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# Associations between low food security and subjective memory complaints among Latino adults

Joseph Saenz<sup>1\*</sup> and Laura Tanner<sup>1</sup>

## Abstract

**Background** Low food security is related with worse cognitive outcomes and poor mental health (e.g., higher anxiety and depression) may explain these associations. Subjective memory complaints may be important indicators of everyday memory problems. Despite a higher prevalence of food insecurity among Latinos, few have explored the links between low food security and subjective memory complaints in Latinos, or potential mechanisms underlying the associations.

**Methods** We used the Sangre Por Salud Biobank sample of 2,481 self-reported Latino patients aged 18–85 from a federally qualified community health center in Phoenix, AZ. Food security was assessed using the 6-item Household Food Security Survey Module and subjective memory complaints were measured using the Frequency of Forgetting Scale. We used linear regressions to test associations between low food security and subjective memory complaints, whether associations were explained by anxiety and depression, and whether associations differed by age or biological sex.

**Results** Around 76% of the sample were food secure, with 18% and 6% experiencing low and very low food security, respectively. In multivariate analyses, compared to the food secure, both low and very low food security related with higher subjective memory complaints and these associations were not modified by age or biological sex. Associations between low food security and subjective memory complaints were no longer significant after adjusting for anxiety and depression, suggesting that poor mental health may mediate associations between low food security and subjective memory complaints.

**Conclusions** Experiences of low food security were related with more frequent memory complaints. Subjective memory complaints are related with future cognitive impairment and dementia, making them important early markers of cognitive problems. Future studies should evaluate potential cognitive benefits of addressing food insecurity and its downstream effects on mental health.

**Keywords** Food security, Subjective memory, Cognition, Latino, Mental health, Anxiety, Depression

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## Background

In 2022, 17 million American households experienced food insecurity [1]. Food insecurity involves an inability to dependably access sufficient food for an active and healthy life [1], which can have effects on health and wellbeing. Those experiencing *low* food security often report a change in dietary quality, difficulty in acquiring food, and a decline in the variety of foods consumed [1, 2]. Individuals experiencing *very low* food security often encounter the inability to purchase food and may eliminate meals, decrease their overall food consumption, and experience feelings of hunger [1, 2]. Those experiencing *very low* food insecurity are also likely to lack the resources needed to access appropriate food sources [1, 2]. Food insecurity burdens are not equal across racial/ethnic groups. Latinos are twice (or more) as likely to experience food insecurity than non-Hispanic whites, with 20.8% of U.S. Latino's living in households experiencing low or very low food security, in 2022 [1].

### Food insecurity, health, and cognition

Research has found potential health effects of food insecurity, noting connections between food insecurity and adverse health outcomes [3, 4], including diabetes [5], hypertension [6], heart disease [7], stress, and depression [8]. Food insecurity has also been linked to cognitive outcomes such as cognitive impairment [9, 10], cognitive decline [11–13], lower cognitive ability [11, 14–16], and dementia [17]. However, key concerns are often overlooked in the association between food security and cognition. Despite higher food insecurity rates among U.S. Latinos, few focus on this group, with some notable exceptions [10, 13, 14]. Studies on Puerto Rican older adults in Boston [13, 14] reported negative effects of food insecurity on general cognitive performance and faster cognitive decline. In a nationally representative sample, food insecurity related to worse cognitive ability and increased incidence of cognitive impairment. However, the effects of food insecurity on cognitive ability were smaller among Hispanics, but race/ethnicity did not modify relationships between food insecurity and incident cognitive impairment [10].

Few studies examine links between food insecurity and subjective cognition. Existing research reports more subjective cognitive complaints in food insecure individuals in low- and middle-income countries [18], and greater subjective cognitive impairment in food insecure U.S. adults [9]. Subjective cognition refers to an individual's perceptions of their memory and cognitive abilities. Subjective memory complaints may be an early marker of cognitive pathology. Individuals who assess their own memory as poor or perceive a decline in their memory (subjective memory complaints) are more likely to develop cognitive impairment [19]. Subjective cognitive

decline has also been related to a nearly two-fold higher risk of developing dementia and a 1.73-fold higher risk of developing mild cognitive impairment [20].

Research examining whether associations between food insecurity and cognition differ by key demographic factors (e.g., age and sex) is inconsistent, with some finding no differences [11, 13, 14] and others finding that negative effects of food insecurity on cognition are stronger in younger and middle-aged adults and women [9]. Therefore, sex differences warrant further consideration. Subjective memory complaints differ by sex in both prevalence and relationship with objective cognitive measures [21, 22]. Traditionalized gender roles, closely linked to biological sex [23], may frame how food insecurity affects both men and women differently. Men are often seen as “breadwinners” [24], whereas women are traditionally associated with food preparations [25, 26], though many women balance both paid labor and food responsibilities in the home [27, 28]. These gendered roles are further evolving as women have more bilateral responsibilities in and outside of the home [29]. There is also reason to evaluate whether food insecurity affects health equivalently across age. With advancing age, factors such as lowered income following retirement and increased disability become more prevalent, both of which impede one's ability to obtain and prepare foods [27].

