Original Research

# Association of Depressive Symptoms and Diabetes Distress With Severe Hypoglycemia in Adults With Type 2 Diabetes

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## Key Messages

- Exploring mental health–related risk factors in severe hypoglycemia, which remains a key challenge for patients with diabetes, is essential.
- Despite the significant overlap between diabetes distress and depressive symptoms, their impact on outcomes and management vary widely.
- This study shows that depressive symptoms, but not diabetes distress, are associated with increased risk for severe hypoglycemia in patients with type 2 diabetes.

## ARTICLE INFO

## ABSTRACT

*Objectives:* To examine the association of depressive symptoms (DS) and diabetes-related distress (DD) with severe hypoglycemia (SH) in adults with type 2 diabetes.

*Methods:* Baseline data from a cohort study of adults with type 2 diabetes (N=2,040) were used. The Patient Health Questionnaire 8-items and Problem Areas in Diabetes 5-items questionnaires were used to assess DS and DD, respectively. SH was defined as a positive report of "calling an ambulance or visiting an emergency department because of hypoglycemia in the past year." Composite dummy variables for the 2 stratification levels of DS and DD were computed and used in multivariable logistic regression analyses.

*Results:* Participants had a mean (± SD) age of 64±11 years, and 45% were female. The average duration of diabetes was 12±9 years; 3% had moderate to severe DS, 8% had moderate to severe DD and 5% had moderate to severe levels of both symptoms. Only 4.2% of participants reported experiencing SH in the past year. The presence of any level of DD (adjusted OR 2.3; 95% CI 1.3, 3.9) or moderate to severe DD (2.2; 1.1, 4.2) was associated with increased risk for SH. Combinations of any levels of DD and DS (4.3; 2.5, 7.3) and moderate to severe DD and DS (2.3; 1.1, 4.8) were associated with increased risk for SH. The presence of any level of DS alone (1.2; 0.3, 4.9) or moderate to severe DS (1.7; 0.6, 5.1) was not associated with increased risk for SH.

*Conclusions:* Patients with type 2 diabetes and symptoms of depression, but not diabetes-related distress alone, were more likely to experience SH than those without either of these symptoms.

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## RÉSUMÉ

*Objectifs :* Examiner l'association des symptômes de dépression (SD) et de la détresse liée au diabète (DD) à l'hypoglycémie grave (HG) chez les adultes atteints du diabète de type 2.

*Méthodes :* Nous avons utilisé les données initiales d'une étude de cohorte d'adultes atteints du diabète de type 2 (N = 2040). Nous avons utilisé les questionnaires respectifs PHQ-8 (*Patient Health Questionnaire 8-items*) et PAID-5 (*Problem Areas in Diabetes 5-items*) pour évaluer les SD et la DD. La HG a été définie ainsi lorsqu'elle a nécessité l'« appel d'une ambulance ou une visite au service des urgences en raison

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d'une hypoglycémie au cours de la dernière année ». Nous avons calculé et utilisé les variables factices composites de 2 niveaux de stratification des SD et de la DD dans les analyses multivariées de régression logistique.

*Résultats :* Quarante-cinq pour cent (45 %) des participants, dont l'âge moyen était de 64 ± 11 ans, étaient des femmes. La durée moyenne du diabète était de 12 ± 9 ans, 3 % avaient des SD modérés à graves, 8 % avaient de la DD modérée à grave et 5 % avaient des niveaux modérés à graves des 2 symptômes. Seuls 4,2 % des participants rapportaient avoir subi une HG au cours de la dernière année. La présence de tout niveau de DD (RIR ajusté 2,3; IC à 95 % 1,3, 3,9) ou de DD modérée à grave (2,2; 1,1, 4,2) était associée à une augmentation du risque de HG. Les combinaisons de tous les niveaux de DD et de SD (4,3; 2,5, 7,3) et de DD et de SD modérés à graves (2,3; 1,1, 4,8) étaient associées à une augmentation du risque de HG. La présence de tout niveau de SD seuls (1,2; 0,3, 4,9) ou de SD modérés à graves (1,7; 0,6, 5,1) n'était pas associée à une augmentation du risque de HG.

