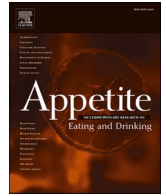




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A lifespan perspective of structural and perceived social relationships, food insecurity, and dietary behaviors during the COVID-19 pandemic

Alexandra Malia Jackson^{a,1,*}, Raven H. Weaver^b, Anaderi Iniguez^b, Jane Lanigan^b

^a Human Development, Washington State University, 14204 NE Salmon Creek Ave, Vancouver, WA, 98686, United States

^b Human Development, Washington State University, 501 Johnson Tower, Pullman, WA, 99164, United States

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ABSTRACT

Physical distancing and economic impacts of the COVID-19 pandemic may influence dietary behaviors. Using a parallel mixed method design, we examined the relationships between structural and perceived social relationships on dietary behaviors across the adult lifespan and by food security status. A representative sample of 360 adults (18–78 years old) living in the United States were recruited through Prolific Academic to complete an online cross-sectional survey. Participants provided data about demographics, food insecurity, structural and perceived social relationships, diet quality, and unhealthy snacking at the onset of the pandemic. Participants responded to open-ended questions about perceived changes in social connections and dietary behavior since COVID-19. Quantitative findings indicated food insecure emerging and older adults were at highest risk for low diet quality and frequent unhealthy snacking. Friend support was associated with higher diet quality. Qualitative findings suggested overall decreases in social connection and changes in dietary behavior, with food insecure adults describing decreases in diet quality. Participants who reported increases in emotional eating also reported decreases in social connection. Findings suggest the pandemic may exacerbate inequalities, particularly among food insecure emerging and older adults. Scaling up preventive interventions to increase social connection and reduce food insecurity during unprecedented challenges may promote healthier dietary behaviors now and in the long-term.

1. Introduction

Physical distancing strategies implemented to slow the spread of the Coronavirus disease (COVID-19) have led to substantial changes in social connections and interactions. Physical distancing measures have decreased in-person interaction, changed access to support systems, increased unstructured time, and altered daily behaviors, all of which may have emotional, social, and behavioral short and long-term effects on individuals (Rosenfeld et al.,). In particular, social distancing may have a substantial negative impact on individuals living alone (Fingerman et al., 2020) or in a rural area during the pandemic (Henning-Smith, 2020). As food is frequently consumed in a social context (Sobal & Nelson, 2003), changes in social interactions due to physical distancing may influence dietary behaviors.

The economic impacts of the COVID-19 pandemic contributed to

significant increases in food insecurity among individuals living in the United States (US) (Wolfson & Leung, 2020a). Food insecurity, which is defined as limited or uncertain access to adequate food (Coleman-Jensen et al., 2019), is associated with multiple negative health outcomes including decreased diet quality, increased frequency of snacking, low and fair ratings of health, and increased risk for chronic disease (Gundersen & Seligman, 2015; Kral et al., 2017; Lee & Frongillo, 2001; Pooler et al., 2019). Among older adults (60 and older), food insecurity has increased significantly over the past ten years and is associated with loneliness, low social support, increased risk for chronic disease, and low diet quality (Burriss et al., 2021; Leddy et al., 2020; Leung & Wolfson, 2021). The rising rates of food insecurity combined with higher risk for severe COVID-19 associated with increasing age (U.S. Department of Health and Human Services, 2020) may have a disproportionate and detrimental effect on older adults. Thus, we take a lifespan perspective

* Corresponding author.

E-mail addresses: Alexandra.m.jackson@wsu.edu (A.M. Jackson), raven.weaver@wsu.edu (R.H. Weaver), Anaderi.iniguez@wsu.edu (A. Iniguez), janigan@wsu.edu (J. Lanigan).

¹ Present Address: Institute for Research and Education to Advance Community Health (IREACH), Washington State University, 1100 Olive Way, Suite 1200, Seattle, WA 98101.

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to describe the associations between social relationships and food insecurity as it relates to dietary behaviors during the COVID-19 pandemic.

Dietary behavior is an umbrella term including three main categories: dietary intake, food choice, and eating behavior (Stok et al., 2018). Each of these categories are influenced and shaped by the interplay of numerous, complex determinants that vary throughout the life course (Birch, 1999; Wethington, 2005). We focus on two aspects of dietary behaviors: diet quality and snacking. Diet quality includes the quality and variety of foods and beverages consumed (Wirt & Collins, 2009), is often measured as an index score, and is associated with a lower risk for chronic disease. We also include snacking. Though definitions vary, snacking can account for up to 20% of dietary intake (Johnson & Anderson, 2010; Leech et al., 2015). The content and nutrient density of snacks vary substantially and thus can have a positive or negative impact on dietary intake.

1.1. Social relationships and diet intake

Social relationships are structural and perceived. Structural social relationships represent the size of a social network, including whether individuals live with, are geographically distanced from, or have frequent social contact with others (Thoits, 2011). Perceived social relationships describe one's sense of social support and social connection with others. Social support is a subjective measure of the adequacy of support and may differ by the type of relationship, such as a friend, family member, or partner (Thoits, 2011; Zimet et al., 1988). Social connection is on the opposite side of a continuum with social isolation, and is defined as subjective feelings about social connections, support, or companionship (Hawthorne, 2006).

The influence of structural social relationships (i.e., living alone or with others) on dietary behavior in adulthood is complex. While the dietary intake of spouses is concordant across adulthood (Louk et al., 1999; Pachucki et al., 2011), living alone or being married/partnered does not appear to be protective against, or a risk factor for, diet quality overall. Rather, there are differences by sex, income level, cooking skill, and diet quality (Conklin et al., 2014; Hanna & Collins, 2015). However, living alone is a risk factor for malnutrition in older adults (Besora-Moreno et al., 2020).

