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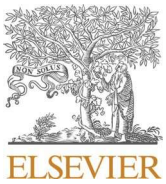

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Characterizing household food security status, perceived neighborhood food environment, and food shopping behaviors among caregivers of children in the Hispanic Community Health Study/Study of Latinos Youth ancillary study (SOL Youth)

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ABSTRACT

U.S. Hispanic/Latino households disproportionally experience food insecurity, which may intersect with their food environments and food shopping behaviors to shape diet and health, but more representative findings are needed. We identified latent classes related to household food security (HFS), food environments, and food shopping behaviors among U.S. Hispanic/Latino households, and investigated their relationships with socio-demographic characteristics. We used cross-sectional data from 983 adult caregivers residing with youth (8-16 y) and participating in the multisite Study of Latino Youth. Caregivers completed the USDA HFS Survey Module (high, marginal, low, very low FS), a 5-item perceived neighborhood food environment (healthy food availability, quality, cost) questionnaire, and a 5-item food outlet shopping frequency questionnaire. We identified the best-fitting solution of latent classes by examining standard fit criteria and determined the relationship of latent classes to distal sociodemographic characteristics. We identified a 5-class solution. The *"average quality, somewhat costly food environment"* class (19.7 %) had low and high HFS and shopped at a variety of food stores; this class had the highest proportion of participants who were foreign-born (96 %) and reporting Spanish as their preferred language (90 %). The *"high quality, high-cost food environment, food-insecure household"* class (22.6 %) shopped at supermarkets and had the highest proportion of participants with a household income of ≤$20,000 (68 %). The *"poor quality, high-cost food environment"* class (16.8 %) had low and high HFS and shopped at supermarkets and convenience stores; this class had the highest proportion of participants who were single (33 %), without a vehicle (53 %), and reporting English as their preferred language (39 %). The *"high quality, somewhat costly food environment, food-secure household"* class (15.0 %) shopped at a variety of food stores and had the highest proportion (65 %) of participants with a household income of >$20,000. The *"high quality, affordable food environment, food-secure household"* class (25.9 %) shopped at supermarkets and had the highest proportion of participants who were US-born (25 %). U.S. Hispanic/Latino adults living with youth reported

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distinct combinations of HFS status, perceived neighborhood food environments, and food shopping behaviors, which underscores the complexity of factors defining adequate food access.

Abbreviations (alphabetized)

AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
HFSS	Household Food Security Survey
NYC	New York City
SNAP	Supplemental Nutrition Assistance Program
T2D	Type 2 diabetes
U.S	United States
USDA	United States Department of Agriculture
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

1. Introduction

Nearly 50 % of United States (U.S.) adults have some level of glucose intolerance; 13.2 % and 34.5 % have type 2 diabetes (T2D) and pre-diabetes, respectively (Centers for Disease Control and Prevention, 2022). Both prediabetes and T2D are disproportionately prevalent in ethnoracial minoritized groups, such as Hispanic/Latino adults (Avilés et al., 2017; Ferdinand and Nasser, 2015; Schneiderman et al., 2014), with Hispanic/Latino adults experiencing nearly twice the rate of newly diagnosed diabetes than that of non-Hispanic white adults (Centers for Disease Control and Prevention, 2020). These disparities are significant because Hispanic/Latino individuals comprise the second largest (United States Census Bureau, 2022) and the second fastest growing ethnoracial group (Budiman and Ruiz, 2021). More concerning is the increased prevalence of T2D in Hispanic/Latino youth (Diabetes in Children Adolescents Work Group of the National Diabetes Education Program, 2004; Aguayo-et al., 2019; Andes et al., 2020; SEARCH for Diabetes in Youth Study Group et al., 2006; Jensen and Dabelea, 2018). By 2050, T2D among youth is estimated to quadruple in prevalence, with Hispanic/Latino youth representing 50 % of all youth with T2D (Imperatore et al., 2012), thus necessitating the need for intervention.

Evidence strongly suggests that improvements to overall diet quality are associated with lower T2D risk (Martín-et al., 2020; Uusitupa et al., 2019), whereas low diet quality is associated with increased T2D risk (Ley et al., 2016). U.S. Hispanic/Latino adults have low diet quality (Mattei et al., 2016; Overcash and Reicks, 2021), and Hispanic/Latino youth diet quality needs improvement (Arandia et al., 2018). One possible explanation for low diet quality among U.S. Hispanic/Latino adults may be the higher than average prevalence of household food insecurity (21.9 % versus 9.9 % for non-Hispanic white households), referring to the limited and inconsistent access to enough food for healthy living (Rabbitt et al., 2024), which has been associated with poor health outcomes (Berkowitz et al., 2017; Seligman et al., 2010; Wright et al., 2019). Food-insecure households have financial constraints and often lack transportation to acquire food, restricting their access to healthful foods (Ma et al., 2016) and their food purchasing power (DeMartini et al., 2013a), limitations often a result of persistent structural disparities directed at marginalized communities. Evidence points to household food security status as a salient factor shaping dietary intake among U.S. Hispanic/Latino youth (Sharkey et al., 2012a; Fernández et al., 2020; Rosas et al., 2009; Dave et al., 2009). Although a previous study in the U.S.-based cohort, Study of Latino Youth (SOL Youth), did not find differences in mean Healthy Eating Index-2010 (HEI-2010) dietary quality scores by household food security status of youth (Potochnick et al., 2019), caregiver diet quality was not explored, which is notable as adults often shield children in the household from food insecurity by compromising their own dietary intake (Hamelin et al., 2002; Coleman-Jensen et al.). Overall, little is known about the relationship of household food security status with dietary intake (Fern´andez et al., 2020; Hilmers et al., 2013) or food acquisition behaviors (Gorman et al., 2017; Sharkey et al., 2013) among U.S. Hispanic/Latino adult caregivers, despite their prominent role in provisioning food for the household and their children.

Furthermore, household food security statue and perceived and observed food environments may uniquely intersect with food shopping behaviors to influence subsequent dietary intake. Perceived food environments are associated with objective food environments (Alber et al., 2018; Barnes et al., 2015; Co and Bakken, 2018a) as well as with household food security (Ma et al., 2016). According to the Model of Community Nutrition Environments, eating behaviors are shaped by community (e.g., stores, restaurants) and consumer (e.g., availability and price of items) food environments (Glanz et al., 2005). However, these relationships are moderated by important psychosocial factors, such as perceptions of the consumer food environment (e.g., perceived neighborhood healthy food availability, quality, and cost) and the household's food security status, and mediated by food shopping behaviors (e.g., frequency of shopping at different food stores) and the home food environment (e.g., what foods are available and accessible) (Green and Glanz, 2015). For example, higher availability of fresh produce from non-chain supermarkets (Zenk et al., 2009) and greater perceived quality of the produce may increase the likelihood that Hispanic/Latino individuals will purchase and consume fruits and vegetables (Alber et al., 2018; Barnes et al., 2019). Perceiving nutritious food as available in the neighborhood was also associated with lower odds of food insecurity among Puerto Rican adults in Boston (Wang et al., 2018). Likewise, Hispanic/Latino adults living in neighborhoods with higher immigrant composition (i.e., "enclaves") have reported healthier food environments, which was associated with lower intake of a high fat/-processed foods dietary pattern (Osypuk et al., 1982). From a structural perspective, these findings are important for ethnoracial minoritized populations, like Hispanic/Latino persons, as they often live in neighborhoods with greater access to non-traditional (vs. traditional) stores that sell fresh produce, dairy, and meat products (Emond et al., 2012; Sanchez-Flack et al., 2017). While this and other quantitative evidence exists for household food security, neighborhood food environments (e.
g., presence of traditional and non-traditional food outlets), and food shopping behaviors (e.g., resourceful shopping strategies and routines) among U.S. Hispanic/Latino households (Gorman et al., 2017; Sharkey et al., 2012b, 2013; Varela et al., 2023; Martin et al., 2012; Dannefer et al., 2016), the complexity of these relationships have not been explored despite the significant combined role they may have in shaping dietary intake.

