



Published in final edited form as:

Int J Eat Disord. 2025 June ; 58(6): 1039–1047. doi:10.1002/eat.24411.

The association of levels of food insecurity and disordered eating behaviors among youth and young adults with diabetes: The SEARCH for Diabetes in Youth Study

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Conflict of Interest

All authors of this study declared no conflicts of interest in relation to this publication.

Prior Presentation:

A preliminary analysis and corresponding results of an interim dataset related to this study were presented as an abstract and an electronic poster by E. K. Wilcher at the American Society for Nutrition's Nutrition Live Online 2020 conference. The abstract appears in the June 2020 edition of *Current Developments in Nutrition*. Other analyses and corresponding results were used as E. K. Wilcher's thesis project submitted in partial fulfillment of the requirements necessary to obtain a master's in public health through the University of Washington in Seattle, WA, USA.

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Abstract

Objective: To examine the relationship between levels of household food insecurity and disordered eating behaviors (DEB) among youth and young adults with youth-onset type 1 (T1D) and type 2 diabetes (T2D).

Method: We used cross-sectional data from the multicenter SEARCH for Diabetes in Youth Study (2015–2020). The Household Food Security Survey Module and the Diabetes Eating Problem Survey-Revised (DEPS-R) were utilized to measure household food insecurity and continuous scores for DEB. In each stratum of diabetes type, we evaluated the association of household food insecurity levels with DEB through linear regression adjusting for potential confounders.

Results: Participants (n=2,669) were on average 21.5 ±5.1 years old and had a mean diabetes duration of 11.2 ±3.3 years, 54.2% were female, 64.0% non-Hispanic white, and respectively

12.9%, 11.1% and 8.43% experienced marginal, low, and very low food security. The overall unadjusted mean DEPS-R score was 13.5 $\pm$ 9.5, with scores of 18.6 $\pm$ 11.8 and 21.1 $\pm$ 11.7 among T1D and T2D participants with very low food security, and scores of 11.5 $\pm$ 8.9 and 15.2 $\pm$ 8.8 among T1D and T2D participants with high food security. Compared to participants who reported high food security, adjusted DEPS-R scores among those with very low food security were 5.8 points (95% CI: 4.3, 7.4) and 6.6 points (95% CI: 3.3, 9.2) higher, respectively, in those with T1D (n=2,274) and T2D (n=395). Less severe levels of household food insecurity showed similar associations with smaller effect sizes.

Discussion: Addressing household food insecurity may decrease DEB and future adverse health outcomes for youth and young adults with diabetes.

Keywords

household food insecurity; disordered eating behaviors; youth and young adults; diabetes

Introduction

Disordered eating behaviors (DEB) are patterns of irregular or abnormal eating, often coupled with a component of psychological distress such as overevaluation of one's weight or shape (1,2). They present in various ways, including chronic dieting, binge eating, compensatory behaviors (e.g., self-induced vomiting, over-exercising, use of laxatives or emetics, etc.), weight cycling, and intentional restriction of food intake (1); they may occur with other mental health comorbidities, including major depressive disorder or generalized anxiety disorder (3). DEB in adolescents carry more severe physical complications than adults (4); and they are associated with greater long-term body mass index (BMI) and waist circumference, and lower short- and long-term self-reported quality of life in youth and young adults (3,5–8).

DEB are twice as common in youth and young adults with type 1 diabetes (T1D) compared to those without diabetes (7.0% vs. 2.8%) (9) and more prevalent in youth and young adults with type 2 diabetes (T2D) than those with T1D (50.3% vs. 21.2%) (10). Specifically, DEB found in persons on insulin therapy are characterized by binge eating behavior followed by intentional withholding of insulin or other hypoglycemic drugs (with or without compensatory behaviors) in an attempt to induce negative energy balance (10,11). This may result in weight loss via hyperglycemia and glycosuria (12,13). Compared to people with diabetes and no DEB, those with DEB have ~1% higher hemoglobin A1c, twice the likelihood of diabetic ketoacidosis, and 1.5–2.5 fold increase in long-term complications of diabetes, including retinopathy, nephropathy and increased mortality (1, 4, 9, 12, 14–16).