Further, little is known regarding the mechanisms of how food insecurity impacts cognition. However, elevated anxiety [9] and depression [9, 11, 15] linked to food insecurity may negatively affect cognitive outcomes, due to their effects on cognitive function [30, 31] making poorer mental health a potential pathway through which effects of food insecurity may operate.

### Food insecurity in Maricopa County

Between 2010 and 2012, 14.9% of Arizona residents were food insecure, and between 2020 and 2022, that rate decreased to 10.2% experiencing food insecurity [32]. The national prevalence of food insecurity has increased from 10.2% in 2021, to 12.8% in 2022 [1]. The Latino population of Maricopa County (County of Phoenix, AZ) continues to experience above-average rates (18%) of food insecurity [3], compared to the national average. Understanding food insecurity in Latino Phoenix residents is crucial, as around 1.2 million Latinos reside in Phoenix, AZ [33].

Many factors impact food security in Maricopa County including poverty, agricultural infrastructure, supply chains, and the broader economy. Economic downturns disproportionately affect marginalized communities, leading to less job security and, therefore, less financial security, which may increase the likelihood of experiencing food insecurity [2]. Currently, 9.8% of American households are now living at or below the household

income-to-poverty ratio (under 1.00) [1]. The food environment of Phoenix, AZ is further impacted by those living at or below the federal poverty line. 28% of Maricopa County households have a total annual income of \$50,000 or less per year [34], and 10.8% of Maricopa residents live below the federal poverty line [34], leading to increased risk of low food security.

### Current study

This study seeks to identify the associations between food insecurity and subjective memory complaints in a sample of self-reported Latinos from Maricopa County in Arizona. Our primary research question is whether food insecurity is related with higher levels of subjective memory complaints. Second, we evaluated whether associations between food insecurity and subjective memory complaints are modified by sex and age. Last, we tested whether potential associations between food insecurity and subjective memory complaints are explained by anxiety and depression. The results will identify how food insecurity, a key modifiable socioeconomic factor, relates with subjective memory complaints in a Latino sample and the potential cognitive benefits of addressing food insecurity and its downstream effects on mental health. Although our results come from a sample in Maricopa County in Arizona, the results may have important implications for the cognitive wellbeing of the Latinos in the United States. Latino populations are projected to expand in coming decades and experience higher rates of cognitive impairment [35] and higher burdens of food insecurity [1].

## Methods

### Data source

This secondary data analysis utilizes the deidentified Sangre Por Salud participant dataset, a partnership between Mayo Clinic Center and the Mountain Park Health Center of Phoenix, AZ. Active patients were enrolled from Mountain Park Health Center's internal medicine to build an infrastructure for biobanking purposes [36]. The Mountain Park Health Center is a federally accredited, non-profit organization whose mission is to provide culturally tailored, precision healthcare for vulnerable populations. The Sangre Por Salud Biobank participants are self-reported Latinos, aged 18–85 years old [36]. Eligible participants were established patients who (1) sought medical care in the last six months at Mountain Park Health Center, (2) were not diagnosed with Type II diabetes, (3) were not currently pregnant and had not been pregnant in the last 12 months, (4) were not lactating (for the purposes of infant/child feeding) within  $\leq 3$  months, (5) were free of a cancer diagnosis for three or more years, and (6) were able to refrain from smoking (up to four hours) during the onsite study visit [36].

All study participants provided informed consent to participate in the Sangre por Salud study. The protocol for this secondary analysis of data from the Sangre por Salud study was reviewed by the Arizona State University Institutional Review Board and deemed exempt pursuant to Federal Regulations 45CFR46 [4]. Between 2013 and 2018, 3,756 participants were enrolled into the Sangre Por Salud study [36]. Our analytic sample included 2,481 self-reported Latinos, aged  $\geq 18$ , with complete information on independent and dependent variables, described below. The majority of our analytic sample (91%) reported Mexican heritage.

### Subjective memory complaints

Subjective memory complaints were measured using the 10-item Frequency of Forgetting (FoF) scale [37]. Although this scale was developed as a measure of memory self-efficacy, others have argued that it is more applicable as a measure of subjective memory complaints, given that it focuses on memory problems in daily life as opposed to perceived ability [38]. The scale assessed the frequency with which respondents experience general memory problems (response options range from 1 to 7 with 1 indicating “no problems” and 7 indicating “major problems”). Next, respondents reported how often they have problems with the following: names, faces, where one placed something, directions to places, and forgetting what one was doing. Response choices for these items range from 1 to 7, with 1 representing “never” and 7 representing “always.” Two items also assessed forgetting what one was reading in (1) the last paragraph and (2) the last sentence, with response options ranging from 1 (never) to 7 (always). The last two items asked about how well one remembers (1) 1–5 years ago and (2) 6–10 years ago with response options ranging from 1 (very bad) to 7 (very good). After reverse coding the two items about how well respondents remember 1–5 and 6–10 years ago, so higher values represent greater memory complaint for each item, a total subjective memory complaints score was calculated by summing the 10 items creating a score ranging from 10 to 70 with higher values representing more memory complaints. The 10 items in the FoF scale demonstrated internal consistency with a Cronbach's alpha of 0.86.