Perceived social support and social connection may be associated with improved diet quality. Using a large national sample, Pieroth et al. (2017) found a positive relationship between social support and diet quality among men aged 40 years and older. Similarly, among older adults, lower social support was a significant factor for nutrition risk (using the Mini-Nutritional Assessment) (Romero-Ortuno et al., 2011) and higher social support was related to higher diet quality (Bloom, Edwards, et al., 2017). While social isolation was associated with a higher risk for malnutrition (Boulos et al., 2017; Landi et al., 2016; Payette et al., 1995), the relationship between social isolation and diet quality is less clear. However, several qualitative studies found eating with others is an important opportunity for social interaction and companionship in late life (Bloom, Lawrence, et al., 2017; Falk et al., 1996).

Assessing both structural and perceived social relationships can help to better understand how social relationships relate to dietary behaviors, as they may have differing effects on intake (Herman et al., 2003; Holt-Lunstad et al., 2015, 2017; Vesnaver & Keller, 2011). For example, natural opportunities for social interaction emerging from structural social relationships (e.g., living together) do not guarantee that individuals eat together in the household. For older adults who live alone, perceived social support outside the home can decrease some of the risks associated with living alone by increasing access to food or providing help preparing meals (Vesnaver & Keller, 2011). Thus, assessing both structural and perceived social relationships and their influence on dietary behavior across the lifespan is warranted.

1.2. Changes to social and economic contexts due to the COVID-19 pandemic

The contextual changes due to the pandemic have limited individuals' ability to engage in physical interaction outside of the home, decreased access to food, and potentially shifted food-related behaviors across the lifespan. A study conducted in early April and May found that 43% of Americans are eating healthier than prior to the COVID-19 pandemic (International Food Information Council, 2020b; 2020a). Similarly, several studies from Europe suggest that since physical distancing strategies were implemented, individuals increased diet quality and reduced consumption of unhealthy foods and snacking (Almandoz et al., 2020; Ammar et al., 2020a; Robinson et al., 2020; Rodríguez-Pérez et al., 2020; Sidor & Rzymiski, 2020). Alternatively, French adults increased energy intake and decreased diet quality compared to before the pandemic (Marty et al., 2020). Marty et al. (2020) suggested changes in diet quality may be related to food choice motivations of the individual; individuals who indicated an increased importance in weight loss increased diet quality, while an increased importance in mood, decreased quality. In Italy, when asked about eating behaviors during the pandemic, adults who reported lower quality personal relationships at phase one of the lockdown reported higher emotional eating in phase two (during reopening) (Cecchetto et al., 2021). Increases in food insecurity in the US, along with changes in dietary behaviors that correspond with differing motivations and social relationships (Wolfson & Leung, 2020a, 2020b), warrant additional research. To expand on these international findings and explore changes in the social and economic context of the pandemic, we use a mixed method approach to assess relationships between structural and perceived social relationships and diet intake (i.e., diet quality and snacking) across the adult lifespan among food secure and insecure individuals. We use mixed methods as it enables the synthesis and integration of the quantitative and qualitative strands of data into a cohesive meta-inference to provide a fuller understanding of structural and perceived social relationships and dietary behaviors across the lifespan and by food security status at the onset of the pandemic.

Our research questions are, during the COVID-19 pandemic:

1. How do structural and perceived social relationships relate to diet quality and snacking across adult life stages and by food security status?
2. How do changes in social relationships differ across adult life stages and by food security status?
3. How do changes in dietary behavior differ across adult life stages and by food security status?
4. What are the relationships between changes in social connection and changes in dietary behavior?

We used quantitative data to explore and describe the associations between social relationships and dietary behavior by food security status and life stage. We did not include a priori hypotheses as we were unsure of the impacts of the substantial disruptions related to the COVID-19 pandemic. Then, we used qualitative data to explore perceived changes in social relationships and dietary behavior across the adult lifespan and by food security status. Lastly, we integrate the quantitative and qualitative findings – comparing, contrasting, and building on the separate strands of data – into a meta-inference (Teddlie & Tashakkori, 2009). As the meta-inference includes the integration of findings from the quantitative and qualitative strands, we do not include a separate research question.

2. Methods

2.1. Participants and procedures

Adults age 18 years or older who spoke English and lived in the US

were recruited using Prolific Academic (Peer et al., 2017). Participants were compensated \$8.00 for the completion of a three-part survey, which is part of a larger study exploring the relationships between physical distancing and health behaviors during the pandemic (Weaver et al., 2021). A representative sample of 400 participants based on age, sex, and race/ethnicity completed the first part of the survey (Prolific Team, 2020). A total of 360 participants completed at least the first two parts of the survey and met the established criteria for accurate completion of attention checks. Data were collected between April 21 and May 6, 2020. This study was certified as Exempt by the Washington State University Institutional Review Board. All participants gave written informed consent prior to taking part in the study.

2.2. Quantitative measures

2.2.1. Diet outcomes of interest

Diet Quality. Diet quality was measured using the dietary screener questionnaire (DSQ), which was modified to assess intake over the past week (Thompson et al., 2017). No additional changes were made. Responses were converted to estimated intake of dietary components using the scoring procedures provided by the National Cancer Institute (Thompson et al., 2017). Individual nutrient intakes were then combined into an overall measure of diet quality that was constructed using mean intake from National Health and Nutrition Examination Survey (NHANES 2009–2010) for each dietary component by sex (Thompson et al., 2017). Participants received one point if their estimated intake of the following food items was equal to or above the mean intake for their sex: fruit, vegetables, whole grains, and calcium. Participants also received one point if their intake for added sugar was equal to or below the mean for their sex, or if they consumed less than one serving per week of processed meat (World Cancer Research Fund, 2018). Scores for each dietary component were summed to a measure of diet quality that ranged from 0 (lower diet quality) to 6 (higher diet quality). This process of calculating an overall measure of diet quality was based on scoring from previous publications (Horwath et al., 2019; Mötteli et al., 2017) (see [supplementary Table 1](#) for scoring procedures).

