

The Psychosocial Burden of Severe Hypoglycemic Events and Impaired Awareness of Hypoglycemia in Adult Continuous Glucose Monitor Users: Results from a Cross-Sectional Survey Study

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INTRODUCTION

- Type 1 diabetes is a lifelong metabolic condition in which normal glucose regulation is disrupted. Despite advances in diabetes management including continuous glucose monitors (CGM) and automated insulin delivery systems (e.g. hybrid closed loop systems), many people with T1D (pwT1D) continue to experience severe hypoglycemic events (SHEs)¹⁻⁵ and impaired awareness of hypoglycemia (IAH)⁷⁻⁸
 - SHEs, defined as medical emergencies that requires the assistance of a third person to recover, can be associated with loss of consciousness, trauma/injury, hospitalization, arrhythmia and death in people with T1D¹⁻⁶
 - Repeated exposure to hypoglycemia can lead to IAH, which limits the pwT1D's ability to recognize and treat future episodes of hypoglycemia.⁷⁻⁸ IAH further increases the risk of SHEs by six-fold⁹⁻¹¹
- The 24/7 patient burden of managing T1D is complex and affects all aspects of life, including psychosocial well-being¹²⁻¹⁴
- Published literature on the impact of SHEs and IAH on the psychosocial well-being of adult CGM users is limited

OBJECTIVE

To describe the psychosocial burden of SHEs and IAH in pwT1D using CGM

METHODS

Study Design

- An online cross-sectional survey was administered to people with T1D from the T1D Exchange Registry

Key Inclusion Criteria

- Self-reported clinical diagnosis of T1D ≥5 years
- Current CGM user
- Aged ≥18 years old

Survey Design & Administration

- SHE frequency was collected through participant responses to the question:
 - "A severe hypoglycemic event (SHE) is a low blood sugar where you experience a change in your mental or physical status (like increased confusion or loss of consciousness) and where you need help from another person to recover. How many times did you experience a severe hypoglycemic event in the past 12 months?"
- IAH status was determined using established cutoffs from the modified Gold score.¹⁵ The Gold score is a 1-item questionnaire that asks individuals to report their experience in detecting hypoglycemic events with responses ranging from 1 (always aware) to 7 (never aware) in a Likert type scale
 - A score of ≤2 = normal awareness (IAH-); 3 = borderline (undetermined); ≥4 suggests impaired awareness of hypoglycemia (IAH+)
- Self-reported rates of anxiety and depression was measured with a bespoke question "Have you ever been diagnosed with or treated by a medical professional for any of the following conditions..."
 - Anxiety/depression were listed as one of the conditions
 - Response options included Yes, No, and Unsure

Patient-reported Outcomes Measures (PROMs)

- Anxiety/depressive symptoms were measured with the Patient Health Questionnaire-4 items (PHQ-4)¹⁶
 - The PHQ-4 is a composite screener comprised of 2 items regarding depression symptoms (taken from the Patient Health Questionnaire-8 items; PHQ-8) and 2 items regarding anxiety symptoms (taken from the Generalized Anxiety Disorder-7, GAD-7)
 - Total PHQ-4 scores range from 0-12, with clinical cutoffs where score of ≥3.0 indicates clinically meaningful anxiety/depressive symptoms and score of <3.0 indicates normal symptoms
- Fear of hypoglycemia (FoH) was measured using the hypoglycemia fear scale (HFS-II) (score 0 - 132; higher score = greater hypoglycemia fear)¹⁷, as part of a larger study
 - HFS-II has two domains:
 - Behavior (HFS-B, score 0 - 60): evaluates how FoH influences the person's behavior, such as avoiding activities that might lead to hypoglycemia
 - Worry (HFS-W, score 0 - 72): assesses the level a person feels about experiencing low blood sugar

Cohort Definitions

- Cohorts were evaluated based on self-reported SHE frequency and IAH status in the past 12 months¹⁹

Table 1. Study Design

Cohort	Definition
Problematic SHEs	Individuals with SHE 1+/IAH+ or SHE 2+/IAH-
Single SHE, no-IAH	Individuals with 1 SHE and IAH-
Undetermined IAH	Individuals with SHE ≥0 and modified Gold score = 3
No-SHE	Individuals with 0 SHE and IAH+ or 0 SHE and IAH-

IAH: impaired awareness of hypoglycemia; SHE: severe hypoglycemic event

Statistical Analysis

- Descriptive analyses (mean, standard deviation [SD], counts, percentages) of participant demographics and clinical characteristics, HFS-II and PHQ-4 scores are reported for the Problematic SHEs and No-SHE cohorts
- HFS-II and PHQ-4 were scored according to their published scoring algorithms¹⁷⁻¹⁸
- Numerical results were summarized by SHE/IAH status and further stratified by insulin-delivery methods: Hybrid closed-loop system/ do-it-yourself (HCLS/DIY), Predictive low glucose suspend (PLGS), Pump without automated insulin-delivery (pump no-AID) and multiple daily injections (MDI)

