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Nosotros mismos nos estamos matando/We are the ones killing ourselves: Unraveling individual and network characteristics associated with negative dietary acculturation among Mexican Americans in New York City

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ABSTRACT

Background: Research on negative dietary acculturation among Mexican-Americans has mostly focused on individual-level processes and has largely ignored the role of social networks.
Methods: This mixed-method study used an egocentric network approach and derived 1620 personal ties of self-identified Mexican adults in New York. 24-hour dietary recalls were used to derive a total Healthy Eating Index (HEI) and subscores. The qualitative portion generated narratives around who helps or hinders their efforts to eat healthfully.
Results: At the individual level, age at which participants migrated to the U.S. was negatively associated with total HEI ($\beta = -0.39$, $p < .01$). An annual income below $30,000 was positively associated with total HEI ($\beta = 0.25$, $p < .05$) and with HEI fruit subscores ($\beta = 0.25$, $p < .05$). Acculturative stress was negatively associated with HEI fruit ($\beta = -0.29$, $p < .05$) and refined grain subscores ($\beta = -0.34$, $p < .01$). At the network level, the proportion of network members who consumed traditional Latino diets was negatively associated with total HEI and HEI refined grains subscores ($\beta = -0.39$, $p < .001$; and $\beta = -0.23$, $p < .05$; respectively). In contrast, the proportion of alters who lived in another country was positively associated with HEI dairy subscores ($\beta = 0.25$, $p < .05$). Juxtaposing qualitative participants' visual representation of their total HEI scores with their lay interpretations of healthy and unhealthy eating matched public health messages of reducing sugar, red meat intake, and processed foods. However, participants felt that this could only be achieved through restriction rather than balance. Qualitative narratives also elucidated how dietary acculturation and income could help shape dietary quality in unexpected ways.
Conclusions: This study found evidence of negative dietary acculturation and showcases the complex ways in which both individual- and network-level processes help shape dietary choices for Mexican-Americans.

1. Introduction

Diet is crucial to the etiology of chronic diseases that disproportionately affect Mexican Americans, most notably type 2 diabetes mellitus (T2DM) (Perez-Escamilla & Putnik, 2007). Mexican Americans are the largest Latino subgroup in the U.S. (Krogstad et al., 2022), but they tend to have low educational attainment, health insurance coverage, household food security, and household incomes relative to other Latinos (Noe-Bustamente et al., 2019) (UDoHaH and OotASfPa, 2021) (Rabbitt et al., 2016). Although a middle class has emerged in later generations among this group, immigrant Mexican Americans are concentrated at the lower tail end of the socioeconomic status (SES)

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distribution (Martin et al., 2015).

Yet, despite their lower SES profiles, Mexican American immigrants have been characterized as the driving force for the findings regarding the Latino epidemiological paradox, or the better-than-expected mortality rates given the group's SES profile (Abraido-Lanza et al., 1999; Markides & Eschbach, 2005). Research on diet-related outcomes also suggests a weaker relationship between SES and obesity among immigrants and their children, although the health advantages among adults seem to disappear when T2DM is accounted for (Barcellos et al., 2012). A decline in dietary quality with increasing exposure to the U.S. has been hypothesized to be a function of dietary acculturation, or the process by which immigrants begin to espouse diet-related norms, values, and beliefs associated with the United States (US). Research among Mexican American adults suggests less consumption of processed foods and sugar-sweetened beverages among those with fewer years living in the country (Maldonado et al., 2021; Perez-Escamilla, 2011). Findings regarding fat intake are less consistent, and a limited body of prior research on food eaten away from home indicates less homemade meals among the more acculturated (Langellier et al., 2015; McClain et al., 2018).

The measurement of dietary quality has increasingly relied on indices to capture more comprehensive dietary patterns, instead of single nutrients or foods (Freedman et al., 2010, 2008). Most notably, the Health Eating Index (HEI), which indicates the degree to which a person meets the U.S. dietary guideline recommendations, is increasingly being used to measure dietary quality in this country (Guenther et al., 2008a, 2008b, 2013a, 2013b, 2014). According to studies using HEI, Mexican American adults tend to have higher mean scores (approximately 71 of 100) compared to other Latino subgroups (e.g., mean scores for Puerto Ricans are approximately 56 of 100) (Siega-Riz et al., 2019). However, other studies with representative samples of Mexican Americans have suggested that the mean is much lower (Ramirez et al., 2022). Among Latino youth, acculturation proxy measures (e.g., generation, Spanish speaking) are associated with better total HEI scores (Arandia et al., 2018). Precision nutrition promises to harness technological innovations to collect nutrition-related data (e.g., jawbone movements with wearable sensors) and developed personalized models for dietary guidance; however, this work is still in its infancy (Chun et al., 2018), similar to the field of precision nutrition for health (Lee et al., 2022).

Most of this research considers dietary acculturation as an individual-level process, and several other theoretical assumptions are worth noting. First, there is an assumption that prior to immigration experience, there is no exposure to U.S. dietary norms, although we know that globalization challenges this assumption (Abraido-Lanza et al., 2006, 2016; Hunt et al., 2004; Lara et al., 2005). Second, exposure to traditional Mexican food is assumed to have durable effects across the life course, although research suggests that immigrant Latinos have both traditional and nontraditional trajectories (Weisberg-Shapiro & Devine, 2019). It is also largely assumed that this exposure dictates preferences and behaviors and that this is also static throughout the lived experience of immigrants despite evidence to the contrary (Devine, 2005).

Morevover, qualitative social science research suggests that food choice trajectories encompass food preferences and emotional attributes of food that emerge in response to the family context and childhood experiences, which may be retained or reimagined depending on the integration context (Counihan, 2009). The idea of foodways, which are culturally bound food rules that influence what food is eaten, how food is prepared, and why are also not static and deeply affected by social and economic conditions (Counihan, 2009). Foodways are also shaped by social and economic conditions. Very little public health work has incorporated these emic systems for understanding and capturing the dynamic process of eating among immigrants and subsequent generations. Further, most public health work on the topic has largely ignored the role of social networks in the process of dietary acculturation for apart from a few notable exceptions (Marquez et al., 2014a, 2014b) (Talegawkar et al., 2020). This is despite evidence that social norms of eating (Robinson et al., 2014), social network members' eating habits (Pachucki et al., 2011), and perceived social support from family and friends can influence their dietary intake (Coleman et al., 2014). Studies focusing on Latinos have found that social network size (Shelton et al., 2011), social network immigrant composition (Creighton et al., 2011), and social influence (Ashida et al., 2012) are associated with healthy eating patterns. However, this last study found that most participants lacked a network member who encouraged these behaviors, and it was unclear whether this differed by the acculturation status of the individual or that of their network members.

Therefore, an important and unanswered question is the extent to which dietary quality is guided by Mexican-oriented frames at both the individual and network levels and the extent that it differs from the Standard American Diet that has been defined as calorie-dense and energy-poor (Grotto & Zied, 2010). This mixed-methods study fills this gap by drawing on social network theory and analysis to investigate the personal networks of immigrant Mexican-American adults living in New York City, and examines whether the cultural profiles of their social networks are associated with the quality of their diet. We believe the extent to which cultural ideas around diet are espoused not only by the individual but the network, is a worthy new direction. It is equally important to understand whether these network-level features are associated with poor dietary quality that has been linked to chronic diseases, including T2DM. The study is also significant because it utilized the HEI for both quantitative and qualitative interviews to understand the extent to which Mexican Americans adhere to the Dietary Guidelines for Americans.

2. Methods

2.1. Study design

This mixed-method study used a convergent design to understand the role of social networks among Mexican Americans in shaping diabetes and diabetes-related health behaviors, such as diet and physical activity. The study design involved two types of data, quantitative and qualitative. In our case, the quantitative data were collected first, followed by the qualitative portion. Despite this sequential feature, the main intent of our convergent design was to compare the two results, which is consistent with other mixed-methods studies using similar designs (Creswell & Plano-Clark, 2018).

2.2. Data sources

Recruitment: N = 81 self-identified Mexican American adults, who were recruited from a large Catholic Church in the Bronx, New York shared data on 1620 personal network ties. Potential participants were identified by the church liaison from prayer and activity groups. The liaison also identified potential participants through the church's telephone roster. Trained bilingual research assistants reached out to participants in person or via telephone to explain details of the study. If the person was interested, they were screened and if eligible, they were consented using a protocol approved by the City University of New York Human Subjects Institutional Review Board (IRB# #2018-1081). The consent procedures included the ability for the same research team to contact the participant for the qualitative portion of the study using the contact information provided. This information was used by the same trained bilingual researchers to explain the qualitative section of the study and if interested, the in-depth interview was scheduled. Details about each effort are explained in detail below.

