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Prevalence of Blindness and Cataract Surgical Coverage in Former Lumbini Zone, Nepal: A Rapid Assessment of Avoidable Blindness (RAAB) Study

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ABSTRACT

Background: Blindness and visual impairment remain major public health concerns among older adults in Nepal, with cataract being a leading cause of avoidable blindness. This study aimed to assess the prevalence and causes of central vision blindness and visual impairment, as well as cataract surgical coverage among people aged 50 years and older in the Lumbini Zone of Nepal..

Methods: A population-based cross-sectional survey was conducted using the Rapid Assessment of Avoidable Blindness (RAAB) methodology. Data were collected using the mRAAB smartphone application and analyzed with the standard RAAB6 software. A total of 3,431 participants aged 50 years and above were examined for visual acuity, causes of visual impairment, and cataract surgical status.

Results: The prevalence of bilateral blindness in the better eye was 2.1% (95% CI: 1.5–2.6) with best correction or pinhole and 2.2% (95% CI: 1.5–2.7) with available correction. Severe visual impairment (SVI) affected 3.1% (95% CI: 2.4–3.9) of participants, while moderate visual impairment (MVI) and early visual impairment affected 14.0% (95% CI: 12.1–15.8) and 12.7% (95% CI: 11.0–14.5), respectively. Cataract was the leading cause of blindness, SVI, and MVI. Untreated cataract accounted for a substantial proportion of visual impairment, with males showing higher prevalence of SVI, MVI, and early visual impairment than females. Cataract surgical coverage (CSC) for visual acuity worse than <3/60 was relatively high, indicating good access to surgical services among those requiring intervention.

Conclusion: Cataract-related blindness continues to be a significant cause of visual disability among older adults in the Lumbini Zone. While cataract surgical coverage was encouraging, particularly among individuals with severe visual impairment, the lower effective cataract surgical coverage highlights the need to improve surgical quality and postoperative visual outcomes. Strengthening cataract services and ensuring high-quality postoperative care are essential to further reduce avoidable blindness in the region.

Keywords: Blindness; Visual Impairment; Cataract; Cataract Surgical Coverage; Rapid Assessment of Avoidable Blindness; Nepal.

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INTRODUCTION

Globally, 2.2 billion people live with vision impairment, of whom at least 1 billion have a vision impairment that is either preventable or yet to be addressed.[1] Populations in Low- and Middle-income countries affected with vision impairments disproportionately due to limited assess in quality eye care services where cataract and uncorrected refractive error remain the major causes of avoidable blindness among older adults.[2-8] Cataracts remain the leading cause of blindness in the developing world, with eye care systems facing significant challenges, including inequalities in service coverage and quality, shortages of trained professionals, and inadequate integration into the health system [2,3,7,9,10.] The Nepal Blindness Survey (1981) showed a prevalence of bilateral blindness of 0.84%, unilateral blindness of 1.7%, and low vision of 1.85% nationwide. The survey also revealed that cataracts were the leading cause of blindness, which was almost 71% of cases and 91% of blind individuals residing in rural areas.[2] In 1994, a regional survey conducted in the Lumbini and Bheri zones revealed that the prevalence of blindness had decreased and cataract surgical coverage had increased compared to the previous decade. However, poor outcome from cataract surgeries remain the challenge, as almost 31% of cataract surgery cases involved individuals who were blind or with severe visual impairment.[4] Between 2006 to 2010 eleven RAAB surveys were conducted in different zones of Nepal showed a further reduction in blindness prevalence of 0.35%, with cataracts remaining the leading cause of blindness. The Global Action Plan (2014-2019) Universal Eye Health plan targets a 25% reduction in visual impairment by 2019 with baseline data of 2010.[5] So, Nepal Netra Jyoti Sangh stepped towards the RAAB survey in all the provinces of Nepal to look at the trends of blindness in the country, the impact of ongoing eye care services, and to produce evidence-based WHO GAP at country level eye care services. Population-based RAAB surveys are important tools for monitoring trends in blindness and evaluating the effectiveness of national eye health programs.[18,20] Former Lumbini Zone has multiple eye hospitals and eye care centers to provide the eye care services. Among them, the Lumbini Eye Institute and Research center/Shree Rana Ambika Shah Eye Hospital, which is tertiary level eye hospital, provide eye care services in the rural areas of the Lumbini zone through its secondary, district, and primary eye care centers.[21] In Lumbini, there are hilly and terai regions. RAAB survey was conducted in Lumbini Zone with the aim to estimate the prevalence of blindness, the main causes of blindness, and cataract surgical coverage.

