HHS Public Access

Author manuscript

J Phys Act Health. Author manuscript; available in PMC 2025 January 10.

Published in final edited form as:

J Phys Act Health. 2024 January 01; 21(1): 77–84. doi:10.1123/jpah.2022-0338.

Household Food Insecurity Is Associated With Physical Activity in Youth and Young Adults With Diabetes: A Cross-Sectional Study

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Abstract

Background: Physical activity (PA) is essential for optimal diabetes management. Household food insecurity (HFI) may negatively affect diabetes management behaviors. The purpose of this study was to cross-sectionally examine the association between HFI and PA in youth and young adults (YYA) with type 1 (N = 1998) and type 2 (N = 391) diabetes from the SEARCH for Diabetes in Youth Study.

Methods: HFI was measured with the US Household Food Security Survey Module. PA was measured with the International Physical Activity Questionnaire Short Form. Walking, moderate-intensity PA (excluding walking), vigorous-intensity PA, moderate- to vigorous-intensity PA, and total PA were estimated as minutes per week, while time spent sitting was assessed in minutes per day. All were modeled with median regression. Meeting PA guidelines or not was modeled using logistic regression.

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Results: YYA with type 1 diabetes who experienced HFI spent more time walking than those who were food secure. YYA with type 2 diabetes who experienced HFI spent more time sitting than those who were food secure.

Conclusions: Future research should examine walking for leisure versus other domains of walking in relation to HFI and use objective PA measures to corroborate associations between HFI and PA in YYA with diabetes.

Keywords

epidemiology; health determinants; sitting/standing; survey research; public health; guidelines and recommendations

The SEARCH for Diabetes in Youth Study (SEARCH) has documented that the incidence and prevalence of type 1 and type 2 diabetes among youth (<20 y) and young adults (≤35 y) (YYA) are increasing in the United States.[1–4] The adjusted annual percent change in incidence from 2002–2003 to 2014–2015 was 1.9% for YYA with type 1 diabetes and 4.8% for YYA with type 2 diabetes.[3] Furthermore, between 2001 and 2017, the prevalence of type 1 diabetes among youth increased by 45%, and the prevalence of type 2 diabetes among youth increased by 95%.[4] As the prevalence of diabetes in YYA continues to increase, identifying unique treatment plans focused on the management of diabetes in YYA becomes increasingly important.

Household food insecurity (HFI) has been identified as a modifiable risk factor which directly affects diabetes management[5] and is associated with health behaviors which impact diabetes management.[6–10] HFI is "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways."[11,12] Between 2015 and 2019, approximately 18% of YYA with type 1 diabetes and 31% of YYA with type 2 diabetes experienced HFI sometime during a 12-month period.[13] One pathway through which HFI may relate to physical activity (PA) is the fatigue and depression associated with inadequate intake of nutritious food may decrease some individuals' motivation for PA and/or make PA challenging.[14–16]

The benefits of regular PA for people with diabetes are well established[17–21] and include acute and chronic improvements in insulin action.[18,21] For this reason, the American Diabetes Association recommends youth with type 1 diabetes and type 2 diabetes engage in 60 minutes of moderate- to vigorous-intensity physical activity (MVPA) per day and muscle and bone strengthening activities a minimum of 3 days per week.[22] This recommendation is in accordance with the 2018 PA guidelines for all children.[23] Further, the 2018 Physical Activity Guidelines for Americans (PAGA) state that adults with chronic health conditions should engage in at least 150 minutes of moderate-intensity PA (MPA) per week, 75 minutes of vigorous-intensity PA (VPA) per week, or an equivalent of MVPA.