As The Model of Community Nutrition Environments outlines, the relationships between household food security, perceived food environments, and shopping behaviors are nuanced, but elucidating these relationships has great potential for informing programming and policies that promote health equity (Odoms et al., 2024). Simultaneously, using an ecological systems approach is central to identifying targets for promoting healthier behaviors, as an ecological systems approach emphasizes relationships among multi-level factors that influence food choice, such as individual factors (e.g., demographics, preferences, and knowledge), social environments (e.g., family, friends, peers), physical environments (e.g., neighborhoods and communities, supermarkets, convenience and corner stores), and the macro-level environments (e.g.,

societal and cultural norms, food production and distribution, economic systems) (Bronfenbrenner, 1979; Story et al., 2008). Capturing these complex relationships requires statistical methods, such as latent class analysis (LCA), that permit identification of underlying, unobserved, and qualitatively different subgroups within a specific population sharing some observed characteristics. LCA categorizes respondents into mutually exclusive classes based on their patterns of responses for measured categorical indicators, revealing "clusters" of an underlying construct for application in clinical and health promotion research (Law and Harrington, 2016). Thus, LCA is appropriate for characterizing the subtleties between household food security, food environments, and food shopping behaviors, and both LCA and a large and diverse sample of U.S. Hispanic/Latino households can ultimately better inform health promotion programming and interventions. Therefore, the objective of this study was to 1) identify latent food security-food environment-food shopping classes and 2) investigate sociodemographic correlates to class membership using cross-sectional data from SOL Youth (Isasi et al., 2014).

2. Methods

SOL Youth is an ancillary study of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), a multi-center prospective, population-based cohort of self-identified Hispanic/Latino participants living in the U.S. Details on the design and implementation of HCHS/SOL were previously described (Sorlie et al., 2010). Briefly, from 2008 to 2011, HCHS/SOL recruited 16,415 participants between the ages of 18–74 years from four study sites (Bronx, NY; Chicago, IL; Miami, FL; San Diego, CA) through a stratified two-stage probability design based on census blocks (LaVange et al., 2010), with the objective of identifying risk factors associated with cardiovascular disease and other chronic conditions (Sorlie et al., 2010). Recruitment for HCHS/SOL involved community-based approaches, including mailings, telephone contacts, and in-person contacts (LaVange et al., 2010). Between 2012 and 2014, the SOL Youth ancillary study was launched, recruiting youth aged 8–16 years who were living with participants (caregivers) from HCHS/SOL. Of the 1777 eligible youth, 1466 youth and 983 of their adult caregivers participated. Only the adult caregivers are included in these analyses. Study staff conducted clinical examinations and interview-administered study questionnaires in their language of preference (English or Spanish). Further details on design and implementation were previously explained (Isasi et al., 2014). The Institutional Review Boards at each study site approved the study and all participants, caregivers and youth, gave their written informed consent and assent, respectively (Isasi et al., 2014; Sorlie et al., 2010).

2.1. Measures

Exposure variables were derived from three SOL Youth questionnaires administered to caregivers: 1) the United States Department of Agriculture (USDA) 18-item Household Food Security Survey Module (HFSSM); 2) perceived neighborhood food environment; and 3) frequency of food shopping at different store types.

2.1.1. USDA 18-item household food security Survey Module

The USDA 18-item HFSSM is a valid and reliable survey of household food security status over the past 12-months (Hamilton et al., 1997; Bickel et al., 2000). The HFSSM captures respondents': 1) perception that their food budget and supply is deficient; 2) perception that the food eaten at home is low quality; 3) instances of reduced food intake or consequences of reduced food intake for household adults, and 4) for household children. As outlined by USDA guidelines, household food security status was determined by summing the total number of affirmative responses (range 0–18) and classifying as: high food security (0), marginal food security(1-2) (Centers for Disease Control and Prevention, 2022; Avilés et al., 2017), low food security(3-7) (Ferdinand and Nasser, 2015; Schneiderman et al., 2014; Centers for Disease Control and Prevention, 2020; United States Census Bureau, 2022; Budiman and Ruiz, 2021), or very low food security(8-18) (Diabetes in Children Adolescents Work Group of the National Diabetes Education Program, 2004; Aguayo-et al., 2019; Andes et al., 2020; SEARCH for Diabetes in Youth Study Group et al., 2006; Jensen and Dabelea, 2018; Imperatore et al., 2012; Martín-et al., 2020; Uusitupa et al., 2019; Ley et al., 2016; Mattei et al., 2016; Overcash and Reicks, 2021).

2.1.2. Perceived neighborhood food environment – availability, quality, and cost of healthy foods

The perceived neighborhood food environment was assessed based on level of agreement (a five-point Likert scale from strongly agree to strongly disagree) with five items of the Perceived Nutrition Environment Measures Survey, a reliable measure of perceived neighborhood food environments in both high and low socioeconomic status neighborhoods (Green and Glanz, 2015). Specifically, the items were: 1) There is a large selection of low-fat products available, 2) The fresh produce is usually of high-quality, 3) There is a large selection of fresh fruits and vegetables, 4) Fruits and vegetables cost too much, and 5) Low-fat foods cost too much. Response options were collapsed into three categories, to maximize sample sizes for LCA: strongly disagree/somewhat disagree/neutral, somewhat agree, and strongly agree.

2.1.3. Frequency of food shopping at different store types

Participants reported the frequency at which the household's main food shopper shopped at five different store types (supermarket, warehouse store, or supercenter; small/medium ethnic food store; small/medium non-ethnic food store; convenience store; farmers market/produce stand), a similar format to previous studies on food shopping (Minaker et al., 2016; Lo et al., 2019). Response options were always, often, sometimes, rarely, and never. Response options were collapsed into four categories (never, rarely, sometimes, often/always) to maximize sample sizes for LCA, with the exception of two store types; response options for supermarket, warehouse store, or supercenter were collapsed into never/rarely/sometimes, often, or always, and response options for small to medium ethnic food store were collapsed into never/rarely, sometimes, often, or always.