Household food insecurity, an inability to access safe and nutritionally adequate food, is associated with higher depressive symptoms, stress, BMI, and probability of chronic diseases, and may further exacerbate risk of DEB (17–20). Household food insecurity is experienced as food scarcity, which likely predisposes individuals to compensatory food restrictive behaviors (19). Inconsistent food availability can trigger subsequent overconsumption (19). Altogether, this may result in cyclical eating, binge eating, food-related guilt, and weight self-stigma (17,21).

Furthermore, youth and young adults with household food insecurity and diabetes have additional stressors related to diabetes management such as regularly monitoring their blood glucose level and constantly adjusting their diet, physical activity, and diabetes medication to prevent or correct hyperglycemia and hypoglycemia, which could increase the risk of poor mental health (22), and thereby the risk for DEB. However, few studies have examined the relationship between household food insecurity and DEB among those with youth-onset T1D or T2D. Greater understanding of the relationship between household food insecurity and DEB among younger populations with diabetes could provide evidence to inform prevention and treatment of DEB. As such, the purpose of this study was to examine the association of household food insecurity levels and DEB among youth and young adults with youth-onset T1D or T2D. We hypothesized that higher levels of household food insecurity will be associated with greater levels of DEB in youth and young adults with T1D or T2D.

Method

Study population

We used cross-sectional data of 2,669 participants (2,274 with T1D and 395 with T2D) from phase 4 of the SEARCH for Diabetes in Youth Study, an ongoing multicenter cohort study that explores diabetes-related outcomes among youth and young adults diagnosed with diabetes at <20 years of age in the United States (23). During phase 4 (2015–2020), participants from the prior phase invited to the in-person exams included all participants with T2D, all participants with T1D who identified as racial/ethnic minorities, and a random sample of non-Hispanic White participants with T1D; the remaining non-Hispanic White sample received an online survey. Sampling non-Hispanic White participants with T1D allowed the study to maintain statistical power for the in-person exams, meet its objectives, yet stay within budget limits. Further details on the SEARCH study methods have been published previously (23). The SEARCH study followed procedures in accordance with ethical standards and was approved by the Institutional Review Boards of all participating institutions. Participants aged ≥ 18 years and parents of participants <18 years gave written informed consent, and participants aged 10–17 years provided assent.

Household food security

For the U.S. Household Food Security Survey Module (HFSSM), which queries household food security in the prior 12 months, adult participants completed 10-items if their households had no resident children or 18-items if their households had children. For participants <18 years, a non-participant parent/guardian from the household completed the 18-item questionnaire. The widely used HFSSM has been demonstrated to be valid and reliable in varying populations (24,25). HFSSM scores were categorized into high food security (zero items affirmed), marginal food security (one to two items affirmed), low food security (three to seven items affirmed in households with children, three to five in households without children), and very low food security ($\geq$ eight items affirmed among households with children, $\geq$ six among households without children) (24). We also refer to the three categories marginal, low and very low food security as household food insecurity levels (26).

Disordered eating behaviors

The presence of DEB for the prior month was measured via the Diabetes Eating Problem Survey-Revised (DEPS-R), a 16-item questionnaire with responses on a six-point Likert scale and an overall score range of 0–80 (27,28), completed by participants of all ages. The DEPS-R has high internal validity and reliability across youth and adults with T1D and T2D (14,28–30). In our sample, Cronbach's alpha coefficient was 0.84, demonstrating strong internal consistency. Scores were on a continuous scale for analyses, with a higher presence of DEB being indicated by a higher score. A score of ≥ 20 points is a positive indicator of presence of DEB (27).