*Conclusions :* Les patients atteints du diabète de type 2 et de symptômes de dépression, mais non seulement de détresse liée au diabète, étaient plus susceptibles de subir une HG que ceux qui n'avaient aucun de ces symptômes.

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## Introduction

The benefits of achieving glycemic control in patients with type 1 and type 2 diabetes mellitus, particularly in minimizing the risk for microvascular complications, have been established in several trials, namely the landmark Diabetes Control and Complications Trial and the UK Prospective Diabetes Study (1,2). Unfortunately, hypoglycemia remains a principal barrier to achieving strict glycemic control. It has long been recognized as a challenge in managing patients with type 1 diabetes and is a growing problem in those with type 2 diabetes, who represent the majority of all diabetes cases (3). Recent evidence suggests that severe hypoglycemia may be equally common in people with type 2 diabetes who are being treated with insulin or insulin secretagogue therapy (4).

Hypoglycemia has a substantial impact on affected individuals, reducing quality of life (5), even resulting in a constant fear of hypoglycemia for some (6). The impact of hypoglycemia goes far beyond the individual because of increased health-care use and loss of work productivity (7,8). Identifying the factors that contribute to the development of hypoglycemia is a key step toward a comprehensive and informed approach to reducing this preventable complication.

There is an abundance of evidence about risk factors associated with hypoglycemia in patients with type 1 diabetes; however, in those with type 2 diabetes, the evidence is limited. Available research suggests that hypoglycemia in adults with type 2 diabetes may result from behavioural, physiologic or therapeutic factors, with little consideration given to psychosocial factors that might contribute to an increased risk for hypoglycemia. Several studies of people with diabetes have documented a 2-fold increased risk for significant depressive symptoms (DS) (9,10) and diabetes-related distress (DD) (11). Clinically, DS and DD are often intertwined, yet may have differing clinical implications. For example, depression is reported to be an independent risk factor for severe hypoglycemia (12) and is associated with time to first severe hypoglycemic episode and frequency of episodes (13), yet such associations have not been observed for DD (14). Research suggests that most patients with diabetes and DS are not clinically depressed, where these symptoms may be more reflective of DD (15). Nonetheless, both DS and DD have been linked to poorer self-care behaviors, including lack of adherence to diet, exercise regimens, glucose monitoring and medications (15), which potentially increase the risk for hypoglycemia (3).

In the limited literature available, DS appear to be a predictor of severe hypoglycemia (SH), particularly in type 1 diabetes (13), whereas DD is not (14). There may be overlap between DS and DD, but none of the available studies examined the relationship of these factors with SH at the same time in the same population. Therefore, our objective was to examine the association of DS and DD with risk for SH in adults with type 2 diabetes. We hypothesized that, compared to those without symptoms, patients with DS or DD would have an elevated risk for SH, and that the risk would be higher when both symptoms are present together.

## Methods

### Design and participants

Baseline data from an ongoing prospective cohort study of adults with type 2 diabetes in Alberta (Alberta's Caring for Diabetes [ABCD] cohort) were used in this study. A detailed description of the cohort design and procedures was previously reported (16). Briefly, English-speaking patients with type 2 diabetes who were older than 18 years of age were eligible to participate in the study. The ABCD cohort study's aim is to better understand the socio-demographic, behavioural, psychosocial and clinical factors that affect various health outcomes in patients with type 2 diabetes. The study involves the administration of a postal survey and linkage with administrative databases. Survey data were used in this analysis. Participants were recruited between December 2011 and December 2013 using several approaches, including invitations through primary care networks, diabetes clinics and various public advertisements.

### Measures and data collection

Data were collected via a mailed self-administered questionnaire. Assessment of the outcome of interest and main explanatory variables was performed as follows.

### Severe hypoglycemia

It is defined as hypoglycemia requiring external assistance for recovery and based on a positive report of "calling an ambulance or visiting an emergency department because of low blood sugar in the past year."

