The association 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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Abstract

The association 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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Objective: The purpose of this study is to examine the relationship between household food insecurity (HFS; i.e., access to nutritionally adequate and safe food) and disordered eating behaviors (i.e., restriction, bingeing, insulin manipulation, etc.) among a sample of youth and young adults with youth-onset type 1 (T1D) or type 2 diabetes (T2D).

Methods: We used cross-sectional data of 2,669 individuals from the SEARCH for Diabetes in Youth Study. Participants ages 18–35 years or parents of participants ages 10–17 years completed the U.S. Household Food Security Survey Module (HFSSM) and the Diabetes Eating Problem Survey-Revised (DEPS-R) between 2016 and 2019. We excluded individuals without completed DEPS-R or HFSSM questions (n = 203) and calculated descriptive statistics of the included study population (n = 2,466). We converted HFS scores to a 10-point standardized scale and dichotomized scores into food secure (HFS ≤ 2.2) vs. food insecure (HFS > 2.2). We used multivariable linear regression to evaluate the association of HFS with continuous DEPS-R score (i.e., 0–80, with a higher score indicating higher levels of disordered

eating behaviors), adjusting for potential confounders (i.e., sex, age, race/ethnicity, participant education, parent education, household income, participant health insurance, presence of depressive symptoms, body mass index, and duration of diabetes). We further stratified analyses by diabetes type. We used predictive mean matching multiple imputation to address missing covariate data, including depressive symptoms (as defined by a score of 10 or greater on the Center for Epidemiologic Studies Depression Scale; missingness: 36%), income (missingness: 24%), highest level of parent education (missingness: 3%), and body mass index (missingness: 36%).

Results: Participants were on average approximately 22 ± 5 years, 55% female, 69% non-Hispanic White, and had a mean diabetes duration of 11 ± 3 years. The overall mean DEPS-R score was 14.6 ± 10.1 points. Mean unadjusted DEPS-R scores in individuals living in food secure households (n = 2,114) and food insecure households (n = 353) were 13.8 ± 9.6 and 19.6 ± 11.3, respectively. The adjusted DEPS-R scores were 3.8 points (95% confidence interval, CI: 2.8, 4.9; $p < 0.001$) higher in food insecure compared to food secure households. In the adjusted models stratified by diabetes type, for individuals with T1D (n = 2,185), the DEPS-R scores were 3.7 points (95% CI: 2.6, 4.9; $p < 0.001$) higher in individuals from food insecure compared to food secure households. However, both the unadjusted and adjusted multivariable regression models for individuals with T2D (n = 360) displayed no significant difference in mean DEB scores (95% CI: –0.3, 4.7; $p = 0.086$) between food insecure versus food secure households.

Conclusions: Household food insecurity among youth and young adults with T1D ($p < 0.001$), and possibly T2D ($p = 0.086$), is associated with more disordered eating behaviors. These results suggest that addressing food insecurity among youth and young adults with T1D may decrease risk of disordered eating behaviors and provide another reason to screen individuals with T1D for food insecurity. Additionally, follow-up analyses with a greater number of participants to determine the relationship between food insecurity and disordered eating behaviors in individuals with T2D are warranted.

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Introduction

Disordered eating behaviors (DEB) are patterns of irregular or abnormal eating, often coupled with a psychological distress component.[1] While DEB may be a precursor to or an indicator of a clinically-diagnosable eating disorder (e.g., anorexia nervosa, bulimia nervosa, binge eating disorder, etc.), DEB is generally a descriptive term that refers to the behaviors associated with psychologically-affected atypical food consumption.[1,2] On the other hand, an eating disorder is a clinical diagnosis characterized by DEB(s) among other traits; thus, DEB are not always indicative of a clinical eating disorder.[3] Similar to eating disorders, DEB exist on a spectrum of severity and are typically marked by comorbid psychological disturbances, such as major depressive disorder or generalized anxiety disorder.[4] DEB present in various ways, including chronic dieting, compensatory behaviors (e.g., self-induced vomiting, over-exercising, use of laxatives or emetics, etc.), weight cycling, and intentional restriction of food intake. Longitudinal studies have revealed that presence of DEB in young adults is associated with negative long-term health consequences, including self-reported poor physical and mental health[4] and diminished social support,[5] the latter of which may persist into mid-age adulthood for women.[6] Greater weight gain compared to peer counterparts has also been demonstrated as a long-term outcome of sustained presence of DEB.[4]