2.1.4. Sociodemographic characteristics

Participants self-reported sociodemographic characteristics including age (<42 y, ≥42 y), sex (female, male), educational attainment (less than high school, high school diploma or General Education Development (GED) credential, more than high school), household income ≤$20,000, >$20,000), employment status (employed full-time, employed part-time, not employed-looking for work, not employed-not looking for work), marital status (single, married/living with partner, separated/divorced/widow (er)), the number of people supported by the household income (<4 people, ≥4 people), the number of drivable motor vehicles in the household (0 vehicles, ≥1 vehicles), participation in the Supplemental Nutrition Assistance Program (SNAP; yes, no, no but participating in other social or food assistance program(s)), nativity (born in U.S. 50 states/D.C. vs U.S. territory/foreign born), language preference (Spanish vs English), Hispanic/Latino heritage (Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, Mixed/Other), and field center (i.e., the study site location). The response options for household income (≤$20,000, $21,000-$40,000, >$40,000) and marital status (single-not living with partner, single-living with partner, married, separated, divorced, widow (er)) were collapsed to maximize the sample size for LCA. Age, the number of people supported by the household income, and the number of drivable motor vehicles in the household were continuous variables and were dichotomized by the sample mean for LCA. Due to small sample sizes for some Hispanic/Latino heritages, this variable was only used to describe the sample and not to predict latent class membership.

2.2. Statistical analysis

We analyzed data from 983 adult caregivers with complete sample design stratification data. Missing data (n: age = 1; sex = 2; educational attainment = 2; household income = 30; employment status = 14; marital status = 1; number of people supported by household income = 6; number of drivable motor vehicles in household = 10; nativity = 1; language preference = 3; low-fat products available = 4; high-quality fresh produce = 4; large selection of fruits and vegetables = 3; fruits and vegetables expensive = 3; supermarket shopping = 3; ethnic food store = 4; non-ethnic food store = 6; convenience store = 5; farmers' market = 6; household food security status = 2) were imputed with multiple imputation for chained equations using classification and regression trees in R Studio. For descriptive purposes, we first compared unadjusted differences in characteristics of the adult caregivers and their households by household food security status using ANOVA for continuous variables and Rao-Scott chi-square tests for categorical variables in SAS version 9.4. Previously published findings from SOL Youth described adult caregiver characteristics by household food security status for all youth participants, not by all households, and some households had more than one youth participating in the study (Potochnick et al., 2019; Maldonado et al., 2022).

Next, we employed LCA with starting values of 1000, 500, and 50 to identify mutually exclusive underlying subgroups from the 11 previously described indicators: household food security status, five indicators of the perceived neighborhood food environment, and frequency of food shopping at five different types of stores. To compare model fit and select the best-fitting model, we compared models from one to six classes on the following criteria: Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), log-likelihood values, and entropy. The practical importance of the identified classes when selecting a model was also considered. We used the manual Bolck-Croon-Hagenaars (BCH) three-step method to identify latent classes and determine the relationship of these classes to distal sociodemographic characteristics, as this method uses BCH weights to reflect latent class variable measurement error (Nylund et al., 2019; Asparouhov and Muthén, 2021). In the first step, we estimated the latent classes and reported conditional item-response probabilities for each class. In the second step, each caregiver was assigned to the latent class in which they had the highest probability for class membership. In the third step, we included sociodemographic characteristics as distal outcomes and compared differences in class-specific distributions. Descriptive analyses were conducted in SAS 9.4 and LCA were conducted in MPlus version 8.6, accounting for the complex survey design and sampling weights.

3. Results

3.1. Sample characteristics

The majority of households experienced some level of food insecurity: 10.9 % had very low food security, 30.2 % had low food security, and 17.0 % had marginal food security. The remainder of households had high food security (41.9 %). Participants who were female, not employed, U.S.-born (i.e., born in 50 states/DC), or single, separated, or widowed tended to live in less food secure households (Table 1). Participants with lower levels of educational attainment, participating in SNAP, living in the Bronx, New York site, reporting ≤$20,000 household income, or reporting English as their preferred language also tended to live in less food secure households.

3.2. Latent classes

A five-class model was the best fitting solution as it had the lowest BIC, alongside lower AIC, loglikelihood, and entropy, compared to lower- or higher-class models (Table 2).

Table 1
Characteristics of caregivers in SOL-Youth by household food security status[1] (n = 983).

Characteristic	High food security	Marginal food security	Low food security	Very low food security	p-value
	n = 412	n = 167	n = 297	n = 107	
	Mean or % (95 % Confidence Intervals)				
Age (y)	41.1 (40.4, 41.9)	40.7 (39.2, 42.2)	41.5 (40.6, 42.5)	40.9 (39.1, 42.6)	0.65
Female, %	83.3 (79.1, 87.4)	92.1 (87.5, 96.8)	93.1 (90.3, 95.9)	93.3 (87.0, 99.5)	0.001
Educational attainment, %					<0.0001
Less than high school	27.9 (22.2, 33.5)	38.4 (28.5, 48.3)	44.3 (37.4, 51.1)	57.1 (45.6, 68.5)	
High school diploma or GED	27.3 (22.0, 32.5)	27.5 (19.5, 35.5)	30.2 (23.5, 37.0)	21.9 (12.6, 31.3)	
More than high school	44.9 (39.0, 50.7)	34.1 (24.4, 43.8)	25.5 (19.0, 31.9)	21.0 (12.0, 30.0)	
Household income, %					<0.0001
≤$20,000	36.2 (30.2, 42.1)	59.8 (50.0, 69.7)	60.7 (53.7, 67.8)	76.4 (66.6, 86.2)	
>$20,000	63.8 (57.9, 69.8)	40.2 (30.4, 50.0)	39.3 (32.2, 46.3)	23.6 (13.8, 33.4)	
Employment status, %					0.001
Employed full-time (≥35 h/week)	42.5 (35.8, 49.1)	29.5 (21.4, 37.7)	28.4 (22.1, 34.7)	20.8 (11.3, 30.2)	
Employed part-time (<35 h/week)	20.1 (15.1, 25.1)	22.7 (15.1, 30.3)	21.3 (15.4, 27.1)	18.8 (10.2, 27.4)	
Not employed, looking for work	14.3 (9.6, 19.0)	29.0 (20.0, 38.0)	25.4 (19.7, 31.1)	33.2 (21.2, 45.2)	
Not employed, not looking for work	23.1 (17.0, 29.3)	18.8 (11.7, 25.9)	24.9 (18.5, 31.3)	27.2 (16.9, 37.6)	
Marital status, %					0.0001
Single, not living with partner	13.1 (8.4, 17.8)	18.5 (10.0, 27.0)	17.5 (11.5, 23.5)	34.7 (22.2, 47.2)	
Single, living with partner	12.0 (8.1, 15.8)	16.6 (9.6, 23.6)	12.6 (8.0, 17.2)	15.9 (7.6, 24.2)	
Married	60.6 (54.1, 67.0)	49.3 (39.4, 59.2)	50.0 (42.2, 57.7)	29.4 (19.3, 39.5)	
Separated	6.8 (3.8, 9.7)	6.9 (2.5, 11.2)	12.4 (8.0, 16.9)	12.0 (4.9, 19.0)	
Divorced	7.2 (4.2, 10.1)	8.1 (3.2, 13.1)	5.8 (2.7, 8.9)	4.4 (0.03, 8.8)	
Widow(er)	0.5 (0.1, 1.0)	0.7 (0.0, 1.6)	1.7 (0.2, 3.2)	3.6 (0.0, 7.7)	
Number of people supported by household income	4.1 (3.9, 4.2)	4.1 (3.9, 4.3)	4.1 (3.9, 4.3)	3.8 (3.4, 4.1)	0.16
Number of drivable motor vehicles in household	1.5 (1.3, 1.6)	1.0 (0.9, 1.2)	1.0 (0.8, 1.1)	0.5 (0.3, 0.7)	<0.0001
SNAP participation, %					<0.0001