Covariates

Age, age- and sex-specific BMI Z-scores (31), and diabetes duration in years were all measured on continuous scales. Categorical variables included sex assigned at birth (male, female), race and ethnicity, self-reported for adult participants and reported by parents of minors, (Hispanic, Non-Hispanic Asian or Pacific Islander, Non-Hispanic Black, Non-Hispanic Native American, Non-Hispanic White), highest level of parent and participant education (less than high school graduate, high school graduate, associate's degree or some college, bachelor's degree or higher), household income ($< \$25,000$, $\$25,000$ – $\$49,000$, $\$50,000$ – $\$74,000$, $\$75,000$ +), and participant insurance (none, private, Medicare and/or Medicaid, other). Depressive symptom scores, as defined by the 20-question Center for Epidemiologic Studies Depression Scale (CES-D) completed by participants of all ages, were measured on a scale of 0 to 60 points (32).

Statistical analyses

We used multivariable linear regression to evaluate the association of household food insecurity levels with continuous DEPS-R score, adjusting for *a priori* defined confounders (i.e., sex, age, race and ethnicity, participant education, parent education, household income, participant health insurance, and duration of diabetes), further stratifying by diabetes type. As a sensitivity analysis, we also conducted linear regression models adjusted for CES-D and/or BMI Z-score (variables with the most missing values because they were collected only for the in-person group of the cohort) in addition to the aforementioned confounders. All missing values were imputed using predictive mean matching multiple imputation (PMM) (33) by performing five imputations for each missing value preceded by 200 iterations. PMM produces valid, robust and precise imputations as it replaces missingness in the dataset with several observed values from individuals without missing values who have similar predicted mean values. Variables with missing values included HFSSM ($n = 108$), DEPS-R ($n = 97$), household income ($n = 725$), parent education ($n = 172$), participant education ($n = 98$), health insurance ($n = 79$), CES-D ($n = 1009$), and BMI Z-score ($n = 998$). Non-missing covariates also used in the imputation model included sex, race and ethnicity, age, and diabetes duration. All analyses were completed using SAS version 9.4 (SAS institute, Cary, NC).

Results

Participants were on average 21.5 ± 5.1 years of age (26.2% aged 10–17 years, 73.8% aged 18–35 years), 54.2% female, 64.0% Non-Hispanic White (Table 1). Those with T1D were younger, less likely to be female, more likely to identify their race/ethnicity as Non-Hispanic White compared to participants with T2D. Participants had diabetes for an average of 11.2 ± 3.3 years, 36.4% of them had a household income of at least \$75,000, and 71.2% had private health insurance. Those with T1D had diabetes for a longer period, were more likely to live in a household with at least \$75,000, and more likely to have private health insurance, compared with those with T2D.

The percentages of participants with marginal, low and very low food security were 11.6%, 9.9% and 7.7% in those with T1D and 20.0%, 18.0% and 12.4% in those with T2D (Table 1). The mean DEPS-R score was 13.5 ± 9.5 for the total sample (23.2% with a score ≥ 20), 12.9 ± 9.3 for those with T1D (20.8% with a score ≥ 20), and 17.5 ± 9.6 for those with T2D (36.9% with a score ≥ 20). In households with very low food security, the mean DEPS-R scores for individuals with T1D and T2D were 18.6 ± 11.8 and 21.1 ± 11.7 , respectively (Table 2). In households with high food security, the mean DEPS-R scores for individuals with T1D and T2D were 11.5 ± 8.9 and 15.2 ± 8.8 , respectively.

Regardless of diabetes type, after adjusting for socio-demographics and duration of diabetes, youth and young adults with different levels of household food insecurity scored higher on the DEPS-R compared to those with high food security, the largest difference being with those with very low food security (5.9 points, 95% CI: 4.5, 7.3) (Table 3). Similar patterns were observed when stratifying by diabetes type, the largest differences in youth and young adults with T1D and T2D were with those experiencing very low food security who scored respectively 5.8 points (95% CI: 4.3, 7.4) and 6.6 points (95% CI: 3.3, 9.8) higher than their counterparts with high food security. Additional adjustments for BMI Z-score and/or depressive symptoms did not change the significance of the differences in DEPS-R scores, except for youth and young adults with T1D and marginal food security and youth and young adults with T2D and low food security where the confidence interval (in the model adjusting for both BMI Z-score and depressive symptoms) included the null value.

