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Prevalence of diabetes and diabetic retinopathy among adults aged 50 years and above in Nepal: a population-based cross-sectional survey

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ABSTRACT

Background Diabetic retinopathy (DR), a microvascular complication of diabetes mellitus (DM), is a leading cause of vision loss worldwide. There is limited national data to inform about the prevalence of DM and DR and its associated factors, which led to the basis of conducting this survey, which would guide us for the same as part of the Rapid Assessment of Avoidable Blindness (RAAB) survey conducted across Nepal.

Methods A population-based cross-sectional RAAB survey was conducted using multistage cluster random sampling. RAAB+DR methodology was conducted between June 2019 and February 2021 among individuals aged≥50 years across selected provinces. Diabetes was diagnosed based on treatment history and random blood glucose test with level>200 mg/dL, while DR was graded by trained ophthalmologists. All relevant data were imported into the RAAB software to determine the prevalence of DM, DR and associated factors.

Results Among the 13 510 participants examined, the prevalence of DM was found to be 6.1% which was higher in Bagmati province at 9.4% (95% CI: 8.2% to 10.7%). Prevalence of DM was higher among females, but DR was more common in males in rural areas and females in urban areas. Untreated diabetes was most common in Madhesh (35.1%). DR prevalence was highest in Bagmati (15.9%; 95% CI: 12.7% to 19.1%), and 2.5% (95% CI: 1.2% to 3.8%) of those patients had sight-threatening DR. In Bagmati, 24.1% of diabetics had never undergone an eye examination.

Conclusion The limited coverage of DR screening underscores the need for enhanced community-based DR screening and referral programmes. Our study lacked the use of plasma blood glucose level measurement to diagnose DM, proper slit lamp examination for diabetic retinopathy grading and diagnosis, and inclusion of a younger population providing a better representation. Strengthening these initiatives can prevent vision-threatening complications in underserved populations.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies in Nepal reported a diabetes prevalence of 14.6% among individuals aged 20 years and above, with diabetic retinopathy (DR) affecting 23.8% of diabetics. However, these studies were predominantly hospital-based or focused on limited geographical areas, offering insufficient data to inform nationwide strategies.

WHAT THIS STUDY ADDS

⇒ This nationally representative, population-based study assessed the prevalence of diabetes mellitus and diabetic retinopathy among individuals aged 50 years and above across selected provinces of Nepal. Significant regional disparities were observed, with Bagmati province reporting the highest prevalence of diabetes mellitus (DM) (9.4%) and DR (15.9%), while Karnali province recorded the lowest (1.9% and 3.9%), respectively. Additionally, 30.8% of known diabetics had never undergone an eye examination.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides critical data to inform targeted interventions for DM and DR. Policymakers can use these findings to design region-specific and gender-sensitive programmes to improve access to diabetes management and DR screening. The study highlights the urgency of raising awareness about DM and DR, emphasising the importance of screening for early detection and treatment to prevent vision-threatening complications. This evidence can also guide future research to explore barriers to care and evaluate the effectiveness of implemented strategies.

INTRODUCTION

Diabetes mellitus (DM) is a chronic endocrinal metabolic disease mainly affecting multiple organ systems in the body parts like heart, kidney, eye and peripheral nerves characterised by sustained high blood sugar levels.[1] It is estimated that globally there will be a rise to 522 million people with diabetes in 2030.[1] Diabetic retinopathy (DR) is a microvascular complication of the retina affecting at least one out of three diabetics.[2] The risk

of DR is closely associated with the duration of diabetes and the level of glycaemic control.[3 4] Among the middle-aged population worldwide, DR is the leading cause of acquired vision loss and blindness, the primary cause of blindness in working-age populations in developed countries and the fifth leading cause of blindness globally.[5–7] Globally, DR is estimated to affect approximately 22–34% of the diabetic population.[8]

The VISION 2020: The Right to Sight initiative prioritises DR as one of the key eye diseases for Southeast Asia and other regions.[9] Retinal screening can significantly reduce the risk of blindness, as early treatment of retinopathy can help preserve vision. With effective screening and treatment, nearly all cases of blindness caused by DR can be prevented.[10] Timely diabetes treatment and regular screening for complications, along with the identification and management of modifiable risk factors such as glycaemic control, hypertension, hyperlipidaemia, nephropathy, anaemia and smoking can reduce or delay complications by up to 50% in newly diagnosed and known diabetics.[11]