Unhealthy Snacking. Unhealthy snacking behavior was measured using a common single item assessment (Stok et al., 2015). It asks how frequently the participant consumed snacks, such as candy or chips each day. Response categories ranged from none to 4 or more per day.

2.2.2. Grouping variables

Demographic Data. Participants reported sociodemographic data including age, sex, race/ethnicity, education level, employment status, income, and employment location. Participants were categorized into three developmentally-based life stages: emerging (ages 18–29), middle (ages 30–59), and late adulthood (age 60+) (Arnett et al., 2014; Levinson, 1986).

Food Insecurity Status. Participants indicated if they had experienced food insecurity since the COVID-19 pandemic using the validated 2-item food insecurity screener (Hager et al., 2010). We identified participants as food insecure if they indicated at least one positive response (either often or sometimes true) for either of the two items.

2.2.3. Covariates

Structural Social Relationships. Structural social relationships were measured using the following indicators: geographic location and living alone. We dichotomized geographic location (living in a rural or non-rural area) and living alone (yes or no).

Perceived Social Relationships. The Multidimensional Scale of Perceived Social Support (Zimet et al., 1988) is a 12-item scale that measures social support from significant other, family, and friends (subscales). Participants provided responses on a 5-point scale (1 = strongly disagree to 5 = strongly agree). Previous research suggests good internal reliability, test-retest reliability, and construct validity (Zimet et al., 1988). We calculated a sum score for each subscale (overall scale

Cronbach's $\alpha = 0.94$).

The Friendship Scale (Hawthorne, 2006) was used to measure social isolation (low score) and social connection (high score). The 5-item scale included five response categories (0 = not at all to 4 = almost always) and was averaged for a total score. Psychometric testing indicates good internal reliability and validity among older adults (Hawthorne, 2006). Reliability of the scale ($\alpha = 0.69$) was acceptable, though lower than previous research ($\alpha = 0.83$) (Hawthorne, 2006).

2.3. Qualitative measures

Participants responded to two open-ended prompts: "What changes have you noticed in your ability to socially connect with others as a result of the social distancing recommendations or requirements?" and "Tell us how your eating behaviors have changed as a result of the COVID-19 pandemic."

2.4. Analysis

Data was collected using a parallel mixed methods design in which quantitative and qualitative data was collected at the same time (Teddlie & Tashakkori, 2009). We analyzed the data in parallel and prioritized the integration of quantitative and qualitative findings into a meta-inference, which can support a more detailed exploration of the relationship between changes in social relationships and intake than either approach alone (Teddlie & Tashakkori, 2009).

2.4.1. Quantitative analysis

Quantitative data was analyzed using SPSS® (SPSS, Version 26, Chicago IL). Descriptive statistics and bivariate correlations were generated for all variables and examined to evaluate distributions. A multivariate analysis of covariance (MANCOVA) followed by pairwise univariate tests were conducted to examine differences across life stage and food insecurity status on diet intake, controlling for measures of structural and perceived social relationships. Using a MANCOVA allowed for the analysis of two dependent variables (diet quality and unhealthy snacking) while accounting for structural and perceived relationships across life stage and food insecurity status. As participants could be grouped by both life stage and food insecurity status, we included the interaction between life stage and food insecurity status in our analysis. A p -value of .05 was used to indicate statistical significance and partial η^2 was used as the estimate of effect size.

2.4.2. Qualitative analysis

A summative content analysis was used to explore open-ended responses using Excel (Hsieh & Shannon, 2005). The first two authors and the last author reviewed responses from 340 cases. Participants who did not answer at least one of the open-ended questions ($n = 20$) were excluded from the analysis. After the initial review, the same three authors developed a coding taxonomy including codes and categories indicating the direction of change (e.g., increased, decreased, compensatory, no change, or not applicable) for social connection and dietary behaviors.

To explore changes in social connection, we coded responses to the following open-ended question: "What changes have you noticed in your ability to socially connect with others as a result of the social distancing recommendations or requirements?" Five types of changes in social connection were evident and coded as: frequency, quality, time, support, and method of communication. Then, we assessed overall change in social connection; designation of change was mutually exclusive. Responses were coded as an increase in social connection if the participant described an increase in social connection, support, quality, or importance of connection. Responses were coded as a decrease in social connection if the participant indicated a decrease in the ability, quality, frequency, or type (e.g., in-person) connection. A response was coded as a compensatory change in social connection if participants mentioned

transitioning to online communication or substituting a new mechanism of interaction to compensate for changing circumstances. A response was coded as no change if the participant described no changes in social interaction since the COVID-19 pandemic. Lastly, if the response was unclear or was ambiguous in describing change, we coded the response as not applicable. For parsimony, we focused on participant's overall change in social connection in the current analysis.

To explore changes in eating behaviors, we coded responses to the following open-ended question: "Tell us how your eating behaviors have changed as a result of the COVID-19 pandemic." Twenty-three types of change in eating behavior were described, reflecting a variety of experiences. To support interpretation, we grouped these codes into five general domains of change: access or availability, intake, context of consumption, emotion, and social interactions while eating. Responses in these domains of change were coded as increased, decreased, compensatory, no change, or not applicable. Designation of change was not mutually exclusive. The type of change was defined with parallel meaning as used with social connection. However, when responses were ambiguous, they were coded as compensatory. For example, if the participant indicated a change in behavior since the pandemic, yet it was unclear if it was an increase or decrease in the behavior or if the participant mentioned an increase and a decrease in the behavior (e.g., "Never getting fresh groceries or the occasional fast food changes my diet a little but not that different most of the time.").