DEB are twice as common in adults with type 1 diabetes (T1D) compared to those without diabetes.[2] Individuals who use insulin may experience “diabulimia,” a DEB characterized by binge eating behavior followed by intentional withholding of insulin with or without self-induced compensatory practice(s) (e.g., self-induced vomiting, overexercise, etc.) in an attempt to limit overall energy intake.[2,3,7] Presence of DEB in individuals with diabetes are associated with health complications, including higher blood glucose and glycosylated hemoglobin levels over time, which can increase risk of diabetic ketoacidosis, microvascular damage, and mortality.[1,2,3(p1),8(p1)] DEB are more prevalent in individuals with type 2 diabetes (T2D) than those with T1D.[2] Binge eating behaviors are most common among those with T2D and DEB,[9] and binge eating can markedly increase the risk of developing T2D.[10] Similar to diabulimia in those with T1D, individuals with T2D may intentionally withhold doses of hypoglycemic drugs, leading to increased weight

loss via glycosuria.[11,12] Due to the resulting poor glycemic control and more frequent episodes of ketoacidosis, DEB are associated with long-term complications of T2D, including nephropathy (and resulting chronic kidney disease) and early death.[2(p2),11(p2),13(p2)]

Household food insecurity – an inability to access to safe and nutritionally adequate food – is associated with poor health outcomes and may be a risk factor for DEB.[14–16] Cyclical eating (i.e., alternating periods of restriction followed by overconsumption), binge eating, food-related guilt, and weight self-stigma have been associated with food insecurity in the general population.[14,15,17,18] There is evidence that household food insecurity may be a risk factor for poor glycemic control and increased utilization of healthcare in youth and young adults with diabetes,[19] but studies regarding the relationship between household food security and DEB in individuals with diabetes are sparse.

The purpose of this study was to examine the association of food insecurity and DEB among a population of youth and young adults with T1D or T2D. It was hypothesized that food insecurity will be associated with greater levels of disordered eating behaviors in youth and young adults with type 1 diabetes or type 2 diabetes.

Methods

Study population

We used cross-sectional data of 2,669 eligible individuals from the SEARCH for Diabetes in Youth Study, an ongoing multicenter study that explores diabetes-related outcomes among youth and young adults in the United States. Between 2016 and 2019, participants ages 18–35 years and parents/guardians of participants ages 10-17 years completed the U.S. Household Food Security Survey Module (HFSSM), and all participants completed the Diabetes Eating Problem Survey-Revised (DEPS-R). Those who did not complete the DEPS-R or HFSSM questions were excluded (n = 203), resulting in a final study population of 2,466 individuals.

Household food security

Adults over the age of 18 completed a 10-question HFSSM if their household had no resident children; otherwise, participants living in households with children were administered an 18-question HFSSM, completed by an adult participant or non-participant guardian over the age of 18 who also resided in the household. The self-reported HFSSM can be completed in a short period of time, and the mode of online survey administration limits the likelihood of social desirability bias.[20,21] Additionally, the HFSSM has been demonstrated to be valid and reliable in varying populations, including pregnant women, men, and people of color.[13,21] The HFSSM in SEARCH measured the prior 12-month period. Household food security (HFS) scores (0–10 for households without children and 0–18 for households with children) were converted to a standardized 10-point scale and then further dichotomized into food secure (HFS ≤ 2.2) vs. food insecure (HFS > 2.2), as indicated by the HFSSM Guide.[22]

Disordered eating behaviors

In the SEARCH cohort, presence of DEB were measured via the DEPS-R, a 16-item, six-point Likert scale questionnaire with an overall score range of 0–80.[13,23] The DEPS-R can be completed in approximately 10 minutes and has high internal validity and reliability across varying populations when compared to provider diagnoses, the *Diagnostic and Statistical Manual of Mental Disorders*, and the Eating Disorder Inventory survey.[23–25] The DEPS-R is validated in individuals who are 10 years of age or older. While some questions in the DEPS-R focus on general disordered eating behaviors (e.g., self-imposed weight focus and perception, self-induced vomiting, intake restriction etc.), others are diabetes-specific (e.g., intentional sustained hyperglycemia, self-induced ketonuria, self-importance of diabetes management). The DEPS-R in SEARCH measured the prior 1-month period. Scores were on a continuous scale during analyses, with a higher presence of DEB being indicated by a higher score on the DEPS-R. The distribution of DEPS-R was assessed for linearity, normality, and homoscedasticity prior to conducting analyses.

