HHS Public Access

Author manuscript

Pediatr Diabetes. Author manuscript; available in PMC 2021 December 01.

Published in final edited form as:

Pediatr Diabetes. 2020 December ; 21(8): 1412–1420. doi:10.1111/pedi.13112.

Socioeconomic position is associated with glycemic control in youth and young adults with type 1 diabetes

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Abstract

Objective: Health inequities persist in youth and young adults (YYA) with type 1 diabetes in achieving optimal glycemic control. The purpose of this study was to assess the contribution of multiple indicators of social need to these inequities.

Research Design and Methods: 222 YYA with type 1 diabetes enrolled in the SEARCH Food Insecurity Study in South Carolina and Washington between the years 2013–2015 were included. Latent class analysis was used to identify socioeconomic profiles based on household income, parental education, health insurance, household food insecurity, and food assistance. Profiles were evaluated in relation to glycemic control using multivariable linear and logistic regression, with HbA1c > 9% (75 mmol/mol) defined as high-risk glycemic control.

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Author Contributions

ADL designed the study and ADL, BAB and BAR designed the analysis plan. XM and MWS performed the data analysis. MWS wrote the manuscript. ADL, XM, BAR, JAM, BAB, ARK, KAS, JML, and CP critically reviewed the manuscript and provided input. All authors have read and approved the final manuscript.

Results: Two profiles were identified: a lower socioeconomic profile included YYA whose parents had lower income and/or education, and were more likely to be uninsured, receive food assistance, and be food insecure. A higher socioeconomic profile included YYA whose circumstances were opposite to those in the lower socioeconomic profile. Those with a lower socioeconomic profile were more likely to have high-risk glycemic control relative to those with a higher socioeconomic profile (OR = 2.24, 95%CI = 1.16–4.33).

Conclusions: Lower socioeconomic profiles are associated with high-risk glycemic control among YYA with type 1 diabetes. This supports recommendations that care providers of YYA with type 1 diabetes assess individual social needs in tailoring diabetes management plans to the social context of the patient.

Keywords

HbA1c; Health status disparities; Social needs; Socioeconomic factors; Type 1 Diabetes

Despite recent advances in technology and medications to enhance diabetes self-management and improve glycemic control, health inequities in the achievement of optimal glycemic control persist among youth and young adults (YYA) with type 1 and type 2 diabetes.[1–3] It is estimated that 56% of youth with type 1 diabetes and 46% of those with type 2 diabetes do not achieve optimal glycemic control[4] and that social context influences glycemic control outcomes among youth with type 1 diabetes.[1,5,6] The American Diabetes Association recognizes the magnitude of health inequities in diabetes outcomes and now recommends that providers assess the individual social needs which contribute to these inequities to appropriately tailor diabetes treatment plans and improve diabetes outcomes.[3]

Previous research has documented the contribution of individual social needs to inequities in health outcomes among youth and adults with type 1 diabetes. For example, socioeconomic position (SEP), as measured by household income and parental education, contributes to health inequities in type 1.[5,7] A recently published systematic review of the literature on socioeconomic status and health outcomes among youth and adults with type 1 diabetes found that household income and educational attainment were consistent predictors of experiencing diabetic ketoacidosis.[7] However, results for glycemic control were inconclusive, suggesting that more research is needed to identify social determinants of disparities in glycemic control in these populations.[7]

Other aspects of SEP, such as health insurance status and food insecurity have also been evaluated as predictors of glycemic control. Low-SEP persons often lack health insurance or are underinsured, and the demands of co-pays and non-covered items (e.g. glucose test strips) can lead to medication underuse.[8,9] Health insurance status has been shown to be strongly associated with glycemic control in YYA with type 1 diabetes.[10,11] Additionally, living in a household with low SEP places a person at a high risk for food insecurity.[12] Food insecurity describes “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in social acceptable ways”[13] and may impact several facets of diabetes care, including adherence to nutrition guidelines, physical activity, and diabetes self-management.[14] In one of the only two pediatric food insecurity and diabetes studies performed to date (n=226), household food insecurity was

associated with 2.37-fold higher odds of poor glycemic control among YYA with type 1 diabetes.[15] Although federal food and nutrition assistance programs provide benefits to partially alleviate food insecurity, a sizeable proportion of participants still experience episodes of food insecurity during one or more months of the year.[12] In fact, research has demonstrated that hospital admissions for hypoglycemic in adults with diabetes in low-income population are increased at the end of each month, suggesting that exhaustion of food budgets may contribute to poor outcomes related to glucose control.[16] Thus, participation in food assistance programs may not fully eliminate inequities in glycemic control among YYA with type 1 diabetes.