The first and third author independently coded each case using the taxonomy and met regularly to discuss the application of the coding taxonomy. Coding spreadsheets were reviewed regularly for discrepancies. All discrepancies were reviewed and discussed. If agreement was not met between the two authors, the discrepancy was discussed with the second author until 100% agreement was achieved.

The first and second author began analysis by assessing changes in social connection across adult life stages and by food security status. Then, we used summative content analysis to count the frequency of directional change to identify patterns within the sample. To explore changes in dietary behaviors, first we explored changes in dietary behaviors in the overall sample, followed by across adult life stage and by food security status. Then, we compared the percentage of responses by life stage and food security status using chi-square analyses (Morse, 2005). Next, we identified if participants mentioned changes in social connection when describing changes in eating behaviors. Lastly, we conducted an exploratory analysis of the relationship between changes in social connection and changes in dietary behaviors.

2.4.3. Meta-inference

The quantitative and qualitative findings were integrated into a meta-inference describing the relationships between structural and perceived social relationships and diet intake across the adult life span and dependent on food insecurity status during the COVID-19 pandemic. We integrated the findings from both strands of data into a meta-inference with a specific focus on comparing the findings from each strand and integrative efficacy (Creswell & Plano Clark, 2018; Teddlie & Tashakkori, 2009). The integration of the strands can provide insight through confirming, disconfirming and building on one another, making additional meaningful conclusions that add to the confidence, credibility, or inferential validity of the findings (Creswell & Plano Clark, 2018; Teddlie & Tashakkori, 2009).

3. Results

3.1. Quantitative results

Sociodemographic and diet characteristics of the sample are presented in Table 1. Nearly 40% of participants reported food insecurity and over 60% of participants scored a 2 or lower on the 6-point scale of diet quality. Bivariate correlations indicated life stage had significant, positive correlations with living alone, family support, and social

Table 1
Demographic data.

Variable	n (%)
Sex	
Male	173 (48.1)
Female	184 (51.1)
Life stage	
Emerging	77 (21.4)
Middle	189 (52.6)
Late	93 (25.9)
Geographic Location	
Urban	81 (22.5)
Suburban	172 (47.8)
Mid-size city or Town	36 (10.0)
Rural	71 (19.7)
Household Size	
Living alone	70 (19.4)
Living with others	290 (80.6)
Race/Ethnicity	
White	247 (68.6)
Hispanic or Latino	20 (5.6)
Asian	27 (7.5)
Black	43 (11.9)
Other	22 (6.1)
Education	
≤4-year degree	186 (51.7)
≥4-year degree	174 (48.3)
Household Income	
<\$35,000/year	108 (30.3)
\$35,000–51,999	79 (22.1)
\$52,000–73,999	66 (18.5)
\$74,000–99,999	52 (14.6)
Over \$100,000	49 (13.7)
Employment Status	
Unemployed or furloughed	79 (22.1)
Part-time	66 (18.5)
Full-time	120 (33.6)
Not seeking work	89 (24.9)
Employment Location	
At home or a private office	156 (43.7)
At a location with frequent in-person interactions	41 (11.5)
Other	160 (44.8)
Food Insecurity	
Food Secure	220 (61.1)
Food Insecure	140 (38.9)
Diet Quality	
0	26 (8.3)
1	61 (19.6)
2	104 (33.3)
3	77 (24.7)
4	38 (12.2)
5	4 (1.3)
6	2 (0.6)
Snacks per day	
None	19 (5.3)
Less than 1 per day	93 (25.8)
1 per day	95 (26.4)
2 per day	85 (23.6)
3 per day	46 (12.8)
4 per day	13 (3.6)
More than 4 per day	9 (2.5)

connection. Food insecurity had significant, negative correlations with support from significant other and social connection. Diet quality had significant, positive correlations with total support, family support, and friend support. Frequency of unhealthy snacking had significant, negative correlations with living alone and diet quality. See Table 2 for more information.

The MANCOVA indicated a significant interaction of life stage and food insecurity status $F(4,598) = 2.71, p = .03$ multivariate $\eta^2 = 0.02$ on diet quality and unhealthy snacking frequency. A comparison of adjusted means (see Table 3) indicated food insecure individuals in emerging and late adulthood had lower diet quality (Fig. 1). Unhealthy snacking frequency was highest among food insecure emerging adults but declined among food insecure middle-age and older adults. Among

Table 2
Correlation matrix: Structural and perceived social support, food insecurity, diet quality, and snacking.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Life Stage	–									
2. Food Insecurity ^a	.04	–								
3. Living Alone ^a	.19**	.04	–							
4. Rural ^a	.08	.06	-.05	–						
5. Support Total	.10	-.09	-.21**	-.04	–					
6. Family Support	.17**	-.05	-.21**	-.02	.85**	–				
7. Significant Other Support	.09	-.14*	-.26**	-.07	.87**	.60**	–			
8. Friend Support	.02	-.05	-.03	-.03	.82**	.55**	.56**	–		
9. Social Connection	.26**	-.20**	-.11*	.01	.57**	.48**	.53**	.43**	–	
10. Diet Quality	.05	-.09	.02	.02	.18**	.15**	.10	.20**	.08	–
11. Unhealthy Snacking	-.10	-.05	-.11*	.01	-.02	-.03	.02	-.06	-.04	-.21**

^a Spearman’s Rho Correlation. * $p < .05$. ** $p < .01$.