In Nepal, the prevalence of diabetes among people aged 20 years and above was 14.6% and the prevalence among people aged 40 years and above was 19%.[12] DR among individuals with diabetes was 23.8%.[7] Newly diagnosed diabetes was defined as patient diagnosed within 1 year and was found to be 6.5%, while sight-threatening DR (STDR) affects 9.5% of the population.[7] The reported prevalence was higher at 83.3% in males among those with diabetes for over 20 years.[7] It is significantly challenging to address DM/DR in Nepal due to limited comprehensive evidence and small-scale studies which are hospital based. Population-based studies are rare, and the available data are often insufficient or inappropriate to guide strategic planning for effective disease control. The limited epidemiological information restricts the development of targeted interventions and policies for managing and preventing DM and DR at the national level. The Rapid Assessment of Avoidable Blindness (RAAB) surveys conducted in Nepal in 1981 and 2012 did not prioritise DR.[13 14] The present survey was a part of the RAAB survey conducted in all ecological regions and provinces of Nepal between 2019 and 2021, with a focus on understanding the current situation of DR alongside other causes and prevalence of avoidable blindness and visual impairment (VI).

MATERIALS AND METHODS

Survey design and setting

A population-based cross-sectional RAAB survey was conducted across all provinces and ecological zones of Nepal between June 2019 and February 2021.[15] The survey used the RAAB7 (RAAB+DR) module, including random blood glucose (RBG) measurement via digital glucometer for DM assessment, in Karnali, Bagmati and Madhesh provinces, while other provinces employed the RAAB6 module without DR assessment.

Karnali province, situated in the northwest, is one of the most remote and underdeveloped areas, predominantly comprising hilly and mountainous region. Bagmati province, in the central region and home to the capital city, features a diverse geography of plains, hills and mountains. In contrast, Madhesh province, in the southeast, consists entirely of densely populated plains with extensive agricultural activity. Together, these three regions provide a comprehensive cross-section of Nepal's geographical diversity, offering valuable insights into the prevalence and patterns of DM and DR as part of the RAAB survey 2021.

Sample size and sampling techniques

Multistage random cluster sampling approach was used with enumeration and examination completed on the same day. Wards, defined as the smallest population units in the 2011 census, were selected as the primary sampling units (cluster). The complete list of wards, along with their all-age population sizes, served as the sampling frame for each province. Clusters were then selected from these wards, with probability proportionate to size. The sample size was calculated using the RAAB+DRV7 software with parameters of 95% CI, 20% allowable error, 10% non-response rate and 1.4 design effect. The province-wise sample sizes/cluster were Madhesh (4075/118), Bagmati (5740/166) and Karnali (4,067/117).

For the second stage of sampling, cluster sketch-mapping and segmentation technique was opted to enrol 35 participants per cluster. Based on estimates from the 2011 census, approximately 15% of the population was aged 50 and older.[16] So a population unit of around 235 people was expected to contain 35 eligible participants. If a selected unit had fewer than 235 people, a second, adjacent ward was randomly preselected to continue enrolment. If a population unit exceeded 470 people, they were divided into two or more segments, where one segment was randomly chosen by the ward chief or a local leader. Once a segment with approximately 35 eligible participants was identified, a starting corner was selected at random, and teams systematically moved from household to household, enumerating eligible individuals until 35 participants were enrolled. If the selected segment did not contain 35 eligible participants, enumeration continued in a preselected neighbouring population unit until the required number was met.