RESULTS

- Participants with Problematic SHEs cohort were slightly older than the No-SHE cohort (49.0 [SD=14.6] vs. 45.6 [SD=15.7]) years (Table 2)
- Participants with Problematic SHEs self-reported numerically higher rates of anxiety and depression compared to the No-SHE cohort (46.7% vs. 33.0%; 49.1% vs. 31.5%) (Table 2)

Table 2. Participant Demographics & Clinical Characteristics^a

	Problematic SHEs ^b (N=375, 20.3%)	No-SHE ^b (N=1033, 55.9%)
Age (years), mean (SD)	49.0 (14.6)	45.6 (15.7)
Gender, n (%)		
Male	108 (28.8)	354 (34.3)
Female	266 (70.9)	666 (64.5)
Non-binary / genderqueer	1 (0.3)	11 (1.1)
Prefer to self-identify	0 (0)	1 (0.1)
Prefer not to answer	0 (0)	1 (0.1)
Race, n (%)		
American Indian/Alaskan Native	3 (0.8)	5 (0.5)
Asian	1 (0.3)	10 (1.0)
Black/African American	21 (5.6)	13 (1.3)
Native Hawaiian or Other Pacific Islander	1 (0.3)	1 (0.1)
North African/Middle Eastern	1 (0.3)	7 (0.7)
White/Caucasian	324 (86.4)	958 (92.7)
Mixed Race	18 (4.8)	32 (3.1)
Other	6 (1.6)	7 (0.7)
Ethnicity - Hispanic or Latino, n (%)	23 (6.1)	55 (5.3)
Most recent HbA1c, mean (SD)	6.9 (1.1)	6.6 (0.9)
Medical emergency treatment for T1D (excluding SHEs) in the past 12 months, n (%)	52 (13.9)	60 (5.8)
Diabetes technology subtypes, n (%)		
HCLS/DIY	209 (55.7)	713 (69.0)
PLGS	33 (8.8)	55 (5.3)
Pump no-AID	52 (13.9)	119 (11.5)
MDI	81 (21.6)	146 (14.1)
Selected Complications, n (%)		
Microvascular		
Nephropathy	31 (8.3)	47 (4.5)
Neuropathy	92 (24.5)	108 (10.5)
Retinopathy	106 (28.3)	222 (21.5)
Macrovascular		
Cerebrovascular disease	8 (2.1)	24 (2.3)
Cardiovascular disease	47 (12.5)	57 (5.5)
Vascular disease	29 (7.7)	40 (3.9)
Hypothyroidism	90 (24.0)	275 (26.6)
Hypertension	152 (40.5)	317 (30.7)
Dyslipidemia	155 (41.3)	371 (35.9)
Joint or bone issues	191 (50.9)	366 (35.4)
Autoimmune disease	90 (24.0)	246 (23.8)
Sleep disorder	108 (28.8)	171 (16.6)
Depression	184 (49.1)	325 (31.5)
Anxiety	175 (46.7)	341 (33.0)

^a Table 2 was previously presented elsewhere.
^b The overall sample also included Single SHE, no-IAH (n=102) and Undetermined IAH (n=337) cohorts.
HbA1c: hemoglobin A1c; **SD**: standard deviation; **T1D**: type 1 diabetes

- Participants with Problematic SHE reported clinically meaningful anxiety/depressive symptoms (PHQ-4 mean score ≥3.0) compared to the No-SHE cohort (PHQ-4 mean <3.0) (Figure 1)