Table 3
Adjusted Means for Diet Quality and Unhealthy Snacking Frequency Across Life stage and Food Insecurity.

	Emerging Adulthood		Middle Adulthood		Late Adulthood	
	Food Secure Adjusted M (SE) (n = 48)	Food Insecure Adjusted M (SE) (n = 20)	Food Secure Adjusted M (SE) (n = 86)	Food Insecure Adjusted M (SE) (n = 65)	Food Secure Adjusted M (SE) (n = 61)	Food Insecure Adjusted M (SE) (n = 31)
Diet Quality	2.11 (.17)	1.81 (.28)	2.31 (.13)	2.26 (.15) ^a	2.42 (.16)	1.74 (.21) ^a
Snacking Frequency	2.34 (.20)	3.11 (.31) ^{b,c}	2.47 (.14)	2.10 (.17) ^b	2.16 (.17)	2.11 (.24) ^c

^a $p = .046$.
^b $p = .004$.
^c $p = .013$.

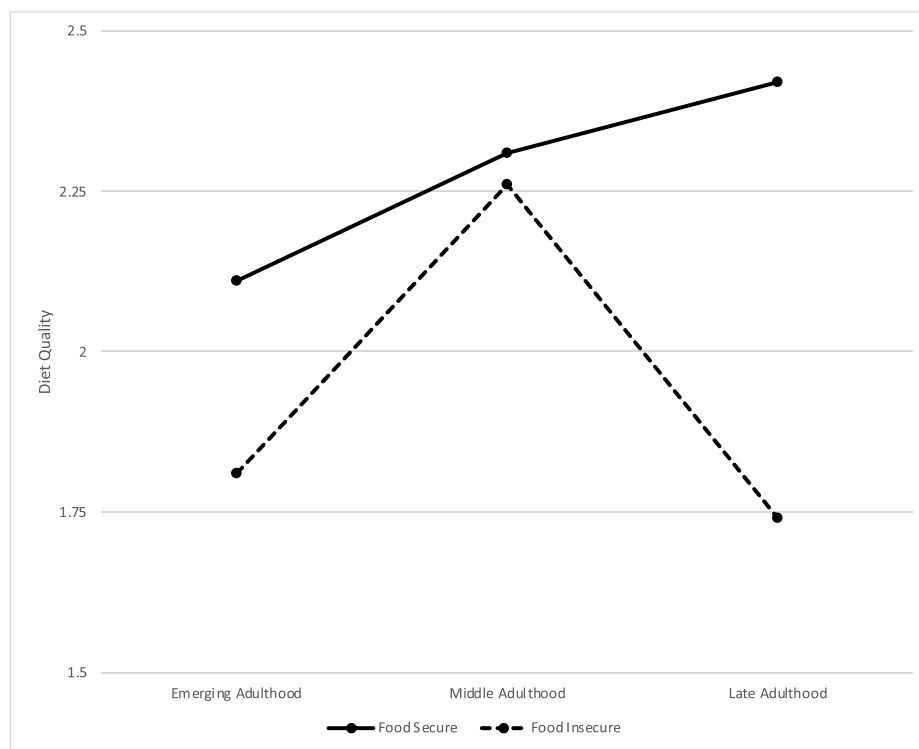


Fig. 1. Adjusted means for diet quality by food insecurity status and life stage.

food secure adults, frequency of unhealthy snacking was highest among food secure middle-age adults and declined among older adults (Fig. 2). Post hoc analyses for structural and perceived social support on diet quality indicated that friend support [$F(1,299) = 6.99, p = .009$, partial $\eta^2 = 0.02$] and food insecurity [$F(1,299) = 5.03, p = .03$ partial $\eta^2 = 0.02$] were the only two indicators significantly associated with diet quality (supplementary Table 2). For frequency of unhealthy snacking,

the interaction between life stage and food insecurity status [$F(2,299) = 3.66, p = .03$ partial $\eta^2 = 0.02$] was significantly associated with frequency of unhealthy snacking (see supplementary Table 3).