Unfortunately, many people do not meet the current PA and guidelines. Based on objectively measured PA data (via accelerometers) from a nationally representative sample, 42% of children ages 6–11 years old obtain the recommended 60 minutes of MVPA per day; however, only 8% adolescents reach this goal. Studies assessing PA levels in youth with

diabetes are inconsistent. While some studies conclude that PA levels of youth with diabetes are either comparable to or lower than PA levels of youth without diabetes,[18,24] others indicate this population typically meets PA recommendation levels.[18] It should be noted that youth-onset type 2 diabetes typically occurs during adolescence at mid-puberty[25,26] when PA has been shown to drastically decline.[27]

PA levels in adults are even more concerning than those in youth.[18] Less than 5% of the general population achieves 30 minutes of PA per day.[27] Moreover, adults with diabetes have been found to participate in less PA than adults without diabetes.[28] The American Diabetes Association specifically recommends people with diabetes decrease sedentary behavior and break up bouts of sitting with brief activity every 30 minutes.[29] Research suggests that those who engage in high amounts of sedentary behavior may be at increased risk of morbidity and mortality regardless of their level of MVPA.[30]

To date, limited studies examine the association between HFI and PA in people with diabetes.[7] In a cross-sectional study of 401 middle-aged adults with type 2 diabetes, Heerman et al[9] found that food insecurity was significantly associated with less self-reported PA/exercise behaviors. Similarly, Gucciardi et al[31] used the Canadian Community Health Survey to cross-sectionally examine 2523 people with diabetes ages 12 years and older and reported an association between HFI and physical inactivity. However, 84% of this sample was 46 years old or older, and 81% of the food secure and 64% of the food insecure were diagnosed with diabetes at 40 years old or older. In addition, diabetes type was not specified.[31] In each of these studies, middle aged and older adults were the focus instead of YYA, and PA was one of many health behaviors rather than the main outcome of interest.

This study applied a conceptual framework which describes a relationship between food insecurity and glycemic control through a behavioral pathway.[32] The purpose of this study was to examine the association between HFI and PA in YYA with type 1 diabetes and type 2 diabetes. It is hypothesized that (1) YYA with HFI will have lower PA levels than YYA who have household food security and (2) YYA with HFI will spend more time sitting than YYA who have household food security.

Methods

The SEARCH for Diabetes in Youth Study

SEARCH is a multisite surveillance and longitudinal cohort study of youth-onset type 1 diabetes and type 2 diabetes spanning 20 years.[33] The present study utilized data from the SEARCH 4 Cohort Study (data collected from 2016 to 2019) to conduct a cross-sectional examination of the association between HFI and PA. Details about the SEARCH study methods have been previously published.[33] All participants were recruited to SEARCH 1,2, or 3 shortly after they were diagnosed with youth-onset diabetes of any type. By the time of the SEARCH 4 study, the age of the study sample ranged from 10 to 35 years. Data collection sites included California, Colorado, Ohio, South Carolina, and Washington.[33] Each SEARCH site obtained approval from their respective institutional review board and obtained informed consent from adult participants or from parents/guardians and assent from participants less than 18 years old.

HFI Assessment

HFI was evaluated with the 18-item US Household Food Security Survey Module (HFSSM).[12] The HFSSM measures HFI over the previous 12 months and has been shown to be a stable, robust, valid, and reliable measurement tool.[12] The first 10 questions pertain to all households (with or without children), and the last 8 questions are specific to households with children ages 0–17 years.[12] Parents/guardians of SEARCH participants under age 18 years and participants with diabetes ≥18 years of age complete the HFSSM. Affirming ≥3 conditions or behaviors on the HFSSM resulted in a respondent being classified as food insecure.[34] Table 1 includes examples of questions from the HFSSM.

PA and Inactivity Assessment

PA was assessed with the International Physical Activity Questionnaire Short Form (IPAQ-SF).[35] This survey requests participants to recall the last 7 days and to report their PA. Respondents report total time spent walking, total time in MPA (excluding walking), and total time in VPA. PA is first reported as number of days per week. Then time is reported as hours per day and minutes per day that one usually spends doing the activity on one of those days. PA was expressed as minutes per week of walking PA, MPA (excluding walking), and VPA. MPA and VPA were summed to create MVPA. Time spent walking, MPA, and VPA, were summed to calculate total PA.[36,37] The IPAQ-SF also queried participants on time spent sitting at work, at home, while doing coursework, and during leisure time during the last 7 days. Time was reported as hours and minutes per day.[35] Time spent sitting was analyzed as minutes per day. A dichotomous variable to indicate adherence to the 2018 PAGA was derived separately for participants <18 years and participants 18–35 years because the 2018 PAGA are different for adults and children.[23]

