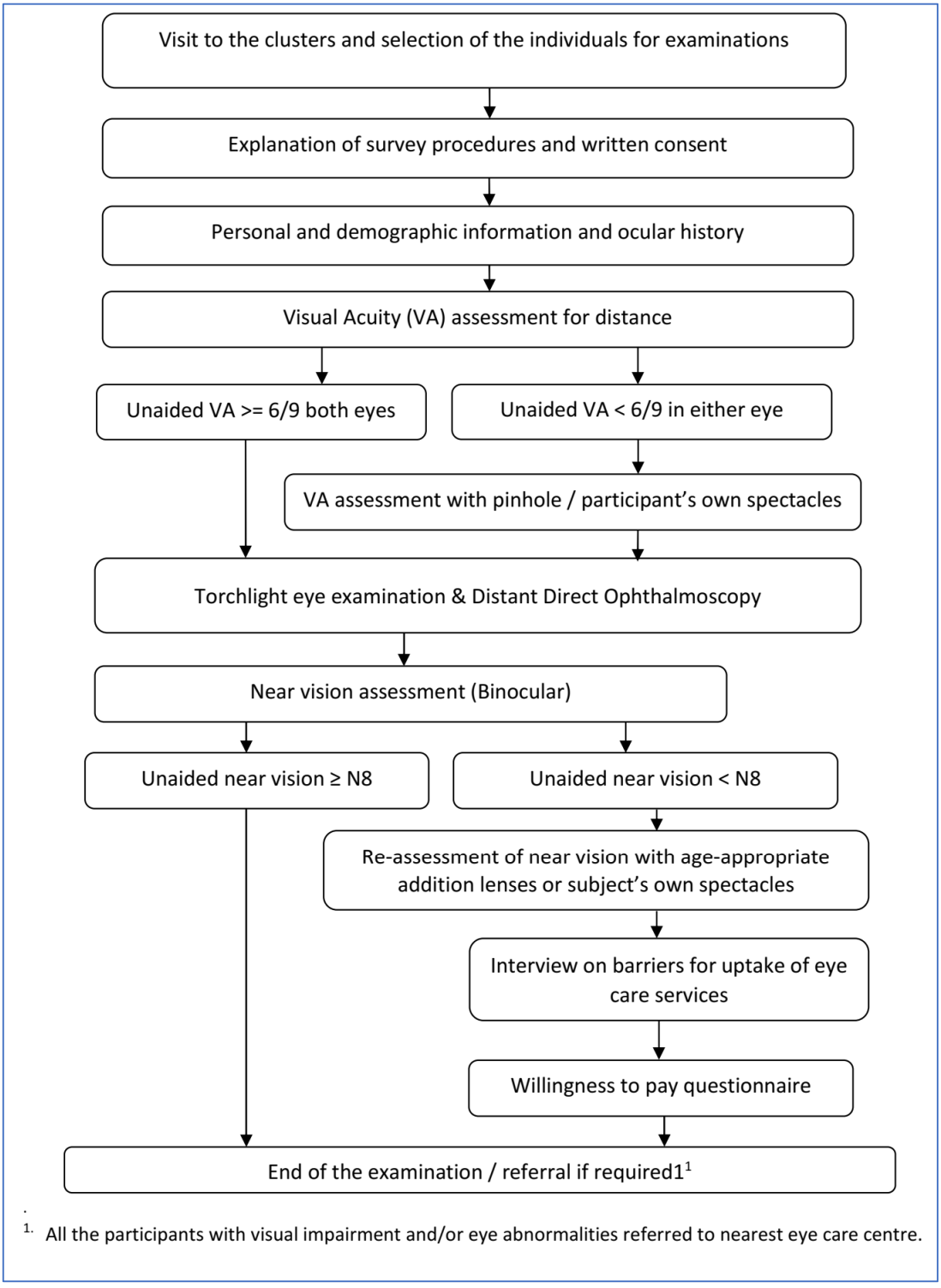

Figure 2: Flowchart showing of the study procedure.

Data management

Data were collected in paper forms and entered in the database developed in Microsoft Access. Data analysis was conducted using Stata v12. The point prevalence estimates, and 95% confidence intervals were calculated. The association between visual impairment, uncorrected refractive error, and other major causes of visual impairment and demographic variables, such as age, gender, education, and occupation, were assessed using multiple logistic regression analysis. The strength of association is described using odds ratios (OR) with 95% confidence intervals (CI).