Statistical analyses

We calculated descriptive statistics for the 2,466 individuals included in the cohort and stratified by diabetes type. We used multivariable linear regression to evaluate the association of dichotomous HFS with continuous DEPS-R score, adjusting for potential confounders (i.e., sex, age, race/ethnicity, participant education, parent education, household income, participant health insurance, presence of depressive symptoms, body mass index, and duration of diabetes). We further stratified these analyses by diabetes type. Multiple imputation by predictive mean matching was used to address missing covariate data, including depressive symptoms (as defined by a score of 10 or greater on the Center for Epidemiologic Studies Depression Scale,[26] CES-D; missingness: 36.4%), household income (missingness: 24.2%), highest level of parent education (missingness: 3.1%), and body mass index (missingness: 36.0%).

Results

Participants were on average 21.6 ± 5.1 years of age, 54.9% female, 68.5% non-Hispanic White, 15% Hispanic, and 16.3% non-Hispanic Black *(Table 1)*. Approximately 29.2% of participants had a household income of at least $75,000, and 16.7% of participants lived with a household income of less than $25,000. While the majority of participants had private health insurance (72%) or Medicaid and/or Medicare (17.3%), only 4.8% of participants reported having no health insurance. The mean body mass index (BMI) of participants was 27.7 ± 7.7 kg/m^2; those with T1D had a mean BMI of 25.4 ± 5.2 kg/m^2, compared to a mean BMI of 36.5 ± 9.2 kg/m^2 in participants with T2D. Overall, the mean diabetes duration of all participants was 11.2 ± 3.3 years; those with T1D had diabetes for 11.4 ± 3.2 years, and those with T2D had diabetes for 10.3 ± 3.6 years.

The unadjusted mean DEPS-R score in the overall sample (*n* = 2,466) was 14.6 ± 10.1 points *(Table 2)*. Mean unadjusted DEPS-R scores in individuals living in food secure households (*n* = 2,241) and food insecure households (*n* = 225) were 14.0 ± 9.7 and 20.4 ± 12.1, respectively *(Table 2)*. In food secure households, the mean unadjusted DEPS-R scores for individuals with T1D and T2D were 13.5 ± 9.5 and 17.6 ± 10.1, respectively. Of the remaining households (i.e., those considered to be food insecure), the

mean unadjusted DEPS-R scores for individuals with T1D and T2D were 20.2 ± 12.2 and 20.9 ± 11.7, respectively. The adjusted DEPS-R scores in the overall sample were 3.9 points (95% CI: 2.7, 5.2; $p < 0.001$) higher in food insecure compared to food secure households *(Table 3).*

In the adjusted multivariable regression model for individuals with T1D (*n* = 2,106), the DEPS-R scores were 3.7 points (95% CI: 2.3, 5.1; $p < 0.001$) higher in food insecure (*n* = 170) compared to food secure (*n* = 1,936) households *(Table 3)*. In the same model for individuals with T2D (*n* = 360), the DEPS-R scores were 3.0 points (95% CI: 2.3, 5.1; $p = 0.045$) higher in food insecure (*n* = 55) compared to food secure (*n* = 305) households.

Discussion

Our study suggests that in a sample of youth and young adults with type 1 diabetes, household food insecurity is associated with increased disordered eating behaviors (DEB), as determined by the Diabetes Eating Problem Survey-Revised. However, this relationship between household food insecurity and DEB lacked statistical significance in individuals with type 2 diabetes, potentially due to insufficient power as a result of a diminished sample size. Despite this, the value of disordered eating scores was greater overall for individuals with type 2 diabetes.

DEB have been associated with both type 1[1,2,27–29] and type 2[3,9–11,30] diabetes, and food insecurity is also associated with both DEB[14,17,31,32] and diabetes.[7,19,33,34] To the best of our knowledge, however, unlike other studies, our findings establish a novel relationship between food insecurity and DEB in an otherwise unexamined population of youth and young adults with T1D or T2D. Due to the tumultuous nature of uncertainty surrounding food acquisition, meal structure and regularity can be hampered in households with food insecurity.[35] There is evidence of a relationship between children whose family or home experience provided low meal structure and subsequent development of disordered eating,[36,37] possibly explaining the link between household food insecurity and disordered eating behaviors in youth. In both children and adults, sustained exposure to stressors – such as food insecurity[32,38,39] and/or a chronic

disease[16,40,41] – are known etiologies of DEB and eating disorders.[42] We speculate that food insecurity may strengthen or reinforce DEB (e.g., binge eating, food hoarding, obsessive or persisting thoughts about food, food-related guilt, etc.), thus worsening the effect and magnitude of DEB.