Discussions

In a large sample of youth and young adults with youth-onset diabetes, we found that participants with different levels of household food insecurity had higher scores for DEB compared to those with high food security, in both those with T1D and T2D, even after adjustments for socio-demographics and diabetes duration. Larger effect sizes were observed among participants with more severe household food insecurity, indicating a dose-response relationship. These findings are similar to a study conducted among adolescents with T1D, which found that adolescent-reported food insecurity was associated with more DEB (34). Some differences with the present study concern the population (10–35 years of age with T1D or T2D vs. 10–17 years with T1D), the utilization of four food security levels rather than dichotomization which allows us to study how the severity of household food insecurity affects DEB, and the food security assessment (HFSSM reported by adults vs. Child Food

Security Assessment questionnaire reported by adolescents). Parent report of children's food insecurity experiences is the typical way to assess food security among youth (24).

Several potential mechanisms may explain the association between food insecurity and DEB in youth and young adults with diabetes. First, greater household food insecurity can influence multiple, overlapping psychosocial problems (35) such as emotional distress (36) and depressive symptoms (18) which are determinants of DEB (3,37). Youth and young adults with household food insecurity and diabetes have additional stressors on their psychosocial wellbeing concerning diabetes management which could increase vulnerability to development of poor mental health (22), and thus, higher risk for DEB. Second, due to the uncertainty in food availability inherent in food insecure households, meal structure and regularity can be hampered (38). Low meal structure, in turn, has been associated with subsequent development of disordered eating in children (39,40). This is consistent with our results by type of diabetes, where individuals with T2D tend to have a lower socioeconomic position (like US national data (41)) and are more likely to have household food insecurity and DEB compared to those with T1D.

There may be a synergistic effect of household food insecurity and DEB that can further inhibit glycemic regulation and long-term health outcomes in diabetes. Indeed, household food insecurity has been associated with elevated cortisol levels, insulin resistance and higher hemoglobin A1c levels in individuals living with diabetes (42,43). Moreover, DEB in persons with diabetes have also been associated with increased hemoglobin A1c and BMI, as well as greater adulthood weight and more frequent episodes of diabetic ketoacidosis (15,16,44). Elevated hemoglobin A1c in youth is associated with greater risk of microvascular complications in adulthood (45). Altogether, evidence is accumulating on the importance of addressing food insecurity and eating behaviors that may impair glucose regulation (e.g., low meal structure, insulin mismanagement, over-consumption of foods that increase glycosuria, food-related guilt that influences cyclical distress, etc.) and increase risk of long-term microvascular damage (46). Addressing these issues may require interventions at individual and structural levels because structural factors such as neighborhood food availability and access, food marketing policies, and government assistance play an important role in eating behaviors (47).

This study is innovative because it considers the level of household food insecurity and DEB in youth and young adults with youth-onset diabetes. This analysis benefited from the large size of the cohort ($n = 2,669$) and the use of validated survey tools despite the pitfall of self-reporting, and the fact that the DEPS-R has not been psychometrically tested for invariance by food security status. A limitation to this study is that characteristics which define household food insecurity and DEB may intersect, for example, cutting the size of meals or skipping meals. Nevertheless, the HFSSM places these experiences in the specific context that it is because there was not enough money for food. There were also differences in recall periods between the HFSSM (prior 12 months) and the DEPS-R (prior 1 month), which may have resulted in non-overlap of household food insecurity and DEB symptoms. Additionally, more than 30% of the observations have been imputed for CES-D and BMI Z-score. Nonetheless, the PMM produces precise and robust imputations (33), and results with or without adjustment for CES-D and BMI Z-score were similar. Temporality of

associations found in this study cannot be established due to the cross-sectional nature of the data.

