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DIABETES AND DRIVING: A SIX-MONTH CROSS-SECTIONAL SURVEY OF THE BASELINE DIABETIC PROFILE AND RISK FACTORS FOR MOTOR-VEHICLE ACCIDENTS AMONG ADULT DRIVERS WITH DIABETES ATTENDING CLINICS IN NORTH INDIA

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ABSTRACT

Background: Diabetes mellitus can impair driving fitness through hypoglycaemia, retinopathy, peripheral neuropathy and cardiovascular events, yet driving-related risk is rarely assessed in routine Indian diabetes care. We characterised the baseline diabetic profile of adult drivers with diabetes and examined factors associated with motor-vehicle accidents (MVAs).

Materials and Methods: A clinic-based cross-sectional survey was conducted over six months across a network of diabetes clinics in North India. Adult drivers with diabetes underwent anthropometry, blood-pressure measurement, a metabolic laboratory panel, fundus examination and monofilament testing, and completed a structured, interviewer-administered questionnaire on driving behaviour, awareness, hypoglycaemia and accident history. Only participants with complete data were analysed. Associations with self-reported MVA since diabetes onset were examined by Fisher exact test and multivariable logistic regression; to reduce collinearity, hypoglycaemia items were combined into a single "significant hypoglycaemia" variable, complications were also analysed as a composite, and a single neuropathy measure was used. Age and sex were not recorded in the source dataset and could not be modelled.

Results: Of 1,251 adults surveyed, 1,192 with complete data were analysed. Most drove two-wheelers (91.9%) and held a valid licence (96.6%). Glycaemic control was suboptimal (mean HbA1c 8.1 ± 1.8%; 43.8% ≥8.0%) and 69.0% were obese. Diabetic retinopathy was present on fundoscopy in 10.0%, symptomatic foot numbness in 20.6%, abnormal vision in 17.5%, and severe hypoglycaemia in the past year in 12.6%. Awareness that diabetes can affect driving was low (46.5%), as were protective practices (glucometer carried 8.0%; glucose checked before driving 5.7%; RTO disclosure 7.7%). MVA since diabetes onset was reported by 5.5%. In bivariate analysis, carrying a carbohydrate snack (OR 5.35; 95% CI 3.20–8.93), abnormal vision (OR 2.57; 95% CI 1.50–4.40), symptomatic neuropathy (OR 1.91; 95% CI 1.12–3.28) and any diabetic complication (OR 1.90; 95% CI 1.11–3.26) were associated with MVA, whereas clubbed significant hypoglycaemia, glucose-lowering therapy and disease duration were not. In multivariable analysis, carrying a snack remained the dominant correlate (adjusted OR 5.40; 95% CI 3.19–9.12); with

the snack term omitted, any diabetic complication was independently associated (adjusted OR 1.87; 95% CI 1.08–3.23). Snack-carrying was itself a strong marker of prior significant hypoglycaemia (27.8% versus 14.0%; OR 2.37; 95% CI 1.66–3.38), supporting a reverse-causation interpretation.

Conclusion: Adult drivers with diabetes in North India carried a heavy cardiometabolic burden and poor glycaemic control, with low awareness of driving-related risk and infrequent protective practices. Diabetic complications—particularly impaired vision—clustered with accident experience, while carrying a carbohydrate snack behaved as a marker of prior hypoglycaemia rather than a cause of crashes. Integrating brief driving-fitness counselling, hypoglycaemia preparedness and complication screening into routine diabetes care is warranted.

Keywords: Diabetes mellitus; driving; motor-vehicle accidents; hypoglycaemia; diabetic retinopathy; diabetic neuropathy; road-traffic safety; India.

INTRODUCTION

Diabetes mellitus is among the most prevalent non-communicable diseases in India, which is home to one of the largest diabetic populations worldwide.[1,2] Beyond its well-recognised micro- and macrovascular complications, diabetes has an under-appreciated bearing on a routine activity of daily life for millions of adults: driving. Several disease-related states can transiently or persistently degrade the sensory, motor and cognitive functions on which safe driving depends. Hypoglycaemia can blunt reaction time, concentration and judgement, occasionally to the point of incapacitation[3,14]; diabetic retinopathy and impaired visual acuity compromise hazard detection[12]; peripheral neuropathy affects pedal control and proprioception; and cerebrovascular or cardiac events may occur without warning at the wheel.