3.2. Qualitative results

More than one-third ($n = 127, 38\%$) of participants indicated a

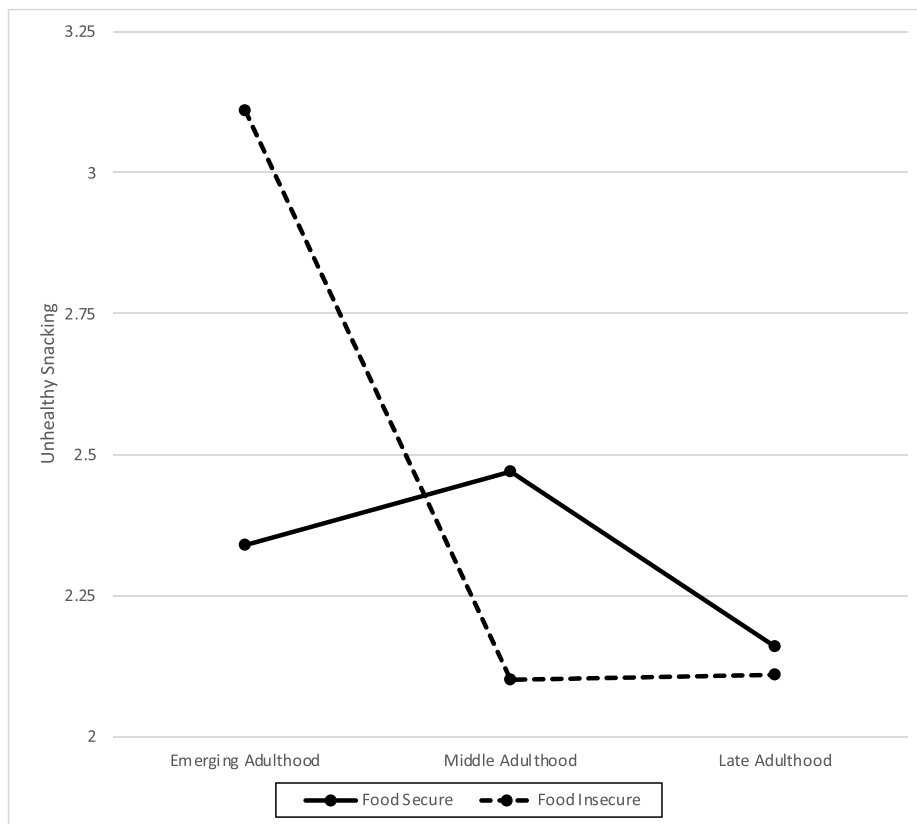


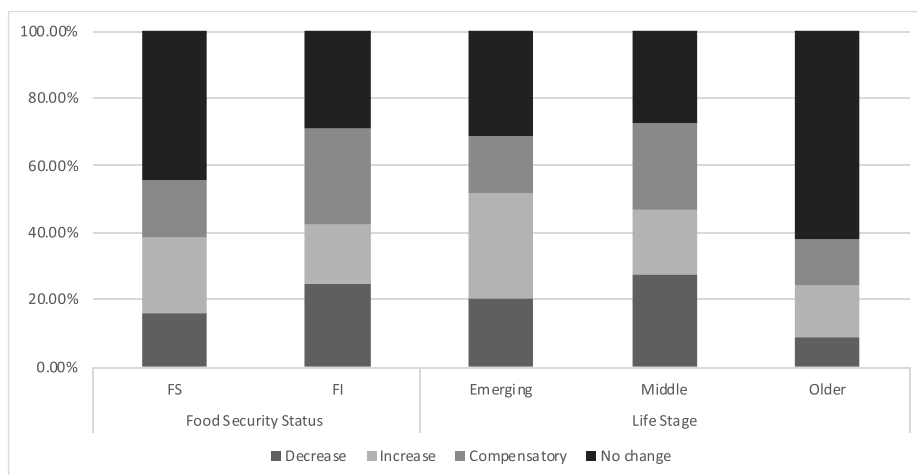
Fig. 2. Adjusted means for unhealthy snacking by food insecurity status and life stage.

decrease in overall social connection since the COVID-19 pandemic. Almost 30% (n = 96) of participants indicated a compensatory change, 11% (n = 35) indicated an increase in social connection, and 22% (n = 74) indicated no change. Seven responses were unclear or ambiguous in describing overall change in social connection (e.g., "I am withdrawn."). Chi-square tests were not significant indicating percentages remained similar when stratified by life stage or food security status (see [supplementary Table 4](#)).

In exploring changes in dietary behavior, 54% (n = 178) of participants described a change in intake, and 44% (n = 148) described a change in access or availability, 42% (n = 142) described a change in contextual aspects of consumption, and 12% (n = 39) described a

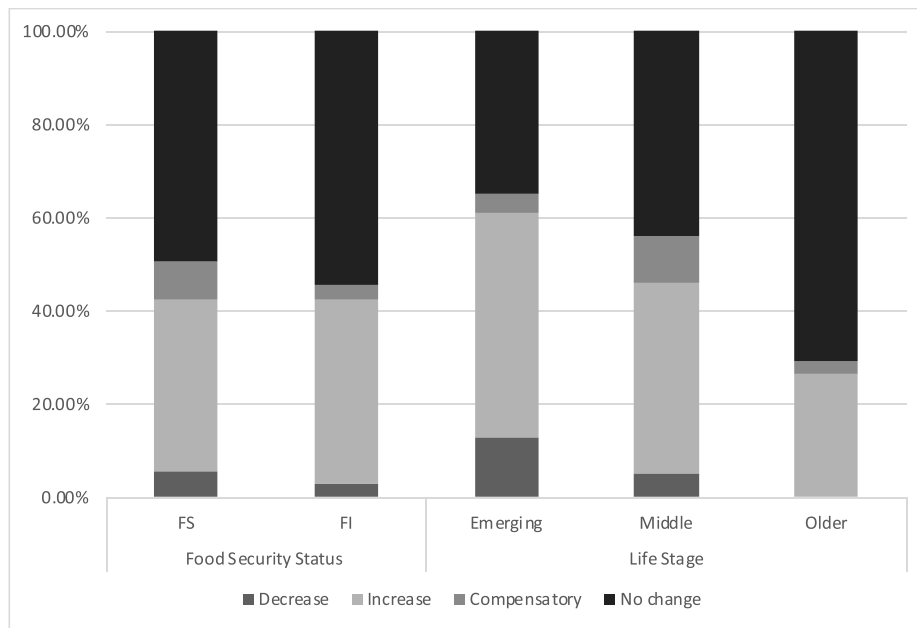
change in emotional eating. Less than 1% (n = 3) described a change in social interactions while eating; these participants were all in middle adulthood and reported increases in family meals. Regarding changes in structural social relationships, one participant indicated a change in location to a rural area and one participant mentioned living alone. Changes in intake were prevalent among food insecure (52%; n = 68) and emerging adults (63%; n = 43).

To disentangle the quantitative results, we focused on changes in diet quality and frequency of snacking by life stage and food security status. We were unable to assess the nutrition quality of the snacks consumed from the qualitative data, thus we were unable to differentiate between changes in healthy or unhealthy snacking. [Figs. 3 and 4](#) show the



Note. FS = Food secure; FI = Food insecure

Fig. 3. Percentage of Responses Indicating Change in Quality of Intake by Food Security Status and Life Stage. Note. FS = Food secure; FI = Food insecure.