Previous studies suggest that greater food insecurity can influence emotional distress[32] and interfere with an individual's ability to achieve adequate diabetes care,[19,33] and inability to address one's own health needs can further increase stress and limit self-efficacy.[43] This could, in turn, potentially give rise to disordered eating behaviors or worsen existing behaviors. Additionally, there is evidence that food insecurity can exacerbate high-risk blood glucose variability (i.e., "glycemic control"[44]) in individuals living with diabetes,[19,34] and there may be a synergistic effect of increased food insecurity and presence of DEB that can further inhibit glycemic regulation. High variability in blood glucose regulation in youth is associated with greater risk of microvascular complications in adults with diabetes,[45] and adults who experienced food insecurity as children are more likely to have higher BMI, DEB, and depressive symptoms.[15] In conjunction with the evidence from our study, this highlights the importance of preventing food insecurity and behaviors that may impair glucose regulation (e.g., diabulimia, over-consumption of foods that increase glycosuria, etc.) or increase risk of long-term microvascular damage.[7,46]

Strengths

This cross-sectional analysis was favorable in its large sample size of the entire study population (*n* = 2,466) and participants with T1D (*n* = 2,106), allowing us to capture the relationship between household food insecurity and disordered eating behaviors in youth and young adults with type 1 diabetes. Our sample of individuals with T2D were This study is novel not only in its contribution to the literature base by examining the association between household food insecurity and disordered eating behaviors in individuals with diabetes – a population that has been neglected in the realm of this relationship – but we also adjusted for multiple social determinants of health beyond the typically-included demographic data (e.g., race/ethnicity, household income, participant education, etc.). These covariates included body mass index,[47] parent education, and participant health insurance. In addition, this study controlled for participant

duration of diabetes and depressive symptoms. Finally, to the best of our knowledge, our study is the first of its kind to explore this relationship in two major age groups – youth and young adults – with diabetes.

Limitations

Measurement error, residual confounding, unmeasured and/or unknown confounding variables, and self-report error and/or recall bias are potential factors that may have introduced information bias into this study. However, the use of validated survey tools strengthened the internal validity of our study. The HFSSM and DEPS-R were self-administered to participants, which likely limited social desirability bias in reporting; however, results from a qualitative study conducted in 2019 suggest that fathers who are answering the HFSSM on behalf of their children may feel less comfortable with accurately recounting their household food security status.[20] The use of validated binary HFS categories likely mitigated the impact of potential under-reporting by fathers or male guardians, as we were unable to determine the gender of parents completing the HFSSM on behalf of their child participant.

The HFSSM captured household food security over the prior 12-month period, and the DEPS-R captured disordered eating behaviors over the prior 1-month period. While there is only one month of overlap in these periods, temporality cannot be definitively established for two reasons: 1) the nature of cross-sectional data provide only a “snapshot” view of the relationship between an exposure and outcome, and 2) the DEPS-R module had been implemented for the first time in the SEARCH 4 Cohort between 2016 and 2019. Therefore, it is unclear as to whether household food insecurity precedes disordered eating behaviors or vice versa. A longitudinal study with repeated measures and follow-up could strengthen the link between household food insecurity and disordered eating overall, especially in those with type 2 diabetes.

While there was evidence for the relationship between HFS and DEB for individuals with T1D, our study was likely limited by sample size in those without T1D, as this relationship lacked statistical significance at $p < 0.05$ in those with T2D ($p = 0.086$). However, individuals with T2D had higher disordered eating

scores overall (compared to those with T1D). Furthermore, our population of individuals with T1D was majority non-Hispanic White, which limits the external validity (i.e., generalizability) of our data to a wider population.

Future work and public health impact

Further examination of the relationship between household food insecurity and disordered eating behaviors in individuals with type 2 diabetes is warranted, as this high-risk group has greater disordered eating behavior scores overall. Incorporating a longitudinal design with repeated measures, a last observation carried forward imputation approach, and a larger sample of individuals with type 2 diabetes is indicated. Other future work should emphasize recruiting a more diverse population of participants, as our sample was majority non-Hispanic white. Sub-analyses by race and ethnicity would help determine the effect of race on the relationship between household food insecurity and disordered eating behaviors.