International licensing frameworks have long recognised these risks and require, in varying degrees, medical fitness assessment and disclosure for drivers treated with insulin or sulfonylureas[4-6]. In India, awareness of the interaction between diabetes and driving remains limited among both patients and clinicians, and driving fitness is seldom addressed during routine diabetes review. Robust, contemporary data describing the driving population of people with diabetes, their metabolic and complication profile, their self-management behaviours behind the wheel, and their accident experience, are scarce in the South-Asian setting.

We therefore conducted a six-month, clinic-based cross-sectional survey across a network of diabetes clinics in North India. The objectives were threefold: (i) to describe the baseline clinical and metabolic profile of adult drivers with diabetes; (ii) to quantify driving behaviours, awareness of driving-related risk, and protective self-management practices; and (iii) to identify clinical and behavioural factors associated with self-reported motor-vehicle accidents (MVAs). By mapping these gaps, the study aims to inform the integration of driving-fitness counselling into everyday diabetes care.

MATERIALS AND METHODS

Study design and setting: This was a cross-sectional, observational survey conducted over a six-month period across participating diabetes clinics in North India. The clinic network served an ambulatory adult population attending for routine diabetes care. Cleaned and de-identified records mapped to seven collection-site identifiers were available for analysis.

Participants: Eligible participants were adults with an established diagnosis of diabetes mellitus who reported currently operating a motor vehicle (two-, three- or four-wheeled, private or commercial). Individuals who consented and completed both the clinical assessment and the structured interview were included, without restriction by diabetes type or treatment modality. A complete-case approach was adopted: participants with any missing clinical measurement or unanswered questionnaire item were excluded from all analyses. Of 1,251 adults surveyed, 59 (4.7%) had incomplete records and were removed, leaving 1,192 participants for analysis.

Data collection and measurements: Each participant underwent a standardised assessment comprising anthropometry (weight, height, body-mass index [BMI]), resting pulse and blood pressure, and a fasting venous laboratory panel (fasting, post-prandial and random glucose; HbA1c; total, LDL and HDL cholesterol; triglycerides; non-HDL cholesterol; serum creatinine; urine albumin-to-creatinine ratio; alanine aminotransferase; and thyroid-stimulating hormone). Dilated fundus examination screened for diabetic retinopathy, distal sensation was assessed by 10-g monofilament testing[11], and visual status was recorded as normal or abnormal.

A structured, interviewer-administered questionnaire (delivered in Hindi) captured diabetes duration (more than one year, yes/no) and pharmacotherapy (insulin; sulfonylureas/glinides), vehicle types driven, licensure, private versus commercial use, disclosure of diabetes to the Regional Transport Office (RTO), awareness that diabetes can affect driving, long continuous driving (>2 hours in the preceding month), symptoms and screening for neuropathy and

retinopathy, prior stroke or myocardial infarction, driving after alcohol in the past year, use of sleep/psychotropic medication, in-vehicle hypoglycaemia preparedness (carrying a fast-acting carbohydrate — sugar, sweets or a snack — or a glucometer; checking glucose before driving), episodes of severe hypoglycaemia in the past year (including those requiring third-party assistance or hospitalisation), and history of MVAs resulting in injury—both ever since the onset of diabetes and within the preceding year.

Definitions: BMI was categorised using WHO Asia-Pacific cut-offs (obesity ≥25 kg/m²)[15]. Suboptimal glycaemic control was defined as HbA1c ≥8.0% and very poor control as ≥9.0%. Hypertension was defined as systolic blood pressure ≥140 mmHg or diastolic ≥90 mmHg. Diabetic retinopathy was defined by its presence on fundus examination and abnormal vision by the recorded visual status. Symptomatic peripheral neuropathy was defined by self-reported foot numbness; distal sensory impairment was also captured objectively by monofilament testing. To avoid duplication of the same construct, only one neuropathy measure (symptomatic neuropathy) was permitted to enter any table or model. Three composite variables were pre-specified for the association analysis: (i) **significant hypoglycaemia**, defined as severe hypoglycaemia in the past year and/or an episode requiring third-party assistance (the two items combined, as they capture the same clinically important construct); (ii) **any diabetic complication**, defined as the presence of retinopathy, symptomatic neuropathy, abnormal vision or an abnormal monofilament test, used so that complications could be considered together rather than as individually under-powered variables; and (iii) **hypoglycaemia-inducing therapy**, defined as treatment with insulin and/or a sulfonylurea/glinide, since these are the agents mechanistically capable of provoking hypoglycaemia while driving. The primary outcome was a self-reported MVA (with injury) at any time since the onset of diabetes. Age and sex were not recorded in the source dataset and therefore could not be categorised or entered into any model.