### Household food insecurity

Household food insecurity was assessed using the 6-item U.S. Household Food Security Survey Module, a robust and standardized instrument measuring food (in)security. This measure assesses direct and immediate access to food in households, and the conditions and behaviors experienced by respondents related to household food consumption [1, 2]. Our measure of food insecurity captures a household's food access in the past 12 months,

and differs from *community*-level food access (i.e., food deserts), as households within communities may differ in their food insecurity status [39]. Respondents reported, in the last 12 months, (1) whether they or others in their household had to cut the size of meals or skip meals because there was not enough money for food; (2) how frequently they had to cut the size of meals or skip meals; (3) whether they ate less than they felt they should because there was not enough money for food; (4) being hungry but not eating because they could not afford enough food; (5) feeling that their food did not last and not having money to buy more; and (6) not being able to afford to eat balanced meals. Responses to the six-item scale were used to identify respondents as experiencing (1) high or marginal food security (hereafter, food secure), (2) low food security, and (3) very low food security, based on established approaches [40].

### Anxiety and depression

Generalized anxiety symptoms were assessed using the 7-item Generalized Anxiety Disorder (GAD-7) scale [41], in which respondents reported how frequently in the last two weeks they experienced problems such as “being so restless that it is hard to sit still” with options including 0) “not at all”, (1) “several days”, (2) “more than half the days”, and (3) “nearly every day.” Responses across the 7 items were summed to calculate a total anxiety score ranging from 0 to 21, with higher values indicating higher anxiety. Depression was assessed using the Patient Health Questionnaire-2 [42] in which respondents reported, over the last two weeks, how often they had “little interest or pleasure in doing things” and “feeling down, depressed, or hopeless.” Response options were identical to those from the GAD-7 and a total depression score was constructed by summing the responses to the two questions, yielding a total depression score ranging from 0 to 6, with higher values indicative of higher levels of depression.

### Control variables

We controlled for demographic variables including participant-reported age, sex, and nativity. We also considered indicators of socioeconomic status including level of schooling (a categorical variable with categories including less than high school, high school education or GED, or beyond high school education) and work status (full-time work, part-time work, or not working). Respondents reported their health as being excellent, very good, good, fair, or poor. Due to limited reports of “excellent” and “poor” health, we recategorized self-rated health as (1) excellent or very good; (2) good; and (3) fair or poor for analyses. To capture respondents’ perceived availability of social support, we created a measure of social support based on responses to six questions (e.g., “Is there someone available to you whom you can count on to listen to

you when you need to talk?”), which have been described elsewhere [43].

### Statistical approach

We first described the level of subjective memory complaints, depression, anxiety, and each of the control variables listed above by level of food security (food secure, low food security, and very low food security). We used chi-square tests and Analysis of Variance (ANOVA) tests to identify whether these factors statistically differed according to one’s level of food security. Next, we used multivariate linear regression to identify how one’s level of food security relates with subjective memory complaints when adjusting for potential confounders (age, biological sex, nativity, work status, self-rated health, and social support). Model 1 included level of food security and the previously mentioned confounders. Model 2 and Model 3 added anxiety and depression, respectively, to assess whether potential links between food insecurity and subjective memory complaints were explained by anxiety and depression individually. Model 4 then included anxiety and depression simultaneously to determine whether anxiety and depression, together, explained associations between food insecurity and subjective memory complaints. Models 5 and 6 then added interaction terms between food insecurity and age and biological sex, respectively, to identify whether food insecurity related with subjective memory complaints equivalently by age and biological sex. All data management and statistical analysis was completed using Stata 18 MP4.

## Results

### Descriptive results

The sociodemographic characteristics of the sample are presented in Table 1 and are categorized by 1,888 participants who experienced food security, 438 participants with low food security, and 155 participants with very low food security. Lower levels of food security were related with higher subjective memory complaints using a  $p < 0.05$  level. Lower levels of social support were observed in groups with lower levels of food security ( $p < 0.001$ ). Higher levels of anxiety ( $p < 0.001$ ) and depression ( $p < 0.001$ ) were also observed in groups with lower levels of food security. No significant association occurred for age by level of food security ( $p = 0.43$ ). The means, standard deviations, and level of significance are presented in Table 1. There was a significant association between higher levels of food security and being born outside of the United States ( $p < 0.001$ ). Food security was also related to educational attainment ( $p < 0.05$ ), with those with beyond a high school education having the highest rates of food security (79.28%) compared to those with less than a high school education (74.86%). Employment was associated with higher levels of food security

**Table 1** Sociodemographic, health, memory, and mental health characteristics of sample according to level of food security ( $n = 2,481$ )