Although previous research has documented the independent association between various SEP indicators and glycemic control among people with type 1 diabetes,[15,17–20] no studies have simultaneously considered a constellation of SEP indicators to predict glycemic control among YYA with type 1 diabetes. To further clarify the association between SEP and glycemic control among YYA with type 1 diabetes, the purpose of this paper is to (1) use latent class analysis to identify distinct socioeconomic profiles (i.e. groups of YYA with similar SEP characteristics), utilizing four socioeconomic indicators: a combination of household income and parental education, health insurance status, household food insecurity, and participation in food assistance programs and to (2) assess the association between these distinct profiles and glycemic control.

METHODS

The Search for Diabetes in Youth (SEARCH) study is a multi-center study that initiated ascertainment of youth <20 years of age with physician-diagnosed diabetes in 2001, and is described in detail elsewhere.[21] Initially, SEARCH was a surveillance effort that identified prevalent (existing) and incident (newly-diagnosed) cases of diabetes of all types in select years in five locations in the United States until it expanded into a cohort study. This manuscript focuses on the SEARCH 3 (2010–2015) cohort which included persons <20 years of age with incident type 1 or 2 diabetes or other type (maturity onset diabetes in youth, hybrid type, etc.) with a diagnosis date in 2002–2005, 2006, or 2008, (2) who had completed a baseline in-person visit, and (3) who had at least 5 years of diabetes duration at the time of the SEARCH 3 clinic visit. SEARCH 3 additionally includes in-person data collection on individuals with a diagnosis date in 2012 who were participating under the registry (e.g. surveillance) protocol of the study. All in-person visits included questionnaires, physical examinations, and laboratory measures.

The SEARCH Food Insecurity study was conducted from November 2013 through June 2015 in only two of the five SEARCH sites, South Carolina and Washington State and was integrated with the SEARCH data collection. The unique element of the SEARCH Food Insecurity study, a survey on household food insecurity and food assistance, was completed during the SEARCH registry and cohort in-person visits. A total of 405 participants completed the food insecurity study. The studies were approved by the local institutional review boards. Participants provided informed consent (if ≥18 years old) or assent (if <18 years old) along with parental consent before data collection.

Socioeconomic Variables

To assess parental education level, parent/guardians of participants <18 years of age reported the highest degree or level of schooling completed for themselves and for their partner. To assess household income, parent/guardians were presented with nine income ranges from "less than $5,000" to "$100,000 and greater." Young adult SEARCH participants ≥ 18 years of age were asked these same questions about their parent/guardians, following the rationale that in early adulthood, the socioeconomic characteristics of the parental household still shape the SEP of the young adult. Household income and parental education were missing for n= 92 and n= 12 participants, respectively. To address this issue, we created a composite, dichotomous socioeconomic indicator variable using household income and parental education data, as described previously.[15] We defined the lower level as household income < $50,000/year (as an approximation of median household income)[22] regardless of parent education category, or parent education less than a bachelor's degree if income data were missing. We defined the higher level as household income ≥ $50,000/year and any parent education category, or ≥ bachelor's degree if income data were missing. Using this composite variable resulted in only six participants with missing income/education data.

Health insurance was also assessed via questionnaire with the following options: Medicaid/Medicare/State-funded/Other federally-funded, Private insurance through employer, Private insurance purchased on your own, Military, School-based insurance, Tribe/Indian Health Service, Any other or type unknown, and None. These were subsequently grouped into three categories: private (i.e. through employer or purchased independently), public (i.e. Medicaid, Medicare, state- or federally funded, tribe or Indian Health Service), and other/unknown or no insurance. Parents/guardians of participants <18 years of age were asked to report the health insurance status of the participant and participants ≥ 18 years of age reported their own health insurance status.

