



Impaired Awareness of Hypoglycemia and Severe Hypoglycemia in Drivers With Diabetes: Insights From the Association of British Clinical Diabetologists Nationwide Audit

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Hypoglycemia is an acute complication in people living with diabetes, with 83% of those with type 1 diabetes experiencing hypoglycemia at least once a month and even higher rates of 5 events per week recorded on continuous glucose monitoring (1). There are limited population-based data on the prevalence of impaired awareness of hypoglycemia (IAH) and severe hypoglycemia (SH) in drivers with diabetes in the U.K. and worldwide. The availability of these data can inform policy decisions and help optimize treatment options for people living with diabetes (2).

To understand the prevalence of IAH and SH in drivers with diabetes, we obtained data from the nationwide audit of FreeStyle Libre (FSL), conducted by the Association of British Clinical Diabetologists (ABCD). Baseline pre-FSL data included demographics, HbA_{1c} values from the previous 12 months, Gold score (3) (to assess hypoglycemia awareness),

and SH. Rates of recurrent SH, defined as two or more episodes of hypoglycemia requiring third-party assistance in the 12 months prior to FSL initiation (4), were documented by clinicians.

The study consisted of 13,127 adults (aged ≥ 17 years) with diabetes, and information about driving was available for 4,262 (96% type 1 diabetes) of those (3,210 drivers and 1,052 nondrivers). Of those with a driving license, 3,182 had a group 1 driving license (a license to drive a motor car and a motorcycle), 25 had a group 2 driving license (a license for large goods vehicles [lorries or trucks], passenger-carrying vehicles [buses], and horse boxes), and 3 had a taxi license. Information about the Gold score was available for 2,849 people with either a group 1 or group 2 driving license. Overall, the prevalence of IAH was 21.8% (622/2,849), and the prevalence of complete loss of awareness of hypoglycemia, defined in this cohort as Gold = 7, was 1.4% (41/

2,849). In those with a group 1 license, 22% ($n = 622/2,823$) had IAH (Gold ≥ 4); 1.4% (41/2,823) had a Gold score of 7, and 5% (147/2,823) had experienced more than 1 episode of SH in the preceding 12 months. None of the participants with a group 2 driving license or taxi license had complete loss of hypoglycemia awareness. One participant reported a single episode of SH; none experienced more than one episode of SH in the preceding year. Of the group 2 drivers, only 73% reported full awareness of hypoglycemia (defined as a Gold score of 1).

Drivers living with diabetes were slightly older (mean \pm SD 44.4 \pm 15.2 vs. 41.3 \pm 18.3 years; $P < 0.00001$) and more likely to be male (54% vs. 44%; $P < 0.0001$), with a shorter duration of diabetes (21.7 \pm 37.9 vs. 26.8 \pm 36 years; $P < 0.0001$), than nondrivers. Drivers had a lower baseline HbA_{1c} (70.6 \pm 19.4 [8.6%] vs. 75.06 \pm 19.14

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Table 1—Demographic and clinical characteristics of people with diabetes with and without IAH

Characteristic	Impaired awareness of hypoglycemia (Gold \geq 4) ($n = 622$)	Normal awareness of hypoglycemia (Gold <4) ($n = 2,227$)	<i>P</i> value
Age (years)	49.2 \pm 15.5	43.2 \pm 15.0	<0.0001
Female sex, <i>n</i> (%)	287 (46)	991 (44)	0.85
Baseline BMI	26.7 \pm 6.1	26.9 \pm 5.6	0.5
Duration of diabetes (years)	24.9 \pm 15.3	20.9 \pm 44.4	0.0003
Insulin pump use, <i>n</i> (%)	110 (17)	394 (17)	0.45
Mean pre-FSL HbA _{1c} , mmol/mol (%)	69.4 \pm 20.1 (8.5)	71.2 \pm 19.7 (8.7)	0.04
Frequent hypoglycemia as indication for FSL initiation, <i>n</i> (%)	231 (37)	391 (17)	<0.0001

Data are mean \pm SD unless otherwise indicated. *P* values are from *t* test or χ^2 test. <0.05 is statistically significant.

mmol/mol [9%]; $P < 0.0001$) and lower Gold score (2.35 \pm 1.5 vs. 3.30 \pm 1.96; $P < 0.0001$) than nondrivers. In this population, the number of episodes of SH in the previous 12 months in nondrivers was 19% ($n = 206$), while for group 1 driving license holders it was 8% ($n = 287$) and for group 2 driving license holders it was 3% ($n = 1$).

In the univariate analysis (Table 1), those with IAH were more likely to be older ($P < 0.0001$), have a longer duration of diabetes ($P = -0.00003$) and lower baseline HbA_{1c} ($P = 0.04$), and have “frequent hypoglycemia” as an indication for FSL initiation ($P < 0.0001$). The regression analysis shows that higher age ($\beta = 0.001$, $P = 0.02$), longer duration of diabetes ($\beta = 0.001$, $P = 0.001$), and frequent hypoglycemia as indications for FSL initiation ($\beta = 0.15$, $P < 0.0001$) were significantly and independently associated with GOLD score in drivers.

Overall, 41 people who were group 1 drivers with diabetes were reported as having complete loss of hypoglycemia awareness (defined as a Gold score of 7), and 147 had experienced ≥ 1 SH episode in the previous 12 months. Of the group 2 drivers, only 73% had full awareness of hypoglycemia (defined as a Gold score of 1), and one participant had a reported SH episode in the preceding 12 months.

These data suggest that the impaired awareness of hypoglycemia is prevalent in drivers with diabetes but lower than the prevalence in nondrivers. Complete

loss of hypoglycemia awareness was rare. In keeping with previous data (5), impaired awareness of hypoglycemia was associated with increasing age, longer duration of diabetes, and frequent episodes of hypoglycemia. Less than one-tenth of drivers had experienced SH in the year prior to FSL initiation. Overall, these data provide useful insights into the prevalence of problematic hypoglycemia in people with diabetes who hold a driving license.

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References

1. Khunti K, Alsfiri S, Aronson R, et al.; HAT Investigator Group. Rates and predictors of hypoglycaemia in 27585 people from 24 countries with insulin-treated type 1 and type 2 diabetes: the global HAT study. *Diabetes Obes Metab* 2016;18:907–915
2. Stork AD, van Haeften TW, Veneman TF. Diabetes and driving: desired data, research methods and their pitfalls, current knowledge, and future research. *Diabetes Care* 2006;29:1942–1949
3. Gold AE, MacLeod KM, Frier BM. Frequency of severe hypoglycemia in patients with type 1 diabetes with impaired awareness of hypoglycemia. *Diabetes Care* 1994;17:697–703
4. International Hypoglycaemia Study Group. Glucose concentrations of less than 3.0 mmol/L (54 mg/dL) should be reported in clinical trials: a joint position statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care* 2017;40:155–157
5. UK Hypoglycaemia Study Group. Risk of hypoglycaemia in types 1 and 2 diabetes: effects of treatment modalities and their duration. *Diabetologia* 2007;50:1140–1147