Covariates

The participant's age and diabetes duration were analyzed as continuous variables, calculated from the participant's date of birth or date of diagnosis, respectively, and the date surveys were completed. Surveys were used to collect information on sex (female and male); race and ethnicity (Hispanic, Non-Hispanic Black, Non-Hispanic White, and other); SEARCH clinic site (South Carolina, Colorado, Ohio, California, and Washington); highest parental education (less than high school graduate, high school graduate, some college/associate degree, and bachelor's degree or more); household income (<$25,000, $25,000-$49,999, $50,000-$74,999, and $75,000+-); insurance type (private/exchanges, state/federal, other/unknown, and none); and smoking status (nonsmoker, current smoker, and former smoker). These covariates were included because they have the potential to function as confounders of the association under study.

Statistical Methods

All analyses were performed with SAS (version 9.4). Significance levels were set at 5%. The IPAQ-SF was developed and tested for use in people 15–69 years old.[35] Therefore, the analysis was restricted to SEARCH participants who were 15 years or older.[35] This decision is supported by a systematic review of the IPAQ and IPAQ-SF that included validity and reliability studies from 12 different countries and found positive validity and reliability

among adults for the IPAQ-SF.[38] The final sample included 1998 YYA with type 1 diabetes and 391 YYA with type 2 diabetes.

For descriptive analyses, the first quartile, median, and third quartile were reported to summarize continuous variables, and frequencies and percentages were reported to summarize categorical variables. For each variable, the number and percentage of missing values was also calculated.

Median (continuous outcome) and logistic (binary outcome) regression were used to study the associations between the exposure (HFI) and the outcomes of interest. For both types of regression, unadjusted and fully adjusted models were fitted. Unadjusted models included HFI only as the exposure variable. Fully adjusted models included the participant's age, diabetes duration, sex, race and ethnicity, SEARCH clinic site, parent education, insurance type, and smoking status as covariates, in addition to HFI. All regression models were stratified by diabetes type.

The associations between HFI and minutes of PA and physical inactivity (VPA, MPA, walking, sitting, MVPA, and total PA) were analyzed using median regression.[39] Median regression is a robust alternative to mean regression to facilitate interpretation of the regression coefficients due to the skewness of the error. Although these outcomes are in principle continuous outcomes, observations appeared discrete since participants tended to round values to whole hours or fractions (eg, 0, 30, and 60 min). To avoid estimation instability due to excessive rounding, random uniform noise (jittering) was applied to obtain pseudo-continuous outcomes.[40] The association between the HFI and the odds of adherence to the 2018 PAGA was assessed via logistic regression.

Under the assumption of missing at random, missing values were imputed using multiple imputation by chained equations.[41] The imputation model included the same variables that were used in the fully adjusted models as described above. A total of 20 imputed data sets based on 200 iterations were created.

Results

Descriptive statistics for the study can be found in Table 2. Approximately 18% of YYA with type 1 diabetes experienced HFI, and approximately 34% of YYA with type 2 diabetes experienced HFI. YYA with type 1 diabetes spent a median of 120 minutes per week in VPA, 120 minutes per week in MPA, 315 minutes per week walking, and 325 minutes per day sitting. Approximately 64% of YYA (51% of youth 15–17 y old and 67% of adults 18–35 y old) with type 1 diabetes met the PAGA guidelines for PA. YYA with type 2 diabetes spent a median of 0 minutes per week in VPA, 60 minutes per week in MPA, 240 minutes per week walking, and 270 minutes per day sitting. Half (54%; 50% of youth 15–17 y old and 54% of adults 18–35 y old) of the YYA with type 2 diabetes reported enough PA to meet the PAGA.

The results of the analyses for YYA with type 1 diabetes are reported in Table 3. In unadjusted median regression analyses, YYA with type 1 diabetes who experienced HFI had an estimated 70.2 (SE: 25.9) less minutes of VPA per week ($P = .01$) but 103.5 (SE:

43.4) more minutes of walking per week ($P = .02$) than YYA with type 1 diabetes who did not experience HFI. Whereas the association between HFI and VPA was almost completely accounted for by confounding, the association with time spent walking remained statistically significant. The estimated (adjusted) median walking time was 85.7 (SE: 38.0) minutes greater for YYAs with type 1 diabetes who experienced HFI than those who were food secure ($P = .02$). In the fully adjusted models, a statistically significant association (P = .01) between HFI and total PA minutes per week was also observed. Those who experienced HFI had a median total PA of 182.1 (SE: 70.2) minutes greater than those who had household food security.