Training and validation

A certified RAAB trainer from the London School of Hygiene and Tropical Medicine provided comprehensive training to the surveyors which includes a team of three (Ophthalmologist, Optometrist/Ophthalmic assistant (OA) and Eye health worker) people. Vision assessment was done by Optometrist/OA and Eye health worker. Eye health worker also helped in measuring blood glucose level. Ophthalmologist examined anterior segment and dilated fundus examination of eye. Each team achieved >0.8 Kappa score for interobserver agreement on visual

Table 1 Acceptance of random blood sugar test and DR examination

Indicators		Madhesh province	Karnali province	Bagmati province	Total
Full sample	Examined	4055 (99.5%)	3983 (97.9%)	5472 (95.3%)	13510 (97.3%)
	Non-responders	20 (0.5%)	84 (2.1%)	268 (4.7%)	372 (2.7%)
	Total	4075 (100.0%)	4067 (100.0%)	5740 (100.0%)	13882 (100.0%)
Examined	RBG taken	3818 (94.2%)	3763 (94.5%)	5435 (99.3%)	13016 (96.3%)
	RBG refused	237 (5.8%)	220 (5.5%)	37 (0.7%)	494 (3.7%)
	Total	4055 (100.0%)	3983 (100.0%)	5472 (100.0%)	13510 (100.0%)
All diabetics	Known diabetes	154 (68.1%)	45 (58.4%)	398 (77.1%)	597 (72.9%)
	Newly diagnosed diabetes	72 (31.9%)	32 (41.6%)	118 (22.9%)	222 (27.1%)
	Total	226 (100.0%)	77 (100.0%)	516 (100.0%)	819 (100.0%)
Known diabetes	RBG taken	148 (96.1%)	44 (97.8%)	392 (98.5%)	584 (97.8%)
	RBG refused	6 (3.9%)	1 (2.2%)	6 (1.5%)	13 (2.2%)
	Total	154 (100.0%)	45 (100.0%)	398 (100.0%)	597 (100.0%)
Known diabetes	Blood sugar <200 mg/dL	94 (63.5%)	30 (68.2%)	195 (49.7%)	319 (54.6%)
	Bloodsugar≥200 mg/dL	54 (36.5%)	14 (31.8%)	197 (50.3%)	265 (45.4%)
	Total	148 (100.0%)	44 (100.0%)	392 (100.0%)	584 (100.0%)
Known diabetes	DR examination done	144 (93.5%)	44 (97.8%)	292 (73.4%)	480 (80.4%)
	DR examination refused	10 (6.5%)	1 (2.2%)	106 (26.6%)	117 (19.6%)
	Total	154 (100%)	45 (100.0%)	398 (100.0%)	597 (100.0%)
Newly diagnosed diabetes	DR examination done	71 (98.6%)	32 (100.0%)	91 (77.1%)	194 (87.4%)
	DR examination refused	1 (1.4%)	0 (0.0%)	27 (22.9%)	28 (12.6%)
	Total	72 (100.0%)	32 (100.0%)	118 (100.0%)	222 (100.0%)
DR examination done	Retinopathy: ungraded	0 (0.0%)	0 (0.0%)	9 (2.3%)	9 (1.3%)
	Retinopathy: graded	215 (100%)	76 (100.0%)	374 (97.7%)	665 (98.7%)
	Total	215 (100.0%)	76 (100.0%)	383 (100.0%)	674 (100.0%)
DR examination done	Maculopathy: ungraded	**0** (0.0%)	**0** (0.0%)	9 (2.3%)	9 (1.3%)
	Maculopathy: graded	215 (100%)	76 (100.0%)	374 (97.7%)	665 (98.7%)
	Total	215 (100.0%)	76 (100.0%)	383 (100.0%)	674 (100.0%)

DR, diabetic retinopathy; RBG, random blood glucose.

acuity, lens status, the assignment of the cause of vision impairment and DR grading followed by field piloting. Each team was led by an ophthalmologist, was deployed to predefined clusters and examined the sample populations. Informed written consent was obtained from all participants. Individuals who had declined giving consent and people living for less than 6 months were excluded from this study.