Household food insecurity levels were associated with DEB in youth and young adults with youth-onset T1D or T2D. Our findings suggest that addressing food insecurity may improve DEB in youth and young adults with diabetes. Our results are consistent with American Diabetes Association guidelines that emphasize the importance of screening for household food insecurity among individuals with diabetes (48). Thus, these results bolster evidence that clinicians and public health professionals should target individuals with diabetes and household food insecurity as being at higher risk for DEB. Regular screening for household food insecurity in clinical settings among youth and young adults with diabetes coupled with appropriate referrals to community and societal level assistance and social support tailored to the individual's age and other characteristics can be beneficial.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

Personal Thanks

The authors thank Emahlea K. Wilcher, University of Washington School of Public Health, Seattle, WA, MPH, for her contributions at an earlier stage of this work.

Funding and Assistance:

The SEARCH for Diabetes in Youth Study is funded by the NIH, National Institute of Diabetes and Digestive and Kidney Diseases (grant no. 1UC4DK108173) and is supported by the Centers for Disease Control and Prevention. SEARCH 4 sites included Kaiser Permanente Southern California (U18DP006133, U48/CCU919219, U01DP000246, and U18DP002714), University of Colorado Denver (U18DP006139, U48/CCU819241-3, U01 DP000247, and U18DP000247-06A1), Cincinnati's Children's Hospital Medical Center (U18DP006134, U48/CCU519239, U01 DP000248, and U18DP002709), University of North Carolina at Chapel Hill (U18DP006138, U48/CCU419249, U01 DP000254, and U18DP002708), Seattle Children's Hospital (U18DP006136, U58/CCU019235-4, U01 DP000244, and U18DP002710-01), and Wake Forest University School of Medicine (U18DP006131, U48/CCU919219, U01 DP000250, and 200-2010-35171). This study was also supported by the SEARCH Food Security Cohort Study (R01DK117461, MPI: Liese & Mendoza). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of NIDDK, NIH. The study sponsor had no role in study design; collection, analysis, and interpretation of data; writing the report; nor the decision to submit the report for publication.

Data availability:

Data described in the manuscript, code book, and analytic code will be made available upon publication to investigators whose proposed use of the data has been approved by an independent review committee. Proposals should be directed to the corresponding author Jason A. Mendoza at jmendoza@fredhutch.org; to gain access, data requesters will need to sign a data use agreement.

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Public significance:

Few studies have assessed the association between food insecurity levels and disordered eating behaviors in youth and young adults with diabetes. In our study, disordered eating behavior scores among participants with marginal, low and very low food security were higher than those with high food security, across type of diabetes. Addressing food insecurity may decrease disordered eating behaviors among youth and young adults with diabetes.

Table 1.

Descriptive statistics of youth and young adults with diabetes in the SEARCH for Diabetes in Youth Study (2015–2020), stratified by diabetes type