Quantitative Sample: Data were collected by trained research assistants between January 2019 and August 2019 in English (n = 1) or Spanish (n = 80), depending on the participants' preferences. Survey data were collected using Qualtrics and social network data were collected using EgoWeb 2.0 (EgoWeb 2). Personal social networks were

measured using a series of survey questions that elicited information about people's social connections (Borgatti et al., 2018a). First, participants listed the names of 20 adults who were important people in their lives over the past six months, and whom they had contact with (either face-to-face, by phone, or online). Second, they reported the characteristics of each network member, including their demographics (gender), social role (family, friend, church contact), and several indicators of acculturation (described below). Finally, to assess the structural features of their personal social networks, the participants were asked to indicate whether each pair of network members knew each other. Participants received $25 for this portion of the protocol.

Qualitative sample: Data were collected by the same research assistants in 2019. Network-level characteristics were computed using network data (e.g., density, transitivity, % of network members that were family) and used to derive the qualitative sampling frame of the qualitative sample. Our goal was not to be representative, but instead, to have enough informational power through a select few of information-rich cases (Malterud et al., 2016). Specifically, we used these quantitative characteristics to set a priori categorizations of networks that were theoretically related to the potential codes and themes. For example, based on multiple features of their network structure and composition, participants were classified as having strong network connectivity if they were in the upper quartile of several network characteristics (i.e., top 25%), moderate connectivity (i.e., most characteristics in the mid 2 quartiles), or weak connectivity (i.e., most characteristics in lower quartile). Potential participants were contacted via phone, and if they were interested, an interview was scheduled where the consent protocol first took place. A total of 25 informants were included in this qualitative phase. Interviews were recorded and transcribed professionally, though the team performed quality checks on all transcripts. The participants received an incentive of $25 for this in-depth interview.

2.3. Quantitative measures

2.3.1. Dependent variable

Our outcome for the quantitative phase of the study was the Healthy Eating Index (HEI), which is a score that reflects the extent to which one's diet aligns with the USDA dietary guidelines. Diet intake was collected by trained research assistants using the ASA-24 tool, and every attempt was made to schedule one recall during the weekday and a second recall during the weekend. However, 53% of participants had both dietary recalls during weekdays (n = 43), 26% had one dietary recall on a weekday and the other dietary recall on a weekend (n = 21), and 11% had both dietary recalls during weekends (n = 9). There were also eight participants who were able to complete only one recall, with seven completing it over a weekday and one over a weekend. The Nutrition Data System for Research software (Harnack, 2020, pp. 1519–1520) was used to analyze the dietary data and construct an HEI score ranging from 0 to 100. Higher scores represent diets that are more strongly aligned with the 2010 USDA dietary recommendations (Guenther et al., 2013a). In addition to the total HEI score, we computed subscores for the following components of the HEI: total vegetables (scores ranging from 0 to 5), total fruit (0–5), whole grains (0–10), refined grains (0–10), and dairy (0–10).

2.3.2. Individual-level variables

Marin Acculturation Scale: This scale assesses acculturation through three distinct domains: language use, media, and social relations (Marin et al., 1987). The overall score was computed by summing the scores on all 8 scale items and dividing this by the number of items on the scale (or the number that the participant responded to). This computed score ranged from 1 to 5, where higher scores indicated more acculturation to the U.S.

Acculturative Stress Scale: This scale was adopted and used by the National Latino and Asian American Survey (NLAAS) to assess the degree of stress experienced through the process of acculturation, such as feelings of guilt for leaving family or friends in their country of origin, finding it difficult to interact with others because of English language barriers, and experiencing difficulties finding work because of the Latino heritage (Singh et al., 2015). An overall score ranging from 1 to 9 was computed by summing the scores on all 9 scale items, with higher scores indicating stronger acculturative stress.

Age at migration to the U.S. Respondents reported their age when they moved to the U.S.

2.3.3. Network-level variables

Proportion of their social network who currently lives in another country: For each person listed as a member of their social network, respondents reported where the person lives, selecting from the following categories: same household, same neighborhood, same state, another state, or another country. For each participant, this was used to compute the percentage of all network members who currently live in another country.

Proportion of their network who were born in Mexico, Central America, or South America: Respondents reported where each of their network members was born, which was used to compute the percentage of all network members who were born in Mexico, Central America, or South America.

Proportion of their network who eats a traditional Latino diet: For each network member, participants indicated the extent to which they agreed with the statement, "This person eats traditional Latino food most of the time" (strongly disagree, disagree, agree, strongly agree). Although traditional foods vary among Latin American countries, research suggests that staples such as legumes, rice, and root vegetables are recognized as part of the traditional diet (Cuy Castellanos, 2015). If the participant responded 'agree' or 'strongly agree' for a given network member, then this member was coded as someone who eats a traditional Latino diet. These responses were used to compute the proportion of network members who eats traditional Latino diet.

Proportion of their network who eats an American diet: For each network member, participants indicated the extent to which they agreed with the statement, "This person eats American food most of the time" (strongly disagree, disagree, agree, strongly agree). "American" can sometimes be used by immigrants as a synonym for imagined normative middle class white values, behaviors and norms, which is why some in acculturation research have pushed for more precise definitions in this space (Hunt et al., 2004). Our rationale for including this was to help participants subjectively distinguish these alters from those they perceive eat a traditional Mexican diet and the extent to which this differened from the Standard American Diet (e.g., sugar-sweetned beverages; processed foods that are calorie dense and nutrient poor) (Grotto & Zied, 2010). If the participant responded 'agree' or 'strongly agree' for a given network member, then this member was coded as someone who eats an American diet. This was used to compute the proportion of network members who eats an American diet.

Proportion of their social network that is Americanized: Noting the issue of using the all-encompassing term "American" above, we computed an overall score for each network member in terms of the strength of their "American culture," we created an index based on four characteristics: (i) where the person was born (scored as 1 = U.S., 0 = other); (ii) where they currently live (scored as 1 = U.S., 0 = not in the U.S., (iii) how well they speak English (scored as 1 = 'well' or 'very well', 0 = 'not well' or 'not at all'), and (iv) if they eat an American diet (1 = agree or strongly agree that person eats American food most of the time'). To compute an overall score representing the strength of "American cultural characteristics" *for each network member*, the network members' scores for each of these features were summed, with final scores ranging from 0 to 4 (i.e., 0 = no Americanized characteristics; 4 = all four Americanized characteristics present).

Diversity in social networks. Each network member's score described above, was used to compute the diversity of these scores (ranging from 0 to 4) in the participants' social networks. The diversity score was

computed using Blau's index of diversity (Blau, 1994), with lower values indicating less diversity in scores (i.e., network members are similar in their scores) and higher values indicating greater diversity in scores.

2.3.4. Control variables

Participants reported their gender, age, education level, and household income category. Their current employment status was categorized as working (yes/no); work was defined as part-time work, full-time work, or self-employment.

One personal network characteristic was included as a control for the network density. This was computed for each participant as the number of reported connections between each pair of their network members divided by the total number of possible connections (i.e., if all pairs of network members were connected to one another). The extent to which social networks are sparsely or densely connected is a key structural feature of networks that can impact their structure and function, and thus is included as a covariate in the analyses (Crossley et al., 2015).

2.4. Quantitative data analysis

First, we computed descriptive statistics of the independent and dependent variables. Bivariate correlations were used to explore the relationships between all pairs of independent variables (individual- and network-level indicators) and dependent variables (HEI total score and subscores). Finally, separate linear regression models were fit to predict each of the following dependent variables: the overall HEI score and the score for each of the five HEI subcomponents, resulting in six models. Each model included the following as independent variables: (i) individual acculturation variables and network acculturation variables that were significantly ($p < .05$) or marginally significantly ($p < .10$) correlated with the dependent variable (with highly correlated predictors excluded), and (ii) individual-level control variables (gender, age, education, household income, working status) and network-level control variables (network density). We report standardized regression estimates and standard errors for all the models. R (version 4.1.0) was used to perform these analyses.

