Higher Prevalence of Hypoglycemia and Unsafe Driving Practices in Adults With Type 1 Diabetes

Aria L. Saunders,[1] Cathy Bodine,[1] Janet Snell-Bergeon,[2] Gregory P. Forlenza,[2] and Viral N. Shah[2]

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Severe hypoglycemia and impaired awareness of hypoglycemia have been shown to increase the incidence of vehicular accidents (1). We evaluated the current driving practices and driving-related education of adults with type 1 diabetes. We also evaluated factors associated with vehicular accidents and risk factors for high-risk driving among these adults.

Adults with type 1 diabetes (age >18 years) for at least 1 year followed clinically at the Barbara Davis Center for Diabetes and who drive a vehicle one or more times per week were invited to participate in a survey study (N = 436, 69% females). This single-center, cross-sectional study was conducted at the Barbara Davis Center for Diabetes Adult Clinic to understand *1*) what actions individuals with diabetes currently take to avoid/treat hypoglycemia while driving, *2*) whether individuals with diabetes are well educated on diabetes-related safe driving practices, and *3*) whether the presence of comorbidities and a lack of such education result in greater driving risk for individuals with diabetes.

In brief, the survey included demographic characteristics, diabetes management and control, presence of complications/comorbidities, and driving practices. A Michigan Neuropathy Screening Instrument Questionnaire score ≥4 and Gold score ≥4 were used to define diabetic neuropathy and hypoglycemia unawareness, respectively. Fear of hypoglycemia was assessed using the Hypoglycemia Fear Survey (score range 25–125, where a higher score indicates more fear), and a Risk Assessment of Diabetic Drivers score ≥0.339 was considered to indicate high-risk driving behavior (2). The study was approved by the University of Colorado institutional review board under the exempt category.

Differences in risk factors for vehicular accidents and high-risk driving were examined using Student t test for continuous variables and χ^2 test for categorical variables. SAS statistical software was used for all analyses.

Nearly 72% of respondents reported having had hypoglycemic episodes while driving, and 4.3% of all respondents reported having a vehicular accident due to hypoglycemia in the previous 2 years. The majority of respondents reported checking their blood glucose levels prior to driving (80.2%) and keeping some form of fast-acting carbohydrate in the car to treat a low blood glucose level while driving (95.5%). Approximately 70% reported pulling over their vehicle while experiencing a hypoglycemic episode. Only 40% of respondents reported having either had education on safe driving practices with type 1 diabetes or are aware of resources outlining safe driving practices. Respondents who reported accidents related to hypoglycemia were older, had a longer duration of diabetes, and had a higher prevalence of hypoglycemia unawareness (Table 1). A higher fear of hypoglycemia and the presence of diabetic neuropathy were associated with high-risk driving.

Overall, the results from the survey indicate that prevalence of hypoglycemia while driving is high in adults with type 1 diabetes (71.4%), resulting in 4.3% of reported vehicular accidents. It is important to note, however, that this percentage of vehicular accidents does not take into account the close calls, so this percentage could be significantly higher. Additionally, some respondents may have had accidents due to hypoglycemia but may not have known that it was caused by hypoglycemia because of either recall bias or hypoglycemia unawareness. Moreover, our study shows that age >45 years with >30 years of diabetes was a notable risk for vehicular accident in our cohort and that hypoglycemia fear and the presence of diabetic neuropathy were associated with high-risk driving.

Our study has an important clinical implication. Despite a high prevalence of hypoglycemia, 60% of all respondents and 44% of respondents who had a vehicular accident did not receive or did not recall receiving appropriate safe driving education. Therefore, providers should emphasize safe driving education during routine clinical appointments for adults with type 1 diabetes, especially for those with longer diabetes duration, with fear of hypoglycemia, and in the presence of diabetic neuropathy.

Our study has some limitations. First, the results may not be representative of the larger population since the survey was limited to patients seen at a specialized diabetes care center. Second, the gap in safe driving education would be expected to be significantly higher in the larger population since individuals

[1]Department of Bioengineering, University of Colorado Denver, Aurora, CO
[2]Barbara Davis Center, University of Colorado Denver, Aurora, CO

Corresponding author: Aria L. Saunders, aria.saunders@cuanschutz.edu

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Table 1—Characteristics of individuals who had accidents vs. no accidents

Variable	No accidents due to hypoglycemia	Accidents due to hypoglycemia	*P*
Respondents, *n* (%)	402 (95.7)	18 (4.3)	
Age, years, mean ± SD	36.5 ± 15.7	46.5 ± 14.4	0.0083
Type 1 diabetes duration, years, mean ± SD	21.8 ± 13.6	34.4 ± 14.1	0.0001
HbA_{1c}, mean ± SD	7.4 ± 1.3	7.1 ± 1.2	0.4338
HF score,* mean ± SD			
Overall	41.3 ± 15.9	47.0 ± 15.4	0.1389
Worry	20.6 ± 13.0	25.8 ± 11.6	0.0984
Behavior	20.7 ± 5.4	21.2 ± 5.3	0.6872
RADD score, mean ± SD	0.9 ± 2.1	1.3 ± 2.1	0.3488
Female, *n* (%)	276 (69.5)	12 (66.7)	0.7971
Have had education on safe driving practices with type 1 diabetes, *n* (%)	158 (39.3)	10 (55.6)	0.1685
Presence of hypoglycemia unawareness,** *n* (%)	80 (19.9)	7 (38.9)	0.0518
Presence of visual impairment,*** *n* (%)	103 (25.6)	6 (33.3)	0.4250
Presence of neuropathy,**** *n* (%)	30 (7.5)	2 (11.1)	0.5681

HF, hypoglycemia fear; RADD, Risk Assessment of Diabetic Drivers. *HF overall score range 25–125, HF worry score range 15–75, HF behavior score range 10–50. **Hypoglycemia unawareness defined as Gold score ≥4. ***Based on self-reported answer to the question: Have you been told by a doctor that you have diabetes-related eye changes? ****Neuropathy defined by Michigan Neuropathy Screening Instrument Questionnaire score ≥4.

who are not regularly seen for diabetes care or who see physicians not specialized in diabetes would be included. Third, our cohort had a large percentage of continuous glucose monitor and hybrid closed loop use, and these devices have been demonstrated to decrease the incidence of hypoglycemia (3). Finally, all the study data were self-reported, and therefore, the conclusions may be representative of self-selection bias. Future research is needed to improve safe driving practices and education among people with type 1 diabetes.

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References

1. Lorber D, Anderson J, Arent S, et al.; American Diabetes Association. Diabetes and driving. Diabetes Care 2014;37(Suppl. 1):S97–S103

2. Cox DJ, Gonder-Frederick LA, Singh H, et al. Predicting and reducing driving mishaps among drivers with type 1 diabetes. Diabetes Care 2017; 40:742–750

3. Miller KM, Kanapka LG, Rickels MR, et al. Benefit of continuous glucose monitoring in reducing hypoglycemia is sustained through 12 months of use among older adults with type 1 diabetes. Diabetes Technol Ther 2022;24:424–434