Ophthalmic evaluation

Examinations were conducted at participants' residence on the same day as enrolment. Distance and near spectacle ownership status were recorded, and presenting distance visual acuity (VA), with spectacles if available, was measured in each eye. Pinhole VA was assessed for any eye with Presenting VA (PVA) worse than 6/12. VA was measured outdoors using Snellen's tumbling E optotype cards (6/60, 6/18 and 6/12 sizes) at distances of 6, 3 and 1 m, recorded as 6/12, 6/18, 6/60, 3/60 and 1/60. A tumbling E chart was used with the E letter in a rotating direction. This allowed people to describe the direction of E (facing right, left, up and down) to signify that they could see clearly. If the orientation four out of five was correctly identified, the persons' VA was considered normal and recorded according to distance. Light perception was tested for eyes with VA worse than 1/60. All eyes underwent a lens examination using a pen torch and distant direct ophthalmoscopy. For eyes with presenting distance visual acuity (PVA) worse than 6/12, a cause of vision impairment was assigned from a standardised list, and the principal cause of vision impairment was determined for each participant. The principal cause was defined as the one most amenable to treatment or prevention. Eyes with PVA worse than 6/12 and no obvious anterior segment cause of vision impairment were dilated for fundus examination. The WHO's criteria for blindness, severe visual impairment (SVI), moderate

Table 2 Treatment and eye examination among people with known diabetes

Treatment	Madhesh province	Karnali province	Bagmati province	Total
No treatment	4 (2.6%)	3 (6.7%)	11 (2.8%)	18 (3.0%)
Diet only	9 (5.8%)	2 (4.4%)	27 (6.8%)	38 (6.4%)
Tablets	133 (86.4%)	37 (82.2%)	310 (77.9%)	480 (80.4%)
Insulin	3 (1.9%)	3 (6.7%)	27 (6.8%)	33 (5.5%)
Tablets+insulin	2 (1.3%)	0 (0.0%)	18 (4.5%)	20 (3.4%)
Other	3 (1.9%)	0 (0.0%)	5 (1.3%)	8 (1.3%)
Total	154 (100%)	45 (100.0%)	398 (100.0%)	597 (100.0%)
Eye examination	Madhesh province	Karnali province	Bagmati province	Total
Never	54 (35.1%)	34 (75.6%)	96 (24.1%)	184 (30.8%)
0–12 months ago	62 (40.3%)	7 (15.6%)	221 (55.5%)	290 (48.6%)
13–24 months ago	16 (10.4%)	2 (4.4%)	34 (8.5%)	52 (8.7%)
>24 months ago	22 (14.3%)	2 (4.4%)	47 (11.8%)	71 (11.9%)
Total	154 (100.0%)	45 (100.0%)	398 (100.0%)	597 (100.0%)

visual impairment and early visual impairment were followed to categorise the visual outcome of the survey participants.[17]

DM and DR assessment

Participants with a prior diabetes diagnosis were classified as having 'known diabetes'. Those with no prior history of diabetes were classified as having 'newly diagnosed diabetes' if their RBG level was ≥200 mg/dL, measured using a digital glucometer during the survey.[18] During and after the finger pricking, all the precautions and safety measures were followed. Information about previous diabetes diagnosis, the use of hypoglycaemic medications and any previous diabetic eye check-ups was obtained through a structured questionnaire. Anterior segment examination was conducted using diffuse torch light and a portable slit lamp.

For diabetic participants, a detailed dilated fundus examination was performed to assess and grade DR using a Heine Beta 200 direct ophthalmoscope and a Keeler Vantage binocular indirect ophthalmoscope with a 20 Dioptres Volk lens. The Scottish DR grading system was used to grade DR and maculopathy.[19] Participants who required specialised care were referred to appropriate health facilities.

Data management and statistical analysis

The data were collected using Android-powered tablets equipped with the mRAAB7 mobile application. The collected data were synced and imported into the RAAB software (RAAB V7) for analysis. Descriptive statistics were used to present the percentages and 95% CI for each outcome variable studied in the survey.

RESULTS

Survey population

In total, 13882 people with age≥50 years were enrolled in the survey, of whom 13510 (97.3%) were examined (6073 male and 7437 female). Of the examined, the acceptance rate for the RBG examination was 13016 (96.3%), which was seen highest in Bagmati province 5435 (99.3%) (table 1).

Diabetes mellitus

The prevalence of known and newly diagnosed DM was found to be 6.1% among examined, which was higher in Bagmati province at 9.4% (95% CI: 8.2% to 10.7%). Karnali province has the lowest prevalence of DM 1.9% (95% CI: 1.3% to 2.6%) (table 1). Participants of age 60–79 had a higher prevalence of DM in all provinces. The study revealed a higher prevalence of DM among males across all provinces (online supplemental table 04).