2.5. Qualitative coding and analysis

Each interview was recorded and transcribed in Spanish. Data were coded using Dedoose, a mixed-method web-based data analysis software (Dedoose). A series of iterative steps were taken to develop the code book and apply codes, which included (1) development of an initial code list derived from etic concepts, emic themes, or both; (2) two or more coders independently coding the same text based on a common definition; (3) results of the coding were compared for consistency of text segmentation and code applications; (4) the codebook was reviewed to determine whether the inconsistencies were due to coder error; and (5) once problems were clarified, all previously coded text was reviewed and, if necessary, recoded so that it was consistent with the revised definition. The inter-coder agreement process entailed a detailed segment-by-segment review that included assessments of consistency in defining the beginning and end of segments, as well as the application of codes within segments. All inconsistencies were noted, discussed, and resolved. Illustrative quotes were presented along with the participant's HEI score displayed graphically. In this way, their narratives are juxtaposed with each of the HEI components that make up their entire score. The plot shows the percentage of total points received for each, starting with 0% at the center and 100% at the outer edge. Visualizing the HEI scores in a radar plot allows the reader to see which components contribute to the total score (Krebs-Smith et al., 2018).

Table 1
Individual (n = 80) and social network characteristics of sample (n = 1620).

Individual Characteristic	*M* (SD)/N (%)
Demographics	
Age (years)	43.1 (11.4)
Female	56 (70.0%)
Education level	
Less than 11th grade	47 (58.8%)
High school graduate or GED	18 (22.5%)
Some college but no degree	15 (18.8%)
Part- or full-time worker, yes	52 (65.0%)
Household income	
<$10,000	20 (25.0%)
$10,000-$29,999	38 (47.5%)
$30,000-$49,999	12 (15.0%)
$50,000+	10 (12.5%)
Acculturation	
Age at migration to U.S. (years)	23.4 (9.4)
Marin acculturation scale, cumulative score[a]	1.6 (0.5)
Acculturative stress[b]	4.2 (2.1)
Dietary Quality: Healthy Eating Index (HEI)	
Overall score[c]	57.7 (12.2)
Total vegetables[d]	4.0 (1.2)
Total fruit[d]	3.1 (1.8)
Whole grains[e]	2.1 (3.1)
Refined grains[e]	4.0 (3.4)
Total dairy[e]	5.0 (3.0)
Social Network Characteristic	***M*** **(SD)**
Network structure	
Density (%)	51.8 (24.6)
Acculturation	
% that live in another country	17.5 (18.6)
% that were born in Mexico/Central America/South America	84.6 (13.7)
% who eat a traditional Latino diet	86.2 (16.5)
% who eat an American diet	47.7 (29.1)
% who are Americanized	30.8 (18.0)
Diversity	65.9 (10.2)
Demographics and social roles	
% who are female	57.8 (18.8)
% who are family members	47.9 (27.1)
% who are friends	45.0 (26.9)
% who are church contacts	23.4 (26.0)

Notes:
[a] Marin acculturation scale, where scores range from 1 (less acculturation to the U.S.) to 5 (more acculturation to the U.S.).
[b] The acculturative stress scale, where scores range from 0 (less acculturative stress) to 9 (more acculturative stress).
[c] Scores can range from 0 to 100; lower scores indicate poorer diet quality, higher scores indicate better diet quality.
[d] Scores can range from 0 to 5.
[e] Scores can range from 0 to 10.

3. Results

3.1. Quantitative findings

The descriptive statistics for the dependent and independent variables are presented in Table 1. The majority (70.0%) of the participants were female, with an average age of 43.1 years, and the majority (58.9%) had high school education or less. Two-thirds of the participants (65.0%) were employed, and the majority had household incomes below $30,000 USD. For individual acculturation, on average, participants moved to the U.S. at 23 years of age. The average scores on Marin Acculturation were low (1.5 out of a range of 0–5), indicating less acculturation to the U.S. The average score for acculturative stress was 4.2, out of a range of 0–9, indicating moderate acculturative stress. Participants' average HEI score was 57.7 out of a possible 100.

Participants' personal social networks had a mean density of 51.8, meaning that, on average, just over half of their network-member pairs were socially connected, while the other half were not. In terms of network acculturation, on average, 17.5% of network members lived in

Table 2
Bivariate correlations between diet quality (HEI scores), individual acculturation, and network acculturation.

	HEI score					
	Overall	Vegetables	Fruit	Whole grains	Refined grains	Dairy
Individual acculturation						
Moving age (years)	**−0.27**$^{+}$	−0.19	**−0.21**$^{+}$	−0.12	−0.11	0.15
Marin Acculturation	0.12	−0.01	0.03	0.09	0.15	−0.03
Acculturative stress	−0.11	−0.01	**−0.22**$^{+}$	−0.13	**−0.28***	−0.13
Network acculturation						
% live in another country	−0.06	−0.12	−0.07	0.04	0.11	**0.28***
% born in Mexico/Central or South America	−0.07	−0.02	−0.09	−0.13	−0.03	−0.01
% who eat a traditional Latino diet	**−0.31***	**0.19**$^{+}$	−0.02	**−0.37***	**−0.22***	**−0.23***
% who eat an American diet	0.08	0.16	−0.03	−0.06	−0.02	**−0.29***
% who are Americanized	0.04	**0.24***	−0.03	0.05	0.08	**−0.23***
Diversity	0.03	0.11	0.06	0.10	0.05	0.13

*$p < .05$, $^{+}p < .10$.

Table 3
Standardized linear regression models determining factors associated with Healthy Eating Index overall score and sub-scores.

	Dependent Variable: HEI score				
	Overall	Vegetables	Fruit	Dairy	Refined Grains
	B (SE)				
Intercept	−0.00	−0.00	0.00	−0.00	0.00
	(0.10)	(0.11)	(0.11)	(0.11)	(0.10)
Age (years)	0.20	0.09	0.12	−0.07	−0.06
	(0.12)	(0.14)	(0.13)	(0.11)	(0.11)
Income below $30,000, yes	**0.25***	0.02	**0.25***	−0.13	0.17
	(0.11)	(0.12)	(0.12)	(0.12)	(0.12)
Female, yes	−0.04	0.10	−0.02	0.10	−0.07
	(0.11)	(0.12)	(0.12)	(0.12)	(0.11)
High school, yes	0.02	0.12	−0.05	−0.02	−0.20
	(0.11)	(0.12)	(0.12)	(0.11)	(0.11)
Individual acculturation					
Moving age (years)	**−0.39****	−0.22	−0.25		
	(0.13)	(0.15)	(0.13)		
Acculturative stress			**−0.29***		**−0.34****
			(0.11)		(0.11)
Network acculturation					
% live in another country				**0.25***	
				(0.12)	
% who are Americanized		0.13		−0.06	
		(0.12)		(0.16)	
% eat a traditional Latino diet	**−0.39*****	0.15		−0.19	**−0.23***
	(0.11)	(0.11)		(0.12)	(0.11)
% eat an American diet			0.18	−0.14	
			(0.11)	(0.15)	
R^2	0.25	0.13	0.15	0.19	0.20
Adj. R^2	0.19	0.05	0.09	0.10	0.14
Num. obs.	80	80	80	80	80

***$p < .001$, **$p < .01$, *$p < .05$.

another county, although an average of 86.2% were born in Mexico, Central America, and South America. On average, 86.2% of network members were perceived to eat a traditional Latino diet, while 47.7% were perceived to eat an American diet. An average of 30.8% of network members had a "strong American culture", and the average diversity score for network members' American culture was 65.9 out of 100.

Participants' social networks, on average, were also characterized as being majority female (57.8%), and just under half of the members were family (47.9%) and friends (45.0%), while one-quarter (23.4%) were church contacts. It is also important to note the typically large standard deviations for each of the network characteristics, highlighting the diversity of these network features across participants (Table 1).

Bivariate correlations are presented in Table 2. With regard to *individual acculturation variables*, moving to the U.S. at a later age was correlated with poorer diet quality. Specifically, it was significantly correlated with poorer overall HEI scores ($r = -0.27$, $p < .10$), and poorer fruit intake subscores ($r = -0.21$, $p < .10$). Marin acculturation scores were not significantly correlated with diet quality, but having more acculturative stress was negatively correlated with many of the HEI subscores including fruit intake ($r = -0.22$, $p < .10$) and refined grains ($r = -0.28$, $p < .05$).