As shown in Table 3, among YYAs with type 2 diabetes, point estimates of the associations between HFI and median PA and physical inactivity outcomes in unadjusted models were all positive, indicating that those with HFI reported more minutes of activity and inactivity, except for MPA and MVPA. However, substantial uncertainty in the estimates yielded statistically nonsignificant results. In contrast, YYA experiencing HFI reported significantly more time spent sitting per day (60.6 min, SE: 29.7, $P = .04$) after adjusting for confounding than those who lived in a food secure household.

Table 4 reports the result of logistic regression assessing the association between HFI and the odds of PAGA adherence. Estimated odds ratios were not far from 1 for both type 1 diabetes and type 2 diabetes YYAs, and these estimates were not statistically significant according to either unadjusted or adjusted models.

Discussion

The purpose of this study was to examine the association between HFI and PA in YYA with type 1 diabetes and type 2 diabetes. It was hypothesized that (1) YYA with HFI would have lower PA levels than YYA who had household food security and (2) YYA with HFI would spend more time sitting than YYA who had household food security. Contrary to the hypothesis, the current study found that YYA with type 1 diabetes who experienced HFI obtained almost 86 more minutes of walking per week than YYA with type 1 diabetes who were food secure. This equates to an hour and 26 minutes per week or approximately 12 minutes per day, which would confer important health benefits given that the 2018 PAGA state that increasing MVPA in any duration is valuable for health.[23] One potential explanation for this findings is that the association between HFI and time spent walking may reflect the underlying association between HFI and low socioeconomic status. Although models were adjusted for some socioeconomic status variables (ie, household income, parent education, and insurance type), other socioeconomic status variables such as occupation and having reliable transportation were not captured in this study, thereby preventing us from differentiating different domains of walking.[42] Thus, YYA with type 1 diabetes and HFI may spend more time walking for transportation or doing work that requires more walking. The study by Maia et al[43] provides some support for this as they found higher odds of HFI among lower white-collar jobs (ie, clerical support workers and service and sales workers) in comparison to higher white-collar jobs (ie, armed forces occupations, managers, professionals and technicians, and associate professionals). Moreover, in a US report on bicycling and walking to work, households in the lowest income category (<$10,000/y)

had the highest rate of walking to work at 8.2%.[44] Overall, the rate of nonmotorized travel to work declined as household income increased.[44] An alternative explanation could be that this finding is an artifact of measurement error, given that walking has been found to be difficult to track and walking questionnaires typically have the lowest validity coefficients compared with other activity types.[45] Future research should explore walking for transportation versus work versus leisure among YYA with type 1 diabetes experiencing HFI.

In this study, YYA with type 2 diabetes experiencing HFI spent an additional hour sitting per day compared with YYA with type 2 diabetes who lived in a food secure household. This finding is consistent with previous studies of people with diabetes which have shown that HFI is associated with inactivity or activity that requires little physical effort.[6,31] In general, barriers to PA for people with type 2 diabetes are comparable to barriers among people without diabetes and include low self-efficacy, lack of social support, obesity, and knee and hip osteoarthritis.[20] The built environment, which includes access to facilities and green space, and safe places to walk may also be a barrier for people with and without diabetes to engage in PA.[20] However, what differentiates YYA with type 2 diabetes experiencing HFI from those who are food secure may be the high levels of mental fatigue and low levels of energy that are associated with HFI and its sequelae, depression, anxiety, and sleep disorders.[46] This constellation of burdens may result in the increased time sitting per day observed in this study. Interventions aiming to increase PA among YYA with type 2 diabetes likely need to address these intermediate, mostly mental-health related consequences of HFI in order to have an impact.