METHODS

The cross- sectional population-based blindness survey was conducted in Lumbini Zone of Nepal in 2019 using standardized RAAB6 survey methodology [6]. Study population was the adults aged 50 years or above at the time of data collection. Sampling frame was created by using the national census data of 2011. Based on census data ward level population was used as population unit or cluster. Sample size was 3465 distributed across 99 clusters, with 35 people 50 years or older in each. Sample size calculation was performed using the RAAB6 software, taking the prevalence of bilateral blindness 2.3%[5] at 95% confidence level.

For the Lumbini zone, 99 clusters were randomly selected using a probability proportional to size approach based on the clusters' population size. The survey team visited households in the selected clusters door to door until 35 eligible participants were identified. The study purpose and examination procedure were explained to the subjects and informed consent was taken before data collection. In cases where an eligible person was absent during the initial household visit at the time of data collection, the survey team again revisited to examine them. Still could not examined, the reason for non-examination was recorded, in accordance with RAAB methodology. If the survey team visited all households in a cluster but failed to find the 35 eligible people, then team continued recruitment in the closest cluster. Two teams from Lumbini Eye Institute and Research

Centre (LEIRC) were trained for the data collection, Ophthalmologist was the team leader in each team. A Pilot study was conducted in one cluster which was not selected in the study cluster. Eligible participants underwent visual acuity assessment with Snellen chart, anterior segment examination with torchlight and media and fundus examination with direct ophthalmoscope. Data were collected using tablets with mRAAB6 data collection software installed. The survey conformed to the tenets of the declaration of Helsinki. The study protocol was reviewed and approved by Nepal Health Research council (NHRC), under the Ministry of Health, Government of Nepal. Written informed consent was taken from all the Participants before they enrolled in the study.

RESULTS

A total of 3431 people from 99 clusters were identified as an eligible subject. Among them 3420 (99.7%) were available for an examination where 45.5% Male and 54.5% Female were presented. The Crude prevalence of bilateral blindness with available correction was 2.2% (95% CI, 1.5-2.7). Severe visual impairment (SVI) affected 3.1% (95% CI 2.4-3.9), moderate vision impairment (MVI) 14% (95% CI 12.1-15.8) and early vision impairment (EVI) 12.7% (95% CI, 11.0-14.5) (Table 1).

Table 1. Prevalence of blindness and visual impairment

Vision category	Male, % (95% CI)	Female, % (95% CI)	All, % (95% CI)
Blindness	2.4 (1.1-2.9)	2.3 (1.5-2.9)	2.2 (1.5-2.7)
SVI	3 (1.9-4.1)	3.2 (2.3-4.1)	3.1 (2.4-3.9)
MVI	14.3 (12.0-16.5)	13.6 (11.6-15.7)	14 (12.1 -15.8)
EVI	12.7 (10.5-14.8)	12.8 (10.8-14.8)	12.7 (11.0-14.5)

The main causes of bilateral blindness were untreated cataract (75.7%), followed by other posterior segment disease (10.8%), non-trachomatous cornea opacity (5.4%), Age Related Macular Degeneration (ARMD) (2.7%), Onchocerciasis (1.4%), Glaucoma (1.4%), diabetic retinopathy (1.4%), and all other globe/CNS abnormalities (1.4%). Cataract was the leading cause of SVI (84.1%). Similarly, Refractive error was the leading cause of EVI (74.5%). So, 97.7% of blindness in the study population was avoidable, with 94.3% of blindness were treatable (Table 2). The crude prevalence of blindness due to bilateral cataract among the subjects was 1.4% (95% CI, 0.9-1.9). While the prevalence of cataract blind eye was 4.3% (95% CI, 3.4-5.2).