With regard to the *network acculturation variables,* having a greater proportion of network members who lived in another country had mixed associations with overall diet quality, and was significantly and positively correlated with higher HEI dairy subscores (i.e., better adherence to dairy recommendations) ($r = 0.28$, $p < .05$). A greater proportion of network members born in Mexico, Central America, or South America often had weak negative associations with diet quality indicators, but these correlations were not statistically significant.

Perceptions of network members' diets were more strongly related to participants' diet quality. A greater proportion of network members who ate a traditional Latino diet was associated with poorer overall HEI scores ($r = -0.31$, $p < .05$) and poorer subscores for whole grains, refined grains, and dairy (see Table 2). A greater proportion of network members who ate an American diet was associated with poorer dairy subscores ($r = -0.23$, $p < .05$).

Finally, having a greater proportion of network members who were "Americanized" had mixed associations with diet quality but had a significant positive correlation with HEI vegetable subscores (i.e., better adherence to vegetable recommendations) ($r = 0.24$, $p < .05$) and a significant negative correlation with HEI dairy subscores (i.e., worse adherence to dairy recommendations) ($r = -0.23$, $p < .05$). Finally, having network members with greater diversity in terms of American culture was weakly and positively correlated with diet quality, but these correlations were not statistically significant.

The results of the regression models are presented in Table 3. *Overall, HEI scores* were negatively and significantly associated with the age at which participants moved to the U.S. ($B = -0.39$, $p < .05$) and the proportion of network members who ate a traditional Latino diet ($B = -0.39$, $p < .05$). This means that, in this sample, participants who moved to the U.S. at a later age and those with more network members who ate traditional Latino diets had on average poorer overall diet quality. Overall, HEI scores were also significantly and positively associated with having an annual income below $30,000 ($B = 0.25$, $p < .05$), meaning that lower incomes were associated with better overall diet quality.

HEI vegetable subscores: No significant associations were identified.

HEI fruit subscores were positively associated with income ($B = 0.25$, $p < .05$) and negatively associated with acculturative stress ($B = -0.29$,

$p < .05$). This indicates that participants had better adherence to fruit intake recommendations if they had incomes below $30,000 and poorer adherence to fruit intake recommendations if they had greater acculturative stress.

HEI dairy subscores were significantly and positively associated with the proportion of network members living in another country (B = 0.25, $p < .05$). Thus, participants with more network members living in countries other than the U.S. had better adherence to dairy intake recommendations.

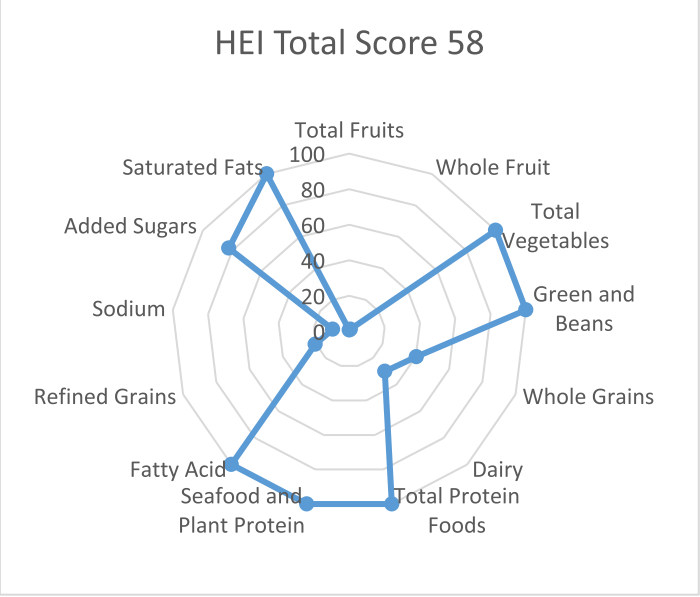
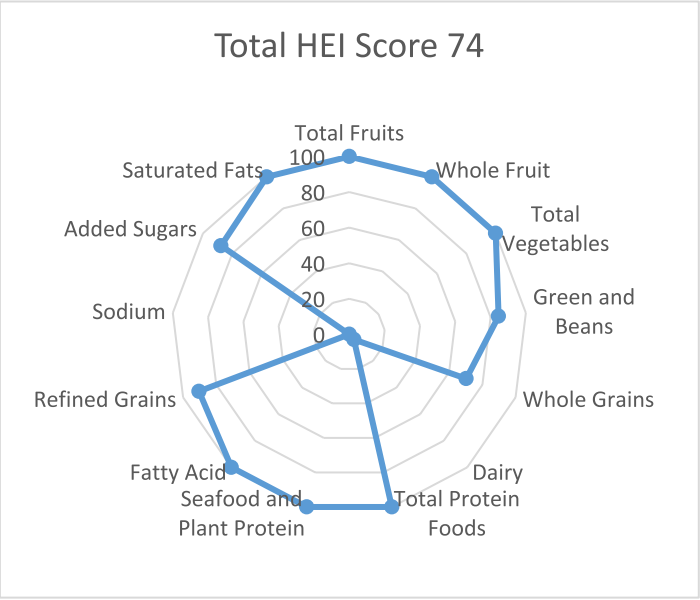
HEI refined grain subscores were negatively associated with acculturative stress (B = −0.34, $p < .01$) and the proportion of network members that ate a traditional Latino diet (B = −0.23, $p < .01$). This indicates that respondents had poorer adherence to refined grain recommendations if they had greater acculturative stress and more network members who ate traditional Latino food.

Given these unexpected results between acculturation and dietary intake, we investigated whether a more cohesive network would have a differential effect. That is, more cohesive networks would have stronger healthy diet norms than would more acculturated groups. However, the interaction terms between network cohesion and network acculturation were not significantly associated with dietary quality (data not shown).

3.2. Qualitative findings

3.2.1. Theme: what is traditional eating? And is it healthy?

Given the quantative findings, we explored ideas about what participants thought was healthy eating in the qualitative phase. They mentioned: skipping meals, eating salads, adding extra vegetables to dishes (vegetables specified were kale, lettuce, carrots, and spinach); drinking smoothies, juices, and shakes (shakes seemed often to refer to the beverages sold by Herbalife agents); reducing portion sizes; eating whole grains; opting for light mayonnaise, low-fat chorizo, and low-fat milk; eating kale and fish; and reducing coffee intake. It was striking that it seemed that the only way healthy eating could be achieved was through adopting new ways of eating that were not connected to traditional Latino foodways and/or some sort of restriction, as opposed to balance, which only one participant mentioned.

Participant 67, low connectivity		Well, I did get sick. So the doctor recommended that I eat more vegetables and to stop eating so much [processed foods] made with flour
Participant 151, high connectivity		We no longer eat pork … we noticed that it was harming us. A lot of people do not notice, but when you eat vegetables or fish when you have to go to the bathroom you go well. When you eat a piece of pork … you'll see that you feel differently [when digesting]. Your body reacts differently.