We ascertained household food security using the 18-item US Department of Agriculture's Household Food Security Survey Module (HFSSM) which measures the construct over the previous 12 months.[13] HFSSM's reliability has been reported, e.g., Cronbach's alpha = 0.86–0.93 and validity has been established.[23] Households with children respond to all 18 items whereas households without children only respond to the first 10 items. For participants <18 years of age, their parents/guardians completed the HFSSM, while participants 18 years and older completed the HFSSM themselves. The items on the HFSSM were combined into a single overall measure of household food insecurity. Household food insecurity (possible responses ranging from 0–10 affirmations for households without children and 0–18 affirmations for households with children) was classified into four categories: high food security (zero affirmations), marginal (1–2 affirmations), low (3–7 affirmations among households with children, 3–5 among households without children), and very low food security (≥8 affirmations in households with children, ≥ 6 affirmations in households without children). Because the majority of the sample was considered food secure, we used a continuous, standardized score to characterize household food insecurity rather than categorizing this variable. The US Department of Agriculture provides a standardized scale with values from 0 to 10 for both types of households (those with and

without children), termed the "standard 0–10 metric," to allow for direct comparisons[13] between both types of households.

Participants were also asked whether they participated in the Supplemental Nutrition Assistance Program, the Special Supplemental Nutrition Program for Women, Infants and Children,, or a local food bank or soup kitchen in the past 12 months.[24] Participants answering "yes" to receiving any of these types of support were classified as participating in a food assistance program.

Outcome measures

Whole blood samples collected during the study visit were analyzed for Hemoglobin A1c (HbA1c) by the Northwest Lipid Metabolism and Diabetes Research Laboratories in Seattle, WA, using an automated nonporous ion-exchange high-performance liquid chromatography system (model G-7; Tosoh Bioscience, Montgomeryville, Pennsylvania).[4] We used the ADA and International Society for Pediatric and Adolescent Diabetes (ISPAD) 2014 Guidelines for HbA1c to categorize participants' glycemic control: for ages <18 years, 1) <7.5% (58 mmol/mol) is optimal, 2) 7.5–9.0% (58–75 mmol/mol) is suboptimal, and (3) >9.0% (75 mmol/mol) is high-risk [25,26]; for ages ≥18 years, 1) <7.0% (53 mmol/mol) is optimal, 2) 7.0–9.0% (53–75 mmol/mol) is suboptimal, and 3) >9.0% (75 mmol/mol) is high-risk.[4,25,26]

Covariates

SEARCH collected data via questionnaire on diabetes duration, age at each visit, and sex. SEARCH used US Census Bureau questions[27] to ascertain race and ethnicity (Hispanic, African American, Asian or Pacific Islander, American Indian, non-Hispanic White, and other race). Diabetes type was based on information obtained from health care providers during the participant recruitment process, around the time of diabetes diagnosis.

Statistical Analyses

Latent class analysis is a type of statistical analysis that is used to identify underlying classes of individuals with similar characteristics according to selected indicators.[28] To identify latent socioeconomic classes in our data, we performed latent class analysis with four indicators: parental income and education (low vs. high), insurance type (private, public, or other/none), food assistance participation (yes vs. no), and household food insecurity score as a continuous variable.

The performance of two through four-class latent class models was assessed. The best-fitting model was chosen using log-likelihood, Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) statistics as a reference for model selection with consideration of class size (each class should have > 5% of the sample) and classification errors. The practical meaning of the identified classes was also considered when choosing the best-fitting model. Because our model is a mix of categorical and continuous variables, the continuous household food insecurity variable was rescaled so that all values fall between zero and one, which allows it to be depicted on the same scale as the class-specific probabilities for the categorical variables. This rescaling is performed by subtracting the lowest observed value from the class-specific means and dividing the results by the range,

which is simply the difference between the highest and the lowest observed value.[29] Supplemental Table S1 provides the criteria used to assess model fit for two- through four-class models. We assigned participants to the class with which they had the highest posterior probability of membership, also known as the "classify-analyze" approach.[30]