Statistical analysis: Analyses were restricted to participants with complete data (N = 1,192). Continuous variables are summarised as mean ± standard deviation or median (for skewed distributions), and categorical variables as counts and percentages. Associations between candidate risk factors and MVA were assessed using the Fisher exact test, with odds ratios (ORs) and 95% confidence intervals (CIs) from 2×2 tables (Haldane–Anscombe correction for zero cells). Two pre-specified multivariable logistic-regression models were fitted: Model 1 included the carbohydrate-snack behaviour together with the clinical variables (significant hypoglycaemia, any diabetic complication, hypoglycaemia-inducing therapy and diabetes duration); Model 2 omitted the snack term, which—being a behaviour adopted in response to prior events—may act as a surrogate for hypoglycaemia rather than an independent cause. The relationship between snack-carrying and prior significant hypoglycaemia was examined directly to test this surrogate hypothesis. Pre-specified sensitivity analyses evaluated the influence of between-centre heterogeneity by excluding the highest-accident centre and examining within-centre associations. Age and sex could not be included, as they were not available. A two-sided $p<0.05$ was considered significant. Analyses used Python (pandas, SciPy, statsmodels).

Ethics: The survey was conducted in accordance with the Declaration of Helsinki. Data were de-identified prior to analysis. Institutional ethics approval and informed consent were obtained per the study protocol.

RESULTS

Participants and driving profile: After excluding 59 participants with incomplete records, 1,192 adult drivers with diabetes were analysed, drawn from seven collection centres. Diabetes of more than one year's duration was reported by 95.0%. Two-wheelers were the dominant vehicle (91.9%), followed by four-wheelers (57.3%); three-wheeler use (2.6%) and commercial driving (1.0%) were uncommon. A valid driving licence was held by 96.6%, and 93.0% drove a private vehicle. Prolonged continuous driving (>2 hours at a stretch in the preceding month) was reported by 37.7%. [Table 1] summarises the overall driving and treatment profile.

Table 1: Driving, licensure and treatment profile of adult drivers with diabetes (N = 1,192, complete cases). Values are percentages.

Characteristic	%
Diabetes duration >1 year	95.0
On insulin	15.8
On sulfonylurea / glinide	58.6
Drives two-wheeler	91.9
Drives four-wheeler	57.3
Drives three-wheeler	2.6
Drives commercial vehicle (incl. app-cabs)	1.0
Holds valid driving licence	96.6
Drives private / personal vehicle	93.0
Prolonged continuous driving (>2 h, past month)	37.7

Demographic and clinical characteristics: [Table 2] summarises the demographic and clinical characteristics of the cohort. The underlying profile nonetheless varied appreciably across the seven contributing centres: suboptimal glycaemic control (HbA1c ≥8.0%) ranged from 29.2% to 53.0%, obesity from 61.8% to 85.7%, and measured hypertension from 16.9% to 65.6%. Diabetic retinopathy on fundoscopy ranged from 0% to 26.0%, symptomatic foot numbness from 7.7% to 35.7%, and severe hypoglycaemia in the past year from 2.9% to 30.2%. Awareness that diabetes can affect driving was similarly heterogeneous (15.6% to 70.3%). These differences most plausibly reflect variation in catchment population, case-mix and referral pattern between centres and are presented descriptively.

Table 2: Demographic and clinical characteristics of adult drivers with diabetes (complete cases, N = 1,192). Values are percentages unless stated.