	All (N=2,669) n (%)	Type 1 Diabetes (n=2,274) n (%)	Type 2 Diabetes (n=395) n (%)
Sex[†]			
Female	1,446 (54.18%)	1,181 (51.93%)	265 (67.09%)
Male	1,223 (45.82%)	1,093 (48.07%)	130 (32.91%)
Age at Study Visit (years)[†]			
Mean (SD)	21.54 (5.11)	21.00 (5.04)	24.70 (4.30)
Median [Min, Max]	21.42 [10.03, 35.99]	20.81 [10.0, 35.99]	24.72 [11.00, 35.57]
10 – 17 years	699 (26.19%)	676 (29.73%)	22 (5.57%)
18 – 35 years	1,970 (73.81%)	1,598 (70.27%)	373 (94.43%)
Diabetes Duration (years)[†]			
Mean (SD)	11.18 (3.32)	11.33 (3.26)	10.32 (3.53)
Median [Min, Max]	11.83 [4.92, 17.67]	11.92 [4.92, 17.67]	11.00 [4.92, 17.08]
Race and Ethnicity[†]			
Hispanic	397 (14.87%)	302 (13.28%)	95 (24.05%)
Non-Hispanic Asian or Pacific Islander	63 (2.36%)	51 (2.24%)	12 (3.04%)
Non-Hispanic Black	446 (16.71%)	266 (11.70%)	180 (45.57%)
Non-Hispanic Native American	47 (1.76%)	14 (0.62%)	33 (8.35%)
Non-Hispanic White	1,708 (63.99%)	1,634 (71.86%)	74 (18.73%)
More Than One Race	8 (0.30%)	7 (0.30%)	1 (0.25%)
Levels of Parent Education^{**†}			
Less than high school graduate	150 (5.62%)	103 (4.53%)	47 (11.90%)
High school graduate	457 (17.12%)	327 (14.40%)	130 (32.91%)
Associate degree or some college	771 (28.89%)	620 (27.26%)	151 (38.23%)
Bachelor's degree or above	1,291 (48.37%)	1,224 (53.82%)	67 (16.96%)
Levels of Participant Education^{**†}			
Less than high school graduate	850 (31.85%)	784 (34.48%)	66 (16.71%)
High school graduate	575 (21.54%)	431 (18.95%)	144 (36.46%)
Associate degree or some college	832 (31.17%)	682 (29.99%)	150 (37.97%)
Bachelor's degree or above	412 (15.44%)	377 (16.58%)	35 (8.86%)
Household Income^{**†}			
Less than \$25,000	656 (24.58%)	457 (20.10%)	199 (50.38%)
\$25,000 to \$49,000	628 (23.53%)	503 (22.12%)	125 (31.65%)
\$50,000 to \$74,000	413 (15.47%)	383 (16.84%)	30 (7.59%)
Greater than \$75,000	972 (36.42%)	931 (40.94%)	41 (10.38%)

	All (N=2,669) n (%)	Type 1 Diabetes (n=2,274) n (%)	Type 2 Diabetes (n=395) n (%)
Participant Health Insurance ^{*†}			
Private insurance	1,901 (71.23%)	1,724 (75.81%)	177 (44.81%)
Medicare and/or Medicaid	470 (17.61%)	347 (15.26%)	123 (31.14%)
Other type of health insurance	162 (6.07%)	126 (5.54%)	36 (9.11%)
No health insurance	136 (5.09%)	77 (3.39%)	59 (14.94%)
Food Security Status ^{*†}			
High Food Security	1,804 (67.59%)	1,608 (70.71%)	196 (49.62%)
Marginal Food Security	343 (12.85%)	264 (11.61%)	79 (20.00%)
Low Food Security	297 (11.13%)	226 (9.94%)	71 (17.97%)
Very Low Food Security	225 (8.43%)	176 (7.74%)	49 (12.41%)
Disordered Eating Behaviors ^{*†}			
Mean (SD)	13.54 (9.47)	12.85 (9.33)	17.54 (9.56)
Median [Min, Max]	12.00 [0.00, 68.00]	11.00 [0.00, 68.00]	15.50 [0.00, 53.00]
Yes (score ≥ 20)	618 (23.15%)	554 (20.76%)	984 (36.87%)
No (score < 20)	2,051 (76.85%)	2,115 (79.24%)	1,685 (63.13%)
Depressive Symptoms Score ^{*†}			
Mean (SD)	10.39 (9.10)	9.94 (9.01)	13.00 (9.12)
Median [Min, Max]	8.00 [0.00, 55.00]	8.00 [0.00, 55.00]	11.00 [0.00, 50.00]

* After multiple imputation by predictive mean matching

† p-value <0.05

Food Security Status is measured with the 18-item Household Food Security Survey Module.

Disordered Eating Behaviors are measured with the 16-item Diabetes Eating Problem Survey-Revised.

Depressive symptoms are measured with the 20-item Center for Epidemiologic Studies Depression Scale.

Table 2.