We assessed differences in covariates and the outcome measures between the two SEP profiles using t-tests for continuous variables and chi-square tests for categorical variables. To evaluate the association between the identified latent classes and glycemic control, we first used logistic regression with glycemic control category as a dichotomous dependent variable, i.e., high-risk [HbA1c > 9.0% (75 mmol/mol)] versus combined optimal and suboptimal categories. The model also included participant age at visit, sex, race/ethnicity, SEARCH site, and diabetes duration. We also employed a multinomial logistic regression model to examine the association between the latent classes and glycemic control measured with three levels (optimal, suboptimal, high-risk). Finally, we examined the association of the latent classes and glycemic control using linear regression with continuous HbA1c as the dependent variable.

Data analyses were conducted using SAS 9.4 for data cleaning, descriptive analyses, and regression analyses between the identified latent classes and health outcomes, and LatentGOLD 5.1 was used for the latent class analysis.[29]

A sample of n=290 who completed the food insecurity survey and had type 1 diabetes served as the starting point for analyses. These constituted 71.6% of the 405 SEARCH 3 participants with type 1 diabetes who participated in a Registry or Cohort visit at the Washington and South Carolina sites during the same period. For the latent class analysis, participants with any missing information on income/education (n=6), household food insecurity score (n=20), food assistance (n=3), health insurance (n=4), and HbA1c (n=32) were excluded. We also excluded any individuals with a diagnosis of type 1 diabetes who reported not taking insulin (n=3). This resulted in a sample size of 222. Comparing demographic characteristics of included versus excluded study participants yielded some differences: included participants were more likely to be from the South Carolina site (86.5% vs. 71.0%), were younger on average (15.6 vs. 17.9 years old), and had a shorter diabetes duration (79.1 vs. 92.9 months); there were no differences for sex (47.1% vs. 52.3% female) or race/ethnicity (72.1% vs. 76.1% non-Hispanic white.

RESULTS

Participant Characteristics

The study sample was on average 15.6 years of age, 47.8% were male, 76.1% were non-Hispanic white, 49.1% were of lower household socioeconomic position as defined by income and education, and the average duration of diabetes was 79 months (6.6 years) (Table 1).

Latent Class Analysis

A two-profile solution was selected from the latent class analysis to identify latent socioeconomic profiles in the study population. Figure 1 displays the item-response

probabilities for the included socioeconomic variables across each of the two socioeconomic profiles - 75% belonged to the higher socioeconomic profile, which represents those with higher parental income and education, who are less likely to receive government-funded health insurance and food assistance and are less likely to be food insecure compared to those in the lower socioeconomic profile. The remaining 25% belonged to the lower socioeconomic profile; these individuals had lower parental income and education, were more likely to have no health insurance and to receive food assistance and were more likely to be food insecure compared to those in the higher socioeconomic profile.

Table 2 displays the distribution of covariates and outcome measures by profile. The lower socioeconomic profile consisted of a non-significantly larger proportion of those with high-risk glycemic control ($p = 0.06$) and featured a significantly higher mean HbA1c (9.7% (83mmol/mol) vs. 9.0% (75 mmol/mol), $p = 0.01$) compared to those in the higher socioeconomic profile. There were no significant differences in sex or race/ethnicity between the two profiles.

Association between Socioeconomic Profile and Glycemic Control

Table 3 describes the association between socioeconomic profile and glycemic control, as measured by continuous HbA1c, two-level glycemic control (high-risk vs. all others) and three-level glycemic control (high-risk vs. suboptimal and high-risk vs. optimal). There was a significant, adjusted association between socioeconomic profile and continuous HbA1c ($b = 0.70$, SE = 0.27, $p < 0.01$). The odds of high-risk glycemic control among those in the lower socioeconomic profile were greater than the odds of those in the higher socioeconomic profile, OR = 2.24 (95% CI = 1.16–4.33), adjusted for age, sex, race/ethnicity, study site, and diabetes duration. For three-level glycemic control, the odds of high-risk glycemic control compared to optimal glycemic control were significantly greater among the lower socioeconomic profile compared to the higher socioeconomic profile, OR = 3.33 (95% CI = (1.03 – 10.74), and there was no significant difference between the profiles for odds of high-risk compared to suboptimal glycemic control.