Note. FS = Food secure; FI = Food insecure

Fig. 4. Percentage of Responses Indicating Change in Frequency of Snacking by Food Security Status and Life Stage. Note. FS = Food secure; FI = Food insecure.

percentages of changes in quality and snacking. Table 4 includes exemplar quotes for each type of change across the life stage and by food security status. When the codes were subsequently analyzed

quantitatively using chi-square tests, differences by food security status were not statistically significant; however, there was a significant difference in diet quality ($p = .004$) and snacking ($p = .03$) by life stage.

Table 4

Participant quotations of changes in diet quality and snacking frequency across life stage and by food security status.

Change in diet quality	Food security status		Life stage		
	Food secure (n = 101)	Food insecure (n = 53)	Emerging adult (n = 29)	Middle adulthood (n = 83)	Older adult (n = 45)
Increased (n = 32)	(n = 23; 23%) <i>I have recently started dieting and eating healthy foods since I cannot engage in exercise as much as I would like to.</i>	(n = 9; 17%) <i>I'm eating more home cooked meals and healthy snacks, because junk food and takeout is more difficult to obtain.</i>	(n = 9; 31%) <i>I know I've snacked a bit more than usual, but I've also been trying to eat more healthier foods.</i>	(n = 16; 19%) <i>I have been eating far more fresh fruit and vegetables and a lot less meat and dairy.</i>	(n = 7; 16%) <i>I feel I am eating healthier as a result of the COVID-19 pandemic. I have more time and energy to prepare healthy food since I'm working from home and sheltering in place.</i>
Decreased (n = 33)	(n = 16; 16%) <i>Don't have the motivation to eat healthy.</i>	(n = 14; 26%) <i>I find it hard to find good healthy food.</i>	(n = 6; 21%) <i>I find that I'm eating less nutritious foods because I'm going to the store less frequently, and fresh foods have less stable shelf lives.</i>	(n = 23; 28%) <i>We're relying a lot more on processed foods mainly pastas and junkier kinds of quick heat meals.</i>	(n = 4; 9%) <i>I am finding it harder to get healthy foods to eat.</i>
Change in snacking frequency	Food secure (n = 87)	Food insecure (n = 33)	Emerging adult (n = 23)	Middle adulthood (n = 59)	Older adult (n = 28)
Increased (n = 45)	(n = 32; 37%) <i>I'm snacking a little more, because I'm home with very little to do.</i>	(n = 13; 39%) <i>I have more "down" time that sometimes I find myself snacking.</i>	(n = 11; 48%) <i>Eating more meals; more snacks too.</i>	(n = 24; 41%) <i>I'm eating at home more, and during the day I'm trolling the kitchen a bit more for a granola bar or something.</i>	(n = 10; 26%) <i>I find myself snacking far more and not eating balanced meals.</i>
Decreased (n = 6)	(n = 5; 6%) <i>I eat more per meal daily, but eat less snacks daily. However, if you look at it weekly, it has not changed since I eat way more one day, and way less one day.</i>	(n = 1; 3%) <i>I'm really not snacking almost at all and I used to snack a lot and I used to eat a lot of sweets now what I'm in the store I'm so focused on getting what I need for meals that I don't even think about going to get any kind of chips or candy. If I don't have them I don't eat them because there's no more running to the store on a whim</i>	(n = 3; 13%) <i>I used to eat a lot of snacks and candies. Now, I don't think it's worth the money or safety (spending more time in a grocery store) to get as much as I did. If I do get something or make a snack at home with what I have, I will eat it. Though, the quantity is little.</i>	(n = 3; 5%) <i>I am more productive, and that keeps me from snacking.</i>	(n = 0)

Note. For parsimony we include responses of increased or decreased diet quality or frequency of intake. Percentages reported are calculated based on the number of participants who mentioned changes in diet quality or snacking for each category (listed as the total n in each respective row).

These findings illuminate the qualitative results further.

We did not identify many substantial differences between change in social connection and change in dietary behavior, which we attribute to the variety of responses about changes in dietary behaviors. However, based on the recent findings that suggest lower quality social relationships were associated with emotional eating during the pandemic (Cecchetto et al., 2021), we explored the connection between change in emotional eating and changes in social connection. Of the 39 participants who indicated an increase in emotional eating, all but one (97%, $n = 38$) indicated a decrease or compensatory change in social connection since the pandemic. Of the 296 participants who did not describe a change in emotional eating, the following changes in social connection were reported: 35% ($n = 103$) decreased; 24% ($n = 70$) no change; 30% ($n = 89$) compensatory; and 11% ($n = 32$) increased. Using chi-square tests, there was a significant difference in changes in social connection ($p < .001$) by emotional eating during the pandemic.

3.3. Meta-inference

Taken together, quantitative analyses indicate food insecure emerging and older adults may be at highest risk for low diet quality. Qualitative findings suggest most adults reported decreases in social connection and changes in aspects of dietary behavior since the pandemic. The frequency of reported changes in social connection and dietary behavior did not differ across food security status. Diet quality and snacking differed by life stage. Mirroring the quantitative data, changes in intake were prevalent among food insecure and emerging adults. Emerging adults were more likely to report increases in frequency of snacking, though we were unable to assess the nutrition quality of the snacks consumed. Nearly all participants who reported increased emotional eating also reported decreased or compensatory changes in social connection. The quantitative and qualitative data indicate food insecurity, emerging and late adulthood are relevant risk factors during the pandemic. Conversely, increases in social connection, including support from friends, may be protective factors to promote healthier dietary behaviors and may reduce emotional eating.