Characteristic	Value
N (drivers)	1,192
HbA1c (%), mean	8.1
HbA1c ≥8.0% (%)	43.8
BMI (kg/m²), mean	27.3
Obesity ≥25 (%)	69.0
Hypertension (%)	32.8
On insulin (%)	15.8
Sulfonylurea/glinide (%)	58.6
Two-wheeler (%)	91.9
Four-wheeler (%)	57.3
Retinopathy, fundus (%)	10.0
Foot numbness (%)	20.6
Severe hypoglycaemia (%)	12.6
Aware driving risk (%)	46.5
MVA since diabetes (%)	5.5

Cardiometabolic and glycaemic profile: The cohort carried a substantial cardiometabolic burden. Mean HbA1c was 8.1 ± 1.8%, with only 30.5% at the ≤7.0% target and 43.8% at ≥8.0% (26.3% ≥9.0%). Mean fasting glucose was 157 mg/dL and median post-prandial glucose 200 mg/dL. Obesity (BMI ≥25 kg/m²) was present in 69.0%, hypertension in 32.8%, hypertriglyceridaemia (≥150 mg/dL) in 52.3% and elevated LDL (≥100 mg/dL) in 34.1% (Table 3). The distribution of glycaemic control and BMI is shown in [Figure 1], and the overall risk-factor burden in [Figure 2].

Table 3: Anthropometric, haemodynamic and laboratory profile (complete cases, N = 1,192; mean ± SD unless stated; median shown for skewed variables).

Parameter	Value	Reference / note
BMI (kg/m²)	27.3 ± 4.4	Obesity ≥25 (Asian)
Weight (kg), median	72.8	—
Systolic BP (mmHg)	130.2 ± 17.5	—
Diastolic BP (mmHg)	78.8 ± 9.9	—
Pulse (bpm)	89.2 ± 13.6	—
Fasting glucose (mg/dL)	157.1 ± 61.8	—
Post-prandial glucose (mg/dL), median	200	—
HbA1c (%)	8.1 ± 1.8	Target ≤7.0
Total cholesterol (mg/dL)	166.4 ± 50.4	—
LDL cholesterol (mg/dL), median	81	Desirable <100
HDL cholesterol (mg/dL), median	42.3	—
Triglycerides (mg/dL), median	153	Normal <150
Serum creatinine (mg/dL), median	0.87	—
TSH (mIU/L), median	2.6	—

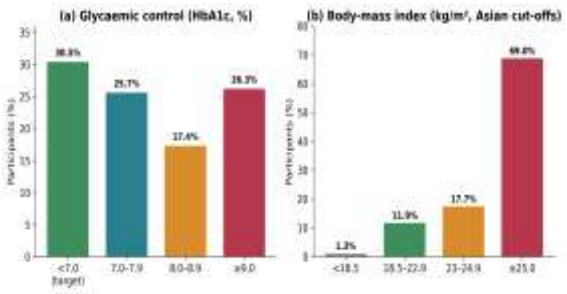

Figure 1: Distribution of (a) glycaemic control by HbA1c category and (b) body-mass index by Asia-Pacific category. Nearly half the cohort had an HbA1c ≥8.0% and more than two-thirds were obese.

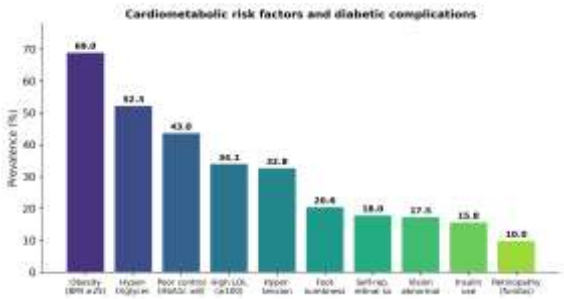

Figure 2: Prevalence of cardiometabolic risk factors and diabetic complications among adult drivers with diabetes. Obesity, hypertriglyceridaemia and poor glycaemic control were the most frequent.

Diabetic complications: Diabetic retinopathy was detected on fundus examination in 10.0% of participants, while 18.0% self-reported a retinal problem and 5.4% had previously received laser therapy or intravitreal injection for diabetic eye disease. Visual status was abnormal in 17.5%. Symptomatic peripheral neuropathy (foot numbness) was reported by 20.6%, although only 69.5% had ever undergone a foot examination and 71.8% an eye examination by a doctor. Considered together, at least one diabetic complication (retinopathy, symptomatic neuropathy, abnormal vision or an abnormal monofilament test) was present in 55.0%. Prior stroke and myocardial infarction were reported by 1.8% and 2.8%, respectively.