The crude prevalence of severe visual impairment (SVI) due to bilateral cataract among the subjects was 2.7% (95% CI, 2.0-3.3) and the prevalence of eyes affected by SVI due to cataract was 6.2% (5.0-7.3). The crude prevalence of moderated visual impairment (MVI) due to bilateral cataract was 9.9% (95% CI, 8.4-11.4). While the prevalence of eyes that are affected by MVI due to cataract was 15.4% (95% CI, 13.5-17.1). The crude prevalence of early visual impairment (EVI) due to bilateral cataract was 13.3% (95% CI, 11.4-15) and the prevalence of eyes that are affected by EVI due to cataract was 18.9% (95% CI, 16.8-21.0) (Table 3).

Cataract surgical coverage (CSC) was higher among persons with more severe visual impairment. CSC (persons) was 87.1% for VA < 3/60, 78.8% for VA < 6/60, and 53.9% for VA < 6/18. Effective CSC was slightly lower at 71.0%, 63.9%, and 42.3% for the respective categories, indicating that most surgeries restored good vision. Coverage was generally comparable between males and females, with females showing slightly higher CSC at milder vision loss levels (Table 4).

The majority of cataract-operated eyes achieved good visual outcomes. According to WHO definitions: Very good (VA ≥ 6/12), Good (VA ≥ 6/18), Borderline (VA <6/18-6/60), Poor (VA <6/60). Based on presenting visual acuity (PVA), 60.2% had very good vision and 15% had good vision, while 15.6% showed borderline and 9.9% poor outcomes. When assessed by best-corrected visual acuity (BCVA), 78.3% achieved very good vision, 4.7% good vision, 9% borderline, and 8.1% poor outcomes. Visual results

Table 2. Causes of blindness and visual impairment				
Category	**Blindness n(%)**	**SVI n(%)**	**MVI n(%)**	**EVI n(%)**
Cataract untreated	56(75.5)	90(84.1)	312(65.4)	86(19.8)
Other Posterior segment disease	8(10.8)	3(2.8)	15(3.1)	3(0.7)
Non-Trachomatous corneal opacity	4(5.4)	0(0)	4(0.8)	7(1.6)
Age-Related Macular Degeneration	2(2.2)	2(1.9)	15(3.1)	3(0.7)
Diabetic Retinopathy	1(1.1)	1(0.9)	6(1.3)	1(0.2)
Onchocerciasis	1(1.1)	5(4.7)	3(0.6)	0(0)
Phthisis	0(0)	3(2.8)	3(0.6)	0(0)
Refractive error	0(0)	2(1.9)	102(21.4)	324(74.5)
Cataract surgical complications	0(0)	1(0.9)	17(3.6)	2(0.5)
Trachomatous corneal opacity	0(0)	0(0)	4(0.8)	3(0.7)
All other globe/CNS abnormalities	1(1.1)	0(0)	1(0.2)	0(0)
Glaucoma	1(1.1)	5(4.7)	3(0.6)	2(0.5)
By Intervention category				
Treatable	56(75.7)	92(86)	414(86.8)	410(94.3)
Preventable (PHC/PEC services)	5(6.8)	3(2.8)	11(2.3)	10(2.3)
Preventable (ophthalmic services)	2(2.7)	7(6.5)	26(5.5)	5(1.2)
Avoidable (A+B+C)	63(85.1)	102(95.3)	451(94.6)	425(97.7)
Posterior segment causes	13(17.6)	14(13.1)	37(7.8)	13(3)