Similar to studies in the general population, in this study, no associations were observed between HFI and VPA, MPA, MVPA, or meeting the PAGA for those with type 1 diabetes or type 2 diabetes. For example, Navarro et al[47] found no associations between HFI and self-reported PA (total PA, VPA, MVPA, and sedentary behaviors) in 5138 US children ages 4–15 years. Similarly, To et al[7] found no relationship between HFI and adherence to PA guidelines in youth but did find a relationship between HFI and MVPA in youth and HFI and meeting the PAGA in adults. One possible explanation for the lack of associations is that this sample of YYA with and without HFI was highly active as estimated by self-report. The percentage of YYA with type 1 diabetes who met the PAGA was 65% among those experiencing HFI and 61% among those who were food secure. Approximately 54% of YYA with type 2 diabetes, regardless of food security status, reported enough PA to meet the PAGA. These high levels of self-reported PA were already observed in an earlier SEARCH study which measured PA with a 3-day PA recall and found compliance with the national aerobic PA recommendations was 82% for YYA with type 1 diabetes and 68% for YYA with type 2 diabetes.[48] A recently published paper, featuring the SEARCH 3 Cohort Study, measured PA with questions used in the Centers for Disease Control and Prevention's 1999 Youth Risk Behavior Survey and reported that youth with type 1 diabetes averaged 3.5 days per week of ≥20 minutes of VPA and 2.8 days per week of ≥30 minutes of MPA.[49] It is possible that the high levels of PA reported by SEARCH participants represent over reports because a pedometer-based study in SEARCH did not indicate that youth with diabetes meet recommended PA levels.[18,50] Although subjective PA measures are often the instrument of

choice, future research focused on HFI and PA would benefit from including an objective measure.[51]

Limitations and Future Research

There are a number of limitations to the IPAQ-SF, some of which have already been alluded to. The IPAQ-SF, like other self-reported PA measures, is known to result in some overreporting of PA, leading to possible measurement error.[52] A further limitation of the IPAQ-SF is that it does not separate different domains of walking. Future studies assessing HFI and PA could markedly advance the field if they considered both the use of an objective measure of PA in addition to differentiating the different domains of walking.

There are additional limitations of this study. Because it is a cross-sectional study, temporality is not known. The HFI is reflective of the food insecurity experience across 12 months; however, the IPAQ-SF measures PA over the last 7 days. Therefore, the experience of HFI may not be concurrent with the recent PA. Future research should therefore consider using measures of HFI and PA that align more closely in their temporal assessment lens.

Conclusions

YYA with type 1 diabetes experiencing HFI reported more walking and total PA time per week than those who were food secure. In contrast, YYA with type 2 diabetes who were food insecure reported more time sitting per day than those who were food secure. Examining this relationship in a longitudinally designed study would contribute toward confirming temporality. For now, these findings provide intriguing data and suggest further research is necessary to disentangle the relationship of HFI with potential occupational influences on walking behavior from influences on walking for leisure or transportation, ideally incorporating objective assessments of PA.

Acknowledgments

The SEARCH for Diabetes in Youth Study is indebted to the many youths and their families and their health care providers, whose participation made this study possible.

Funding:

This work was funded by the SEARCH Food Security Cohort Study (R01DK117461). The SEARCH for Diabetes in Youth Cohort Study (R01DK127208, 1UC4DK108173) is funded by the National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases and supported by the Centers for Disease Control and Prevention. The Population Based Registry of Diabetes in Youth Study (1U18DP006131, U18DP006133, U18DP006134, U18DP0 06136, U18DP006138, and U18DP006139) is funded by the Centers for Disease Control and Prevention (DP-15–002) and supported by the National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases.

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Table 1

Selected Questions From the US Household Food Security Survey Module[12]

These are items 1–3 of the United States Household Food Security Survey Module. Each item is a statement that people have made about their food situation. For each statement, response options include “often true”, “sometimes true”, or “never true” (for your household) in the last 12 months.
1 (I/We) worried whether (my/our) food would run out before (I/we) got money to buy more.
2 The food that (I/we) bought just didn’t last, and (I/we) didn’t have money to get more.
3 (I/we) couldn’t afford to eat balanced meals.

J Phys Act Health. Author manuscript; available in PMC 2025 January 10.