Hypoglycaemia and driving-safety practices: Severe hypoglycaemia in the preceding year was reported by 12.6%; 6.2% had required assistance from another person and 6.5% had required hospitalisation. When severe episodes and those needing assistance were combined, significant hypoglycaemia affected 16.4%. Despite this, in-vehicle preparedness was limited: only 17.2% carried a carbohydrate snack (sugar or sweets) in the vehicle, 8.0% carried a glucometer and 5.7% checked their blood glucose before driving. Awareness that diabetes could affect driving ability was reported by fewer than half (46.5%), and only 7.7% had disclosed their diabetes to the transport authority. Driving after alcohol in the past year was reported by 10.1%, and 5.0% used sleep or psychotropic medication [Table 4]. These awareness and practice gaps are depicted in [Figure 3].

Table 4: Awareness, hypoglycaemia and driving-safety indicators (complete cases, N = 1,192).

Indicator	%
Aware diabetes can affect driving	46.5
Disclosed diabetes to transport office (RTO)	7.7
Carries sugar/sweets/snack in vehicle	17.2
Carries glucometer in vehicle	8.0
Checks glucose before driving	5.7
Severe hypoglycaemia in past year	12.6
Hypoglycaemia requiring third-party help	6.2
Significant hypoglycaemia (severe or needing help)	16.4
Hypoglycaemia requiring hospitalisation	6.5
Drove after alcohol in past year	10.1
Uses sleep / psychotropic medication	5.0

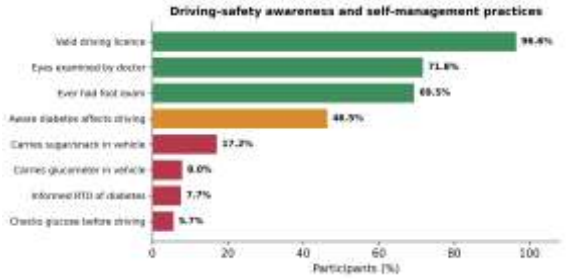

Figure 3: Driving-safety awareness and self-management practices. Licensure was near-universal, but downstream protective behaviours—awareness, hypoglycaemia preparedness and disclosure—were uncommon.

Motor-vehicle accidents and associated factors

A motor-vehicle accident (with injury) since the onset of diabetes was reported by 5.5% of participants, and an accident within the preceding year by 1.7%. In bivariate analysis [Table 5; Figure 4], four factors were significantly associated with MVA: carrying a carbohydrate snack (sugar or sweets) in the vehicle (OR 5.35; 95% CI 3.20–8.93; p<0.001), abnormal vision (OR 2.57; 95% CI 1.50–4.40; p=0.001), symptomatic peripheral neuropathy (OR 1.91; 95% CI 1.12–3.28; p=0.026), and any diabetic complication as a composite (OR 1.90; 95% CI 1.11–3.26; p=0.021). Notably, when severe hypoglycaemia and episodes requiring assistance were clubbed into a single significant-hypoglycaemia variable, it was not associated with MVA (OR 0.93; 95% CI 0.46–1.85; p=1.00); glucose-lowering therapy (insulin or sulfonylurea; OR 1.14; p=0.69) and diabetes duration >1 year (OR 1.71; p=0.77) were likewise unassociated.

Vision therefore emerged as the single most consistent complication-level correlate of accidents, in keeping with its direct role in hazard detection. To respect the shared construct between symptomatic neuropathy and monofilament testing, only the former was carried forward; the two behaved concordantly (monofilament-abnormal OR 1.25; not significant).

Table 5: Factors associated with motor-vehicle accidents since diabetes onset (complete cases, N = 1,192; bivariate, ordered by odds ratio). Only one neuropathy measure and one combined hypoglycaemia measure were entered. *p<0.05.