DISCUSSION

This study provides evidence that, among a population of YYA with type 1 diabetes, a multifaceted socioeconomic profile composed of parental education, household income, health insurance status, food assistance, and household food insecurity status is associated with glycemic control.

The majority of participants belonged to a socioeconomic profile characterized by higher household income/parental education, who were less likely to receive government-funded health insurance or food assistance, and who were food secure. As seen in Figure 1 by the difference in item response probabilities between the profiles, the two variables most contributing to differences between the profiles within both groups were household food security and participation in food assistance programs, suggesting that these components are important when assessing the impact of SEP on glycemic control among those with type 1 diabetes. This aligns with previous research which demonstrated a relationship between food insecurity and glycemic control,[15] and also extends these findings by assessing SEP using

several related, but distinct, measures of SEP in the same model to address the influence of multiple social needs on disparities in glycemic control.

Recent evidence shows that the incidence of type 1 diabetes is increasing among YYA in the United States.[31] Moreover, the majority of YYA with type 1 diabetes do not achieve glycemic control targets recommended by the American Diabetes Association[25] and the ISPAD.[4,32,33] These elevated rates of high-risk glycemic control have persisted even with the continual development of enhanced technological and therapeutic advances in diabetes care. This suggests that throughout the coming years, it will become vital to identify effective means of enhancing glycemic control to prevent both short- and long-term complications of type 1 diabetes in these YYA.

The results of the present study suggest that one mechanism for enhancing glycemic control among YYA with type 1 diabetes may be to consider SEP factors that extend beyond the classic measures of parental education and income, such as household food security and food assistance when developing diabetes treatment plans. These factors may influence glycemic control, above and beyond the influences of household income, education level, and type of health insurance, through multiple pathways, including food availability, dietary quality, and the affordability of insulin and other self-management supplies.[8,34] In fact, the American Diabetes Association's Standards of Medical Care in Diabetes[3] recommends that care providers universally assess the social context of each patient, including food insecurity, housing stability, and other financial barriers, to appropriately tailor diabetes treatment and self-management to the individual patient. This information should be used to make appropriate referrals and provide support from additional providers, such as community healthcare workers when they are available.[3]

In order for providers to consider the impact of social needs and to potentially intervene to improve health outcomes in a clinical setting, providers must first implement a screening program to assess these individual social needs.[35] Several validated screening tools exist that may be used in clinical settings, and evaluations of such screening programs assessing factors such as food insecurity in pediatric clinical settings have identified several factors necessary for successful screening.[36–38] For these screening programs to be successful in a clinical setting, it is important for providers to have identified available social services in the area and have developed a referral system to these services. It is also important for providers to clearly communicate how they will ensure the privacy and confidentiality of patients' responses to screening so that patients will feel comfortable completing the screening tools.[36,37] Providers should also ensure that all patients are screened despite the apparent social status of the patient, and that patients' needs and desires for access to services are honored.[36] Research on implementing social needs screening in the primary care setting suggests that both providers and patients tend to be willing to participate in such screenings, and that implementation is enhanced by seeking input from relevant stakeholders and effectively utilizing electronic health record capabilities to reduce impact on clinician workload.[39] When appropriately implemented, screening for social determinants of health in clinical settings has the potential to increase access to social services and to improve health outcomes.[36]

This study has several limitations, including the cross-sectional study design. Because the information about socioeconomic indicators was assessed at the same time point as glycemic control, it is not possible to make causal inferences concerning the association between these factors. This study also did not collect data assessing housing stability, another economic indicator which may influence diabetes outcomes. Participants over the age of 18 reported the household income of their parents/guardians and it is possible that these participants are unsure of their parent's income. The generalizability of this study is also limited, as participants were recruited from South Carolina and Washington, but are not necessarily representative of other areas of the United States. An additional limitation is the potential for misclassification introduced by using the "classify-analyze" approach to latent class analysis as this method does not take into account uncertainty in the assignment of participants to classes and may lead to attenuated estimates of association.[30,40]