Results

Socio-demographic profile of the participants

In total, 4,800 participants were enumerated from 80 clusters. Of this, 4057 were examined (84.5% response rate). The mean (±standard deviation) age of those not examined was higher compared to those examined (31.3±10.7 versus 33.1±10.9 years; p<0.05). More women were examined compared to men (89.4% versus 77.9%; p<0.01) (Table 1).

Table 1: Characteristics of those examined and not examined.

	Total enumerated	Not examined	Examined[1]		p
	n	n	n	%	
Age group (years)					
15 - 29	1967	305	1652	84.0	<0.01
30 - 39	1116	138	978	87.6	
>=40	1608	181	1427	88.7	
Gender					
Male	2,046	452	1594	77.9	<0.01
Female	2,754	291	2463	89.4	
Education level					
No formal schooling	568	23	545	96.0	0.001
School education	2613	172	2441	93.4	
Intermediate	1107	103	1004	90.7	
College and above	72	5	67	93.1	
Location					
Plains	2940	459	2481	84.4	0.05
Hilly regions	1619	260	1359	83.9	
Mountains	241	24	217	90.0	
Area					
Rural	2341	335	2006	85.7	0.04
Urban	1979	338	1641	82.9	
City	480	70	410	85.4	
Total	**4800**	**743**	**4057**	**84.5**	

[1] Row percentages presented.

Among those examined, 1652 were in the 15-29 (40.7%) years age group. There were 1594 (39.3%) men, and 545 (13.4%) had no formal schooling. In total, 2418 (61.2%) of those examined were from the plains, and 2006 (49.4%) were from rural areas. The characteristics of the participants are shown in Table 2.

Table 2: Characteristics of the participants examined.

	Total examined	
	n	**%**
Age group (years)		
15 - 29	1652	40.7
30 - 39	978	24.1
>=40	1427	35.2
Gender		
Male	1594	39.3
Female	2463	60.7
Education level		
No formal schooling	545	13.4
School education	2441	60.2
Intermediate	1004	24.7
College and above	67	1.7
Location		
Plains	2481	61.2
Hilly regions	1359	33.5
Mountains	217	5.3
Area		
Rural	2006	49.4
Urban	1641	40.4
City	410	10.1
Total	**4057**	**100.0**

Visual impairment

Based on unaided visual acuity in the better eye, the prevalence of visual impairment was 3.52% (95% CI: 2.89–4.13; n=143) based on the unaided visual acuity in the better eye. The prevalence of visual impairment dropped to 2.61% (95% CI: 2.14–3.15; n=106) based on the presenting visual acuity in the better eye (Figure 3).

Visual impairment was higher in the older age groups ($p<0.01$) and among those with lower levels of education ($p<0.01$). The prevalence of VI was also significantly higher among those living in the mountains. Gender and area of residence were not associated with visual impairment (Table 3). URE (74.53%; n=79) was the leading cause of visual impairment, followed by cataract (16.98%; n=18) and other causes (8.49%; n=9).