### Depressive symptoms

DS were assessed by using the Patient Health Questionnaire 8-items (PHQ-8), a self-reported measure based on the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders (4th ed.) criteria for major depression (17). Each of the PHQ-8 items was scored from 0 (not at all) to 3 (nearly every day), with higher scores indicating more DS. A total score was computed as the sum of the scores of the 8 items (range 0 to 24) and was categorized into 2 levels using 2 different cut-off points (17):

1. Absent DS (scores <10) vs. any DS (scores ≥10)
2. Absent DS (scores <15) vs. moderate to severe DS (scores ≥15)

*Diabetes-related distress*

The Problem Areas in Diabetes 5-items (PAID-5) questionnaire was used to assess DD. PAID-5 assesses diabetes-specific distress related to emotions, treatment, diet and support and includes the following items: feeling scared when you think about living with diabetes; feeling depressed when you think about living with diabetes; worrying about the future and the possibility of serious complications; feeling that diabetes is taking up too much of your mental and physical energy every day; and coping with complications of diabetes (18). PAID-5 is a short version of PAID-20, and it has been shown to have measurement properties similar to those of the 20-item version (19). It was chosen for use in the ABCD cohort study to reduce respondents' burden, as was the case for other measures included in the survey. Each of the PAID-5 items is scored on a 5-point Likert scale ranging from 0 (not a problem) to 4 (a serious problem), with higher scores indicating more DD. A total score was computed as the total of the 5 items (range 0 to 20) and was categorized into 2 levels using 2 different cut-off points (18):

1. Absent DD (scores <5) vs. any DD (scores ≥5)
2. Absent DD (scores <10) vs. moderate-severe DD (scores ≥10)

*Other variables*

Data concerning age; sex; income (<$80,000, ≥$80,000); education level (less than high school, high school or more); marital status (married, not married); ethnicity (white, Indigenous, others); diabetes duration; number of comorbidities; dietary behaviours, using the diet domain of the Summary of Diabetes Self-Care Activities (SDSCA) (20); physical activity (sufficiently active, inactive) (21); current insulin use; medication adherence, using the SDSCA; self-monitoring of blood glucose, using the SDSCA; current smoking status; and self-efficacy (Self-Efficacy for Managing Chronic Disease 6-Item Scale [22]) were also collected.

*Data analysis*

Composite dummy variables (both absent, only DS present, only DD present or both present) for the 2 stratification levels of DS and DD (any or moderate to severe) were computed as the main independent variables in all analyses. Patients with moderate to severe DS, DD or both were compared with patients without either of these symptoms on demographic, clinical and health-risk behaviours using chi-square analyses and ANOVA, as appropriate.

Logistic regression models were used to examine the independent association of DS and DD with the risk of experiencing SH; 1 regression model was run for each stratification level of DD and DS. Simple models with just the DS/DD dummy variables were run initially, then subsequently adjusted for age, sex, income, education, marital status, ethnicity, diabetes duration, number of comorbidities, insulin and medication use, adherence to dietary behaviors, meeting physical activity guidelines, smoking status, self-monitoring of blood glucose and self-efficacy level. Missing data in individual items of measures were handled according to the developer's guidelines. Missing data were <5% in the variables included in this study and were handled using mean imputation where applicable. All analyses were performed using STATA 13.1 (StataCorp, College Station, Texas, United States).

## Results

### General characteristics of participants

Participants had a mean (± SD) age of 64±11 years, and 45% were female. The majority were Caucasian (91%) with at least a high school education (86%), and 76% reported an annual household income <$80,000. On average, participants had lived with diabetes for 12±9 years, and the majority (82%) reported 2 or more chronic conditions in addition to diabetes; 33% were taking insulin. In terms of self-care behaviours, these participants followed recommended dietary behaviors 4±1.5 days per week, tested blood sugar levels 4±2.5 days per week and took their medication 6±1.7 days per week. Of the participants, 76% did not meet recommended physical-activity guidelines, 10% were smokers and 36% were deemed to have low self-efficacy for managing chronic diseases.

### Depressive symptoms and diabetes-related distress

The majority of participants (84%) did not have DD or DS, while 3% had moderate to severe DS alone, 8% had moderate to severe DD alone and 5% had moderate to severe levels of both DS and DD (Table 1). Compared to patients without DD or DS, those with moderate to severe levels of both symptoms were significantly younger, of lower income and lower education levels and less likely to be married. They were more likely to be smokers, have more chronic conditions and exhibit poorer self-efficacy and self-care behaviors.