Table 3. Crude prevalence of Blindness and visual Impairment due to cataract						
Cataract causing blindness	**Male**		**Female**		**Total**	
	n(%)	**95% CI**	**n (%)**	**95%**	**n (%)**	**95% CI**
Bilateral cataract	18(1.2)	0.5-1.8	31(1.7)	0.9-2.2	49(1.4)	0.9-1.9
Unilateral cataract	99(6.4)	4.7-7.9	99(5.3)	4.2-6.5	198(5.8)	4.6-6.9
Cataract eyes	135(4.3)	3.1-5.5	161(4.3)	3.3-5.2	296(4.3)	3.4-5.2
Cataract causing SVI						
Bilateral cataract	39(2.5)	1.7-3.3	54(2.9)	1.9-3.7	93(2.7)	2.0-3.3
Unilateral cataract	120(7.7)	6.6-10.2	118(6.3)	6.4-9.7	238(7)	6.7-9.6
Cataract eyes	198(6.4)	4.9-7.8	226(6.1)	4.7-7.2	424(6.2)	5.0-7.3
Cataract causing MVI						
Bilateral cataract	168(10.8)	8.8-12.8	172(9.2)	7.5-10.8	340(9.9)	8.4-11.4
Unilateral cataract	175(11.2)	9.2-13.2	196(10.5)	9.1-12.0	371(10.9)	9.5-12.2
Cataract eyes	511(16.4)	14.0-18.8	540(14.5)	12.5-16.3	1051(15.4)	13.5-17.1
Cataract causing EVI						
Bilateral cataract	224(14.4)	12.0-16.8	230(14.4)	10.5-14	454(13.3)	11.4-15
Unilateral cataract	186(12)	10.0-13.8	201(10.8)	9.4-12.2	387(11.3)	10.1-12.5
Cataract eyes	634(20.4)	17.6-23.1	661(17.7)	15.7-19.6	1295(18.9)	16.8-21.0

Table 4. Cataract Surgical coverage (CSC)			
Vision category	**Male**	**Female**	**Total**
Cataract surgical Coverage (eyes)-percentage			
VA<3/60	72.2	72.2	72.2
VA<6/60	63.9	64.9	64.4
VA <6/18	40.7	43.6	42.2
Cataract surgical coverage (persons)-percentage			
VA<3/60	89.2	85.4	87.1
VA<6/60	80.3	77.5	78.8
VA<6/18	52.5	55.2	53.9
Effective cataract surgical coverage (persons) - percentage			
VA<3/60	73.7	68.9	71
VA<6/60	65.2	62.9	63.9
VA<6/18	41.5	43	42.3

were notably better among intraocular lens (IOL) recipients compared to non-IOL cases (Table 5).

Table 5. Visual outcome of cataract surgery

Visual outcome	VA type	Non-IOL	IOL	Total
Very good > 6/12	PVA	0(0)	458(60.20)	458(60.20)
	BCVA	0(0)	602(79.10)	602(79.10)
Good: > 6/18	PVA	0(0)	115(15.10)	115(15.10)
	BCVA	0(0)	36(4.70)	36(4.70)
Borderline: <6/18-6/60	PVA	1(12.5)	119(15.60)	120(15.60)
	BCVA	1(12.5)	68(8.90)	69(8.90))
Poor <6/60	PVA	7(87.5)	69(9.10)	76(9.10))
	BCVA	7(87.5)	55(7.20)	62(7.20))