Treatment and eye examination for DR

Overall, 480 (90.4%), in Madhesh province 133 participants (86.4%), Karnali province 37 participants (82.2%), Bagmati province 310 participants (77.9%) were under oral hypoglycaemic medication. Notably, 30.8% (184) had never undergone ocular examination, while other participants had at least one examination in various time intervals (table 2, online supplemental figures 1 and 2).

Diabetic retinopathy

Of all diabetics, DR examinations were conducted on 674 (82.3%) in total, whereas 215 (95.1%) participants in Madhesh, 76 (98.7%) in Karnali and 383 (74.2%) in Bagmati province. The DR examination was graded at 98.7% (665) in total (table 1).

Among diabetics, 118 (14.40%) had some form of retinopathy. In Madhesh province, 182 (80.5%) participants (95% CI: 73.8% to 87.3%) exhibited no retinopathy (R0), while 33 (14.6%) individuals (95% CI: 8.7% to 20.5%) had some form of retinopathy. Bagmati province had 289 (56.0%) diabetics (95% CI: 51.2% to 60.8%) with no retinopathy, while 82 (15.9%) individuals (95% CI:

Table 3 Prevalence of DR among diabetics

Gradings	Madhesh province (n=226)		Karnali province (n=77)		Bagmati province (n=516)		Total (n=819)	
	N	P (95% CI)	N	P (95% CI)	N	P (95% CI)	N	%
Retinopathy grade								
No retinopathy (R0)	182	80.5% (73.8 to 87.3)	71	92.2% (86.4 to 98.0)	289	56.0% (51.2 to 60.8)	542	66.2
Background DR: mild (R1)	23	10.2% (5.3 to 15.1)	3	3.9% (0.0 to 8.1)	50	9.7% (7.2 to 12.2)	76	9.3
Background DR: observable (R2)	9	4.0% (1.5 to 6.5)	0	0.0% (0.0 to 0.0)	20	3.9% (2.1 to 5.6)	29	3.5
Background DR: referable (R3)	1	0.4% (0.0 to 1.3)	0	0.0% (0.0 to 0.0)	10	1.9% (0.7 to 3.2)	11	1.30
Proliferative DR (R4)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	2	0.4% (0.0 to 0.9)	2	0.20
Ungradable DR (R6)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	9	1.7% (0.5 to 3.0)	9	1.10
Any retinopathy	33	14.6% (8.7 to 20.5)	3	3.9% (0.0 to 8.1)	82	15.9% (12.7 to 19.1)	118	14.40
Maculopathy grade								
No maculopathy (M0)	199	88.1% (83.0 to 93.1)	70	90.9% (84.3 to 97.5)	326	63.2% (58.3 to 68.0)	595	72.6
Maculopathy: observable (M1)	9	4.0% (1.2 to 6.8)	1	1.3% (0.0 to 3.9)	25	4.8% (3.1 to 6.6)	35	4.3
Maculopathy: referable (M2)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	13	2.5% (1.2 to 3.8)	13	1.6
Ungradable Maculopathy (M6)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	9	1.7% (0.5 to 3.0)	9	1.1
Any maculopathy	9	4.0% (1.2 to 6.8)	1	1.3% (0.0 to 3.9)	38	7.4% (5.2 to 9.6)	48	5.9
Any retinopathy and/or maculopathy	34	15.0% (9.0 to 21.1)	4	5.2% (0.3 to 10.1)	87	16.9% (13.5 to 20.2)	125	15.3
Sight-threatening DR (R4 and/or M2)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	13	2.5% (1.2 to 3.8)	13	1.6
Any laser scars	2	0.9% (0.0 to 2.6)	0	0.0% (0.0 to 0.0)	7	1.4% (0.4 to 2.3)	9	1.1

DR, diabetic retinopathy.