This study can generate further research and may have public health impact. Addressing food insecurity may decrease risk of DEB and provide additional screening opportunities for food insecurity. Intensive interventions that combine treatment modalities for both DEB as well as management of diabetes are recommended to co-treat disordered eating in those with diabetes;[27] however, such interventions can be costly or otherwise unattainable for those living in low-income or otherwise impoverished settings, which may worsen the burden on health.[48] Additionally, results from this study suggest that increased disordered eating behavior screening for those with T2D is advisable, as those with T2D have higher overall disordered eating scores. These results may allow clinicians and other public health professionals to target individuals with household food insecurity – particularly those with T1D – as being at higher risk for potential disordered eating.

Tables

Table 1. Descriptive statistics of full cohort, pre-imputation, stratified by diabetes type.

	Type 1 (N=2106)	Type 2 (N=360)	Overall (N=2466)
Sex			
Female	1110 (52.7%)	243 (67.5%)	1353 (54.9%)
Male	996 (47.3%)	117 (32.5%)	1113 (45.1%)
Age at study visit (years)			
Mean (SD)	21.1 (5.04)	24.7 (4.34)	21.6 (5.10)
Median [Min, Max]	20.9 [10.0, 36.0]	24.7 [11.0, 35.6]	21.5 [10.0, 36.0]
Race/ethnicity			
Non-Hispanic White	1582 (75.1%)	106 (29.4%)	1688 (68.5%)
Hispanic	279 (13.2%)	90 (25.0%)	369 (15.0%)
Non-Hispanic Black	239 (11.3%)	163 (45.3%)	402 (16.3%)
Other	6 (0.3%)	1 (0.3%)	7 (0.3%)
Highest level of participant education			
Less than high school graduate	707 (33.6%)	53 (14.7%)	760 (30.8%)
High school graduate	395 (18.8%)	129 (35.8%)	524 (21.2%)
Associates degree or some college	646 (30.7%)	144 (40.0%)	790 (32.0%)
Bachelors degree or above	358 (17.0%)	34 (9.4%)	392 (15.9%)
Highest level of parent education			
Less than high school graduate	85 (4.0%)	36 (10.0%)	121 (4.9%)
High school graduate	279 (13.2%)	106 (29.4%)	385 (15.6%)
Associates degree or some college	558 (26.5%)	132 (36.7%)	690 (28.0%)
Bachelors degree or above	1132 (53.8%)	62 (17.2%)	1194 (48.4%)
Missing	52 (2.5%)	24 (6.7%)	76 (3.1%)
Household income			
Less than $25,000	302 (14.3%)	110 (30.6%)	412 (16.7%)
$25,000 to $49,000	360 (17.1%)	83 (23.1%)	443 (18.0%)
$50,000 to $74,000	277 (13.2%)	17 (4.7%)	294 (11.9%)
Greater than $75,000	698 (33.1%)	21 (5.8%)	719 (29.2%)
Missing	469 (22.3%)	129 (35.8%)	598 (24.2%)
Participant insurance			
Private insurance	1608 (76.4%)	168 (46.7%)	1776 (72.0%)
Medicare and/or Medicaid	317 (15.1%)	110 (30.6%)	427 (17.3%)
Other type of health insurance	112 (5.3%)	32 (8.9%)	144 (5.8%)
No health insurance	69 (3.3%)	50 (13.9%)	119 (4.8%)
CES-D score			
Mean (SD)	10.2 (8.87)	12.9 (8.90)	10.7 (8.94)
Median [Min, Max]	7.50 [0, 55.0]	10.0 [0, 43.0]	8.00 [0, 55.0]
Missing	870 (41.3%)	28 (7.8%)	898 (36.4%)
Body mass index (kg/m^2)			
Mean (SD)	25.4 (5.20)	36.5 (9.21)	27.7 (7.73)
Median [Min, Max]	24.5 [15.5, 49.7]	34.6 [19.4, 81.2]	26.0 [15.5, 81.2]
Missing	861 (40.9%)	27 (7.5%)	888 (36.0%)
Diabetes duration (years)			
Mean (SD)	11.4 (3.23)	10.3 (3.57)	11.2 (3.30)
Median [Min, Max]	12.0 [4.92, 17.7]	11.0 [4.92, 17.1]	11.8 [4.92, 17.7]

Table 2. Mean unadjusted disordered eating behavior* score, points (± SD**), and household food security, n (%), stratified by diabetes type.***