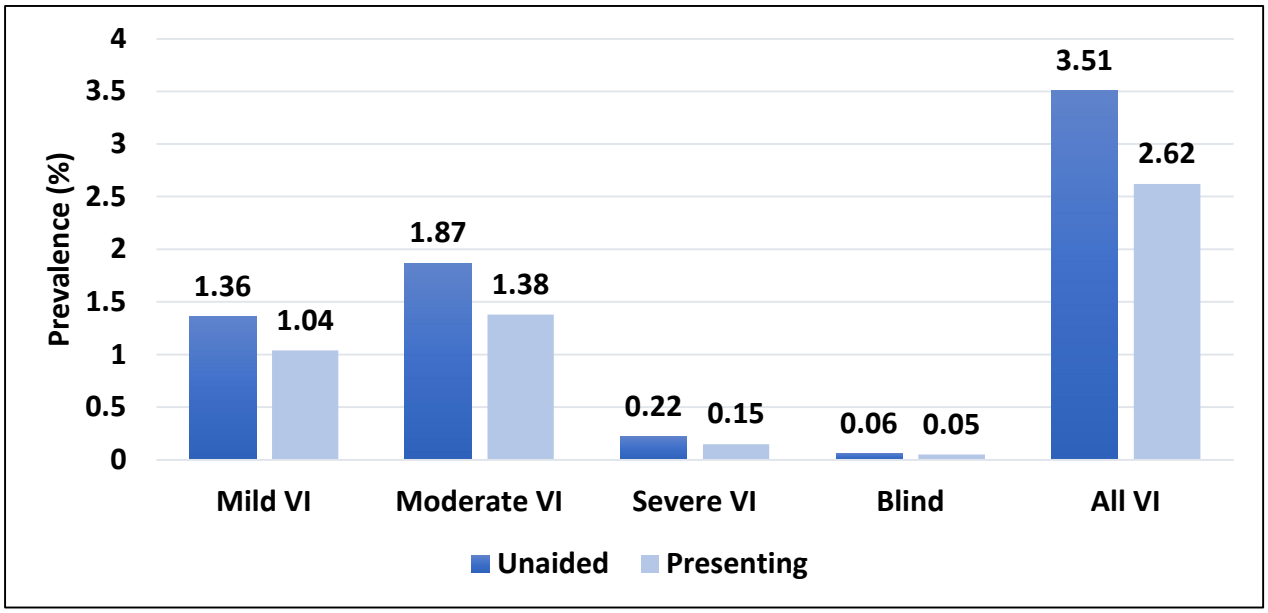

Figure 3: Categories of visual impairment based on visual acuity in the better eye.

Table 3: Prevalence of visual impairment stratified by personal and demographic characteristics (bivariate analysis).

	Total in the sample	**Visual Impairment** (Presenting visual acuity worse than 6/12 in the better eye)		**p**
	n	**n**	**%**	
Age group (years)				<0.01
15 - 29	1652	23	1.4	
30 - 39	978	22	2.2	
Gender				
Male	1594	44	2.8	0.635
Female	2463	62	2.5	
Education level				<0.01
No formal schooling	545	32	5.9	
School education	2441	63	2.6	
Intermediate	1004	11	1.1	
College and above	67	0	0.0	
Location				<0.01
Plains	2006	56	2.8	
Hilly regions	1359	51	3.8	
Mountains	217	5	2.3	
Area				
Rural	2006	56	2.8	0.734
Urban	1641	39	2.4	
City	410	11	2.7	
	4057	**106**	**2.6**	

Prevalence of uncorrected refractive errors

The prevalence of URE in the better eye was 1.95% (95% CI:1.54–2.42; n=79). Based on either eye definition, the prevalence of URE was 2.56% (95% CI: 2.50–3.10; n=104). On multiple logistic regression analyses, URE in either eye was associated with older age groups. Those with higher levels of education were less likely to have URE. Participants residing in hilly regions and mountains had higher odds for URE (Table 4).

Table 4: Prevalence and association of Uncorrected Refractive Errors (URE) with personal and demographic characteristics – Multivariable analysis

	Total in the sample (n=4057)	URE - Either eye (n=104)		Odds ratio (95% CI)	p
	n	n	%		
Age group (years)					
15 - 29	1652	23	1.39	Reference	
30 - 39	978	19	1.94	1.20 (0.63 - 2.26)	0.630
>=40	1427	62	4.34	2.31 (1.37 - 3.89)	<0.01
Gender					
Male	1594	43	2.70	Reference	
Female	2463	61	2.48	0.93 (0.62 - 1.40)	0.73
Education level					
No formal schooling	545	22	4.04	Reference	
School education	2441	70	3.97	0.70 (0.41 - 1.12)	0.19
Higher education	1071	12	1.12	0.35 (0.16 - 0.76)	<0.01
Location					
Plains	2481	41	1.65	Reference	
Hilly regions	1359	54	3.97	2.98 (1.83 - 4.87)	
Mountains	217	9	4.15	3.68 (1.60 - 8.49)	<0.01
Area					0.02
Rural	2006	57	2.84	Reference	
Urban	1641	37	2.25	1.26 (0.78 - 2.01)	0.34
City	410	10	2.44	2.17 (0.99 - 4.80)	0.05

Prevalence of spectacles use

Overall, 340 (8.38%; 95% CI: 7.54 – 9.27) participants reported using spectacles at the time of examination. Single-vision glasses for distance vision were the most commonly used type of spectacles (39.7%; n=135%), followed by bifocals (37.9%; n=129) and single-vision glasses for near vision (21.5%; n=73). Private eye clinics (32.1%; n=109) and private eye hospitals (24.7%; n=84) were the leading service providers of spectacles (Table 5).