### Hypoglycemic episode history

Overall, 85 (4.2%) participants reported experiencing SH in the past year. Patients who experienced SH had lower income and education levels, were less likely to be married, had longer durations of diabetes, reported more comorbidities, were more likely to use insulin, more likely to test their blood sugar levels, less likely to meet physical-activity guidelines and had much lower self-efficacy than those who did not report experiencing SH in the past year (Table 2).

### Associations of any depressive or distress symptoms with severe hypoglycemia

A significantly higher proportion of those with DS alone (6.6%), DD alone (8.6%) or both DS and DD (10.3%) reported experiencing SH in the past year compared to those without DS or DD (3.3%). In both unadjusted and adjusted models, the presence of any level of DD (adjusted OR 2.3; 95% CI 1.3, 3.9) and any level of DD and DS combined (4.3; 2.5, 7.3) was associated with increased risk for experiencing SH (Table 3). However, the presence of any level of DS alone was not associated with increased risk for SH (1.2; 0.3, 4.9). After adjusting for self-efficacy, the observed associations remained statistically significant; however, the point estimates were attenuated.

### Associations of moderate to severe depressive or distress symptoms with severe hypoglycemia

In unadjusted analyses, moderate to severe levels of DS, DD or both were significantly associated with increased risk for experiencing SH; however, in the adjusted model, only the presence of moderate to severe DD (OR 2.2; 95% CI 1.1, 4.2) or DS and DD combined (2.3; 1.1, 4.8) was associated with increased risk for SH (Table 3). In this adjusted model, the presence of DS alone was not associated with increased risk for experiencing SH (1.7; 0.6, 5.1). Adjusting for self-efficacy attenuated the effects for all groups, although point estimates were still suggestive of elevated risk.

## Discussion

In this study, DD alone or accompanied by DS was associated with higher risk for experiencing SH; however, this was not observed in those with DS alone. Also, as hypothesized, compared