Table 4 Prevalence of any retinopathy and/or maculopathy by age and gender in DM patients

	Males		Females		Total	
Age group	N	P (95% CI)	N	P (95% CI)	n	P (95% CI)
Madhesh province						
50–59	5	13.2% (2.3 to 24.0)	5	13.9% (0.5 to 27.3)	10	13.5% (4.8 to 22.2)
60–69	6	15.0% (4.0 to 26.0)	3	7.3% (0.0 to 17.6)	9	11.1% (3.5 to 18.7)
70–79	8	28.6% (10.2 to 47.0)	6	17.6% (5.0 to 30.3)	14	22.6% (11.8 to 33.4)
80+	1	16.7% (0.0 to 46.7)	0	0.0% (0.0 to 0.0)	1	11.1% (0.0 to 31.8)
Total	20	17.9% (9.3 to 26.4)	14	12.3% (4.7 to 19.9)	34	15.0% (9.0 to 21.1)
Karnali province						
50–59	1	9.1% (0.0 to 26.5)	0	0.0% (0.0 to 0.0)	1	4.2% (0.0 to 12.4)
60–69	3	15.0% (0.2 to 29.8)	0	0.0% (0.0 to 0.0)	3	9.1% (0.0 to 18.5)
70–79	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)
80+	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)	0	0.0% (0.0 to 0.0)
Total	4	9.3% (0.6 to 18.0)	0	0.0% (0.0 to 0.0)	4	5.2% (0.3 to 10.1)
Bagmati province						
50–59	10	14.5% (6.5 to 22.5)	12	13.5% (6.0 to 21.0)	22	13.9% (8.7 to 19.1)
60–69	9	12.3% (5.4 to 19.2)	22	22.7% (14.4 to 31.0)	31	18.2% (12.7 to 23.8)
70–79	11	18.0% (8.8 to 27.3)	13	15.7% (8.6 to 22.7)	24	16.7% (11.1 to 22.3)
80+	4	21.1% (2.4 to 39.7)	6	24.0% (6.6 to 41.4)	10	22.7% (9.1 to 36.4)
Total	34	15.3% (10.8 to 19.8)	53	18.0% (13.6 to 22.5)	87	16.9% (13.5 to 20.2)

DM, diabetes mellitus.

12.7% to 19.1%) experienced retinopathy. In total, 125 (15.3%) had any form of maculopathy. Bagmati province had 326 (63.2%) individuals (95% CI: 58.3% to 68.0%) without maculopathy and 38 (7.4%) individuals (95% CI: 75.2% to 9.6%) with maculopathy. The presence of STDR (R4 and/or M2) was found to be 13 (1.6%). The overall prevalence of retinopathy among the entire population was 0.9%, with the highest prevalence observed in Bagmati province at 1.5% (95% CI: 1.2% to 1.8%) and least in Karnali province at 0.1% (95% CI: 0.0% to 0.2%) (table 3). In Madhesh province, the prevalence of retinopathy and/or maculopathy was noted as 15.0%, with a higher rate in males (17.9%) compared with females (12.3%). The highest prevalence (28.6%) of retinopathy was observed in males aged 70–79. Bagmati province showed a higher overall prevalence of 16.9%, with females (18.0%) having a slightly higher rate than males (15.3%). Males of age 80 years and above were the prime contributor to the prevalence (22.7%) (table 4).

Blindness and visual impairment

Overall blindness was noted higher among diabetics in comparison with the non-diabetic population. In Bagmati province, the prevalence of SVI was slightly higher in diabetics 1.6% (95% CI: 0.5% to 2.6%) compared with non-diabetics 1.2% (95% CI: 0.9% to 1.6%). Blindness showed a similar trend, being higher in diabetics 1.6% (95% CI: 0.5% to 2.6%) compared with non-diabetics 1.0% (95% CI: 0.7% to 1.3%) (table 5).

Causes of blindness and visual impairment

Cataract was found to be the major cause of blindness and VIs among diabetic and non-diabetic population. In Madhesh province, cataract was the leading cause of blindness, affecting 66% (95% CI: 9% to 99%) of diabetics and 89% (95% CI: 78% to 96%) of non-diabetics. DR contributed to 33% (95% CI: 1% to 91%) of blindness in diabetics. For SVI, cataract was the primary cause, impacting 75% (95% CI: 19% to 99%) of diabetics and 92% (95% CI: 86% to 96%) of non-diabetics. In Karnali province, cataract was the sole cause of blindness among diabetics 100% (95% CI: 19% to 100%) and 58% (95% CI: 41% to 74%) of non-diabetics. For SVI, cataract was the primary cause, contributing to 100% (95% CI: 2.5% to 100%) of diabetic cases and 80% (95% CI: 68% to 89%) of non-diabetic cases. In Bagmati province, cataract was the leading cause of blindness in 50% (95% CI: 16% to 84%) of diabetics and 63% (95% CI: 49% to 75%) of non-diabetics. For SVI, cataract was responsible for 75% (95% CI: 35% to 97%) in diabetics and 66% (95% CI: 53% to 77%) in non-diabetic participants.