Table 5: Types of spectacles and spectacles providers

	n (%)
Type of spectacles	
Single vision - Distance vision	135 (39.7)
Single vision - Near vision	73 (21.5)
Bifocals	129 (37.9)
Progressive Addition Lenses (PALS)	3 (0.88)
Spectacle provider	
Eye care centre	42 (12.3)
Local optical shop	2 (0.59)
Eye Camp	17 (5.0)
Private eye hospitals	84 (24.7)
Private eye clinic	109 (32.1)
Secondary eye hospital	19 (5.6)
Tertiary eye hospital	67 (19.7)
Total	**340 (100)**

On multiple logistic analyses, spectacles use was associated with older age groups, female gender, and higher levels of education. The odds of spectacle use were higher in urban areas and cities than in rural areas. However, the association with the location was not significant (Table 6).

In total, 225 (5.55%; 95% CI: 4.86–6.39) participants had a history of using spectacles. Broken/damaged spectacles (33.33% n=75) were the leading reason for discontinuation of spectacles, followed by using glasses for a headache only (25.8%; n=58) (Figure 4).

Table 6: Prevalence and association of Spectacles use with personal and demographic characteristics –Multivariable analysis

	Total in the sample (n=4057)	Spectacles use (n=340)		Odds ratio (95% CI)	p
	n	n	%		
Age group (years)					
15 - 29	1652	64	3.87	Reference	
30 - 39	978	60	6.13	1.96 (1.35 - 2.84)	<0.01
>=40	1427	216	15.14	7.73 (5.56 - 10.74)	<0.01
Gender					
Male	1594	117	7.34	Reference	
Female	2463	223	9.05	1.60 (1.25 - 2.06)	<0.01
Education level					
No formal schooling	545	36	6.61	Reference	
School education	2441	204	8.36	2.41 (1.64 - 3.54)	<0.01
Higher education	1071	100	9.34	5.14 (3.28 - 8.06)	<0.01
Location					
Plains	2481	223	8.99	Reference	
Hilly regions	1359	98	7.21	0.88 (0.65 - 1.18)	0.39
Mountains	217	19	8.76	1.11 (0.64 - 1.95)	0.71
Area					
Rural	2006	128	6.38	Reference	
Urban	1641	161	9.81	1.51 (1.13 - 2.02)	<0.01
City	410	51	12.44	2.21 (1.47 - 3.34)	<0.01