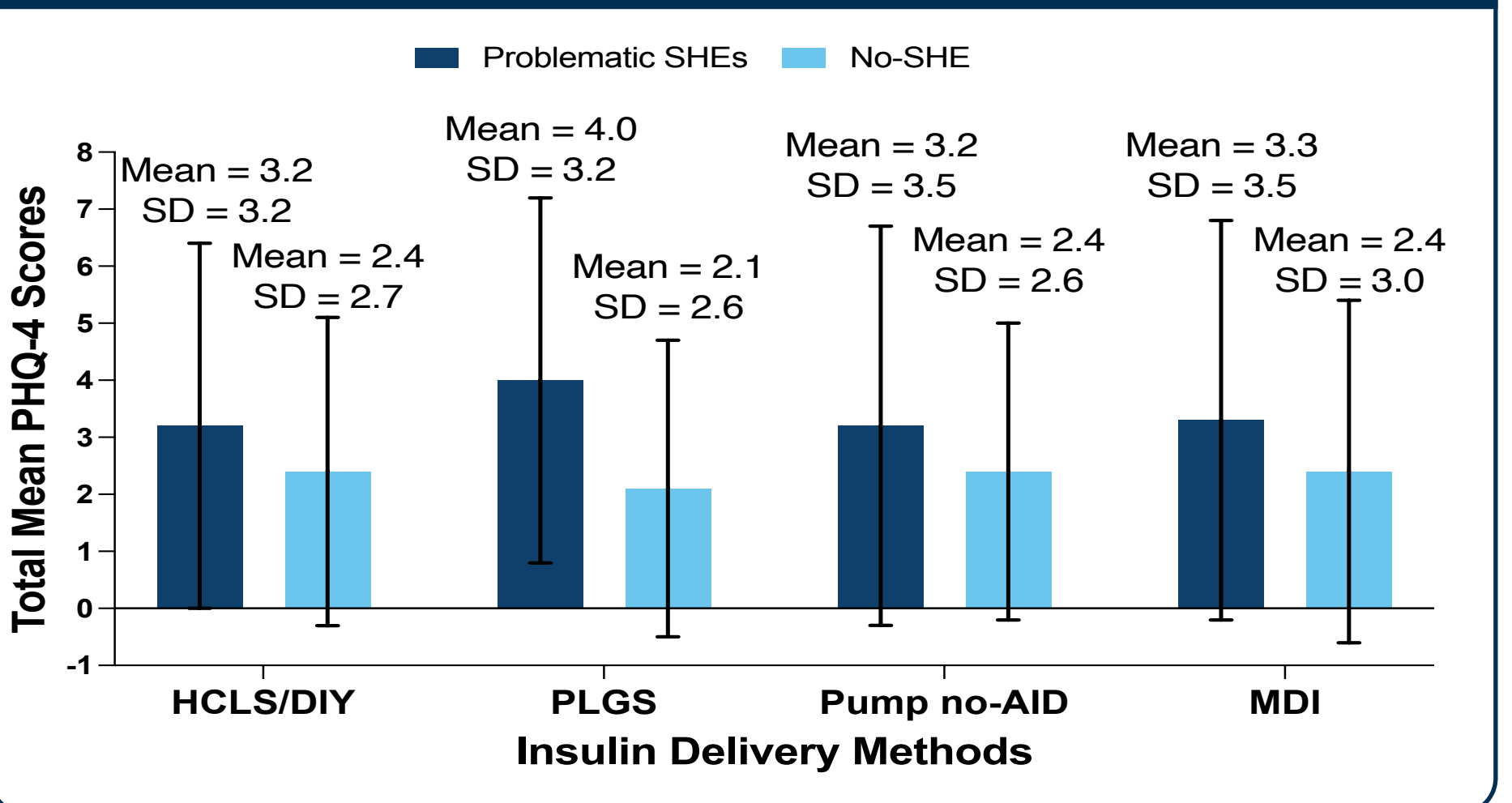
Author Disclosures

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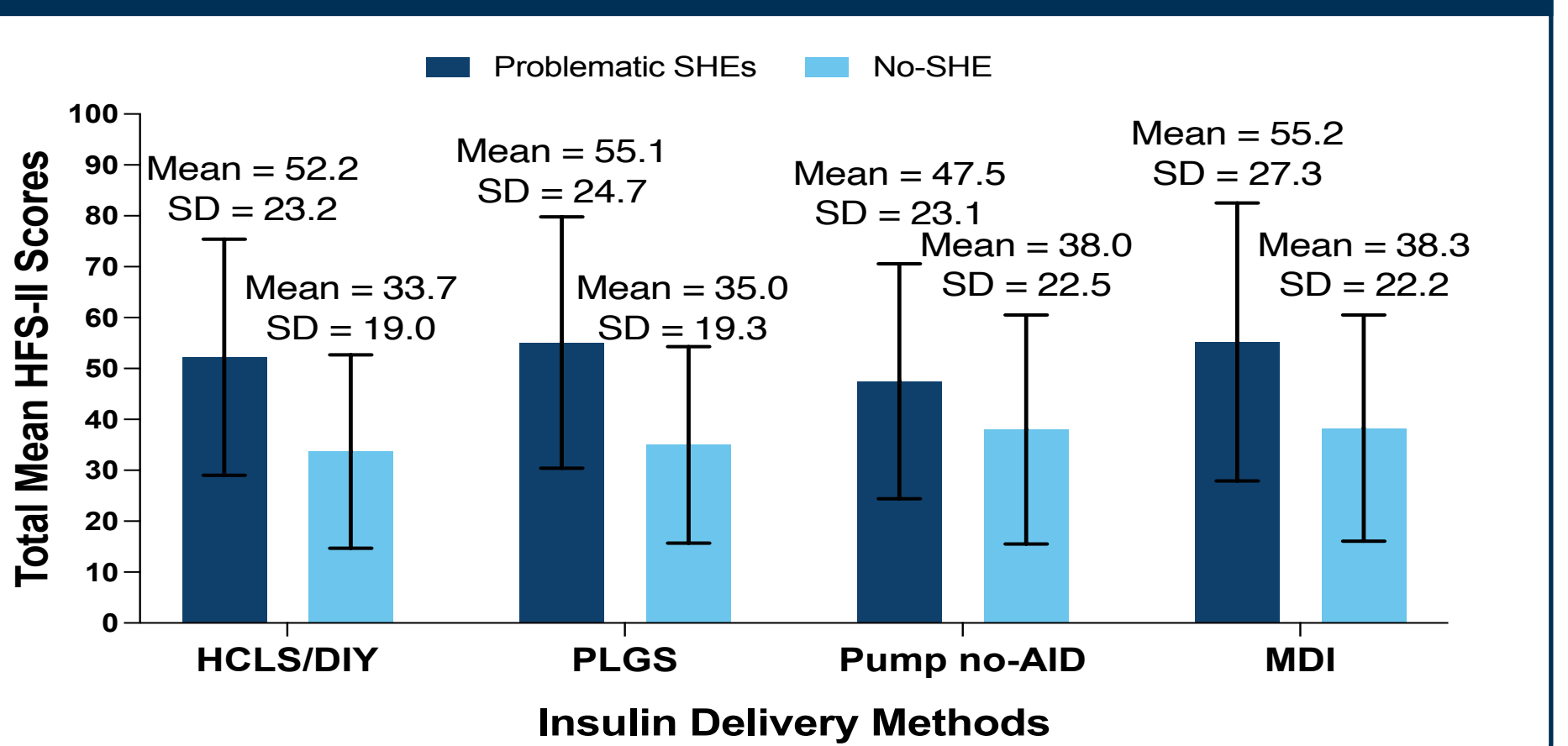
Figure 1. Total Mean PHQ-4 Scores Between Problematic SHEs and No-SHE Cohorts and Stratified by Different Insulin Delivery Methods



HCLS/DIY: hybrid closed-loop system/do-it-yourself; IAH: impaired awareness of hypoglycemia; MDI: multiple daily injections; PHQ-4: Patient Health Questionnaire-4; PLGS: predictive low glucose suspend; Pump no-AID: pump without automated insulin-delivery; SD: standard deviation; SHE: severe hypoglycemic event
PHQ-4 clinical cut-off: scores <3.0 indicates normal symptoms and ≥3.0 indicates clinically meaningful anxiety/depressive symptoms

- Largest numerical mean difference in HFS-II scores between Problematic SHEs and No-SHE cohorts was observed in PLGS, followed by HCLS/DIY, MDI, and Pump no-AID users (Figure 2)

Figure 2. Total Mean HFS-II Scores Between Problematic SHEs and No-SHE Cohorts and Stratified by Different Insulin Delivery Methods



HCLS/DIY: hybrid closed-loop system/do-it-yourself; HFS-II: hypoglycemia fear scale; IAH: impaired awareness of hypoglycemia; MDI: multiple daily injections; PLGS: predictive low glucose suspend; Pump no-AID: pump without automated insulin-delivery; SD: standard deviation; SHE: severe hypoglycemic event

Limitations

- Study participants were from the T1D Exchange Registry, a cohort of individuals with T1D who tend to be highly engaged, have a high degree of diabetes technology use, and have historically been shown to be more likely to achieve glycemic targets
- Study participants were mostly White, non-Hispanic or Latino, identified as female, highly educated, were self-selected and needed access to the internet and email, which may all impact the generalizability of these results
- All data were self-reported; eligibility and clinical data were not verified by a clinician
- All analyses were descriptive; no inferential statistics were performed

CONCLUSIONS

- Across insulin delivery methods,**
 - Participants with Problematic SHEs reported a PHQ-4 score ≥3.0, indicating the presence of psychological distress and the need for further evaluation of potential anxiety/depressive disorders
 - Participants with Problematic SHEs reported numerically higher fear of hypoglycemia (higher HFS-II scores) compared to No-SHE cohort
- Future studies should evaluate the correlation between psychosocial burden and SHE frequency/IAH status across different insulin delivery methods
- Collectively, these findings suggest an unmet need in pwT1D with Problematic SHEs, highlighting the need for innovative therapies beyond insulin delivery methods

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