	Food Secure ( $n = 1,888$ )		Low Food Security ( $n = 438$ )		Very Low Food Security ( $n = 155$ )		Sig.
	<i>n</i> /Mean	Row %/ <i>SD</i>	<i>n</i> /Mean	Row %/ <i>SD</i>	<i>n</i> /Mean	Row %/ <i>SD</i>	
<b>Frequency of Forgetting</b> (mean, <i>SD</i> )	26.99	10.86	29.89	10.76	33.68	12.61	***
<b>Depression</b> (mean, <i>SD</i> )	0.83	1.33	1.32	1.59	2.08	1.89	***
<b>Anxiety</b> (mean, <i>SD</i> )	3.97	4.86	5.64	5.14	8.05	5.82	***
<b>Age</b> (mean, <i>SD</i> )	40.88	13.17	41.12	11.94	42.28	14.21	
<b>Sex</b>							
Women ( <i>n</i> , %)	1,333	75.91	312	17.77	111	6.32	
Men ( <i>n</i> , %)	555	76.55	126	17.38	44	6.07	
<b>Education</b>							
Less than High School Education ( <i>n</i> , %)	1,063	74.86	276	19.44	81	5.70	*
High School Education ( <i>n</i> , %)	408	76.26	87	16.26	40	7.48	
Beyond High School Education ( <i>n</i> , %)	417	79.28	75	14.26	34	6.46	
<b>Country of Birth</b>							
Foreign Born ( <i>n</i> , %)	1,471	78.04	334	17.72	80	4.24	***
U.S. Born ( <i>n</i> , %)	417	60.97	104	17.45	75	12.58	
<b>Employment</b>							
Full-Time ( <i>n</i> , %)	681	78.46	146	16.82	41	4.72	*
Part-Time ( <i>n</i> , %)	347	78.86	64	14.55	29	6.59	
Not Working ( <i>n</i> , %)	860	73.32	228	19.44	85	7.25	
<b>Self-Rated Health</b>							
Excellent/Very Good ( <i>n</i> , %)	502	80.32	100	16.00	23	3.68	***
Good ( <i>n</i> , %)	850	76.65	194	17.49	65	5.86	
Fair/Poor ( <i>n</i> , %)	536	71.75	144	19.28	67	8.97	
<b>Social Support</b> (mean, <i>SD</i> )	19.08	5.12	17.16	5.74	15.21	6.05	***

**Note.** The column labeled “sig” provides the statistical significance testing of differences in variables across food security groups, which were tested using ANOVA for continuous variables and chi-square tests for binary and categorical variables. \* Indicates  $p < 0.05$ , \*\* Indicates  $p < 0.01$ , \*\*\* Indicates  $p < 0.001$

( $p < 0.05$ ). Better self-rated health was related to increased levels of food security ( $p < 0.001$ ). Levels of food security did not differ by biological sex ( $p = 0.940$ ).

### Regression results

Our regression results are provided in Table 2. Model 1 estimated associations between level of food security and subjective memory complaints while accounting for confounding factors (age, biological sex, education, self-rated health, social support, nativity, and employment status). Compared to those experiencing food security, those experiencing low ( $\beta = 2.03$ , 95% confidence interval [CI]: 0.93, 3.14) or very low food security ( $\beta = 4.13$ , 95% CI: 2.36, 5.90) reported more subjective memory complaints. Because this model does not account for any of the proposed mechanisms linking food security status to subjective memory complaints (i.e., anxiety and depression), the food security parameter estimates serve as estimates of the “total effects” of food security status on subjective memory complaints. Although our study is primarily focused on level of food security, we also note that factors such as being foreign born ( $\beta = -1.68$ , 95% CI: -2.76, -0.61) and having more social support ( $\beta = -0.35$ , 95% CI: -0.43, -0.27) were related with lower subjective memory complaints.

In Model 2, we added anxiety to Model 1 to determine whether the associations between level of food security and subjective memory complaints were explained by anxiety alone. In Model 2, those reporting higher levels of anxiety tended to report more subjective memory complaints ( $\beta = 0.83$ , 95% CI: 0.74, 0.92) and the associations between level of food security and subjective memory complaints were either reduced in size or became non-significant. Specifically, low food security was no longer related with subjective memory complaints when adjusting for anxiety ( $\beta = 1.03$ , 95% CI: -0.01, 2.06), whereas very low food security remained a significant predictor of subjective memory complaints ( $\beta = 1.80$ , 95% CI: 0.13, 3.48), but the parameter estimate dropped notably from the estimates in Model 1.