This study also had several strengths, including use of a standardized, comprehensive measure of food insecurity which is the criterion measure of food insecurity in the US.[13] Another strength of this study was the use of latent class analysis to pursue a data-driven approach to the categorization of participants into lower or higher socioeconomic profiles. This method allows for the simultaneous consideration of multiple facets of SEP and enhances our understanding of the impact of these multiple, highly correlated facets on glycemic control in YYA with type 1 diabetes.

In conclusion, a multifaceted profile representing lower SEP, as measured by parental education, household income, health insurance status, household food insecurity, and food assistance, is associated with high risk glycemic control among YYA with type 1 diabetes. Particularly, household food security and food assistance, socioeconomic indicators extending beyond the traditional measures of income and education, are potentially important contributors to disparities in glycemic control in this population. These findings support recommendations that care providers of YYA with type 1 diabetes assess individual social needs, including household food security and food assistance in tailoring diabetes management plans to the social context of the patient to improve glycemic control and to reduce the risk of future diabetes complications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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

The authors wish to acknowledge the involvement of the South Carolina Clinical & Translational Research Institute, at the Medical University of South Carolina, NIH/National Center for Advancing Translational Sciences (NCATS) grant number UL1 TR000062, UL1 Tr001450 and Seattle Children's Hospital and the University of Washington, NIH/NCATS grant number UL1 TR00423.

Funding

This study was supported in part by a Provost Social Science Grant and the Advanced Support Program for Integration of Research Excellence (ASPIRE II) at the University of South Carolina and the Center for Child Health, Behavior, and Development of the Seattle Children's Research Institute.

The SEARCH for Diabetes in Youth Study has been funded by the Centers for Disease Control and Prevention (awards U48/CCU919219, U01DP000246, U18DP002714, and U18DP006133) with support from the National Institutes of Diabetes and Digestive and Kidney Diseases.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention and the National Institute of Diabetes and Digestive and Kidney Diseases.

Conflicts of Interest

KAS and JML report grants from the National Institutes of Health during the conduct of the study. ARK received travel support from Novo Nordisk to present data at the American Diabetes Association 79th Scientific Sessions from June 7 – June 11, 2019.