**Table 1**
General characteristics of participants according to depressive symptoms and diabetes distress

| | Overall (N=2,040) | DS & DD absent n=1,710; 83.8% | Only DS present n=61; 3.0% | Only DD present n=162; 7.9% | DS & DD present n=107; 5.3% | p value |
|---|---|---|---|---|---|---|
| Age, years | 64.4±10.6 | 65.1±10.4 | 60.6±9.3 | 62.1±11.5 | 59.2±10.2 | <0.001 |
| Age group | | | | | | |
| <50 years | 175 (8.6) | 123 (7.2) | 6 (9.8) | 24 (14.8) | 22 (20.6) | <0.001 |
| 50−65 years | 916 (44.9) | 740 (43.3) | 37 (60.7) | 77 (47.5) | 62 (57.9) | |
| >65 years | 949 (46.5) | 847 (49.5) | 18 (29.5) | 61 (37.7) | 23 (21.5) | |
| Sex, female | 917 (45.2) | 747 (43.9) | 32 (54.2) | 84 (52.2) | 54 (50.9) | 0.054 |
| Income | | | | | | |
| <$80,000 | 1555 (76.2) | 1284 (75.1) | 49 (80.3) | 129 (79.6) | 93 (86.9) | 0.023 |
| ≥$80,000 | 485 (23.8) | 426 (24.9) | 12 (19.7) | 33 (20.4) | 14 (13.1) | |
| Education level | | | | | | |
| Less than high school | 288 (14.1) | 239 (14.0) | 8 (13.1) | 15 (9.3) | 26 (24.3) | 0.006 |
| High school or more | 1,752 (85.9) | 1,417 (86.0) | 53 (86.9) | 147 (90.7) | 81 (75.7) | |
| Marital status, married | 1,459 (71.5) | 1,243 (72.7) | 45 (73.8) | 113 (69.8) | 58 (54.2) | 0.001 |
| Ethnicity | | | | | | |
| White/Caucasian | 1,852 (90.8) | 1,562 (91.4) | 56 (91.8) | 139 (85.8) | 95 (88.8) | 0.022 |
| Aboriginal | 48 (2.3) | 44 (2.6) | 0 (0.0) | 1 (1.2) | 2 (1.9) | |
| Others | 140 (6.9) | 104 (6.1) | 5 (8.2) | 21 (13.0) | 10 (9.3) | |
| Diabetes duration, years | 12.3±8.8 | 12.2±8.8 | 12.1±7.9 | 12.2±8.7 | 12.9±8.5 | 0.890 |
| <10 years | 764 (37.5) | 652 (38.1) | 21 (34.4) | 58 (35.8) | 33 (30.8) | 0.431 |
| ≥10 years | 1,276 (62.5) | 1,058 (61.9) | 40 (65.6) | 104 (64.2) | 74 (69.2) | |
| Number of comorbidities | 3.4±2.0 | 3.3±2.0 | 4.1±2.0 | 3.7±2.2 | 4.7±2.1 | <0.001 |
| 0 | 96 (4.7) | 86 (5.0) | 2 (3.3) | 7 (4.3) | 1 (0.9) | 0.005 |
| 1 | 265 (13.0) | 241 (14.1) | 3 (4.9) | 16 (9.9) | 5 (4.7) | |
| 2 or more | 1,679 (82.3) | 1,383 (80.9) | 56 (91.8) | 139 (85.8) | 101 (94.4) | |
| Diet (0−7 days) | 4.4±1.5 | 4.6±1.5 | 3.1±1.6 | 4.1±1.6 | 3.8±1.5 | <0.001 |
| Blood sugar testing (0−7 days) | 4.1±2.5 | 4.0±2.5 | 4.2±2.7 | 4.5±2.3 | 4.1±2.7 | 0.097 |
| Medications (0−7 days) | 6.3±1.7 | 6.3±1.6 | 5.8±2.2 | 6.3±1.7 | 5.9±2.0 | 0.005 |
| Insulin use, yes | 672 (32.9) | 511 (29.9) | 31 (50.8) | 75 (46.3) | 55 (51.4) | <0.001 |
| Physical activity, inactive | 1557 (76.3) | 1274 (74.5) | 52 (85.3) | 138 (85.2) | 93 (86.9) | <0.001 |
| Smoking, current | 213 (10.4) | 161 (9.4) | 8 (13.1) | 23 (14.2) | 21 (19.6) | 0.002 |
| Self-efficacy (0−10) | 7.5±2.2 | 8.0±1.9 | 4.7±2.1 | 6.1±2.0 | 3.8±2.1 | <0.001 |
| Low (<7.5) | 731 (35.8) | 463 (27.1) | 55 (90.2) | 114 (70.4) | 99 (92.5) | <0.001 |
| High (≥7.5) | 1309 (64.2) | 1247 (72.9) | 6 (9.8) | 48 (29.6) | 8 (7.5) | |
| Severe hypoglycemia in the past year | 85 (4.2) | 56 (3.3) | 4 (6.6) | 14 (8.6) | 11 (10.3) | <0.001 |

*DD*, Diabetes distress; *DS*, depressive symptoms.
Note. Data presented as mean ± SD or n (%).

to patients without any symptoms, those with combined DD and DS had higher risks for SH than those with DD alone. We were unable to untangle the pathways through which DD or DS might influence the risk for SH in this study, but previous studies suggest a behavioral pathway by which DD, DS or a combination of the 2 might hinder adequate self-management in people with diabetes (23,24). Specifically, the increased risk for SH in patients with diabetes and DD or DD and DS together might be due to poor self-care behaviours that are known to increase the risk for hypoglycemia, including poor adherence to diet, glucose monitoring and treatment regimen (25).

Previous studies have addressed either DD or DS but not the combination in relation to hypoglycemia in type 2 diabetes; nonetheless, our results are consistent with studies that found DD but not DS to be associated with overall glycemic control (26,27). One longitudinal cohort study of 4,117 patients with type 1 or type 2 diabetes found that depressed patients experience significantly shorter times to first hypoglycemia episode and a 30% higher risk for more frequent episodes than nondepressed patients, after adjusting for various factors, including diabetes severity (13). Another study found that patients with insulin-treated type 1 or type 2 diabetes and with depression are 60% more likely to have severe hypoglycemic episodes compared to nondepressed patients (12). A more recent study that involved a retrospective analysis of 32,545 records of patients with insulin-treated type 2 diabetes found that patients with depression, anxiety or affective disorder have increased odds for experiencing hypoglycemia (25). It is noteworthy that these studies did not measure or account for DD. Similarly, the only study that examined the relationship between DD and SH failed to identify a significant association (14). However, this study did not include DS as a variable of interest and was conducted in the context of a clinical trial to improve DD.