DISCUSSION

The prevalence of DM in Karnali province (1.9%) was comparable to that observed in the Far Western province (2.8%) of Nepal.[20] The findings from Karnali and the Far Western provinces, which are geographically adjacent, were similar, likely due to common rural landscapes.

Table 5 Prevalence of blindness and visual impairment among people with and without diabetes (among examined)

	Persons with diabetes		Persons without diabetes	
VI	n	P (95% CI)	n	P (95% CI)
Madhesh province (total sample=4055, total diabetics=226)				
Normal vision	152	67.3% (59.8 to 74.7)	2584	67.5% (65.1 to 69.8)
Early VI	40	17.7% (11.9 to 23.5)	580	15.1% (13.8 to 16.5)
Moderate VI	27	11.9% (7.8 to 16.0)	479	12.5% (11.1 to 14.0)
Severe VI	4	1.8% (0.0 to 3.5)	128	3.3% (2.6 to 4.1)
Blindness	3	1.3% (0.0 to 2.8)	58	1.5% (1.1 to 1.9)
Karnali province (total sample=3983, total diabetics=77)				
Normal vision	61	79.2% (69.3 to 89.1)	3024	75.9% (75.3 to 79.5)
Early VI	6	7.8% (1.0 to 14.6)	418	10.7% (9.3 to 12.1)
Moderate VI	7	9.1% (2.3 to 15.9)	360	9.2% (7.9 to 10.5)
Severe VI	1	1.3% (0.0 to 3.8)	65	1.7% (1.2 to 2.1)
Blindness	2	2.6% (0.0 to 6.3)	39	1.0% (0.6 to 1.3)
Bagmati province (total sample=5472, total diabetics=516)				
Normal vision	440	85.3% (82.2 to 88.4)	4033	81.4% (79.4 to 83.3)
Early VI	36	7.0% (4.6 to 9.3)	500	10.1% (8.8 to 11.4)
Moderate VI	24	4.7% (2.9 to 6.4)	314	6.3% (5.4 to 7.3)
Severe VI	8	1.6% (0.5 to 2.6)	60	1.2% (0.9 to 1.6)
Blindness	8	1.6% (0.5 to 2.6)	49	1.0% (0.7 to 1.3)
Total sample=13510, total diabetics=819				
Normal vision	653	79.7%	9641	71.4%
Early VI	82	10.0%	1498	11.1%
Moderate VI	58	7.1%	1153	8.5%
Severe VI	13	1.6%	253	1.9%
Blindness	13	1.6%	146	1.1%

VI, visual impairment.

Inhabitants often walk on foot as their primary mode of transportation and are primarily engaged in agricultural activities. The prevalence of DM in Madhesh province (5.6%) was lower, while the prevalence in Bagmati province (9.4%) was on the higher side and similar to the prevalence reported among the elderly population (>60 years) in a community-based survey conducted in Nepal.[7] This may be attributed to the sedentary lifestyle, unhealthy dietary habits and limited physical activity commonly observed in urban settings. A similar pattern was observed in a meta-analysis, which reported a pooled prevalence rate of type 2 diabetes among the Nepalese population was 8.4% where lower prevalence was noted in rural populations (1.0%), compared with urban populations.[21] This variation could be due to the higher levels of physical activity in rural areas, where most individuals are engaged in manual farming, livestock rearing and dietary habits.[16]

In this survey, about one-third (n=222) of participants were newly diagnosed with diabetes. Additionally, 3.0% of known diabetics (Madhesh: 2.6%, Karnali: 3.0% and Bagmati: 2.8%) were not seeking any treatment for the disease, with a higher proportion of untreated cases observed among females compared with males, which was similar to the survey results from Far Western Province (16.9%). The main reasons behind this could be gender disparities, financial constraints, lack of awareness, cultural norms and limited rural healthcare access.[20] Similarly, a survey from a referral centre in Nepal highlighted the poor management of diabetes, revealing that over half of the patients were uncertain about whether their diabetes was well controlled. This can be attributed to education status in our country and knowledge about non-communicable diseases and the significant complications they carry.[22]