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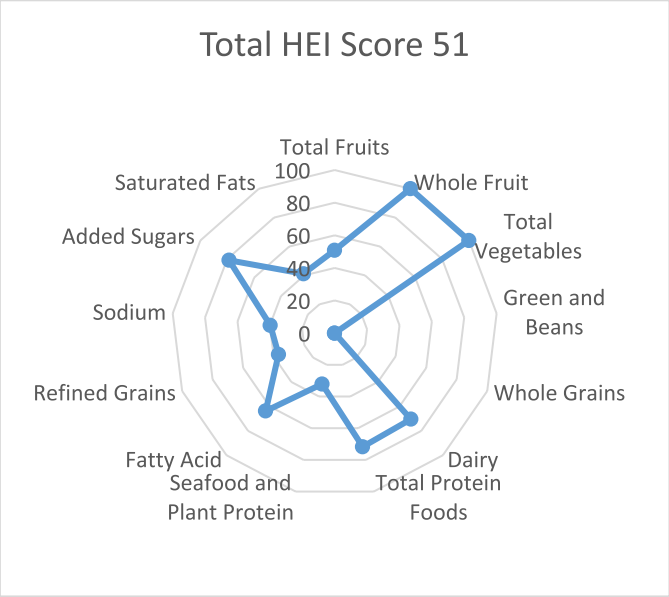
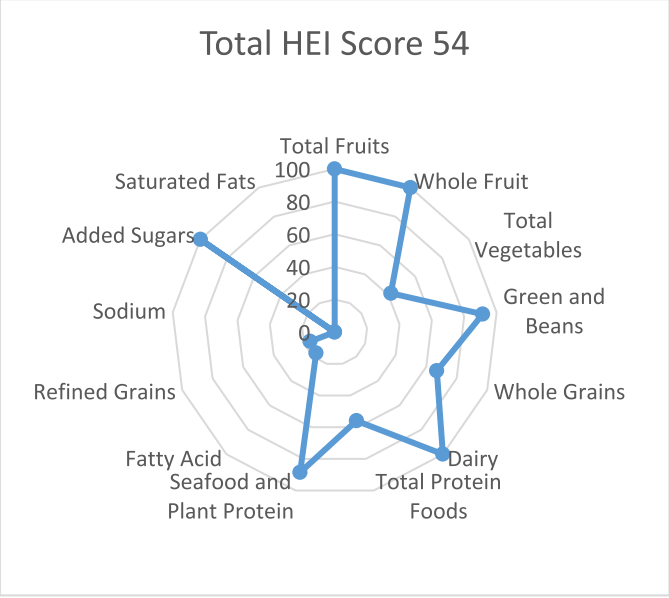
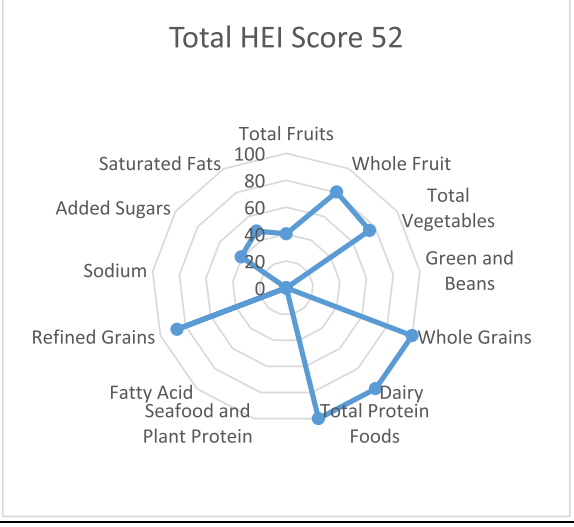
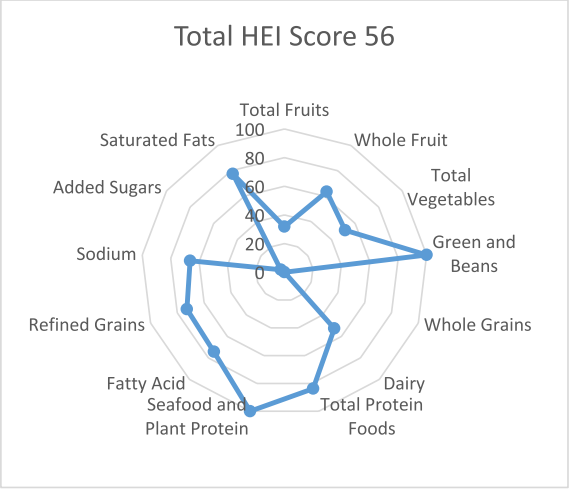
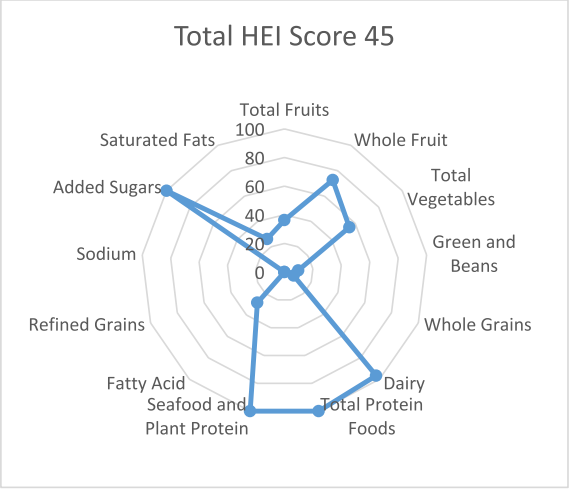
Participant 104, high connectivity		Yes, this friend is very helpful. She tells me: don't buy this mayonnaise because it has too much fat. She also tells me "do not drink soda, only water." Now [because of her] I also buy whole wheat bread for the house.
Participant 86, low connectivity		My dad likes to buy [the food for the house] and avoids sugar. He tries to buy a lot of vegetables. Fish. We cut down on meat. We have [low-fat] yogurt. I guess he considers this healthier
Participant 134, low connectivity		When my mother worked at the restaurant she would tell me "darling you have to eat healthy because all that fried food is no good. It *tastes* very good … I will not tell you to stop eating it altogether. But a little bit at a time. You can have whatever you want, but a little bit when you eat

3.2.2. Theme: what is traditional eating? And is it unhealthy?

Once again, we first explored the idea of unhealthy eating with participants given the quantative associations between HEI and individual as well as network-level factors. "*Grasa*" or fat as well as sugar and red meat were often cited as specific foods that were fundamentally unhealthy that were also part of traditional Mexican dishes. Only one participant made a distinction between "good" fat in fish like salmon and "bad" fat. Another participant also alluded to the idea that frozen meat was unhealthy because "you do not know how long it has been there" or "what it may have [hormones]". One important theme that emerged was that people in the network made healthy eating difficult because of a preference for one of these unhealthy items, which sometimes were explicitly framed as traditional by participants. Often, social network alters were children or spouses who made healthy food preparation difficult. This social context suggests unhealthy values and practices were the norm for many of our participants, which supports the quantitative findings.

Another theme centered around strategies on how to reduce the unhealthfulness of Mexican food, though there seemed to be a wide range of what constituted Mexican food in this country. While participants contrasted tacos and tortas as fast-food and often cheap in price that could be bought in "en la calle" or in the street with homemade meals prepared "*en la casa*" or at home like pozole or mole, both kinds of Mexican food were framed by many as unhealthy. Though not all participants felt Mexican food was inherently unhealthy, the theme of Mexican food being unhealthy recurred frequently in the interview data. Some described the stress of living in the U.S. as an important factor and how they would buy food from "*la calle*" as a strategy to reduce time from cooking at home. Others described perceptions of how someone in their network was cooking traditional Mexican dishes in an "unhealthy" way and how they had to strategize by either avoiding the person or reducing their portions. The nostalgia in which some participants spoke of for this food was striking, as well as the idea that some of these traditional dishes were "guilty" pleasures. These narratives illustrate the wide range in opinions and highlight the network and individual level acculturation factors that participants contend with in their everyday context.

Participant 60, moderate connectivity		She makes tacos, but she includes a salad or she tries to cook with less oil. She tries not to include too many things that are greasy because otherwise it is will be too heavy "*pesada*"
Participant 127, moderate connectivity		My [sister] tells me that I should not be eating tortillas at night; to not eat too much. She tells me that our metabolism is different at night and it does not work [as fast]. Yes, she can say that because she is not here [in the U.S.] … they do not know how it is here

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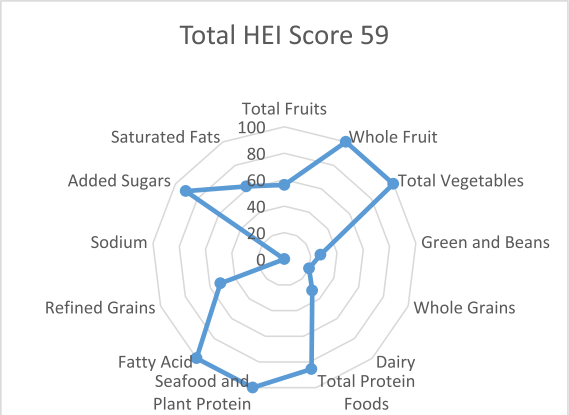
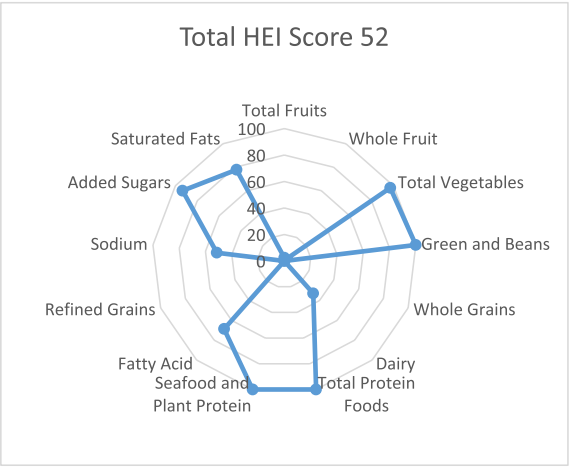
Participant 114, high connectivity		I ask my mom to cook for me [traditional Mexican dishes] like pozole, tostada, "picaditas." I know none of this is healthy, but I like it. If I ask her to make it for me, she will make it for me, she never tells me no
Participant 88, low connectivity		Yes, she always cooks our food [Mexican] … mole, ribs with adobo. But it all huge portions … and everything has a lot of grease "grasa"