Factor	MVA in exposed %	MVA in unexposed %	OR (95% CI)	p
Carries sugar/sweets/snack in vehicle	15.6	3.3	5.35 (3.20–8.93)	<0.001*
Abnormal vision	10.5	4.4	2.57 (1.50–4.40)	0.001*
Peripheral neuropathy (symptomatic)	8.5	4.7	1.91 (1.12–3.28)	0.026*
Any diabetic complication (composite)	6.9	3.7	1.90 (1.11–3.26)	0.021*
Diabetes duration >1 year	5.6	3.3	1.71 (0.41–7.16)	0.768
Hypoglycaemia-inducing therapy (insulin/SU)	5.7	5.0	1.14 (0.67–1.94)	0.690

Significant hypoglycaemia (severe or needing help)	5.1	5.5	0.93 (0.46–1.85)	1.000
Retinopathy (fundus)	3.4	5.7	0.58 (0.21–1.62)	0.395

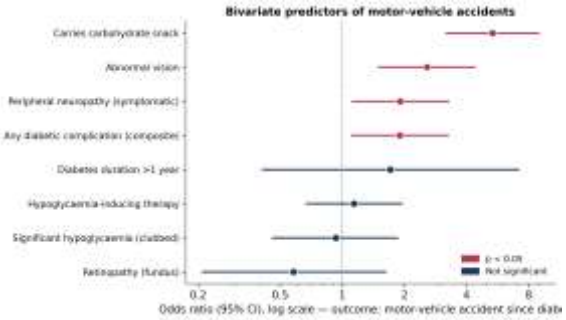

Figure 4: Forest plot of bivariate odds ratios (log scale) for a motor-vehicle accident since diabetes onset. Red markers indicate statistically significant associations (p<0.05).

Two multivariable logistic-regression models were fitted [Table 6]. In Model 1, which included the carbohydrate-snack behaviour, snack-carrying was by far the dominant correlate (adjusted OR 5.40; 95% CI 3.19–9.12; p<0.001); any diabetic complication showed a borderline independent association (adjusted OR 1.69; 95% CI 0.97–2.95; p=0.063), while significant hypoglycaemia, glucose-lowering therapy and disease duration were not associated. When the snack term was omitted (Model 2)—on the grounds that it is a behaviour adopted in response to prior events—any diabetic complication became an independent predictor (adjusted OR 1.87; 95% CI 1.08–3.23; p=0.024).

Table 6: Multivariable logistic-regression models for motor-vehicle accident since diabetes onset (N = 1,192; 65 events). Model 1 includes the carbohydrate-snack behaviour; Model 2 omits it (treating it as a surrogate for prior hypoglycaemia). Values are adjusted odds ratios (95% CI). *p<0.05.

Variable	Model 1 — aOR (95% CI)	p	Model 2 — aOR (95% CI)	p
Carries carbohydrate snack	5.40 (3.19–9.12)	<0.001*	— (excluded)	—
Any diabetic complication (composite)	1.69 (0.97–2.95)	0.063	1.87 (1.08–3.23)	0.024*
Significant hypoglycaemia (clubbed)	0.66 (0.32–1.35)	0.250	0.90 (0.45–1.81)	0.767
Hypoglycaemia-inducing therapy (insulin/SU)	1.05 (0.61–1.83)	0.855	1.14 (0.66–1.95)	0.640
Diabetes duration >1 year	1.06 (0.24–4.64)	0.938	1.31 (0.30–5.63)	0.717

Snack-carrying was strongly linked to prior hypoglycaemia: participants who carried a carbohydrate snack had significant hypoglycaemia far more often than those who did not (27.8% versus 14.0%; OR 2.37; 95% CI 1.66–3.38; p<0.001), and also reported markedly more prior accidents (15.6% versus 3.3%). Because the clubbed hypoglycaemia variable did not itself predict accidents, the snack–accident association is best understood not as hypoglycaemia-mediated crash risk but as a behavioural marker of individuals who have already experienced adverse events (hypoglycaemia and/or crashes) and have adopted a protective habit in response—i.e. reverse causation. As the design is cross-sectional, temporality cannot be confirmed, and this remains an interpretation.