(continued on next page)

Table 1 (*continued*)

Characteristic	High food security	Marginal food security	Low food security	Very low food security	p-value
	n = 412	n = 167	n = 297	n = 107	
	Mean or % (95 % Confidence Intervals)				
No	25.9 (20.6, 31.2)	12.6 (6.9, 18.3)	9.2 (4.8, 13.5)	6.6 (0.9, 12.3)	
Yes	40.7 (34.8, 46.6)	56.9 (47.4, 66.4)	62.5 (55.8, 69.1)	76.0 (66.4, 85.7)	
No, but participates in other social or food assistance program(s)	33.4 (27.7, 39.1)	30.5 (21.9, 39.1)	28.4 (21.9, 34.9)	17.4 (8.9, 25.9)	
Born in US 50 States/D.C., %	13.0 (8.9, 17.1)	15.0 (8.3, 21.6)	14.3 (9.1, 19.6)	27.4 (16.1, 38.7)	0.04
Language preference, %					0.01
Spanish	77.5 (71.9, 83.0)	82.7 (75.9, 89.5)	81.2 (75.3, 87.2)	62.3 (50.2, 74.4)	
English	22.5 (17.0, 28.1)	17.3 (10.5, 24.1)	18.8 (12.8, 24.7)	37.7 (25.6, 49.8)	
Hispanic/Latino heritage, %					0.08
Central American	7.0 (4.1, 9.9)	12.9 (6.5, 19.2)	7.3 (4.4, 10.2)	10.6 (4.6, 16.6)	
Cuban	8.0 (5.0, 11.0)	8.1 (3.4, 12.7)	5.3 (2.3, 8.2)	5.3 (0.3, 10.3)	
Dominican	14.9 (9.9, 19.9)	12.7 (6.5, 18.9)	15.1 (9.6, 20.6)	23.4 (13.1, 33.7)	
Mexican	52.8 (46.2, 59.3)	44.2 (34.5, 53.8)	48.2 (40.7, 55.8)	39.0 (26.8, 51.0)	
Puerto Rican	10.0 (6.7, 13.4)	11.1 (5.5, 16.7)	17.3 (10.7, 23.9)	16.3 (7.8, 24.8)	
South American	5.6 (3.2, 8.0)	8.4 (3.6, 13.1)	5.6 (2.9, 8.4)	1.4 (0.0, 3.4)	
Mixed/other	1.8 (0.3, 3.2)	2.7 (0.1, 5.3)	1.2 (0.0, 2.6)	4.1 (0.0, 8.2)	
Field center,[2] %					0.01
Bronx, New York	31.8 (25.8, 37.8)	34.1 (25.0, 43.3)	41.2 (33.8, 48.6)	51.4 (40.1, 62.7)	
Chicago, Illinois	14.0 (10.6, 17.9)	17.0 (10.6, 23.3)	15.2 (10.8, 19.6)	12.9 (7.0, 18.7)	
Miami, Florida	14.2 (10.5, 17.9)	19.5 (12.2, 26.7)	12.7 (8.5, 16.9)	17.7 (9.9, 25.5)	
San Diego, California	40.0 (33.3, 46.7)	29.4 (19.9, 39.0)	30.9 (23.3, 38.5)	18.0 (9.5, 26.6)	

GED = General Educational Development, SNAP=Supplemental Nutrition Assistance Program.

Continuous variables are shown as means (95 % CI) and categorical variables are shown as percentages (95 % CI).

[1]The USDA 18-item Household Food Security Survey Module assessed household food security status. Affirmative responses were tallied to produce scores ranging from 0 to 18. Scores were then categorized as high food security (0), marginal food security (1-2) (Centers for Disease Control and Prevention, 2022; Avilés et al., 2017), low food security(3-7) (Ferdinand and Nasser, 2015; Schneiderman et al., 2014; Centers for Disease Control and Prevention, 2020; United States Census Bureau, 2022; Budiman and Ruiz, 2021), and very low food security(8-18). (Diabetes in Children Adolescents Work Group of the National Diabetes Education Program, 2004; Aguayo-et al., 2019; Andes et al., 2020; SEARCH for Diabetes in Youth Study Group et al., 2006; Jensen and Dabelea, 2018; Imperatore et al., 2012; Martín-et al., 2020; Uusitupa et al., 2019; Ley et al., 2016; Mattei et al., 2016; Overcash and Reicks, 2021).

[2]Field center represents each participant's affiliated center and the city in which it was located.

"Average quality, somewhat costly" (Class 1) – Average quality and somewhat costly food environment with diverse food store shoppers

The *"average quality, somewhat costly"* class comprised 19.7 % of the sample. Household food security status for this class was mixed; participants lived in households with high or low food security status. Participants in this class *somewhat* perceived their neighborhood food environment to offer a large selection of low-fat products and high-quality fresh fruits and vegetables at a high cost (Table 3). Participants in the *"average quality, somewhat costly"* class reported often shopping at supermarkets, warehouse stores, or supercenters, as well as small-to medium-sized ethnic food stores. They also reported rarely or sometimes shopping at small-to medium-sized non-ethnic food stores and sometimes shopping at convenience stores.

"High quality, high-cost, food-insecure" (Class 2) – High quality and high-cost food environment with food insecure supermarket shoppers

The "high quality, high-cost, food-insecure" class comprised 22.6 % of the sample. Participants in the *"high quality, high-cost, food-insecure"* class lived in households with low food security status and perceived their neighborhood food environment to offer a large selection of low-fat products and high-quality fresh fruits and vegetables at a high cost. Adults in this class reported always shopping at supermarkets, warehouse stores, or supercenters.

"Poor quality, high-cost" (Class 3) – Poor quality and high-cost food environment with supermarket and convenience store shoppers

The *"poor quality, high-cost"* class comprised 16.8 % of the sample. Household food security status for this class was mixed; participants in this class lived in households with either high or low food security status. Participants in this class perceived their neighborhood food environment to offer a poor selection of low-fat products and fresh fruits and vegetables, and low-quality, costly fruits and vegetables. Adults in the *"poor quality, high-cost"* class reported *always* shopping at supermarkets, warehouse stores, or supercenters, never/rarely or sometimes shopping at small-to medium-sized ethnic food stores, and sometimes shopping at convenience stores.

"High quality, somewhat costly, food-secure" (Class 4) – High quality and somewhat costly food environment with food-secure small- to medium-sized food store shoppers

The *"high quality, somewhat costly, food-secure"* class comprised 15.0 % of the sample. Participants in this class lived in households with high food security status. Participants in this class perceived their neighborhood food environment to offer a large selection of low-fat products and high-quality fresh fruits and vegetables, but somewhat perceived low-fat items and fruits and vegetables to cost too much. Participants in the *"high quality, somewhat costly, food-secure"* class never/rarely/sometimes shopped at supermarkets, warehouse stores, or supercenters, often shopped at small-to medium-sized ethnic food stores, often/always

Table 2
Fit indices for 1–6 class models among SOL-Youth households (n = 983).