Bivariate analysis of household food insecurity levels vs. disordered eating behaviors as measured by DEPS-R score in youth and young adults with diabetes, stratified by diabetes type

		DEPS-R score*			
		High FS	Marginal FS	Low FS	Very Low FS
All	<i>n</i>	1,804	343	297	225
	Mean (SD)	11.87 (9.00)	15.70 (10.67)	16.89 (10.58)	19.18 (11.83)
	Median [min, max]	10.00 [0.00, 53.00]	13.00 [0.00, 68.00]	15.00 [0.00, 58.00]	17.00 [0.00, 67.00]
Type 1 Diabetes	<i>n</i>	1608	264	226	176
	Mean (SD)	11.46 (8.94)	14.49 (10.14)	16.26 (10.62)	18.63 (11.84)
	Median [min, max]	10.00 [0.00, 53.00]	12.00 [0.00, 68.00]	15.00 [0.00, 58.00]	16.00 [0.00, 67.00]
Type 2 Diabetes	<i>n</i>	196	79	71	49
	Mean (SD)	15.24 (8.75)	19.75 (11.40)	18.89 (10.30)	21.13 (11.73)
	Median [min, max]	14.00 [0.00–49.00]	18.500 [1.00, 53.00]	17.00 [0.00, 44.00]	17.00 [1.00, 50.00]

Abbreviations: DEPS-R, Diabetes Eating Problem Survey-Revised; FS, Food Security

* After multiple imputation by predictive mean matching

Table 3.

Difference in disordered eating behaviors as measured by DEPS-R by household food insecurity level among youth and young adults with type 1 and type 2 diabetes

		Difference in DEPS-R scores (95% CI)		
		Marginal vs. High FS	Low vs. High FS	Very Low vs. High FS
All N = 2,669	Model 1	3.83 (2.72, 4.94)	5.01 (3.82, 6.21)	7.31 (5.92, 8.69)
	Model 2	2.97 (1.85, 4.09)	3.98 (2.78, 5.19)	5.91 (4.52, 7.30)
	Model 3	2.80 (1.68, 3.92)	4.02 (2.86, 5.18)	6.28 (4.88, 7.69)
	Model 4	1.86 (0.77, 2.95)	2.33 (1.04, 3.62)	2.89 (1.40, 4.38)
	Model 5	1.67 (0.55, 2.79)	2.34 (1.13, 3.56)	3.23 (1.61, 4.86)
Type 1 Diabetes n = 2,274	Model 1	3.08 (1.85, 4.31)	4.77 (3.47, 6.08)	7.53 (6.05, 9.00)
	Model 2	2.42 (1.16, 3.67)	3.99 (2.63, 5.35)	5.81 (4.25, 7.37)
	Model 3	2.28 (1.01, 3.55)	4.05 (2.74, 5.37)	6.19 (4.54, 7.83)
	Model 4	1.32 (0.06, 2.57)	2.37 (0.89, 3.84)	2.57 (0.79, 4.35)
	Model 5	1.16 (-0.16, 2.48)	2.41 (1.03, 3.79)	2.91 (0.91, 4.91)
Type 2 Diabetes n = 395	Model 1	4.51 (1.79, 7.23)	3.65 (0.93, 6.36)	5.90 (2.78, 9.01)
	Model 2	4.59 (1.90, 7.28)	4.30 (1.53, 7.08)	6.58 (3.34, 9.82)
	Model 3	4.39 (1.77, 7.02)	4.21 (1.45, 6.96)	6.65 (3.49, 9.82)
	Model 4	3.72 (1.11, 6.33)	2.77 (0.05, 5.50)	4.72 (1.60, 7.84)
	Model 5	1.16 (0.89, 5.92)	2.53 (-0.18, 5.24)	4.66 (1.60, 7.72)

Abbreviations: DEPS-R, Diabetes Eating Problem Survey-Revised; CI, Confidence interval; FS, Food Security

Model 1= unadjusted

Model 2= adjusted for sex, age, race and ethnicity, participant education, parent education, household income, participant health insurance, and duration of diabetes

Model 3 (sensitivity analysis) = model 2 + additional adjustment for body mass index Z-score

Model 4 (sensitivity analysis) = model 2 + additional adjustment for depressive symptoms

Model 5 (sensitivity analysis) = model 2 + additional adjustment for body mass index Z-score and depressive symptoms