Model 3 added depression (instead of anxiety) to Model 1 to test whether associations between level of food security and subjective memory complaints were explained by depression alone. Higher depression was related with greater subjective memory complaints ( $\beta = 2.43$ , 95% CI: 2.13, 2.73), and adding depression to the model altered the size of the associations between level of food security and subjective memory complaints, but not the statistical significance. Both low ( $\beta = 1.24$ , 95% CI: 0.18, 2.29) and very low ( $\beta = 2.16$ , 95% CI: 0.46, 3.86) food security were

**Table 2** Linear regression of subjective memory complaints on food security (*n* = 2,481)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
<b>Food Security (Reference: Food Secure)</b>												
Low Food Security	2.03***	[0.93, 3.14]	1.03	[-0.01, 2.06]	1.24*	[0.18, 2.29]	0.92	[-0.11, 1.96]	1.24	[-2.61, 5.10]	1.94**	[0.64, 3.25]
Very Low Food Security	4.13***	[2.36, 5.90]	1.80*	[0.13, 3.48]	2.16*	[0.46, 3.86]	1.51	[-0.16, 3.17]	4.82	[-0.63, 10.27]	4.35***	[2.27, 6.42]
<b>Age</b>	0.09***	[0.06, 0.13]	0.11***	[0.08, 0.14]	0.11***	[0.08, 0.14]	0.11***	[0.08, 0.14]	0.09***	[0.05, 0.13]	0.09***	[0.06, 0.13]
<b>Sex</b>												
Men (Reference: Women)	-2.45***	[-3.40, -1.51]	-1.74***	[-2.63, -0.85]	-1.73***	[-2.64, -0.83]	-1.59***	[-2.48, -0.71]	-2.45***	[-3.40, -1.50]	-2.46***	[-3.54, -1.38]
<b>Education (Reference: High School Education)</b>												
Less than High School Education	-0.49	[-1.60, 0.62]	-0.01	[-1.05, 1.03]	-0.24	[-1.29, 0.82]	-0.02	[-1.05, 1.01]	-0.50	[-1.61, 0.61]	-0.49	[-1.60, 0.62]
Beyond High School Education	-0.26	[-1.53, 1.01]	0.23	[-0.97, 1.42]	0.19	[-1.02, 1.40]	0.30	[-0.88, 1.49]	-0.27	[-1.54, 1.00]	-0.26	[-1.53, 1.01]
<b>Employment (Reference: Full Time Work)</b>												
Part-Time	0.68	[-0.54, 1.90]	0.62	[-0.52, 1.76]	0.62	[-0.54, 1.78]	0.60	[-0.53, 1.74]	0.67	[-0.55, 1.89]	0.69	[-0.53, 1.91]
Not Working	-0.37	[-1.34, 0.60]	-0.46	[-1.37, 0.45]	-0.52	[-1.44, 0.41]	-0.50	[-1.41, 0.40]	-0.37	[-1.34, 0.61]	-0.36	[-1.33, 0.62]
<b>Country of Birth (Reference: U.S. Born)</b>												
Foreign Born	-1.68**	[-2.76, -0.61]	-1.04*	[-2.06, -0.03]	-0.79	[-1.82, 0.24]	-0.80	[-1.81, 0.21]	-1.68**	[-2.76, -0.60]	-1.68**	[-2.76, -0.60]
<b>Social Support</b>												
	-0.35***	[-0.43, -0.27]	-0.20***	[-0.28, -0.13]	-0.19***	[-0.27, -0.11]	-0.17***	[-0.24, -0.09]	-0.35***	[-0.43, -0.27]	-0.35***	[-0.43, -0.27]
<b>Self-Rated Health (Reference: Excellent or Very Good)</b>												
Good	1.82***	[0.78, 2.86]	0.88	[-0.10, 1.85]	1.20*	[0.21, 2.19]	0.84	[-0.13, 1.81]	1.83***	[0.79, 2.87]	1.82***	[0.79, 2.86]
Fair/Poor	4.63***	[3.46, 5.81]	2.30***	[1.18, 3.43]	3.07***	[1.94, 4.20]	2.19***	[1.07, 3.31]	4.63***	[3.46, 5.80]	4.64***	[3.46, 5.81]
<b>Anxiety</b>			0.83***	[0.74, 0.92]			0.61***	[0.50, 0.73]				
<b>Depression</b>					2.43***	[2.13, 2.73]	1.11***	[0.73, 1.49]				
<b>Food Security * Age</b>												
Low Food Security * Age									0.02	[-0.07, 0.11]		
Very Low Food Security * Age									-0.02	[-0.14, 0.11]		



Table 2 (continued)

	Model 1	Model 2		Model 3		Model 4		Model 5		Model 6	
	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI	$\beta$ 95% CI
Food Security * Sex											
Men * Low Food Security										0.31 [-2.10, 2.72]	
Men * Very Low Food Security										-0.76 [-4.57, 3.06]	

Note: “ $\beta$ ” indicates unstandardized parameter estimate. “95% CI” represents 95% confidence interval. \* Indicates  $p < 0.05$ , \*\* Indicates  $p < 0.01$ , \*\*\* Indicates  $p < 0.001$

related with higher subjective memory complaints, but parameter estimates shrank compared to those observed in Model 1.

Models 2 and 3 suggest that the statistical links between level of food security and subjective memory complaints were partially explained by anxiety and depression, respectively, because some food security parameter estimates remained statistically significant despite controlling for anxiety and depression in Models 2 and 3, respectively. We then used Model 4 to test whether anxiety and depression *together* explained the associations between level of food security and subjective memory complaints. When adjusting for anxiety and depression in the same model, no relationship between food security status and subjective memory complaints was observed suggesting that anxiety and depression, together, explained the statistical link between level of food security and subjective memory complaints.