# Classes	BIC	AIC	Loglikelihood	Entropy
1	25898.546	25766.500	−12856.250	–
2	25380.111	25111.128	−12500.564	0.822
3	25230.424	24824.503	−12329.252	0.844
4	25131.126	24588.268	−12183.134	0.810
5	**25091.995**	**24412.200**	**−12067.100**	**0.796**
6	25123.340	24306.608	−11986.304	0.824

BIC=Bayesian Information Criterion, AIC = Akaike Information Criterion.

Table 3
Item-response probabilities from five latent classes of food security, perceived food environment, and food shopping behaviors among SOL-Youth households (n = 983)[1].

	"Average quality, somewhat costly"	"High quality, high cost, food-insecure"	"Poor quality, high cost"	"High quality, somewhat costly, food secure"	"High quality, affordable cost, food secure"
	n = 194	n = 222	n = 165	n = 148	n = 254
Perceived neighborhood food environment[2]					
Large selection of low-fat products available					
Strongly disagree/ somewhat disagree/ neutral	0.278	0.201	**0.708**	0.055	0.199
Somewhat agree	**0.515**	0.288	0.163	0.311	0.093
Strongly agree	0.207	**0.511**	0.129	**0.633**	**0.708**
Fresh produce usually of high-quality					
Strongly disagree/ somewhat disagree/ neutral	0.232	0.069	**0.895**	0.037	0.057
Somewhat agree	**0.735**	0.362	0.051	0.207	0.198
Strongly agree	0.033	**0.569**	0.054	**0.756**	**0.745**
Large selection of fresh fruits and vegetables					
Strongly disagree/ somewhat disagree/ neutral	0.080	0.003	**0.774**	0.050	0.000
Somewhat agree	**0.679**	0.276	0.180	0.018	0.045
Strongly agree	0.241	**0.722**	0.046	**0.931**	**0.955**
Fruits and vegetables cost too much					
Strongly disagree/ somewhat disagree/ neutral	0.373	0.000	0.283	0.173	**0.728**
Somewhat agree	**0.586**	0.138	0.329	**0.525**	0.196
Strongly agree	0.041	**0.862**	**0.388**	0.303	0.076
Low-fat foods cost too much					
Strongly disagree/ somewhat disagree/ neutral	0.290	0.000	0.354	0.108	**0.698**
Somewhat agree	**0.663**	0.120	0.309	**0.674**	0.178
Strongly agree	0.048	**0.880**	0.336	0.218	0.125
Type and frequency of food store shopping[3]					
Supermarket, warehouse store, or supercenter					
Never/ rarely/ sometimes	0.362	0.302	0.331	**0.370**	0.217
Often	**0.442**	0.157	0.219	0.308	0.241
Always	0.197	**0.541**	**0.450**	0.323	**0.542**
Small to medium ethnic food store					
Never/ rarely	0.156	0.295	**0.371**	0.132	0.295
Sometimes	0.307	0.334	**0.357**	0.113	0.293
Often	**0.397**	0.174	0.131	**0.418**	0.214
Always	0.140	0.196	0.141	0.337	0.198
Small to medium non-ethnic food store					
Never	0.079	0.251	0.272	0.057	**0.354**
Rarely	**0.345**	0.332	0.271	0.337	0.282
Sometimes	**0.378**	0.313	0.280	0.124	0.242
Often/ always	0.199	0.104	0.178	**0.482**	0.122
Convenience store					
Never	0.111	0.274	0.215	0.095	**0.356**
Rarely	0.339	0.263	0.200	**0.422**	0.184
Sometimes	**0.380**	0.294	**0.425**	0.013	**0.353**
Often/ always	0.170	0.169	0.160	**0.470**	0.107
Farmers' market/produce stand					
Never	0.269	0.294	0.329	0.221	**0.356**
Rarely	0.280	0.194	0.123	**0.421**	0.148
Sometimes	0.267	0.344	0.332	0.125	0.265
Often/ always	0.184	0.167	0.215	0.233	0.231
Household food security status[4]					
High	**0.417**	0.222	**0.373**	**0.641**	**0.557**
Marginal	0.148	0.114	0.148	0.109	0.214
Low	**0.390**	**0.426**	**0.333**	0.216	0.184
Very low	0.045	0.238	0.147	0.035	0.045

[1] *"Average quality, somewhat costly"* = Average quality and somewhat costly food environment with diverse food store shoppers; *"High quality, high cost, foodinsecure"* = High quality and high-cost food environment with food insecure supermarket shoppers; *"Poor quality, high cost"* = Poor quality and high-cost food environment with supermarket and convenience store shoppers; *"High quality, somewhat costly, food secure"* = High quality and somewhat costly food environment with food-secure small to medium food store shoppers; *"High quality, affordable cost, food secure"* = High quality affordable food environment with food-secure supermarket shoppers. Bolded values indicate highest probabilities, which define the class.
[2] The 4-item, Likert response scale Perceived Nutrition Environment Measures Survey assessed the perceived neighborhood food environment.
[3] Participants reported the frequency at which the main food shopper shopped at five different store types (supermarket, warehouse store, or supercenter; small/ medium ethnic food store; small/medium non-ethnic food store; convenience store; farmers market/produce stand).
[4] The USDA 18-item Household Food Security Survey Module assessed house hold food security status. Affirmative responses were tallied to produce scores ranging from 0 to 18. Scores were then categorized as high food security (0), marginal food security (1-2), low food security (3-7), and very low food security (8-18).

shopped at small-to medium-sized non-ethnic food stores, rarely or often/always shopped at convenience stores, and rarely shopped at farmers' markets/produce stands.

"High quality, affordable, food-secure" (Class 5) – High quality affordable food environment with food-secure supermarket shoppers

The *"high quality, affordable, food-secure"* class comprised 25.9 % of the sample. Participants in this class lived in households with high food security status. Participants in this class perceived their neighborhood food environment to offer a large selection of low-fat products and high-quality fresh fruits and vegetables at a reasonable cost. Adults in the *"high quality, affordable, food-secure"* class reported always shopping at supermarkets, warehouse stores, or supercenters, never shopping at small-to medium-sized non-ethnic food stores or farmers' markets/ produce stands, and never or sometimes shopping at convenience stores.