Accident reporting varied widely between centres (0% to 13.4%), and this heterogeneity materially influenced the neuropathy result. A sensitivity analysis excluding the HCDC centre—which had both the highest accident rate (13.4%) and the highest neuropathy burden (34.7%)—abolished the neuropathy–MVA association (OR 1.58; 95% CI 0.70–3.57; p=0.247), and the association was non-significant within HCDC (OR 1.34; p=0.55), indicating an ecological rather than an individual-level effect. By contrast, the snack association strengthened after excluding HCDC (OR 7.59; 95% CI 3.70–15.57; p<0.001).

DISCUSSION

In this six-month survey of 1,192 adult drivers with diabetes in North India, three findings stand out. First, the driving diabetic population carried a heavy and largely uncontrolled cardiometabolic burden: nearly half had an HbA1c ≥8.0%, more than two-thirds were obese, and half had hypertriglyceridaemia. Second, clinically meaningful complications relevant to driving fitness were common—at least one complication in over half, symptomatic neuropathy in one in five, abnormal vision in one in six and retinopathy on fundoscopy in one in ten—yet a substantial minority had never undergone foot or eye examination. Third, awareness of the diabetes–driving interaction and the adoption of protective practices were strikingly low, even among participants who had experienced severe hypoglycaemia.

When accident correlates were examined with de-duplicated, pre-specified variables, impaired vision emerged as the most consistent complication-level signal (OR 2.57), and the burden of complications considered as a whole was independently associated with accidents (adjusted OR 1.87 with the behavioural snack term removed). This directs attention to remediable sensory and microvascular impairment—particularly vision—as a plausible contributor to crash risk, and supports systematic visual and complication screening in drivers with diabetes.

The strongest statistical association—carrying a carbohydrate snack—requires careful interpretation. Snack-carrying was a powerful marker of prior significant hypoglycaemia (27.8% versus 14.0%) and of prior accidents, yet the clubbed hypoglycaemia variable did not itself predict accidents. Taken together, this indicates that the snack behaviour is

best read as a surrogate for a history of adverse experience rather than a cause of crashes: those who have been frightened by hypoglycaemia or a collision adopt the precaution afterwards (reverse causation). This also answers a natural question about mechanism—since medication (the driver of hypoglycaemia) and clubbed hypoglycaemia were not themselves associated with accidents, the pathway is unlikely to be a simple drug→hypoglycaemia→crash sequence in this cross-sectional, predominantly type 2 sample.

Although symptomatic peripheral neuropathy was associated with accidents in the pooled analysis, the signal was not robust: it disappeared when the single highest-accident centre (HCDC) was removed and was non-significant within that centre, indicating centre-level co-occurrence of high neuropathy and high accident reporting rather than a consistent individual-level effect. A genuine contribution of neuropathy remains biologically plausible but cannot be affirmed from these data and is treated as hypothesis-generating.

Marked between-centre heterogeneity was itself instructive. UHC recorded the highest use of sulfonylureas and insulin yet the lowest accident rate (0.5%); HCDC combined the lowest insulin use, lowest fundus-detected retinopathy and lowest severe-hypoglycaemia rate—and the highest awareness (70.3%)—with the highest accident rate (13.4%), largely explained by its exceptionally high neuropathy burden (34.7%); PCD carried the greatest burden of retinopathy and severe hypoglycaemia but a modest 4.2% accident rate; and RRD&HCC reported no accidents at all. LHC had neuropathy comparable to HCDC but a low accident rate, though its small sample (n=42) limits interpretation. These divergent patterns underscore that no single clinical variable maps cleanly onto accident risk in this cross-sectional dataset, that small denominators produce unstable estimates, and that pooled associations must be read against the possibility of ecological confounding.

Only 7.7% had disclosed their diabetes to the transport authority, reflecting both limited patient awareness and the absence, in practice, of a diabetes-specific fitness-to-drive pathway in this setting. The findings support embedding a short driving-fitness enquiry—covering hypoglycaemia history, visual and neuropathic status, and safe-driving practices—into periodic diabetes review, aligned with international guidance emphasising individualised assessment rather than blanket restriction.[10]