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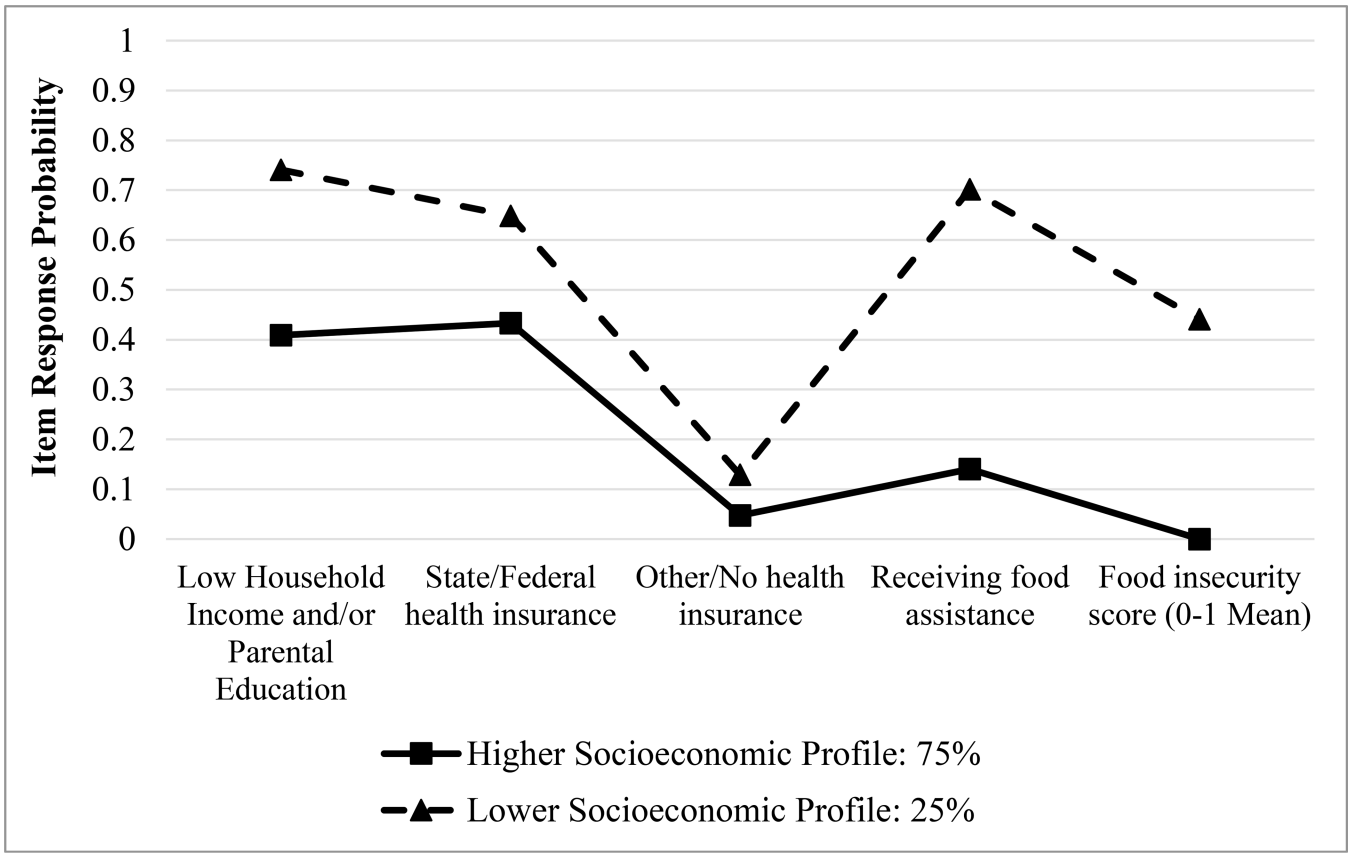

Figure 1:
Graphical display of item response probabilities for socioeconomic indicators across each of the two profiles for type 1 diabetes resulting from latent class analysis

Table 1—

Characteristics of participants with type 1 diabetes in the SEARCH Food Insecurity Study, 2013–2015 in the South Carolina and Washington sites, n=222.

Age at Study visit (years), *mean (sd)*	15.6 (5.4)
Sex, *n (%)*	
Male	106 (47.8)
Race/Ethnicity, *n (%)*	
Non-Hispanic White	169 (76.1)
Other race/ethnicity	53 (23.9)
Diabetes Duration (months), *mean (sd)*	79.0 (40.3)
SEARCH Study Site, *n (%)*	
South Carolina	90 (40.5)
Washington	132 (59.5)
Highest Parent Education, *n (%)*	
Bachelor's degree or higher	93 (42.1)
Less than Bachelor's degree	128 (57.9)
Family Income, *n (%)*	
≥$50,000	99 (54.7)
<$50,000	82 (45.3)
Socioeconomic Position*, *n (%)*	
Higher	113 (50.9)
Lower	109 (49.1)
Health Insurance, *n (%)*	
Private	99 (44.6)
Public (Federal or State)	108 (48.6)
Other/None	15 (6.8)
Household Food Insecurity (standardized), *mean (sd)*	0.87 (1.7)
High Food Security, *n (%)*	168 (75.7)
Marginal Food Security, *n (%)*	11 (5.0)
Low Food Security, *n (%)*	26 (11.7)
Very Low Food Security, *n (%)*	17 (7.7)
Household Food Assistance, *n (%)*	62 (27.9)
Private Food Assistance only, n (%)	8 (1.3)
Hemoglobin A1c (HbA1c) %, *mean (sd)*	9.2 (1.8)
Hemoglobin A1c (HBA1c) mmol/mol, mean (*sd*)	77 (19.7)
Glycemic Control Category, *n (%)*†	
Optimal	30 (13.5)
Suboptimal	86 (38.7)
High Risk	106 (47.8)

* Lower socioeconomic position (SEP) was defined as household income <$50,000/year and any parent education category, or parent education <bachelor's degree if income data were missing; higher SEP was defined as household income ≥$50,000/year and any parent education category, or ≥ bachelor's degree if income data were missing.