3.3. Association of latent class membership with sociodemographic characteristics

When modeling sociodemographic characteristics as distal outcomes, several characteristics differed by class membership, including household income, marital status, number of drivable motor vehicles in the household, SNAP participation, nativity, language preference, and field center (Fig. 1). For household income, the "*high quality, somewhat costly, food-secure*" class had the highest proportion of participants (65 %) with a household income of >$20,000, whereas the "*high quality, high-cost, food-insecure*" and "*poor quality, high-cost*" classes had the highest proportion of participants (68 % and 57 %, respectively) with a household income of ≤ $20,000. The "*average quality, somewhat costly*" class and "*high quality, affordable, food-secure*" class had relatively equal proportions of participants in each income category (≤$20,000: 45 % and 49 %, respectively; >$20,000: 55 % and 51 %, respectively). All latent classes had a high proportion of married participants, but the "*poor quality, high-cost*" class comprised the highest proportion (33 %) of single participants and the "*high quality, high-cost, food-insecure*" and "*high quality, affordable, food-secure*" classes had the highest proportions (21 % and 21 %, respectively) of separated/divorced/widowed participants. The "*average quality, somewhat costly,*" "*high quality, high-cost, food-insecure,*" and "*high quality, somewhat costly, food-secure*" classes had relatively equal proportions of single and separated/divorced/widowed participants (single: 11 %, 20 %, 12 %, respectively; separated/divorced/widowed: 12 %, 21 %, 14 %, respectively), although the "*high quality, high-cost, food-insecure*" class proportions were almost twice the "*average quality, somewhat costly*" and "*high quality, somewhat costly, food-secure*" class proportions.

For number of drivable motor vehicles, the "*poor quality, high-cost*" class was the only latent class with a higher proportion of participants with no vehicles (53 %) versus one or more vehicles (47 %), although the proportions were close to equal. The "*high quality, high-cost, food-insecure*" class had the second highest proportion of participants with no drivable motor vehicles (41 %), but the proportion of participants with one or more vehicles was still high (59 %). The majority of participants in the "*average quality, somewhat costly,*" "*high quality, somewhat costly, food-secure,*" and "*high quality, affordable, food-secure*" classes had one or more drivable vehicles (77 %, 80 %, and 75 %, respectively).

For SNAP participation, the "*high quality, high-cost, food-insecure*" and "*poor quality, high-cost*" classes had higher proportions of SNAP participants (64 % and 67 %, respectively) compared to other latent classes. The "*average quality, somewhat costly*" class and "*high quality, affordable, food-secure*" class had high proportions of both SNAP participants (52 % and 51 %, respectively) and other food or social assistance participants (36 % and 28 %, respectively), but the "*high quality, affordable, food-secure*" class had a higher proportion of non-SNAP participants than the "*average quality, somewhat costly*" class (22 % vs. 13 %). The "*high quality, somewhat costly, food-secure*" class was distinct from the other classes in that the proportions of SNAP and non-SNAP participants were relatively similar (31 % and 26 %) but the proportion of participants reporting other food or social assistance participation was the highest (43 %) of all latent classes ("*average quality, somewhat costly*": 36 %, "*high quality, high-cost, food-insecure*": 24 %,

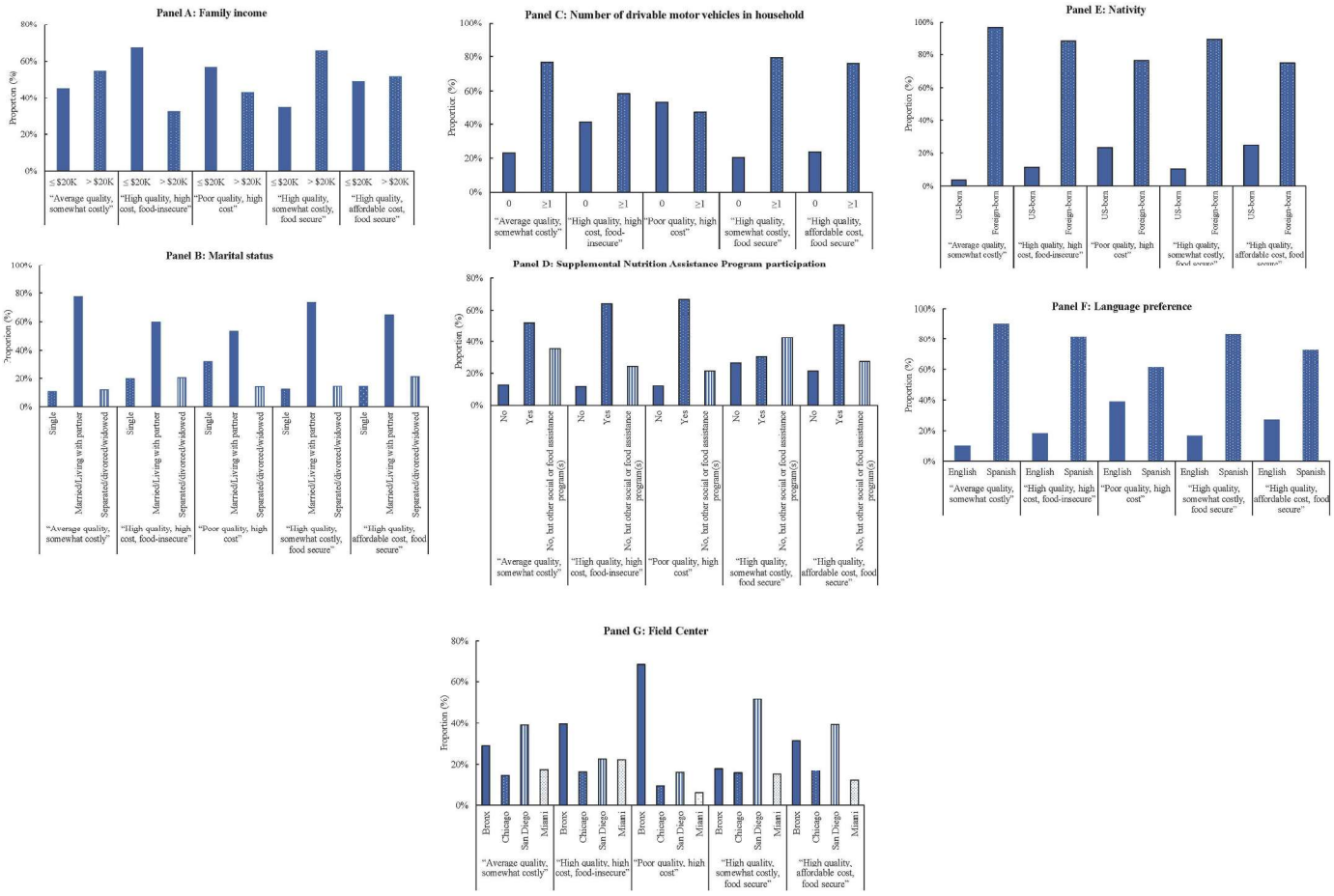

Fig. 1. Sociodemographic characteristics for each food security-food environment-food shopping latent class among SOL-Youth households (n = 983)[1].
[1]Distributions of sociodemographic characteristics were determined using Step 3 of the manual Bolck-Croon-Hagenaars three-step method, modeling the relationship of latent classes to individual sociodemographic characteristics as distal outcomes. Family income, marital status, number of drivable motor vehicles in the household, SNAP participation, nativity, language preference, and field center differed across latent classes. Each variable category equals 100 % of the class.

"poor quality, high-cost": 21 %, *"high quality, affordable, food-secure"*: 28 %).