	Type 1 (N=2106)	Type 2 (N=360)	Overall (N=2466)
DEPS-R score			
Mean (SD)	14.0 (9.91)	18.1 (10.4)	14.6 (10.1)
Median [Min, Max]	12.0 [1.00, 70.0]	16.0 [1.00, 55.0]	12.0 [1.00, 70.0]
Household food security			
Food insecure	274 (13.0%)	79 (21.9%)	353 (14.3%)
Food secure	1832 (87.0%)	281 (78.1%)	2113 (85.7%)

**Based on score from the Diabetes Eating Problem Survey-Revised*
***SD = standard deviation*
****Values obtained post-imputation*

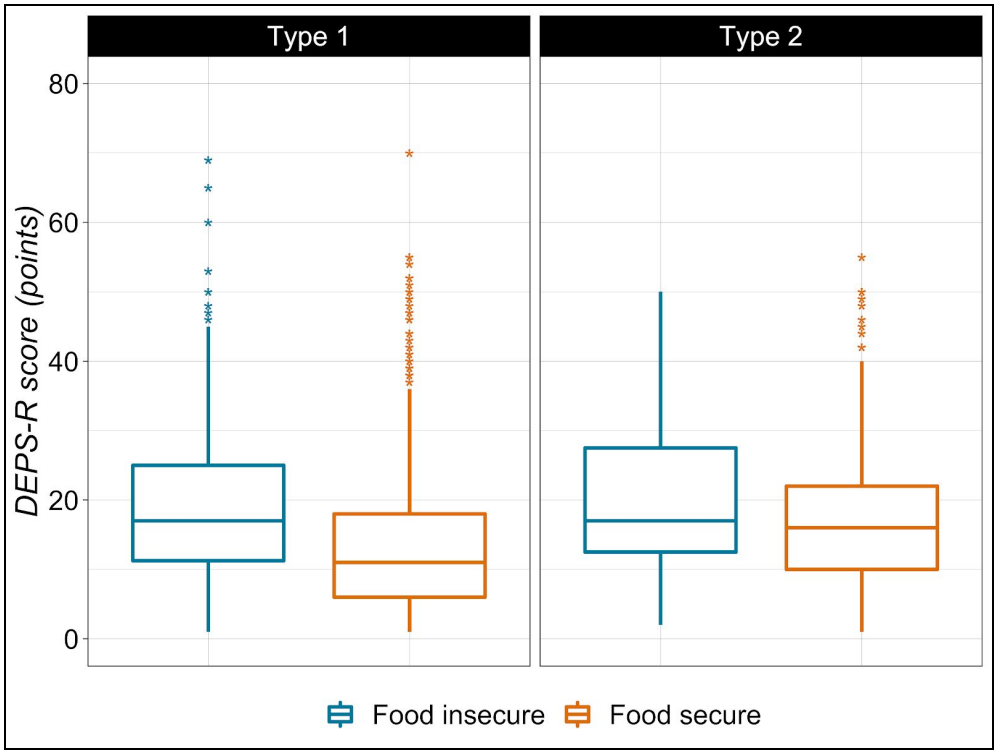
Table 3. Multivariable linear regression models.

Difference in DEPS-R scores, food insecure vs food secure, adjusted* *(95% CI**)*		*p-value****
Overall *(unadjusted)* *n = 2,466*	6.3 *(5.0, 7.7)*	*< 0.001*
Overall *n = 2,466*	3.8 *(2.8, 4.9)*	*< 0.001*
Type 1 diabetes *n = 2,106*	3.7 *(2.6, 4.9)*	*< 0.001*
Type 2 diabetes *n = 360*	3.0 *(–0.3, 4.7)*	*0.086*

**Adjusted for confounding variables: sex, age, race/ethnicity, participant education, parent education, household income, participant health insurance, presence of depressive symptoms, body mass index, and duration of diabetes*
***CI = confidence interval*
****p < 0.05 considered to be significant*

Figures

Figure 1. Adjusted disordered eating behavior* scores versus HFS,** stratified by diabetes type, post-imputation.



Based on score from the Diabetes Eating Problem Survey-Revised
**Based on score from the United States Household Food Security Survey Module*

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Glossary

CI: confidence interval

DEB: disordered eating behavior(s)

DEPS-R: Diabetes Eating Problem Survey-Revised

HFS: household food (in)security

HFSSM: Household Food Security Survey Module

SD: standard deviation

T1D: type 1 diabetes

T2D: type 2 diabetes