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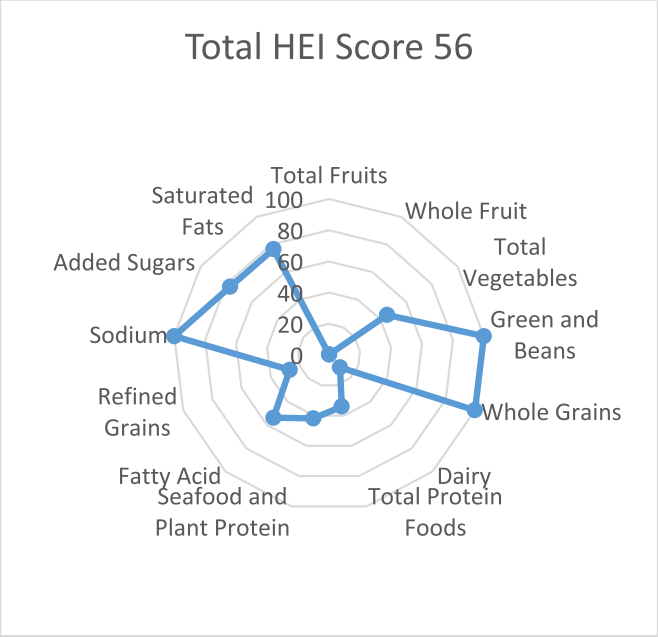
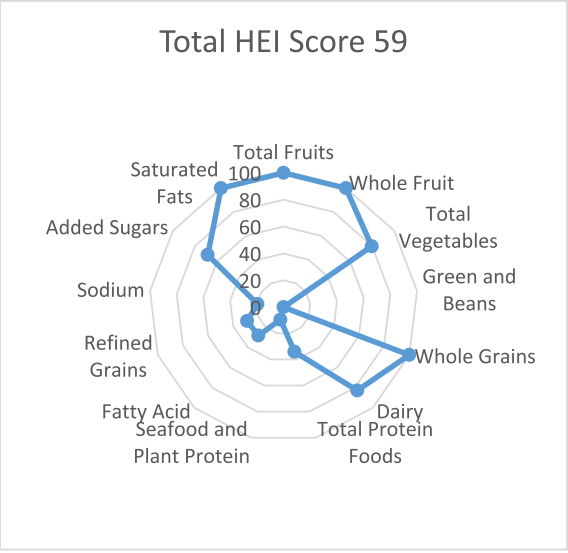
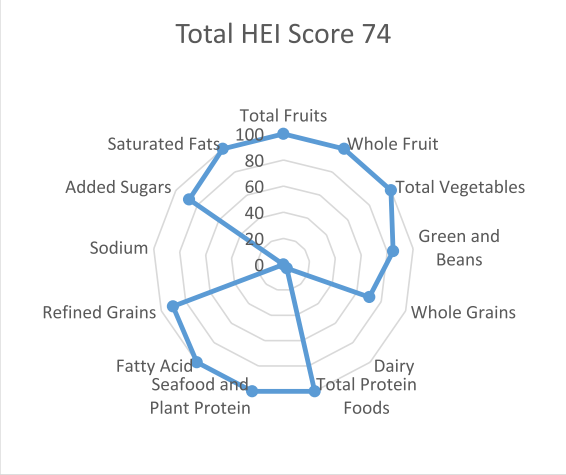
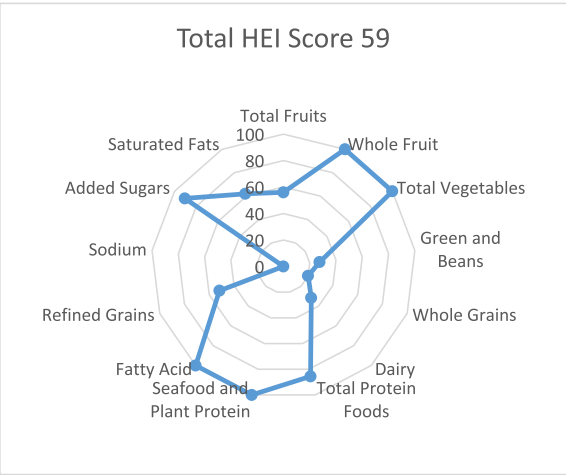
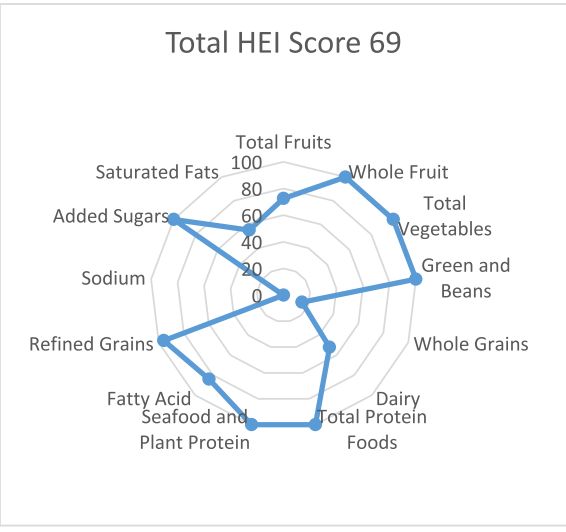
Participant 174, moderate connectivity		You know us Mexicans … she cooks [well] but a lot of steaks, chops, eggs with ham and chorizo. Whatever she has in the fridge … plus rice and beans. The meat though … all the meat is fried in lard.
Participant 107, moderate connectivity		Yes, I still cook traditional dishes but I try to take out the fat. If I make a *lasaña/lasgne* with ground beef I also shred some carrots, pumpkin. I throw some spinach in there. It has meat, but a lot of vegetables.

However, when participants were asked to explicitly compare the healthfulness of dietary practices in the United States with those in Mexico, there was ambivalence. Some thought that dietary practices in the U.S. were worse and contributed to diseases. Others implemented lessons that they learned back home about healthy eating (e.g., gardening) in the United States, although not everyone shared the same self-efficacy. Unlike the majority of the interviewees, participants 150 and 171 specifically located their conceptualizations of healthy eating within their own cultural traditions drawn from rural or semi-rural upbringing in Mexico, in which their families ate seasonal plant-based foods that they grew themselves. They are explicit that they like these foods because they were raised with them, and they also indicated in various ways that these habits either set them apart from their social networks in New York and require specific resources (knowledge about gardening and access to a plot for # 150 or a taste for and corresponding ability to be satiated by beans for # 171). These participants had high overall HEI scores, mainly driven whole fruit and vegetable intake. They also seemed to embedded in networks that did not always uphold the same healthy eating practices.

Participant 151, high connectivity		There are more sick people here in this country than in ours … it is the way we eat [here]. We are the ones killing ourselves.
Participant 114, high connectivity		I feel things have changed a lot [here in the U.S.] Because I feel like in Mexico I would eat a lot more vegetables and drink more water … I would do a lot more physical activity.
Participant 150, high connectivity		I'm thinking of the habits of, well, of my family, and when I was little and lived with my parents, they always farmed. They didn't grow food to sell but for our own consumption: chiles, tomatillos, tomatoes, and then, corn, squash. So, I began to see that here, too, they sell that, right? The farmers, for example, have their little stand here on Saturdays. Sometimes I come and buy from them, right? Certain products. And as I mentioned, I have seven years volunteering in a community garden. I have my own plot and I plant potatoes, tomatoes, chiles. Since the garden is very big and many people plant, and we all take care of the garden, I cut [inaudible] everything that is there. Whenever I go, I'm alone there.