[†]Glycemic control was categorized as follows: for ages <18 years, 1) <7.5% (58mmol/mol) is optimal, 2) 7.5–9.0% (58–75 mmol/mol) is suboptimal, and (3) >9.0% (75mmol/mol) is high risk; for ages ≥18 years, 1) <7.0% (53 mmol/mol) is optimal, 2) 7.0–9.0% (53–75 mmol/mol) is suboptimal, and 3) >9.0% (75 mmol/mol) is high risk.

Table 2

Characteristics of participants with type 1 diabetes in the SEARCH Food Insecurity Study, 2013–2015 in the South Carolina and Washington sites by socioeconomic profile

	Higher Socioeconomic Profile† (n=168)	Lower Socioeconomic Profile† (n=54)	*p*
Demographic and Clinical Covariates			
Age at Study Visit (yrs), *mean (sd)*	15.6 (5.5)	15.6 (5.4)	0.99
Sex, *n (%)*			
Male	76 (45.2)	30 (55.6)	0.19
Race/Ethnicity, *n (%)*			
Non-Hispanic White	128 (76.2)	41 (75.9)	
Other race/ethnicity	40 (23.8)	13 (24.1)	0.97
SEARCH study site, *n (%)*			
South Carolina	70 (41.7)	20 (37.0)	
Washington	98 (58.3)	34 (63.0)	0.55
Diabetes Duration (mo), *mean (sd)*	78.1 (40.8)	81.7 (39.1)	0.56
Outcome Variables			
HbA1c, %, *mean (sd)*	9.0 (1.7)	9.7 (2.0)	0.01
HBA1c, mmol/mol, mean (*sd*)	75 (18.6)	83 (21.9)	
Glycemic Control, *n (%)**			
Optimal	26 (15.5)	4 (7.4)	
Suboptimal	69 (41.1)	17 (31.5)	
High Risk	73 (43.4)	33 (61.1)	0.06

*Glycemic control was categorized as follows: for ages <18 years, 1) <7.5% (58mmol/mol) is optimal, 2) 7.5–9.0% (58–75 mmol/mol) is suboptimal, and (3) >9.0% (75mmol/mol) is high risk; for ages ≥18 years, 1) <7.0% (53 mmol/mol) is optimal, 2) 7.0–9.0% (53–75 mmol/mol) is suboptimal, and 3) >9.0% (75 mmol/mol) is high risk.

†SEP = Socioeconomic Position

Table 3

Adjusted associations between socioeconomic profiles and glycemic control among SEARCH youth and young adults with type 1 diabetes participating in the SEARCH Food Insecurity Study in Washington and South Carolina between November 2013 and June 2015

	HbA1c		Two-level glycemic control*	Three-level glycemic control*	
			High risk vs. Others (ref.)	High risk vs. Optimal (ref.)	Suboptimal vs. Optimal (ref.)
	b (SE)	*p*	OR (95%CI)	OR (95%CI)	OR (95%CI)
Lower vs. Higher Socioeconomic Profile (ref.)	0.70 (0.27)	0.01	2.24 (1.16 – 4.33)	3.33 (1.03 – 10.74)	1.65 (0.50 – 5.46)

*Glycemic control was categorized as follows: for ages <18 years, 1) <7.5% (58mmol/mol) is optimal, 2) 7.5–9.0% (58–75 mmol/mol) is suboptimal, and (3) >9.0% (75mmol/mol) is high risk; for ages ≥18 years, 1) <7.0% (53 mmol/mol) is optimal, 2) 7.0–9.0% (53–75 mmol/mol) is suboptimal, and 3) >9.0% (75 mmol/mol) is high risk.