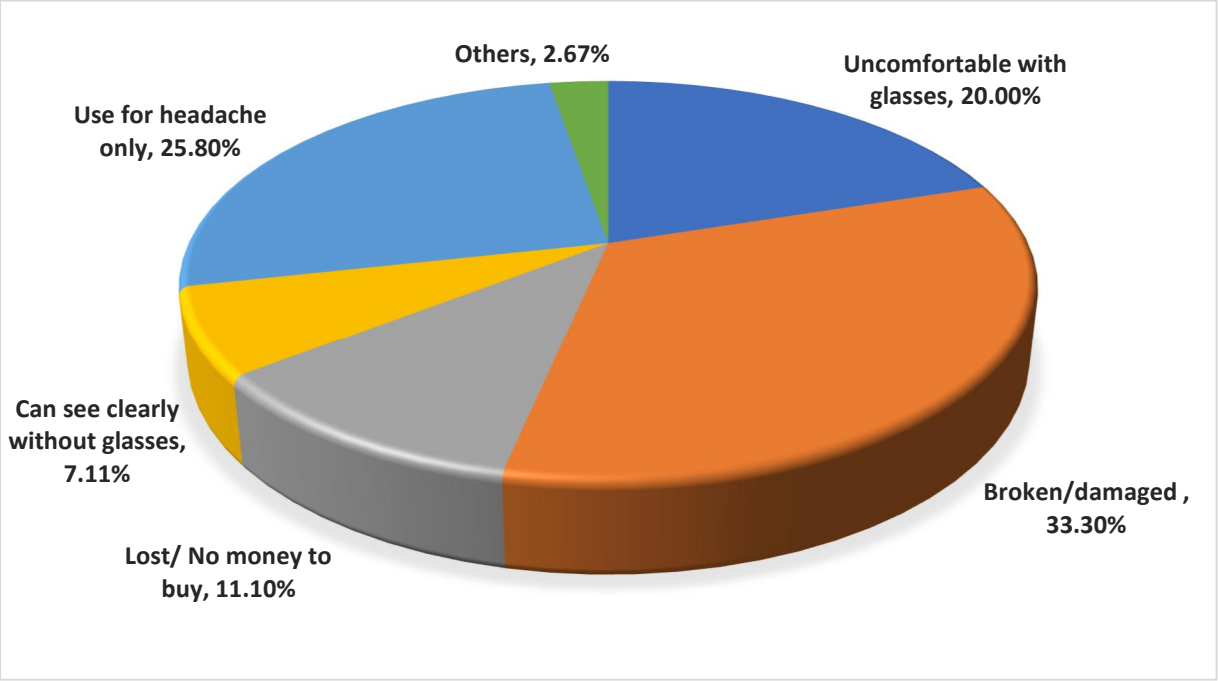

Figure 4: Reasons for discontinuation of spectacles (n=224)

Spectacle coverage for Refractive errors

Based on met, unmet, and under-met needs, the Refractive Error Coverage (Spectacle coverage) and Effective Refractive Error Coverage were 34.8% and 31.3% respectively. (Table 7)

Table 7: Refractive Error Coverage and Effective Refractive Error Coverage

Need	n
Met need (a)	36
Under met need (b)	4
Unmet need (c)	75
Effective-Refractive Error Coverage (REC) (%) =a / a+b+c*100	31.3
Spectacle coverage / REC (%) = a+b / a+b+c*100	34.8
Quality gap = 1-(E-REC/REC)	**10.0**

Near vision impairment

Among the 1945 participants aged 35 years and older, the prevalence of near vision impairment was 34.24% (95% CI: 32.1 – 36.40; n=666).

Barriers for uptake of services

Among the 79 people with URE, the leading reasons for not utilizing the services were ‘aware of the problem, can manage,’ followed by ‘no time available/other priorities,’ and ‘services very far,’ which were reported by 34 (43.0%), 14 (17.7%), and 13 (16.5%) participants, respectively. Remaining 18 (22.8%) of participants gave other reasons.

Willingness to pay for spectacles for distance and near vision spectacles

Data on willingness to pay for spectacles for distance vision was available from 71/79 participants. In total, 26.7% (n=19) were willing to pay over 100 to 500 Nepali rupees, 28.2% (n=20) were willing to pay 501 and 1000 Nepali rupees for spectacles for distance vision. About 26.8% (n=19) participants were willing to pay more than 1000 Nepali rupees for spectacles. However, 18.3% (n=13) wanted spectacles for free.

Similarly, the data on willingness to pay for near-vision spectacles were available from 628/666 participants. In total, 49.6% (n=309) were willing to pay 50 to 500 Nepali Rupees, 42.0% (n=262) were willing to pay 510 to 1000 Nepali rupees, and 5% (n=32) were willing to pay over 1000 Nepali rupees for their near vision. Approximately 3% (n=21) of participants wanted spectacles for free.

Comparison with other studies

We report the prevalence of URE, spectacles use, and near-vision impairment for the first time in Nepal using the RARE methodology. The Rapid Assessment of Avoidable Blindness (RAAB) methodology was the most commonly used rapid methodology in Nepal prior to this study. The prevalence of visual impairment across the RARE studies done in different parts of the world ranged from a minimum of 3% in South India to a maximum of 19.3% in Columbia (Table 8).[4-11] The prevalence of visual impairment was even lower in Koshi province in Nepal. The high prevalence reported from Columbia compared to other studies using same methodology could be attributed to the older age of the participants included in that study. Uganda and Tanzania had older participants.[6, 8]

Similarly, the prevalence of URE varied across the regions. Columbia (12.50%)[5] had the highest prevalence of uncorrected refractive error (URE), followed by Tanzania (7.5%),[6] Uganda (4.60%), [8] South India (2.70%),[4] Mozambique (2.60%),[9] and South Africa (1.50%)[10] (Table 8).