We evaluated whether the associations between level of food security and subjective memory complaints differed by key demographic factors, including age (Model 5) and biological sex (Model 6). This was tested by adding interaction terms between level of food security and age in Model 5, and level of food security and sex in Model 6. Models 5 and 6 do not adjust for anxiety and depression so that we could evaluate whether the total effects of food security differ by demographic factors. Interaction terms between neither age nor biological sex were statistically significant, suggesting that associations between level of food security and subjective memory complaints were not modified by age or biological sex.

Mediation tests

Although our regression results suggested that anxiety and depression may mediate associations between level of food security and subjective memory complaints, we made use of the R macro “PROCESS” [44] to further test the significance of the indirect effects of level of food security on subjective memory complaints (results not shown). The PROCESS macro builds confidence intervals around indirect effects (at the 95% confidence level) using a bootstrapping process. Indirect effects are calculated using the product of the relevant coefficients representing impacts of independent variables (i.e., level of food security) on the mediators (i.e., anxiety or depression), and impacts of mediators on the dependent variable (i.e., subjective memory complaints).

Results from the PROCESS macro suggested that low ( $\beta = 1.21$ , 95% CI: 0.75, 1.68) and very low food security ( $\beta = 2.80$ , 95% CI: 2.06, 3.55) related with higher anxiety, while controlling for covariates. Low ( $\beta = 0.33$ , 95% CI: 0.19, 0.47) and very low food security ( $\beta = 0.81$ , 95% CI: 0.59, 1.03) also related with depression. Matching results in Model 4, low ( $\beta = 0.92$ , 95% CI: -0.11, 1.96) and very

low food security ( $\beta = 1.51$ , 95% CI: -0.16, 3.17) were not significantly related to subjective memory complaints when mediators are included in regressions, whereas anxiety and depression were associated with higher subjective memory complaints. Analyses of indirect effects supported both anxiety and depression mediating effects of level of food security on subjective memory complaints. Percentile bootstrapped confidence intervals (using 5,000 iterations) around indirect effects did not include 0 for indirect effects of low food security through anxiety ( $\beta = 0.75$ , 95% CI: 0.43, 1.10), very low food security through anxiety ( $\beta = 1.72$ , 95% CI: 1.14, 2.43), low food security through depression ( $\beta = 0.36$ , 95% CI: 0.17, 0.60), and very low food security through depression ( $\beta = 0.90$ , 95% CI: 0.51, 1.40).

## Discussion

We found that experiencing low and very low food security were related with higher subjective memory complaints in a sample of self-reported Latinos in Maricopa County, a community that experiences a higher burden of food insecurity than the national average [3]. We also found that higher depression and anxiety may mediate these associations. Food security remains an important public health concern disproportionately impacting Latino communities [3]. An evolving body of research finds that negative impacts of food insecurity on well-being are exacerbated by potential health impacts [4].

Our findings are in line with prior studies finding associations between food insecurity and adverse cognitive outcomes [9, 45]. However, we extend past work in important ways. First, we found associations between food insecurity and *subjective* cognitive abilities, which has received far less research attention compared to objective measures of cognition [9, 18]. Associations between food insecurity and subjective cognitive abilities are particularly important; as subjective cognitive complaints are early markers of cognitive pathology and relate to worse trajectories of cognitive abilities over time [19, 20, 46]. As an early marker of potential pathology, there is considerable interest in subjective memory complaints as a means of recognizing individuals at risk of poor cognitive outcomes who could benefit from early prevention efforts to protect against adverse cognitive health outcomes. Our results suggest the need for routine screening for food insecurity and subjective memory complaints in healthcare settings, to better identify individuals in need of support, resources, and interventions.

A second key contribution of this study was our focus on the experiences of food insecurity in diverse populations with differing ethnic backgrounds, age, and biological sex. We evaluated the potential effects of food insecurity in a sample of self-reported Latinos. Projections indicate that the number of Latinos in the U.S.

living with Alzheimer's disease or related dementias will increase from around half a million to 3.2 million between 2020 and 2060, representing the sharpest increase among race/ethnicity groups in the U.S. [35]. Despite the increased burden of both Alzheimer's disease or related dementias and food insecurity in Latino populations [3, 35], few studies have explored associations between food insecurity and cognition in U.S. Latinos [10, 13, 14]. Although Wang & El-Abbadi (2024) used a nationally representative sample to explore associations between food insecurity and cognition, others used data from a sample of Puerto Ricans in Boston [13, 14]. The majority of our Latino sample in Maricopa County reported Mexican (91%) heritage, providing an important geographic and ethnic counterpoint to existing work on U.S. Latinos. Despite population differences among previous studies, our findings are in agreement with other research finding relationships between food insecurity and adverse cognitive health in U.S. Latinos [10, 13, 14]. Consistent evidence connecting food insecurity to poorer cognitive outcomes, coupled with a disproportionate burden of food insecurity in the Latino community, indicate a greater need to develop culturally appropriate strategies to reduce food insecurity, particularly among Latinos.