For nativity and language preference, all latent classes had a high proportion of participants who were foreign-born or reported Spanish as their preferred language, which reflects the overall characteristics of the HCHS/SOL cohort. However, the *"poor quality, high-cost"* class and *"high quality, affordable, food-secure"* class had the highest proportions of participants who were U.S.-born (23 % and 25 %, respectively) or reported English as their preferred language (39 % and 27 %, respectively). Most participants comprising the *"average quality, somewhat costly,"* *"high quality, high-cost, food-insecure,"* and *"high quality, somewhat costly, food-secure"* classes were foreign-born (96 %, 89 %, and 90 %, respectively) and reported Spanish (90 %, 82 %, and 83 %, respectively) as their preferred language. The latent classes also differed by study field centers, with the *"poor quality, high-cost"* class comprised mostly of participants at the Bronx field center (68 %) and the *"high quality, somewhat costly, food-secure"* class comprised mostly of participants at the San Diego field center (52 %). The *"average quality, somewhat costly"* class and *"high quality, affordable, food-secure"* class had high proportions of participants at both the Bronx (29 % and 32 %, respectively) and San Diego (39 % and 39 %, respectively) field centers, followed by the Miami field center (18 %) for the *"average quality, somewhat costly"* class and the Chicago field center (17 %) for the *"high quality, affordable, food-secure"* class. The *"high quality, high-cost, food-insecure"* class had a high proportion of participants at the Bronx field center (40 %), followed by the Miami (22 %) and San Diego (22 %) field centers.

4. Discussion

Among a heritage-diverse sample of U.S. Hispanic/Latino households with youth, we identified five latent classes for household food security status, perceived neighborhood food environments, and food shopping behaviors, findings which demonstrated distinct and salient intersections of psychosocial environments shaping the food shopping behaviors of U.S. Hispanic/Latino households. In the context of households' food security status, participants' perceptions of the availability, quality, and cost of healthy foods in their food environments appeared to influence how they navigated their food environment. Specifically, participants in the two classes with mixed (low and high) household food security status differed in their food environment perceptions and shopping behaviors; the *"average quality, somewhat costly"* class shopped at a variety of food outlets (often at supermarkets, warehouse stores, or supermarkets; often at small to medium ethnic food stores; sometimes at small to medium non-ethnic food stores and convenience stores), whereas the *"poor quality, high-cost"* class always shopped at supermarkets, warehouse stores, or supercenters, and sometimes shopped at convenience stores. Despite the *"high quality, somewhat costly, food-secure"* and *"high quality, affordable, food-secure"* classes being categorized with high household food security, they also were distinct in their perceived food environment and food shopping behaviors. The *"high quality, somewhat costly, food-secure"* class often shopped at small to medium ethnic food stores, often/always shopped at small to medium non-ethnic food stores, and rarely or often/always shopped at convenience stores. In contrast, the *"high quality, affordable, food-secure"* class, the largest class (25.9 %), always shopped at supermarkets, warehouse stores, or supercenters. Notably, the only class characterized solely with household food insecurity, the *"high quality, high-cost, food-insecure"* class, also always shopped at supermarkets, warehouse stores, or supercenters.

Our findings contribute important insights into the understudied interplay of perceived neighborhood food environments, particularly the availability, quality, and cost of foods, with food shopping behaviors for households at risk of food insecurity. Among primarily African American women living in an area of South Carolina with limited food access, Ma and colleagues identified three latent classes of shoppers: 1) accessing community food banks/pantries, food shopping infrequently, and using transportation other than a household car; 2) accessing community food banks/pantries and engaging in more frequent and proximal food shopping; and 3) not accessing community food banks/pantries and engaging in distal food shopping (Ma et al., 2018), each of which was distinctly associated with household food security status, SNAP participation, type of transportation used for food shopping (e.g., household car, public transit), perceived access to adequate neighborhood food shopping, and frequency of proximal versus distal food shopping. While all three of our latent classes with participants in food-insecure households (*"average quality, somewhat costly;"* *"poor quality, high-cost;"* and *"high quality, high-cost, food-insecure")* were characterized by often or always shopping at supermarkets, warehouse stores, or supercenters, the frequency of shopping at other types of stores differed by latent class but, nonetheless, demonstrated the potential reliance of Hispanic/Latino households on non-traditional food stores. Previous research on *tiendas*, or Hispanic/Latino-serving small grocery stores, demonstrated similar availability and quality of fresh produce, but less available and affordable low-fat milk and meat options, compared to supermarkets (Emond et al., 2012).

Our findings on distinctions in sociodemographic factors by latent classes also adds to limited quantitative evidence regarding intersections of household food security, perceived food environment, and food shopping behaviors among U.S. Hispanic/Latino adults. The *"average quality, somewhat costly"* and *"high quality, affordable, food-secure"* classes were comprised of participants with similar sociodemographic characteristics, but the latent class characteristics were distinct between the two, highlighting the importance of multi-level factors shaping food choice. Specifically, the *"average quality, somewhat costly"* class was characterized by shopping at a variety of store types and a mix of high and low food security status, versus the *"high quality, affordable, food-secure"* class, which was characterized by shopping mostly at supermarkets, warehouse stores, or supercenters. Most studies considering the relationship between food environments and household food security status, or vice versa, demonstrate that presence of supermarkets in a neighborhood or distance to the nearest supermarket may not be the most salient factors for predicting a household's food security status (Widener et al., 2018; Wilde et al., 2017) and which is confirmed by our identified *"high quality, somewhat costly, food-secure"* class, characterized as never/rarely/sometimes shopping at supermarkets. Rather, the perceived food environment (e.g., cost, quality) and other factors (e.g., mode of transportation) appear to be more influential (Wilde et al., 2017; Tach and Amorim, 2015). Several studies among racially- and ethnically-diverse samples in urban U.S. cities showed that food-insecure participants were more likely than their food-secure counterparts to perceive an insufficient number of food stores in their community, a lack of affordable healthy food choices (DeMartini et al., 2013b; Vedovato et al., 2016) and preferred foods (DeMartini et al., 2013b) in their community, high difficulty in accessing fruits and vegetables in their neighborhood, and fair or poor quality of groceries in their neighborhood (Mayer et al., 2014). Additionally, for Puerto Rican adults in Boston, those living far ($\geq$0.5 miles) from their primary food shopping location had a high probability of living in food-insecure households while adults with low language acculturation living near ($<$0.5 miles) their primary shopping location had the lowest probability of living in a food-insecure household, demonstrating that close proximity to primary shopping location is critical for food security while also suggesting potential protective factors, such as social capital, may exist in neighborhoods where adults with low language-based acculturation reside (Wang et al., 2018).