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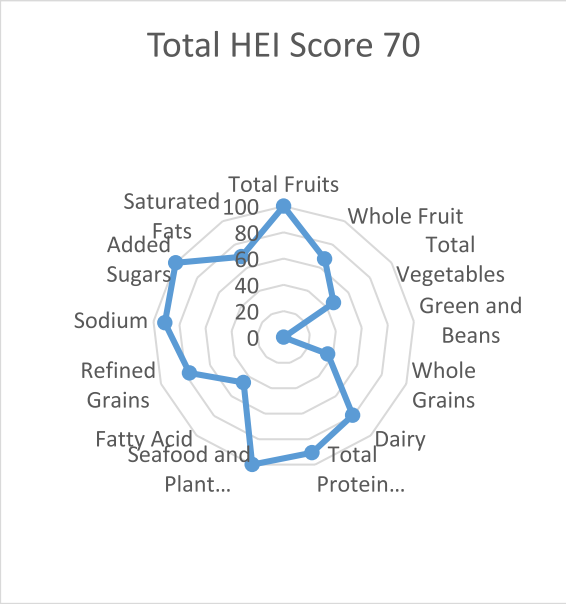
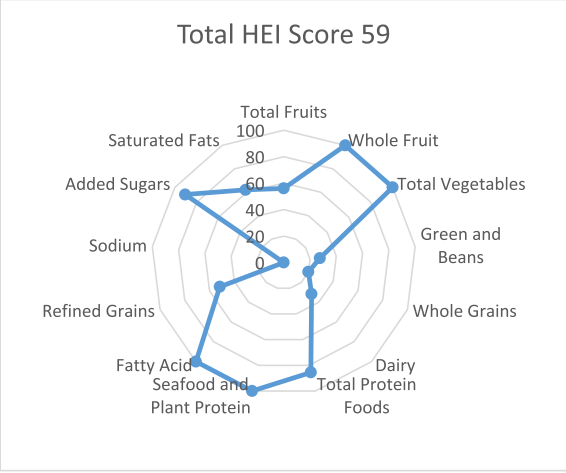
Participant 171, moderate connectivity		[When asked about habits from Mexico] … Well, look, since I'm a person who was raised in the countryside, I eat more little beans, beans. Yes, with salsa. I'm saying, if I'm in a hurry, I'll eat beans with an egg. It's light and quick. Sometimes with salsa, or cheese. I eat a lot of vegetables, too. I eat a lot of potato, guaje, and things like that, all of those kinds of vegetables.

3.2.3. *Theme: money and other factors that shape eating*

As with the quantitative analysis, money was seen as an important factor shaping the social context. The extent to which money mattered for healthy eating though differed greatly across participants. At one extreme were participants who understood healthy to be much more expensive than Mexican food that could be purchased for less money and was more filling. Other participants felt that money should not dictate dietary quality but often gave evidence on how it could hinder or help efforts, especially because fruits/vegetables were seen as expensive. Where food shopping was done mattered, such as the example below, where participants relied on big box discount stores for better prices on produce. Finally, some participants offered an interesting perspective on how money scarcity in Mexico shaped dietary behavior. Because there was less "money" or discretionary income for things like junk food or soda, money was used only to buy food for survival and sustenance. Perhaps these lessons learned in Mexico can help explain the quantitative finding in which less income was associated with better dietary quality, although these narratives highlight the complexity of these economic decisions in immigrants' lived experiences.

Participant 114, high connectivity		For example, there's a store nearby, near my home, and they sell smoothies. A smoothie is going to cost you $5, while a tamal is going to cost you $1 and with atole [a corn porridge-based beverage] it's $3, at the most … So, you can compare: a smoothie that is healthy, $5, and a tamal and atole at $3.50 or $3 ….

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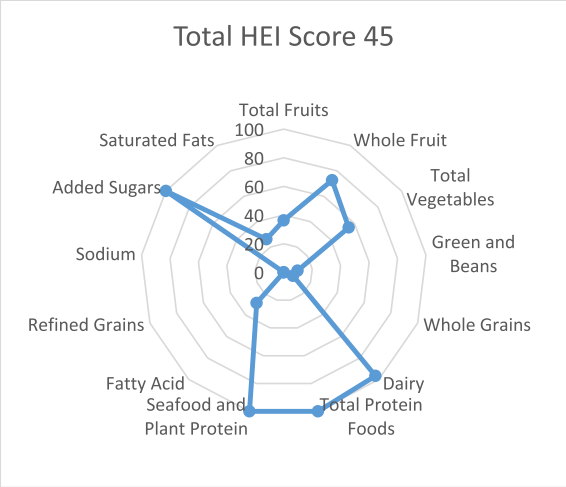
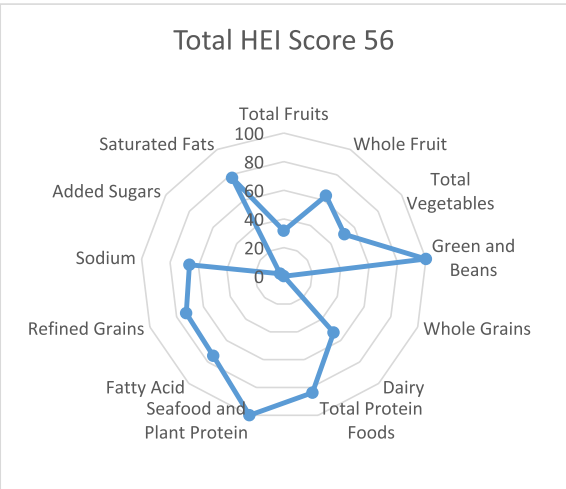
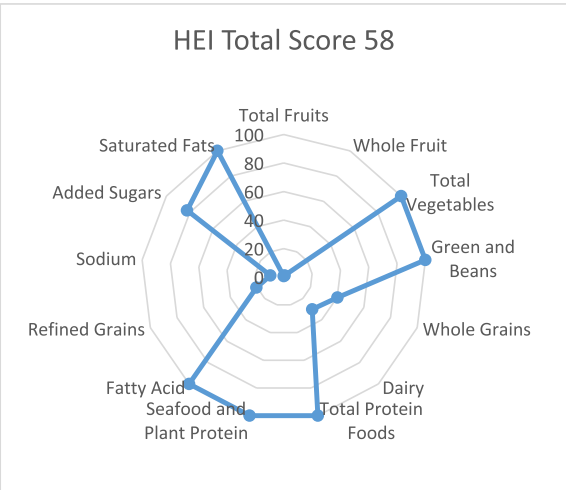
Participant 127, moderate connectivity		Over there [in Mexico] there is not a lot of money. You do not have the luxury of drinking a soda or a juice a day … you cannot do this in Mexico. [In the U.S] They say organic food is supposed to be better … but those things are expensive. In the super[market] they have organic [food] but it pricey, a lot more pricey.
Participant 60, moderate connectivity		It is very different [in Mexico] because there is less money … because there is a little bit more money here than in Mexico. You have to work and spend more [here] but I do not think money alone should change the way you eat.
Participant 67, low connectivity		Vegetables and produce are more expensive. Vegetables and fruits are [also] expensive, especially if you buy them organic. Right now, the economy is very bad. You really see the difference when you go to Cotsco [compared] to a regular supermarket which will have more expensive vegetables. For example, if I buy cucumbers, 3 big ones, it will cost me $2.50. In the supermarket, it will be $2 each.

4. Discussion

This study sought to understand the extent to which individual- and network-level attributes were associated with dietary quality among Mexican immigrants in New York City in order to elucidate the complex process known as dietary acculturation. We found evidence for an association between network-level acculturation variables and HEI, which suggests a negative dietary acculturation pattern that is in line with the Standard American Diet (Grotto & Zied, 2010). However, it was a higher proportion of network members who ate traditional Latino diets was associated with lower HEI scores and refined grains subscores. The proportion of network members living in another country was associated with higher dairy subscores. This suggests the possibility of social influence as mechanism for shaping food access, food choice, and eating

patterns that is more complex than "Americanized" vs. "traditional" dichotomy. Further, juxtaposing the qualitative narratives to each participant's graphical display of their HEI scores allowed us to understand how close social ties influenced individual HEI scores, as well as the extent to which the narratives matched this quantitative metric. The themes that emerged were the many ways in which participants had to negotiate eating in their personal networks around preferences, different tastes and schedules, and ideas about what healthy and unhealthy eating meant. Healthy eating was mostly explained as restriction of salt, sugar, and fat, and only one participant offered ideas about balance and moderation. Similar to other studies on transnational ties (Viruell--Fuentes & Schulz, 2009), we found evidence that transnational ties also provide emotional support and that contact is maintained through phone contact, including WhatsApp.