Perhaps the most important feature of our study is that DD and DS were measured in the same population. Despite the overlap between DD and DS, our data and those of others suggest that there is an important clinical distinction between DD and DS in those with type 2 diabetes. When DS is discussed in the diabetes literature, it often refers to symptoms of major depressive disorder, a psychiatric condition defined as the persistent presence of at least 5 of 9 well-defined symptoms over 2 weeks (28). On the other hand, DD represents an emotional response to a demanding health condition such as diabetes, which usually presents as worries, concerns and fears about certain aspects of that condition (29). A previous study that included measures of both symptoms shows that elevated DS most likely reflects DD and suggests that more than 80% of patients with diabetes and high DD are not clinically depressed (30). In our study, DD accounted for about 50% of psychological symptoms, whereas DS accounted for 18% and combined DD and DS accounted for 32%. These figures indicate that at least half of the psychological distress experienced in this population results from issues and concerns related to diabetes, which is consistent with previous literature (30). This distinction has important clinical implications in terms of available treatment modalities for these 2 symptoms. Although there may be an overlap of negative emotions, depression may constitute a biochemical disorder that requires pharmacotherapy and/or behavioural therapy to overcome, whereas distress does not typically require pharmacotherapy and might be reduced by simple therapeutic interventions, such as psychoeducation and motivational interviewing (31).

**Table 2**
General characteristics of participants according to hypoglycemia history

| Characteristic | SH: No (N=1,955; 95.8%) | SH: Yes (N=85; 4.2%) | p value |
|---|---|---|---|
| Age, years | 64.3±10.4 | 65.7±13.6 | 0.236 |
| Age group | | | |
| <50 years | 163 (8.3) | 12 (14.1) | 0.070 |
| 50–65 years | 886 (45.3) | 30 (35.3) | |
| >65 years | 906 (46.3) | 43 (50.6) | |
| Sex, female | 878 (45.2) | 39 (46.4) | 0.823 |
| Income | | | |
| <$80,000 | 1,482 (75.8) | 73 (85.9) | 0.033 |
| ≥$80,000 | 473 (24.2) | 12 (14.1) | |
| Education level | | | |
| Less than high school | 269 (13.8) | 19 (22.4) | 0.026 |
| High school or more | 1,686 (86.2) | 66 (77.7) | |
| Marital status, married | 1,410 (72.1) | 49 (57.7) | 0.004 |
| Ethnicity | | | |
| White/Caucasian | 1,776 (90.8) | 76 (89.4) | 0.502 |
| Aboriginal | 47 (2.4) | 1 (1.2) | |
| Others | 132 (6.8) | 8 (9.4) | |
| Diabetes duration, years | 12.2±8.8 | 13.9±8.2 | 0.069 |
| <10 years | 743 (38.0) | 21 (24.7) | 0.013 |
| ≥10 years | 1212 (62.0) | 64 (75.3) | |
| Number of comorbidities | 3.4±2.0 | 4.2±2.2 | <0.001 |
| 0 | 94 (4.8) | 2 (2.4) | 0.317 |
| 1 | 257 (13.2) | 8 (9.4) | |
| 2 or more | 1,604 (82.1) | 75 (88.2) | |
| Diet (0–7 days) | 4.4±1.5 | 4.3±1.6 | 0.389 |
| Self-monitoring of blood glucose (0–7 days) | 4.0±2.5 | 4.6±2.5 | 0.036 |
| Oral hypoglycemia medications (0–7 days) | 6.3±1.7 | 6.1±1.9 | 0.247 |
| Insulin use, yes | 623 (31.9) | 49 (57.7) | <0.001 |
| Physical activity, inactive | 1,483 (75.9) | 74 (87.1) | 0.017 |
| Smoking, current | 203 (10.4) | 10 (11.8) | 0.684 |
| Self-efficacy (0–10) | 7.6±2.2 | 5.9±2.4 | <0.001 |
| Low (<7.5) | 676 (34.6) | 55 (64.7) | <0.001 |
| High (≥7.5) | 1,279 (65.4) | 30 (35.3) | |

*SH*, Severe hypoglycemia.
Note. Data presented as mean ± SD or n (%).