It was surprising to see that 30.8% of known diabetics (Madhesh: 35.1%, Karnali: 75.6% and Bagmati: 24.1%) had never undergone an eye examination, which was higher among females overall, except in Karnali province. Possible reasons for this discrepancy include busy schedules, low prioritisation of eye health, lack of education and dependency on males for healthcare access in Madhesh and Bagmati provinces. In contrast, the lower percentage of untreated females in Karnali province may

be attributed to the availability of extensive outreach camps and door-to-door eye care services. Only 40% to 60% of Americans with diabetes undergo annual dilated fundus examinations, with even lower rates observed among underserved and racial/ethnic minority populations.[23 24] This issue is likely more pronounced in rural areas of developing countries, where there is a significant gap in knowledge about the disease and limited access to necessary eye care services.

Among the diabetics, community-based studies conducted in Nepal over the past 15 years have documented the prevalence of DR ranging between 10.6% and 23.8%.[7 11 25 26] Additionally, the rates observed in our survey are comparable to those reported in a survey from the hilly regions of Nepal, where 12.6% of cases had evidence of DR, and 1.1% had clinically significant DME.[11] However, a higher prevalence of DR (23.8%) is reported among the aged 40 years and above urban population in Nepal.[7] But RAAB-based surveys conducted in Papua New Guinea, Costa Rica, Republic of Moldova, Hungary and India reported significantly higher rates of DR and/or maculopathy among the diabetic population aged 50 years and above, with prevalence rates of 46.4%, 23.5%, 55.9%, 20.7% and 21.9%, respectively.[27–31] We noted that the prevalence of DR observed in our survey was consistent with the findings from other developing nations.[32 33] The variations in prevalence rates of DR across different studies are likely attributed to differences in survey methodologies and sample populations, as well as genetic, lifestyle and environmental factors.

In this survey, a higher proportion of males exhibited some form of retinopathy or maculopathy compared with females, with prevalence rates of 17.9% in Madhesh, 9.3% in Karnali and 15.3% in Bagmati for males, compared with 12.3% in Madhesh, 0.0% in Karnali and 18.0% in Bagmati for females. This finding is consistent with a survey conducted in the Far Western province, where the prevalence of retinopathy or maculopathy was higher in males (18.0%) than in females (8.8%), a pattern also observed in several other studies.[7 20 33 34] This discrepancy may be related to lifestyle factors, such as higher rates of alcohol consumption and cigarette smoking, which are more common among the male population. The prevalence of STDR in Bagmati province observed in the present survey (2.5%) was notably higher than that reported in the Far Western province (0.8%) but significantly lower compared with the prevalence reported among the urban population in Nepal (9.5%) and the pooled global prevalence (10.2%).[7 20 35] The prevalence of SVI or blindness among diabetics in Madhesh (3.1%), Karnali (3.9%) and Bagmati (3.2%) compared with non-diabetic individuals in the same regions (Madhesh 4.8%, Karnali 2.7% and Bagmati 2.2%). These findings align with those from a survey in the Far Western province, where 3.9% of diabetic patients had severe VI or blindness, in contrast to 1.8% among non-diabetic patients.[20]

This survey's strength lies in its rigorous methodology and the implementation of a comprehensive home-to-home screening programme, ensuring that the reported prevalence rates of diabetes and DR accurately reflect the true burden of these conditions in the general population. Additionally, individuals identified as needing ophthalmic interventions during the survey were provided with free surgical or optical services as part of the programme. However, the survey has some limitations, including the absence of slit-lamp examinations and advanced diagnostic tools, which might have enhanced the detection of early PDR and maculopathy. Furthermore, as the survey was integrated into the RAAB survey targeting individuals aged 50 years and older, it does not provide insights into the prevalence of diabetes and DR in younger populations. It is also worth noting that the survey experienced a 12 month delay due to the COVID-19 pandemic, although it was later completed with all necessary precautions in place.

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