Comparison with previous studies: Our accident and hypoglycaemia findings sit within a broad international literature. A pooled estimate suggests people with diabetes carry roughly a 12–19% higher crash risk than the general population[8], while the largest single study—a Norwegian analysis of some 3.1 million adults, of whom about 170,000 were on glucose-lowering medication—found a modestly elevated crash risk for insulin-treated diabetes (OR 1.4; 95% CI 1.2–1.6)[9]. Severe hypoglycaemia requiring third-party assistance has repeatedly emerged as a stronger signal: in a Canadian population-based case-control study it carried an odds ratio of 4.07 (95% CI 2.35–7.04) for a crash[7], and in older drivers diabetes roughly doubled injury risk[18]. Consistent with our data, a recent report in adults with type 1 diabetes linked diabetic neuropathy and fear of hypoglycaemia to high-risk driving and found that a majority—including 44% of those who had crashed—had never received safe-driving education[17], echoing the awareness gap we observed. Our headline observations—a very low uptake of protective practices, and complications (notably vision) clustering with accidents—are directionally concordant with prior work, even though our absolute accident prevalence is lower, as expected for a predominantly type 2, self-reported, clinic-based sample.

The comparison with the general (largely non-diabetic) driving population is equally instructive. India's national statistics remain severe: the Ministry of Road Transport and Highways' Road Accidents in India 2023 report recorded 480,583 crashes, 172,890 deaths and 462,825 injuries in a single year—about 55 crashes and 20 deaths every hour—with two-wheelers accounting for the largest share of fatalities (approximately 44.8%) and the working-age population (18–60 years) bearing more than 83% of deaths.[13,16] Critically, that national dataset attributes crashes almost entirely to behavioural and road factors—overspeeding (around 68% of fatalities), wrong-side driving, alcohol or drug use, red-light violations and mobile-phone use—and captures no information on drivers' medical or metabolic status. Diabetes, hypoglycaemia, retinopathy and impaired vision are thus invisible to national road-safety surveillance, even though they are biologically capable of precipitating crashes and are highly prevalent among Indian drivers. Our finding that the overwhelming majority of drivers with diabetes are unaware of this risk, rarely check glucose before driving and almost never disclose their condition suggests a systematic blind spot—a clinically meaningful, potentially modifiable contributor to road-traffic injury that is neither measured in national data nor addressed in routine care. Incorporating a brief metabolic and fitness-to-drive assessment into diabetes review—and, in time, capturing medical context within crash surveillance—could help close this gap.

Strengths and limitations: Strengths include the large sample, the combination of objective clinical measurement (fundoscopy, monofilament testing, a full metabolic panel) with a structured behavioural questionnaire, a de-duplicated and pre-specified analytic approach, and a focus on an under-studied, high-burden population. Several limitations should temper interpretation. Most importantly, age and sex were not recorded in the source dataset; these are established determinants of crash risk, and their absence prevented age dichotomisation and any demographic adjustment—their inclusion in future

models is essential. Diabetes duration was captured only as a coarse binary (>1 year), which 95% of participants met, leaving little discriminatory power; a continuous duration measure is desirable. The cross-sectional design precludes causal inference, and accident history was self-reported and subject to recall and social-desirability bias, likely underestimating true rates. A complete-case analysis excluded 59 of 1,251 participants (4.7%); the proportion is small but may introduce minor selection effects. Some laboratory values contained extreme entries consistent with data-entry artefacts; medians were used for skewed variables to mitigate this. Site-level accident rates varied widely and were treated descriptively. Finally, the clinic-based frame may not represent people with diabetes who do not access formal care.

CONCLUSION

Adult drivers with diabetes attending clinics in North India combined poor glycaemic control and a high cardiometabolic and complication burden with low awareness of driving-related risk and infrequent protective behaviours. When accident correlates were examined with de-duplicated, pre-specified variables, diabetic complications—particularly impaired vision—clustered with accident experience, whereas carrying a carbohydrate snack behaved as a marker of prior hypoglycaemia rather than a cause of crashes, and a pooled neuropathy signal proved to be an artefact of between-centre heterogeneity. These findings support integrating brief driving-fitness counselling, hypoglycaemia preparedness and systematic vision and complication screening into routine diabetes care. Because national road-safety data omit drivers' metabolic status entirely and the present dataset lacked age and sex, prospective multi-centre studies capturing full demographics, medical context and verified accident outcomes are needed to establish causal risk factors and evaluate such interventions.

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