4. Conclusions

In the US, the COVID-19 pandemic has led to substantial social and economic impacts, which have influenced dietary behaviors. Our results provide additional evidence of increased rates of food insecurity during the COVID-19 pandemic (Wolfson & Leung, 2020a) and suggest, experiencing food insecurity during emerging and late adulthood may have a significant negative impact on diet quality. We found that nearly 40% of participants experienced food insecurity in April 2020, which is significantly higher compared to the 10.5% reported from a nationally representative sample in 2019 (Coleman-Jensen et al., 2019). Reducing food insecurity must be a priority. Notably, diet quality in this sample was well below the national average. Only 39% of participants met or exceeded the national average intake of three or more foods or nutrients; only two participants met or exceeded the national average of all foods or nutrients.

Social support may be an important mechanism to promote diet quality and could reduce food insecurity. Previous research among older adults demonstrated the importance of having an established support system to reduce food insecurity (Burris et al., 2021). We also identified that social support from friends was associated with improved diet quality. These findings, along with a substantial number of participants reporting declines in social connection since the pandemic, indicate an important opportunity for intervention.

Our quantitative results indicate food insecure emerging adults consumed unhealthy snacks frequently, which was also mirrored in the qualitative findings with high rates of increased snacking (of unknown quality). Therefore, increases in unhealthy snacking during the pandemic, coupled with already rising rates of snacking prior to the

pandemic, highlight another key area for intervention to promote diet quality (Dunford & Popkin, 2017). While previous research during the pandemic indicates both increases and decreases in snacking (Ammar et al., 2020; Larson et al., 2021; Robinson et al., 2020), our qualitative findings suggest increased snacking and offer more nuance about frequency of snacks across the lifespan and by food security status. That is, emerging adulthood and food insecure adults may be important populations to consider targeting for health promotion interventions after the pandemic.

Food secure adults may be better positioned to increase diet quality and thus improve their health during and emerging from the pandemic. Alternatively, food insecure adults may have been focused on obtaining food (as highlighted in the quotes included in Table 4), hindering their ability to improve diet quality. The differing experiences of managing healthy intake during the pandemic, combined with previous research indicating associations of food insecurity with multiple negative health outcomes (Gundersen & Seligman, 2015; Lee & Frongillo, 2001; Pooler et al., 2019), and rising rates of food insecurity, suggest the pandemic will continue to exacerbate inequalities in health behaviors among vulnerable populations. Our findings help to explain why health was not a significant motivator for diet quality during the pandemic (Marty et al., 2020). Health as a motivator for consumption may only be appropriate among food secure adults because food insecure adults may be focused on managing scarcity.

Interestingly, we did not identify an impact of structural social relationships (e.g., living alone or living in a rural area) on dietary behaviors; structural social relationships were not a significant theme in the qualitative data, either. We speculate that geographic location may have been less relevant at the onset of the COVID-19 pandemic, as many states were in the height of implementing physical distancing restrictions when we collected data. While living alone was not significantly related to diet quality, living alone was negatively correlated with perceived social support and decreased snacking. As the pandemic evolves, it will be important to assess changes in these factors, as well as the relationship between living alone and other health-related behaviors.

Lastly, our findings continue to build on research indicating an important relationship between social connection and emotional eating during the pandemic (Cecchetto et al., 2021). Based on these findings, the profound, negative changes in social connection due to physical distancing may have substantial long-term effects on dietary behaviors. As strategies to mitigate the spread of COVID-19 evolve, continuing to assess changes in social relationships and emotional eating could help to understand this link.

5. Strengths and limitations

Strengths of this research include the use of attention checks to ensure data quality and validated measures to assess diet quality, food insecurity, and perceived social relationships. We collected data from a nationally representative (by age, sex, and race/ethnicity) population during the peak of social distancing recommendations in the US. Our modest sample size allowed us to detect differences between food secure and insecure adults. However, we were unable to explore differences by race/ethnicity due to small sample sizes. Using a mixed method study design and analytic approach allowed for a more nuanced and holistic investigating of the relationships between social relationships and food insecurity on dietary behaviors. Similarly, taking a lifespan approach enabled us to identify potential risk and resilience across life stages. Limitations of this research include the use of a cross-sectional survey, which means we cannot determine causation. In addition, all data were self-reported. To minimize participant burden, we used a dietary screener that did not assess portion size. While the dietary screener was validated in adults younger than 69 years old (Thompson et al., 2017), this screener has been used in other large samples with participants who are older than 69 years old (Shelton et al., 2021; Xu et al., 2021). Due to

the measure used to assess frequency of unhealthy snacking, we did not capture nutrient density of snacks. Qualitative data was derived from written responses to two open-ended questions. While these questions allowed participants to share what may have been the most relevant changes and offered additional insight into the changes participants experienced, the questions elicited a variety of responses. Due to the nature of using a survey tool for data collection, we were unable to ask follow-up questions or request clarification about their responses. Lastly, the qualitative data was coded by authors who were not blinded to the study hypotheses.

6. Future research

As the COVID-19 pandemic evolves, longitudinal research is necessary to understand the long-term impacts of social changes and food insecurity on dietary behaviors across the lifespan. Our results indicate the COVID-19 pandemic may exacerbate inequalities in health, particularly among food insecure, emerging, and older adults. Thus, the continued exploration of the effects of food insecurity during the pandemic, as well as other measures of economic change (e.g., unemployment, financial wellness) and their influence on dietary behaviors is warranted. In addition to the implementation and dissemination of programs that reduce food insecurity, we suggest continuing to investigate aspects of social support to promote health behaviors during the COVID-19 pandemic.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2021.105717>.

Author contributions

AMJ, RHW and JL designed the study and were responsible for data collection. AMJ, RHW, and AI analyzed the data. All authors participated in writing the paper, and all authors read and approved the final manuscript.

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