Our sample encompasses a broad age range, yet we did not find evidence that associations between food insecurity and subjective memory complaints were modified by age. Prior studies have hypothesized that, with advancing age, the consequences of food insecurity may be intensified or complicated by a higher prevalence of vulnerabilities including fixed incomes, mobility limitations, chronic conditions, and an increased reliance on others [47]. However, it is not entirely surprising that the consequences of food insecurity were seen across the age spectrum. Given that food insecurity questions targeted *household* food insecurity (e.g., "did you or other adults in your household ever cut the size of meals...?"), health effects of food insecurity may be experienced by household residents regardless of age as all household members are likely to be impacted by household food insecurity. This may be especially relevant for Latinos, who are more likely to live in multigenerational households, with a larger range of ages, when compared to non-Hispanic whites [48].

We also examined whether the association between food insecurity and subjective memory complaints was modified by biological sex. In contrast to some existing literature, biological sex did not modify the association between food insecurity and subjective memory complaints. In a systematic review on food insecurity and mental health conditions, Osei-Owusu et al., (2024) found two studies that identified a stronger relationship between food insecurity and mental health conditions



for men than women and one study identified food insecure women were more likely to experience heightened psychological distress than men. Other research has also found women experience worse health outcomes when experiencing food insecurity [49] than men [9]. However, other studies determined that sex did not modify associations between food insecurity and other various health outcomes [50–52], including throat/pharynx head and neck cancer [50], mental health outcomes [51], and cardiovascular disease risk factors including BMI and waist circumference [52].

Due to more traditionalized gender roles in Latino populations, it is surprising that effect modification by biological sex is unfounded in our study. Women are more likely to be the mediators of nutritional outcomes [27], and therefore, may influence health outcomes of food insecure households [4]. However, men may also face distress associated with inability to provide food as this conflicts with a “breadwinning” role. Traditional gender roles then may create gender-specific paths that may lead to distress, regardless of gender, potentially explaining the negative effects of food insecurity on subjective memory complaints that we observe for both men and women. Furthermore, we only have information on the study participant’s sex but lack information on the sex of the household head, which may influence both household food insecurity and the effects of food insecurity on health within households and should be evaluated in future work.

Our results also add to a growing body of research attempting to identify the mechanisms connecting food insecurity to poorer cognitive health. We found that those experiencing lower food security had higher levels of both anxiety and depression and these factors may play a role in conveying the negative effects of food insecurity on subjective memory complaints. Depression has been associated with structural alterations in the brain including the frontal lobe and hippocampus [53], which are critical regions for cognitive functions, including memory. Moreover, chronic systemic inflammation, which is associated with both worse objective cognitive outcomes and subjective cognitive complaints [54], has been found to be elevated in individuals with anxiety disorders [55] and individuals experiencing food insecurity [56]. In contrast to past work that generally observes significant associations between food insecurity and cognition even when adjusting for depression or anxiety [9, 11, 15], we observed no significant relationship between food insecurity and subjective memory complaints after adjusting for depression and anxiety. This suggests that effective management of depression and anxiety in individuals experiencing food insecurity may be a potential method of mitigating harmful health effects.

Although management of anxiety and depression may be effective, public health and policy efforts may be more impactful by targeting food insecurity itself, a modifiable risk factor, rather than its downstream effects. Although existing policies such as the U.S.D.A Supplemental Nutrition Assistance Program (SNAP) aim to facilitate food access, evidence suggests that additional changes are needed to improve access, eligibility, and participation. Low-income households often rely on SNAP benefits to supplement household food purchases. However, living at or above the federal poverty line decreases eligibility to essential governmental assistance, such as SNAP for those experiencing food insecurity.

In 2022, the national average cost of a meal was \$3.14, more than 8% above the cost per meal when using SNAP benefits [57], leading to a nearly \$300 deficit per person, per year when comparing SNAP benefits received to actual food costs. Between 2017 and 2019, 36.9% of Latinos in Maricopa County were eligible to receive SNAP benefits, of those who qualified, only 76.1% accessed SNAP benefits [58]. The implications of not accessing SNAP benefits (when eligible) have been associated with a more rapid pace of decline in cognitive function over a nine-year period [12] and highlights the need for additional policy change to improve access, eligibility, and increased participation in SNAP benefits. Additionally, even when individuals access SNAP benefits, more resources are needed [1] to ensure that individuals have access to healthy foods such as fresh fruits and vegetables in their communities, transportation to/from grocery stores, and well-equipped kitchens to prepare foods at home. A multilevel policy approach may be needed to increase participation, eligibility, and access to SNAP benefits.