Table 2

Demographic and Clinical Characteristics of Youth and Young Adults Participating in the SEARCH for Diabetes in Youth Cohort Study (2015–2020), According to Household Food Security Status,[a] N = 2389

	Type 1 diabetes (N = 1998)			Type 2 diabetes (N = 391)		
	Total	**Food secure**	**Food insecure**	**Total**	**Food secure**	**Food insecure**
Age, (Q1, median, Q3)	19, 22, 25	18, 21, 25	19, 22, 26	22, 25, 28	21, 24, 28	23, 25, 28
Missing data, n (%)	0			0		
Sex, %						
Female	52.7	52.0	57.3	67.0	65.0	71.2
Male	47.3	48.0	42.7	33.0	35.0	28.8
Missing data, n (%)	0			0		
Race and ethnicity, %						
Hispanic	13.1	13.2	12.3	24.3	25.9	19.5
Non-Hispanic Black	11.6	10.0	19.6	45.5	47.5	42.4
Non-Hispanic White	72.6	74.1	64.6	18.7	15.6	25.4
Other	2.8	2.7	3.5	11.5	11.0	12.7
Missing data, n (%)	0			0		
Household income, %						
<$25,000	20.0	15.2	41.1	50.2	44.4	59.3
$25,000-$49,999	22.7	20.4	33.1	34.8	33.3	38.5
$50,000-$74,999	16.5	16.2	17.9	6.9	10.5	1.1
$75,000+	40.9	48.2	8.0	8.1	11.8	1.1
Missing data, n (%)	539 (27.0)			144 (36.8)		
Clinic, %						
Carolinas	20.3	19.0	26.0	36.1	35.7	38.1
Ohio	18.3	19.8	14.2	16.4	17.1	16.1
Colorado	33.1	33.3	33.6	21.0	20.2	28.9
California	12.2	12.7	9.9	20.7	23.6	12.7
Washington	16.1	15.2	16.1	5.9	3.4	10.2
Missing data, n (%)	0			0		
Parent education, %						

	Type 1 diabetes (N = 1998)			Type 2 diabetes (N = 391)		
	Total	**Food secure**	**Food insecure**	**Total**	**Food secure**	**Food insecure**
<HS graduate	4.3	4.0	5.8	10.9	10.4	11.6
HS graduate	14.6	12.6	23.6	32.2	34.0	29.5
Some college/associate degree	26.7	24.5	37.1	39.2	37.8	42.0
Bachelor's degree+	54.5	59.0	33.4	17.7	17.8	17.0
Missing data, n (%)	129 (6.5)			34 (8.7)		
Insurance status, %						
State/federal	14.8	11.7	29.7	33.4	31.4	38.9
Private	78.2	81.8	61.2	45.6	47.8	39.8
Other/unknown	3.2	3.4	2.7	6.4	7.5	3.5
None	3.8	3.1	6.5	14.6	13.3	17.7
Missing data, n (%)	56 (2.8)			14 (3.5)		
Diabetes duration, mo, (Q1, median, Q3)	118, 149, 169	119, 149, 169	120, 149, 171	80, 132, 159	81, 133, 158	76, 138, 164
Missing data, n (%)	0			0		
Smoking status, %						
Never smoker	71.3	74.0	57.7	65.2	67.6	60.0
Former smoker	17.3	17.2	18.7	17.0	15.2	21.7
Current smoker	11.5	8.8	23.6	17.8	17.2	18.3
Missing data, n (%)	102 (5.1)			15 (3.8)		
VPA, min/wk, (Q1, median, Q3)	0, 120, 360	0, 120, 360	0, 60, 360	0, 0, 360	0, 0, 360	0, 0, 360
Missing data, n (%)	203 (10.2)			49 (12.5)		
MPA, min/wk, (Q1, median, Q3)	0, 120, 420	0, 120, 360	0, 150, 360	0, 60, 360	0, 60, 360	0, 60, 360
Missing data, n (%)	316 (15.8)			67 (17.1)		
Walking, min/wk, (Q1, median, Q3)	100, 315, 840	90, 300, 840	144, 420, 900	60, 240, 833	50, 210, 720	100, 330, 840
Missing data, n (%)	417 (20.9)			106 (27.1)		
Sitting, min/d, (Q1, median, Q3)	240, 325, 480	240, 300, 480	240, 360, 480	180, 270, 420	180, 240, 390	210, 300, 480
Missing data, n (%)	522 (26.1)			150 (38.4)		
MVPA, min/wk, (Q1, median, Q3)	60, 300, 732	60, 300, 720	0, 360, 860	0, 180, 720	0, 180, 720	0, 165, 652
Missing data, n (%)	172 (8.6)			38 (9.7)		
Total PA, min/wk, (Q1, median, Q3)	255, 675, 1335	270, 660, 1260	205, 780, 1560	90, 535, 1260	90, 510, 1230	90, 540, 1350
Missing data, n (%)	157 (7.9)			34 (8.7)		