Other qualitative themes that dovetailed our quantitative finding of a higher proportion of network members eating traditional Latino diets with lower HEI scores lay concepts around traditional Mexican cuisine as well as the difference between homemade Mexican food (*comida de casa*) and Mexican food eaten on the street (*comida de calle*). Some also experienced Mexican food as heavy (*pesada*) and replete with grease (*grasa*), which was surprising since traditional Mexican food has been framed as healthier in older qualitative studies on the West Coast of the U.S. (Counihan, 2009). More recent research among Mexicans in rural areas has mentioned grasa by respondents (Kimoto et al., 2014) and high-fat diets have been found to be associated with insulin concentrations in Mexican American communities in the United States (Marshall et al., 1991). Qualitative research with other Latino immigrant communities has found similar ideas about "heavy" food or *comida pesada*, mainly driven by the larger portion sizes and affordability of food in the U.S. relative to their home country (Weisberg-Shapiro & Devine, 2019). Indeed, although the dietary acculturation literature consistently shows better diets among the less acculturated, other studies have highlighted that it is those in the "middle" section of the acculturation experience that are actually most at risk for diet-related diseases (Perez-Escamilla & Putnik, 2007). Although this sample was comprised of immigrants, most had resided in the U.S. for over 20 years. Given the lack of options for regularization of status, the vast majority of Mexicans who have come to reside in the New York metropolitan area since the mid-1990s have seen opportunities for economic and social integration limited compared to some of their neighbors who do not face the same barriers to regularization of immigration status and naturalization (Smith, 2006). That is, "Mexican" neighborhoods in New York City are often shared with other Latino subgroups, unlike the Mexican enclaves of Los Angeles and Chicago. Anthropologists have drawn attention to the ways that specifically anti-Mexican strands of nativism in the United States have inhibited the ability of Mexicans to occupy space (both literally and figuratively) to create and reproduce cultural traditions (Rosaldo, 1994; Pratt et al., 2021). There is evidence of the precarity of Mexican identification in New York (Negron, 2014) (Planas, 2020). Therefore, we interpret the lay concepts of Mexican cuisine as part and parcel of this in-between-status Mexican experience in New York City. It is noteworthy that dietary guidelines explicitly emphasize that a healthy dietary pattern is not a rigid prescription. It encourages customization so that nutrient-dense foods and beverages can still reflect cultural traditions. It seems important that nutrition educators recognize the possibility that some among this important Latino subgroup may have difficulty linking traditional foods and health though some point the gap in training (Burt et al., 2022; Knoblock-Hahn et al., 2010). Helping uplift traditional Mexican foodways for this and subsequent generations of Mexican Americans has important implications for dietary quality and nutrition education.

Individual-level acculturation measures were also associated with HEI. Lower HEI scores were associated with greater age at migration and acculturative stress. To our knowledge, no previous study has used this measure of acculturative stress and dietary quality in adults, which measured guilt for leaving family and friends in the home country, as well as stress over deportation and the extent to which legal status affected access to health and social services. Research on age at migration has highlighted this as an important indicator for successful integration, with people who immigrated at older ages potentially having less supportive environments for linguistic acquisition, which might in turn cause stress. These language barriers are known indicators of fewer employment opportunities and difficulties accessing social and health services, including the Supplemental Nutrition Assistance Program (SNAP). Studies on the role of age at migration and acculturative stress on psychological outcomes highlight that it is those who migrate during their midlife (i.e., after age 35) that have poorer outcomes relative to those migrating at earlier ages. One main hypothesis is that because late-life immigrants are less likely to migrate to the U.S. for educational and employment opportunities for themselves, they largely migrate to reunite with their families and are thus bound to these few social ties (Guo et al., 2019). Future research should seek to further understand the emotional and economic ramifications of this integration process for adults who migrate after the age of 35 and how it implicates diet. It would also be important to test the extent to which structural holes or the "strength of weak ties" hypothesis bares out in Mexican American communities like the one in our sample (Borgatti et al., 2018b; Borgatti & Halgin, 2011, pp. 1–14).

The paradoxical findings of lower income with higher HEI scores are also worth contextualizing in the larger literature on healthy migrant effects. Specifically, despite low SES, migrants have comparable outcomes in terms of mortality and other important health indicators (Abraido-Lanza et al., 1999; Markides & Eschbach, 2005). The qualitative narratives highlighted that, for some participants, growing in extreme poverty in rural parts of Mexico afforded them lay interpretations of healthy eating around substances that would mean beans and root vegetables are desirable. For some of our participants, these experiences also gave them skill sets for survival, such as cultivating their own food. Although we are cautious in drawing causal statements from these experiences, they highlight the importance of how past experiences of deprivation may give way to positive coping strategies for healthy eating. Other research among Mexican communities in the West provided similar evidence that some women retained plant cultivation, as in the case of our participant, who is an avid gardener (Counihan, 2009) even in the face of barriers and constraints of life in New York City. There was also evidence that experiences of this subsistence agropastoral economy tied into their practiced food traditions (Counihan, 2009), although it is also important to note how gardening could be associated with painful periods of poverty and scarcity for some. Finally, despite their low SES, our sample overall HEI of 58 is slightly lower than the average of 59 for adults ages 31–59 in the United States (USDA. HEI Scores for Americans, 2022).

Despite these insights, our study has some limitations. First, the cross-sectional nature of our analysis precludes our ability to make causal claims and our use of non-probability sampling techniques did not yield a representative sample of Mexican Americans in NYC. Longitudinal studies with representative samples using personal network data would be particularly useful in helping the field move forward, by testing if network characteristics cause change in diet quality. Second, personal network or egocentric network research has been criticized for solely focusing on the ego's experiences, which may or may not align with that of the alters views (Borgatti & Halgin, 2011, pp. 1–14). Nonetheless, perceptions of social contexts and the behaviors of others are powerful determinants of social influence (Holt-Lunstad, 2022), and our study provides evidence that these perceptions are associated with dietary quality. Third, this study did not explicitly measure childhood social environments, so its ability to demonstrate how these shaped current behaviors is limited. Studies with life-course perspectives may be particularly useful for moving the field forward. Lastly, some have criticized the Heathy Eating Index because it focuses solely on adherence to the DGA, whereas other measures such as the Alternate Healthy Index and NutriGrade specifically focus on foods known to reduce the risk of

chronic disease (Schwingshackl et al., 2016) including Latino samples (Huffman et al., 2011). However, HEI has been shown to perform equally well as the alternate healthy eating index in larger samples (Morze et al., 2020) and we think it is important to use common measures across public health studies, although the food similarity index may be a measure that is particularly useful in future studies on dietary acculturation (Van Hook et al., 2014). Machine learning approaches that automate classifications of food consumption are also worth highlighting (Bell et al., 2020; Mirtchouk et al., 2019).

5. Conclusions

A fundamental premise of the Dietary Guidelines for Americans is that everyone, irrespective of age, race, ethnicity, or health status, can benefit from choosing foods and beverages that support healthy dietary patterns. Healthy dietary patterns in turn have been associated with lower risk of chronic diseases, including T2DM. The Healthy Eating Index captures the extent to which an individual adheres to the Dietary Guidelines; hence, it is described as a measure of dietary quality. The process of dietary acculturation may complicate adherence for Mexican Americans who may not harness the potential benefits of traditional Mexican cuisine in an attempt to combat the many stressors they face as part of their integration journey. Nutrition educators may be excellent thought partners in reversing this trend by citing specific cultural foodways and helping prepare individuals to eat healthily while retaining their heritage and budgetary constraints, and accounting for the social contexts that may also be shaping their food access and preferences.

Ethical statement

The School of Public Health and Health Policy at the City University of New York's Institutional Review Board Human Subjects Committee approved all protocols used in the Social Networks and Mexican Americans Study. Participants were consented at the time of the first interview before any data collection occurred.

Author contributions

Overall integrity of the work from inception to publication: Flórez, de la Haye. Design, acquisition of data, or analysis and interpretation of data: Flórez, Bell, Hernández, Verdaguer, Gálvez, de la Haye. Preparation and review of the manuscript for important intellectual content: Flórez, Bell, Hernández, Verdaguer, de la Haye. Final approval of the version to be published: Flórez, Bell, Hernández, Verdaguer, Gálvez, de la Haye.

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Declaration of competing interest

The authors have no conflict of interest to disclose.

Data availability

The data that has been used is confidential.

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