DISCUSSION

The results from this Rapid Assessment of Avoidable Blindness (RAAB) study conducted in Lumbini Zone, Nepal, provides important insights into the extent of blindness and visual impairment among individuals aged 50 and older. The main findings of the study highlight that cataract is the leading cause of blindness and visual impairment, despite the availability of cataract surgery and need for better access to quality eye care services. The overall prevalence of blindness (presenting vision <3/60) among individuals aged 50 years and older was 2.2% (95% CI, 1.5–2.7). The prevalence of severe visual impairment (SVI) was 3.1% (95% CI, 2.4–3.9), while moderate visual impairment (MVI) and early visual impairment (EVI) were 14% (95% CI, 12.1–15.8) and 12.7% (95% CI, 11.0–14.5), respectively. These results show that a sizable section of the people has vision problems that might affect everyday activities and quality of life. These numbers make it clearly evident that many people still have untreated cataracts even if availability to cataract surgery has improved over time (Table-1). Our findings are consistent with national and regional data: for example, in a recent all-province RAAB in Nepal (2018–21), the national prevalence of blindness among people 50 and above was estimated at 1.1% (95% CI 1.0–1.2) and any vision impairment <6/12 at 20.7% (95% CI 19.9–21.5)[7] (Mishra et al.). In that survey, the prevalence of blindness was higher in women (1.3%) than men (0.9%) and varied by province, with Lumbini among the highest (1.8%). Our estimate of 2.2% is somewhat higher, which may reflect the zone-level rather than provincial sample, which represents only six districts whether province represents twelve districts. This study reveals that in Lumbini zone, untreated cataract is the leading cause of blindness (75.7%), severe visual impairment (84.1%), and moderate visual impairment (65.4%), with a notable contribution in early visual impairment (19.8%). Refractive error was the primary cause of early visual impairment (74.5%) and significantly contributed to moderate visual impairment (21.4%), highlighting gaps in access to corrective services. Similar studies conducted in South Africa also reveals untreated cataract (55.2%) is the leading cause of blindness, Severe Visual Impairment (53.3%), Untreated refractive error was the major cause of moderate visual impairment (49.1%)[8] which reflects leading blindness cause untreated cataract is still high in our region than South Africa. Posterior-segment diseases such as glaucoma, diabetic retinopathy, and age-related macular degeneration accounted for a smaller yet important share of visual loss. A significant proportion of visual impairment 85.1% of blindness, 95.3% of SVI, 94.6% of MVI, and 97.7% of EVI was avoidable through treatment or prevention, emphasizing the need to strengthen cataract surgical programs, refractive services, and preventive care to address both treatable and preventable causes of vision loss (Table-2). These findings align with prior studies in Nepal which have consistently shown cataract as the dominant cause of blindness: for example, a review of Nepalese data noted that cataract accounted for around 62% of bilateral blindness in more recent surveys.[2-3,4,5,9,10] Internationally, similar patterns are seen: in low- and middle-income countries cataract remains the leading cause of blindness by wide margins.[8,11] The high proportion of avoidable vision loss underscores the ongoing need for service strengthening. The crude prevalence of blindness due to bilateral cataract in this study population was 1.4% (95% CI, 0.9–1.9), with a higher prevalence among females (1.7%) compared to males (1.2%). This gender