	Type 1 diabetes (N = 1998)			Type 2 diabetes (N = 391)		
	Total	**Food secure**	**Food insecure**	**Total**	**Food secure**	**Food insecure**
Meets PA guidelines, %	63.9	64.6	60.9	53.8	53.8	54.6
Missing data, n (%)	172 (8.6)			38 (9.7)		

Abbreviations: HS, high school; MPA, moderate PA; MVPA, moderate to vigorous PA; PA, physical Activity; **Q1**, quartile 1; Q3, quartile 3; VPA, vigorous PA.

[a]Activity reported before adding random noise to make variable truly continuous.

Table 3

Association Between Household Food Insecurity and PA in Youth and Young Adults With Type 2 Diabetes[c]

	Type 1 diabetes, N = 1998				Type 2 diabetes, N = 391			
	Model 1[a,c]		Model 2[b,c]		Model 1[a,c]		Model 2[b,c]	
Outcomes	**Estimate (SE)**	***P***	**Estimate (SE)**	***P***	**Estimate (SE)**	***P***	**Estimate (SE)**	***P***
VPA, min/wk	−70.2 (25.9)	.01	0.8 (14.3)	.96	18.0 (45.6)	.69	17.5 (19.5)	.37
MPA, min/wk	0.4 (22.4)	.99	24.5 (18.0)	.17	−9.3 (40.2)	.82	−6.2 (20.0)	.76
Walking, min/wk	103.5 (43.4)	.02	85.7 (38.0)	.02	81.1 (61.8)	.19	66.9 (48.6)	.17
Sitting, min/d	37.6 (19.5)	.06	30.2 (16.1)	.06	46.8 (33.2)	.16	60.6 (29.7)	.04
MVPA, min/wk	55.0 (49.3)	.26	36.9 (34.6)	.29	−8.5 (70.2)	.90	5.0 (45.7)	.91
Total PA, min/wk	112.2 (74.0)	.15	182.1 (70.2)	.01	79.7 (143.0)	.58	81.1 (116.4)	.49

Abbreviations: MPA, moderate PA; MVPA, moderate to vigorous PA; PA, physical activity; VPA, vigorous PA.

[a]Crude model.

[b]Adjusted for participant's age, diabetes duration, sex, race and ethnicity, SEARCH clinic site, parent education, insurance type, smoking status, and household income.

[c]Analysis based on multiple imputation.

Table 4

Association Between Household Food Insecurity and Meeting the PA Guidelines for Americans in Youth and Young Adults With Type 1 Diabetes and Type 2 Diabetes, the SEARCH for Diabetes in Youth Study

	Model 1[a,c]			Model 2[b,c]		
Outcomes	**Odds ratio**	**CI**	***P***	**Odds ratio**	**CI**	***P***
Type 1 diabetes						
Meets PA guidelines	1.2	0.9–1.5	.17	1.0	0.7–1.3	.89
Type 2 diabetes						
Meets PA guidelines	0.9	0.6–1.3	.79	0.9	0.5–1.5	.69

Abbreviations: CI, confidence interval; PA, physical activity.

[a]Crude model.

[b]Adjusted for participant's age, diabetes duration, sex, race and ethnicity, SEARCH clinic site, parent education, insurance type, smoking status, and household income.

[c]Analysis based on multiple imputation.