It is interesting that we observed an attenuation of the associations between DD and DS with the risk for hypoglycemia when adjusting for self-efficacy, suggesting a potential effect of self-efficacy on these associations. Self-efficacy, a social cognitive theory construct, is the belief that a person has the ability to carry out a behavior (32). Higher self-efficacy has been associated with better behavioural outcomes in diabetes self-management programs (33). Previous studies suggest a strong correlation between self-efficacy

**Table 3**
Odds ratios from logistic regression models examining associations of depressive and distress symptoms with severe hypoglycemia

| | Unadjusted | Adjusted[*] | Adjusted[†] |
|---|---|---|---|
| Any DS (PHQ8 ≥10) *and* any DD (PAID5 ≥5) | | | |
| Both absent (n=1,198): reference | | | |
| Only DS (n=72) | 1.2 (0.3, 4.9) | 0.97 (0.2, 4.3) | 0.70 (0.2, 3.1) |
| Only DD (n=470) | 2.3 (1.3, 3.9) | 2.2 (1.3, 3.9) | 1.9 (1.1, 3.4) |
| Both present (n=300) | 4.3 (2.5, 7.3) | 3.1 (1.7, 5.8) | 2.1 (1.1, 4.1) |
| Moderate to severe DS (PHQ8 ≥15) *and* moderate-severe DD (PAID5 ≥10) | | | |
| Both absent (n=1,710): reference | | | |
| Only DS (n=61) | 2.1 (0.7, 5.9) | 1.7 (0.6, 5.1) | 1.2 (0.4, 3.6) |
| Only DD (n=162) | 2.8 (1.5, 5.1) | 2.2 (1.1, 4.2) | 1.7 (0.8, 3.2) |
| Both present (n=107) | 3.4 (1.7, 6.7) | 2.3 (1.1, 4.8) | 1.6 (0.7, 3.5) |

*DD*, Diabetes distress; *DS*, depressive symptoms; *PAID5*, problem areas in diabetes 5 items; *PHQ8*, patient health questionnaire 8 items.
[*] Age, sex, income, education, marital status, diabetes duration, insulin and medication use, number of comorbidities, diet, physical activity, smoking status and self-monitoring of blood glucose.
[†] Same as model *a* plus self-efficacy.

and DS and a positive role for self-efficacy in improving diet, physical activity and regimen distress in DD interventions (34). The impact of self-efficacy on DD and DS in relation to hypoglycemia warrants further exploration, preferably in a longitudinal analysis exploring potential mediation effects.

Our study had several limitations, the first of which is the cross-sectional design of the study, limiting any interpretation of a causal mechanism linking DD or DS to SH. Although there is evidence of a potential behavioural pathway, and while it is intuitive to suggest that being distressed and depressed could negatively impact health behaviours, leading to increased risk for hypoglycemia, the opposite could also be true. Second, data in this study were based on self-reported measures, which are subject to a few issues such as volunteer bias, although we did try to mitigate these problems by using validated tools; the PHQ-8 and PAID-5 have reliably measured DS and DD, respectively, in people with diabetes (17,18). Furthermore, recall of severe hypoglycemic episodes over a period of 1 year by people with type 2 diabetes is considered a valid measure of SH is this population (35). Last, the majority of participants were well-educated, English-speaking Caucasians residing in Alberta and they had relatively lower levels of DD and DS compared to the levels previously reported; these characteristics limit the generalizability of these findings to other populations that may have higher levels of these symptoms.

## Conclusions

We found that patients with type 2 diabetes and DD or DS and DD combined are more likely to experience SH than those without either of these conditions. This study provides evidence that the distinction between depressive and distress symptoms could have differing clinical implications, and it calls for further investigation of how best to address these symptoms independently and in combination. Furthermore, longitudinal studies are required for better understanding of these relationships.

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## Author Disclosures

Conflicts of interest: none.

## Author Contributions

FAS conceived the study, conducted the analysis, and wrote the manuscript. ROY provided feedback on the analysis, contributed to various sections of this manuscript, and reviewed the final draft. JAJ provided feedback on the analysis and discussion, and reviewed the final draft of the manuscript.

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