The prevalence of spectacle use varied between 1% to 7% across the studies. The prevalence of spectacle use in Tanzania[16] and Uganda[17] was 1.70% and 1%, respectively, which was the lowest. In contrast, South India (7%) had the highest prevalence. [4] A higher prevalence of spectacles use (8.4%) was noted in the current study (Table 8).

The prevalence of spectacle coverage is also very diverse across the studies. The two countries with the highest prevalence were South Africa (51.40%)[10] and Columbia (50.90%),[5] followed by South India (29%),[4] Eritrea (13.30%),[11] Uganda (5.96%),[8] and Tanzania (1.69%).[6] The prevalence of near vision impairment varied substantially between the regions, from 36% to 52%. [4-7] Nepal had the lowest prevalence of near vision impairment (34.2%) (Table 8).

The variability across the studies can be attributed to the age groups included in the study and the availability and uptake of services in the region. Moreover, the differences in definitions and methods used might contribute to the differences. The lower prevalence of visual impairment, URE, and near vision impairment despite the difficult terrain in Nepal can be attributed to the availability and uptake of services. This is corroborated by a higher prevalence of current and past spectacles use and better coverage. As expected, the prevalence of URE was higher in the hilly regions and mountains of the Koshi Province compared to the plains. This is in line with the lower prevalence of spectacle use in these regions.

Table: 8: Summary of results from Rapid Assessment of Refractive Errors studies conducted in different parts of the world

Country/ Region	Year of study	Age group (years)	Visual impairment	Prevalence of URE	Prevalence of spectacles use	Spectacle coverage (%) - Distance	Near vision impairment
South India	2006	15-50	3%	2.70%	7%	29%	51.80%
Tanzania	NA	24-49	10.40%	7.50%	1.70%	1.69%	46.50%
South Africa	2009	15-35	NA	1.50%	3.80%	51.40%	NA
Columbia	NA	15-96	19.30%	12.50%	NA	50.90%	NA
Bangladesh	2010-2012	15-49	8.10%	NA	NA	13.30%	NA
Eritrea	NA	15-50	NA	NA	3.37%	22.20%	36.10%
Uganda	NA	30-55	10.00%	4.60%	1%	5.96%	50.30%
Mozambique	NA	15-50	4.20%	2.60%	4.70%	0%	NA
Nepal – Koshi Province (Current study)	2022	15-50	2.61%	1.95%	8.38%	34.8	34.24%

Strengths and limitations

The strengths of this study include a large population representing the entire Koshi Province. A good response rate despite a difficult geographical terrain is an additional strength. In this study, the definition of uncorrected refractive error was based on the improvement of visual acuity on using pinhole. It is assumed that the participants with presenting visual acuity of 6/12 or better do not have uncorrected refractive errors, even though some individuals might have small degrees of ametropia. Small degrees of uncorrected refractive error might not significantly impact an individual and need not be prioritized from a public health planning point of view.

Restricting the eye examinations to simple visual acuity assessment and assigning the cause of visual impairment to the most easily treatable/correctable cause leads to an underestimation of some minor causes of visual impairment. Moreover, the definition for refractive error used in this study might not identify young hyperopes, who may have good visual acuity for distance vision but can benefit from spectacle correction. Although RARE has limitations, the ease of data collection using local resources in a short time makes it a valuable tool for gathering information. It helps to estimate the need for refraction services and plan appropriate services with time-bound, realistic targets. RARE can also be used to monitor eye care services and provides valuable insight into temporal trends when repeated over time. This will help to determine the progress toward achieving universal eye health in the region.

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Team members:

1. Sabin Kumar Mahato (OA)
2. Bijay Tamang (OA)
3. Indrajeet Kumar Yadav (OA)
4. Shivram Chaudhary (OA)
5. Rita Pradhan (CEHW)
6. Parshuram Shrestha (CEHW)
7. Shrawn Majhi (CEHW)
8. Manish Khawash (CEHW)

Technical team:

1. Rajiv Karn (Implementation lead)
2. Amit Kumar Meheta (Quality control)
3. Pankaj Raj Adhikari (Quality control)
4. Srinivas Marmamula (Technical lead)
5. Ranjan Shah
6. Saibaba Saravanan

Data management team:

1. Dhiraj Mandal
2. Gautam Majhi
3. Mithlesh Meheta
4. Rupesh Kumar

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