disparity suggests that women may face greater barriers to accessing cataract surgery or eye-care services a pattern observed elsewhere. For example, a pooled analysis of RAAB surveys (148 surveys 2003–21) found that effective cataract surgical coverage (ECSC) was higher in men than women (risk difference ~3.2%).[12] The overall prevalence of eyes blinded by cataract was 4.3% (95% CI, 3.4–5.2), further underlining the substantial burden cataract imposes on vision. Additionally, the prevalence of SVI due to bilateral cataract was 2.7% (95% CI, 2.0–3.3), while the prevalence of MVI and EVI due to cataract were found to be 9.9% (95% CI, 8.4-11.4) and 13.3% (95% CI, 11.4-15), respectively. Overall, this indicates a significant visual-health burden, with moderate and early impairments being more prevalent-potentially reflecting a lack of early intervention and accessible eye-care services. In the area of service coverage, the cataract surgical coverage (CSC) for individuals with VA < 3/60 demonstrated a favorable outcome, with a coverage rate of 87.1%-showing only minimal gender differences (89.2% for males and 85.4% for females). This suggests that a significant proportion of individuals with severe vision impairment are receiving timely surgical intervention. However, when considering those with VA < 6/18, the coverage rate decreased to 53.9%, which indicates a critical gap in the early identification and treatment of cataracts before substantial vision loss occurs (Table-4). Comparatively, a RAAB in the Narayani Zone of Nepal reported a CSC of 91.5% for VA<3/60 (2017).[13] The national RAAB (2021) reported CSC 82.7% for VA<6/60 among those aged 50+ in Nepal.[14] Internationally, CSC values vary widely, for example in India the ECSC at 6/12 threshold was only ~36.7% (CSC ~57.3%) in one study, indicating large quality and access gaps.[13] Our data thus suggest that while Service Access (CSC) is reasonably high for severe vision loss, the much lower coverage for less severe vision loss (VA<6/18) signals a need to shift an emphasis toward earlier detection, counselling, and treatment. Regarding the visual outcomes of cataract surgery, a significant proportion of patients achieved very good outcomes: 60.2% had PVA>6/18 and 78.3% achieved BCVA>6/18 post-surgery. This suggests that the majority of patients experienced substantial improvement in vision, with a particularly high rate of success in those receiving intra-ocular lens (IOL) implants. However, the presence of the remaining ~9–15% borderline and ~8-9% poor outcomes signal important gaps in surgical quality, follow-up care, underlying ocular co-morbidities, or patient selection (Table-5). In the national RAAB Nepal report, which analyzed visual outcomes, poorer outcomes were associated with co-morbid posterior segment disease and surgery performed many years previously (Insert reference). A recent global analysis of ECSC also emphasizes that increasing coverage alone is insufficient: quality (good outcome) must be assured if population impact is to be maximized.[12] Cataract Surgical Coverage (CSC) serves as a critical indicator of the accessibility and utilization of cataract surgery services within a population. In Nepal, the CSC is notably high, with values of 91.5% reported in the Narayani Zone (2017) and 87.1% in the Lumbini Zone (2019).[13] Similarly, Thailand (95.1%)[11] and the Maldives (93.5%) exhibit high levels of CSC, likely attributable to well-established national health systems, universal health coverage, and effective integration of eye care service.[15] In contrast, lower CSC levels in Tanzania (68.9%) [16] and Mozambique (28.4%) point to barriers such as limited infrastructure, surgical workforce shortages, and financial or geographic challenges. These variations highlight the need for sustained investment in comprehensive eye care systems, particularly in low-resource settings, to enhance surgical uptake and reduce avoidable blindness.[17]

CONCLUSIONS

This study demonstrates that avoidable blindness and visual impairment remains the public health concern in former Lumbini Zone of Nepal. Cataract and uncorrected refractive error continue to be the leading causes of vision loss among people aged 50 years and older. Although cataract surgical coverage is relatively high, the gap between surgical coverage

and effective surgical coverage indicates the need of improvement in surgical quality and postoperative outcomes. Strengthen early detection of eye disease, improving equitable access to quality cataract and refractive services, and expanding community-based eye care program are essential to further reduce avoidable blindness and achieve universal eye health goals in Nepal.

Limitations

This study is cross-sectional in design; therefore, causal relationships cannot be established. It included only individuals aged 50 years and above, limiting generalizability to younger populations. Field-based visual assessment may introduce measurement bias, and some causes of visual impairment may have been misclassified due to limited diagnostic facilities. In addition, the findings are representative only of the Lumbini Zone and may not be fully generalizable to other regions of Nepal.

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Authors' Contributions

Saraswati Khadka Thapa contributed to the conceptualization, methodology, project administration, and provision of resources. Shital Khattri Chettri was responsible for data curation, while Ranjan Shah performed the formal analysis. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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