Considering food insecurity remains prevalent among U.S. Hispanic/Latino households, the two latent classes characterized by high food security in our sample is notable. In fact, our study findings, together with previous studies among U.S. Hispanic/Latino adults, suggest that more unique relationships between household food security status and shopping behaviors may exist. Among Mexican-origin families in

colonias on the Texas-Mexico border, purchasing food from a neighbor, from mobile food vendors, or from *pulgas* (i.e., flea markets) was associated with lower odds household food insecurity (Sharkey et al., 2012b) and/or child hunger (Sharkey et al., 2013). Among mostly Hispanic mothers in Rhode Island, households with low or very low food security status did not differ from food-secure households for frequency of shopping at different types of stores (i.e., supermarket, convenience store, corner store/neighborhood market, superstore, or discount store), except for specialty stores (less likely to shop here) (Gorman et al., 2017). Additionally, online grocery shopping and delivery increased with the COVID-19 pandemic, including for low-income households (Duffy et al., 2022), and may expand possible solutions for improving food access through online grocery shopping from small food retailers, like *bodegas* (small, owner-operated stores), especially when combined with expanded community outreach and ability to use food and nutrition assistance benefits (Trude et al., 2022, 2024). Our findings for the "high quality, s*omewhat costly, food-secure"* class emphasize the importance of non-traditional food stores in promoting food security and healthy food purchases among heritage-diverse U.S. Hispanic/Latino adults. Additional multi-level intervention and policy research is needed that capitalizes on existing non-traditional food outlets in U.S. Hispanic/Latino neighborhoods to ensure that they offer high-quality healthy, affordable, and culturally relevant food, are easily accessible at a variety of hours to households without a personal vehicle (Dannefer et al., 2016; Breland et al., 2013), and accept federal food and nutrition assistance benefits like SNAP.

Quant evidence provides additional insights into food shopping for Hispanic/Latino households at risk of food insecurity. Specifically, a costly food environment can result in households traveling outside their neighborhood to shop, which might be accessible to those with a household vehicle but would be an additional expense for low-income households regardless of whether they had a household vehicle (Kaufman and Karpati, 2007). Many low-income Hispanic/Latino families, especially those residing in urban areas, rely on transportation other than a personal vehicle (e.g., friend/family member, taxi, public transit, shared ride service), which necessitates conducting most food shopping in proximal locations, such as their own neighborhood, to save time and money even if the available food is not as healthy and affordable (Kaufman and Karpati, 2007; Chaufan et al., 2011, 2012). However, a combination of the perceived neighborhood food environment and the monthly household financial cycle also shapes shopping patterns. In New York City, Hispanic/Latino families typically conducted a major shopping trip to a more distal supermarket at the beginning of the month, when their food assistance benefits arrived, and smaller trips to nearby *bodegas* (small, owner-operated stores) each week to supplement the household food supplies, even though prices were higher and food choices limited and of poorer quality compared to supermarkets (Kaufman and Karpati, 2007). The *"poor quality, high-cost"* class in our study may be capturing households using a vehicle to access distal supermarkets for larger, less frequent shopping trips, but accessing convenience stores during times when traveling to more distal stores is not feasible.

Less evidence exists on the connections between food environments and food shopping behaviors among U.S. ethnoracial minoritized populations. Qualitative research suggests that these consumers appear to consider several different food environment factors when making food shopping decisions, such the ability to 'take credit' to obtain needed food and paying off the debt later (Kaufman and Karpati, 2007; Breland et al., 2013) and food outlet characteristics, including the convenience of the location, accessible hours of operation, availability of staple foods, and comfort and familiarity (Dannefer et al., 2016; Breland et al., 2013), including ease in using SNAP benefits and having Spanish-speaking attendants (Chaufan et al., 2011, 2012). A qualitative study with *tienda* managers and employees in San Diego, CA noted that both the physical (e.g., displays, floor stickers, and reusable bags) and social (e.g., sales, coupons, family member food preferences, children present when shopping, nutritional content of food, and customer service) dimensions of the store were influential to what food items their customers purchased (Sanchez-Flack et al., 2016), further highlighting the intricacy of possible factors influencing a customer's perception of their food environment. The few quantitative studies available confirm the importance of the food environment in shaping food shopping behaviors. For example, for each additional type of fruit or vegetable available in corner stores in Connecticut, Black and Hispanic customers had 12 % and 15 % higher odds, respectively, of purchasing fruits and vegetables (Martin et al., 2012). Likewise, perceiving corner stores as being convenient for shopping, having high-quality fresh fruits, being clean, selling traditional Latino food ingredients, and having good customer service was associated with higher odds of shopping at a corner store in a predominately Mexican heritage sample of adults living in two Latino neighborhoods participating in corner store interventions in Los Angeles, CA (Sharif et al., 2017). In fact, participants were also more likely to perceive corner stores as providing information on nutrition and healthy eating (Sharif et al., 2017). While only a small percentage of participants that shopped at corner stores perceived them positively, they reported positive perceptions of corner stores for cleanliness and safety, selling traditional Latino ingredients, having good customer service, and having staff members who spoke their language (Sharif et al., 2017). These latter factors may play a more significant and nuanced role in shaping food purchases for Hispanic/Latino shoppers. Thus, our findings add much-needed robust evidence of the important connection between the perceived food environment and food shopping behaviors in the context of household food security status.

This study has several notable strengths. First, these cohort data provided a rich set of measures, including the valid and reliable USDA 18-item HFSS Module, to identify latent classes. Likewise, latent class analysis is a statistical method that allows modeling unobservable constructs, such as food shopping behaviors in the context of the perceived neighborhood food environment and household food security, and provides more nuanced insights into these multi-level, complex relationships. Our study was the first study of its kind among U.S. Hispanic/Latino households, leveraging data from a heritage-diverse cohort in four U.S. cities which increases the generalizability of our findings to urban-dwelling Hispanic/Latino families and can inform targeted community- and family-based approaches to promoting food security and healthy diets for these families. To date, qualitative, versus quantitative, studies have provided richer insight into these complex intersections for U.S. Hispanic/Latino families, further highlighting the important contributions of our latent class analysis from a cohort of U.S. Hispanic/Latino households.

This study also has limitations. First, these analyses were cross-sectional, limiting conclusions about the directionality of the relationships documented. Additionally, we used measures capturing participants' perceptions of their neighborhood food environment, not objective measures of the neighborhood food environment, although previous research has shown that perceived food environments are correlated with objective food environments (Alber et al., 2018; Barnes et al., 2015; Co and Bakken, 2018b). The instrument capturing food shopping behaviors may have missed additional non-traditional food acquisition sources, such as food prepared and sold by neighbors, or free sources of food, such as food pantries and home gardens. These food acquisition strategies additionally shape household food security status. The sample size also limited our ability to investigate the differences in class membership by Hispanic/Latino heritage, which can provide additional insight.

5. Conclusions

Our latent class findings underscore the complexity of adequate food access for U.S. Hispanic/Latino households with children, notably the structural roles of socioeconomic status and food environments, and their relationships with household food security and food shopping

patterns; the ways in which U.S. Hispanic/Latino households with children navigate their food shopping environments to manage the food security of the household underscore the multifaceted relationships between the perceived neighborhood food environment, household food security status, and food shopping behaviors. Future research should employ mixed methods to further clarify the distinctions of these relationships for Hispanic/Latino families, and to identify additional multi-level targets for interventions and programming. Additional research is also needed to understand how these latent classes relate to the dietary quality of caregivers and their children, which may further reveal protective or harmful aspects of perceived neighborhood food environments and food shopping behaviors. However, longitudinal study designs would facilitate valuable insights into how these latent classes change over time and predict dietary intake and health outcomes.

CRediT authorship contribution statement

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Data availability

Data described in the manuscript, code book, and analytical code will be made available upon request pending approval by the HCHS/SOL publications committee: https://sites.cscc.unc.edu/hchs/.

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