Other factors such as social support and being foreign born were related to fewer subjective memory complaints. Past studies have noted lower levels of global cognitive function in foreign born relative to U.S. born Latinos [59]. However, differences in subjective cognitive impairment by nativity among Mexican Americans have been ambiguous [60] and foreign-born health advantages within the Latino population have been observed for several health outcomes [61], including cognitive function [62]. This may reflect health selection (as one must be healthy enough to migrate) as well as potentially better health behaviors in Hispanic migrants [61, 62]. Our findings are also consistent with prior work, finding social support to be related with better subjective cognitive function [63]. Beneficial impacts of social support for memory could be explained through mechanisms such as reduced stress and increased interpersonal activity [64], which may benefit cognition. Nativity status and social support may be important factors for understanding

subjective memory complaints and its risk factors within the Maricopa County Latino community and beyond.

We acknowledge several limitations. Our study used a cross-sectional study design and cannot determine the direction of the association between food insecurity and subjective memory complaints. Future studies should consider multiple time points measuring food insecurity and subjective memory complaints to evaluate the causal direction. Subjective memory complaints may influence food insecurity in several potential ways. Experiencing reduced cognitive functioning, (e.g., poor memory or forgetfulness) may impede one's ability to conduct instrumental activities of daily living [65], including but not limited to planning, procurement, and preparation of healthy foods. Furthermore, poor memory and forgetfulness may impede one's ability to obtain a high-paying stable job [14], which may increase one's likelihood of experiencing food insecurity. Last, procurement of SNAP benefits may be burdensome for people experiencing memory problems [12, 14]. These bi-directional associations should be considered in future work. Though we adjusted for several economic, social, and demographic confounders, there remain unmeasured confounders such as family size, presence of children, head of household gender, marital status, housing status, ease of location to healthy food access, and access to transportation, which should guide future research. We also lack information on income, which may confound associations between level of food security and subjective memory, leading to inflated estimates of the effects of food insecurity. We also acknowledge that gender roles surrounding food may be important, but our sample only measures biological sex. Future work should assess gender identity and the extent to which individuals endorse traditional gender roles about food.

Furthermore, our measure of food security focuses primarily on financial food access [1, 66], which is one of multiple pillars of food security. Other pillars of food security (availability/presence of food, effective food utilization, and food stability) are not captured in our measures and should be the focus of future work [66]. Although poverty affects financial access to food, food insecurity is a conceptually distinct aspect of economic hardship and can affect health in distinct ways [67, 68]. Therefore, not all households below the poverty line experience food insecurity and food insecurity is still experienced by some households above the poverty line [1, 68]. Other factors contribute to food insecurity risk outside of poverty including climate events, storage and processing of foods, and food quality or safety. Therefore, future studies should consider food security measures, which include all aspects of the food security pillars [66]. Also, our measure of food security only captures the prior 12 months. Future studies should measure food

insecurity over longer periods to assess whether effects of food insecurity on subjective memory complaints accumulate over time. We also lack information on the neighborhood food environment (particularly access to food in the community), which may impact food insecurity [69]. Further, poor diet quality, which has been linked to subjective cognitive decline [68], may be a consequence of food insecurity [70] making diet quality [70, 71] a possible mechanism explaining its health effects. Future studies should collect detailed measures of community-level food availability and diet quality to better understand the factors that contribute to food insecurity and may explain its related health effects.

Additionally, our sample included only Latino patients at Mountain Park Health Center and excluded those with Type II diabetes, cancer, and those who are pregnant or breastfeeding. Therefore, our findings may not generalize to the overall population of Latinos who reside in other communities, do not have access to healthcare, or have existing health conditions such as diabetes and cancer. Future work should coordinate across multiple health centers to improve generalizability to the overall population.

## Conclusion

Despite policy efforts to reduce the burden of food insecurity in the United States, 17 million households encountered food insecurity in 2022 [1] and, globally, 2.3 billion people experienced some level of food insecurity in 2023 [33]. Using a sample of Latino adults, this study finds that experiences of low food security are related with a greater likelihood of reporting subjective memory complaints. This is particularly distressing as subjective memory complaints are an early marker of possible cognitive pathology. We emphasize that food insecurity is a modifiable risk factor and that interventions may be an opportunity to promote cognitive well-being and enhance quality of life. Our results point to the importance of identifying food insecure households and developing targeted, culturally specific strategies that take advantage of existing community resources to alleviate food insecurity and address its potential effects on mental and cognitive health outcomes.

## Abbreviations

SNAP	Supplemental nutrition assistance program
ANOVA	Analysis of variance
FOF	Frequency of Forgetting

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## Author contributions

J.S. and L.T. were involved in conceptualization of the study, development of the methodology, writing of the original draft, reviewing, and editing of the draft. J.S. curated the data, coded the data, and conducted the formal data analysis. L.T. conducted the literature review and transcribed statistical output to create data results tables.

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## Data availability

The datasets analyzed in the current study are available by contacting Biobank@mayo.edu to request access to samples and/or data.

## Declarations

### Ethical approval and consent to participate

The Sangre Por Salud study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Institutional Review Board of Mayo Clinic (IRB #12-008503). All study participants provided informed consent to participate in the Sangre por Salud study. The protocol for the present study, based on secondary analysis of the Sangre por Salud study data, was reviewed by the Arizona State University Institutional Review Board (#STUDY00018799) and deemed exempt pursuant to Federal Regulations 45CFR46 [4].

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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