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ORIGINAL ARTICLE

A cross-sectional assessment of food practices, physical activity levels, and stress levels in middle age and older adults' during the COVID-19 pandemic

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Abstract

Aim This cross-sectional study examined how the COVID-19 pandemic impacted the food practices, physical activity (PA) levels, and stress levels of aging adults ages 40 years and older from seven states. It also explored to what extent the COVID-19 outcomes were affected by the social determinants of health (SDH).

Subject and methods Respondents ($n = 1250$) completed an online survey. Descriptive statistics were used to analyze the sociodemographic attributes and COVID-19 responses while the multiple llinear regression (MLR) test evaluated to what extent the SDH variables measured were associated with the reported COVID-19 impacts food practices, PA levels, and stress levels.

Results Respondents were mostly White (75.9%), married (58.7%), age 60 years and older (61.8%), with a high school education or higher (97.4%). Most of the respondents (85.8%) live in areas that respondents perceived as supportive of health and well-being opportunities for older adults. Nearly one-half of the respondents reported maintaining their pre-pandemic grocery shopping/food buying frequency (44.7%) and PA levels (48.1%). However, 48.6% reported being "somewhat or very stressed" due to the pandemic. Findings revealed that the COVID-19 impacts on food-buying, PA levels, and stress levels were significantly influenced by age, gender, race, education, location, community, nutritional risk, quality of life, food security, and income ($p < 0.05$).

Conclusion These findings provide valuable information as we continue to confront the impact the COVID-19 pandemic has had on the health and well-being of aging adults. We can use this information to inform future public health programming interventions and opportunities.

Keywords Aging adults · COVID-19 · Food · Stress · Physical activity

Introduction

An ongoing public health concern for aging adults is the novel coronavirus disease, COVID-19. Understanding the pandemic's impact on the food practices, physical activity levels, and stress levels of community-residing adults ages 40 years and older is critical so that health and wellness agencies can address these challenges through community-based resources and interventions. In doing so, they will help support healthy aging during and following a global pandemic. Many of the mitigation measures (e.g., social distancing, stay-at-home orders, mask-mandates (World Health Organization 2020; The New York Times 2020) presented several challenges to aging adults, including food procurement (Wolfson et al. 2020), physical activity (Campbell

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2020), and social and emotional well-being (Pearman et al. 2021; Steinman et al. 2020).

The pandemic uncovered the vulnerability of global food supply chains given the adverse impacts on the food supply and food access (O'Hara and Toussaint 2021). This was further exacerbated by panic buying due to the fear of foods increasing in price and necessities running out (Arafat et al. 2021). While older adults across all races experienced a rise in food insecurity during the pandemic, older adults who were Black or Hispanic had the most substantial rise (Ashbrook 2020; Henning-Smith 2020). Food insecurity poses a risk for developing psychological distress, depression, anxiety, and stress (Rivan et al. 2021; Jones 2017; Gyasi et al. 2020; Frith and Loprinzi 2018). The pandemic also led to an expanded utilization of online grocery purchasing (Redman 2020; Morgan 2021), E-shopping and infrequent shopping became more regular, while takeaway and home food delivery became an alternative to dining in restaurants (Poelman et al. 2021; Bakalis et al. 2020).

The COVID-19 pandemic is also associated with an increase in energy intake and a decrease in nutritional quality (Marty et al. 2021; Bahl et al. 2021; Sidor and Rzymski 2020; Buckland et al. 2021). Similarly, physical activity was also negatively impacted during the early part of the pandemic (Dunton et al. 2020; Bahl et al. 2021; Visser et al. 2020; Staff 2020). Moreover, the vulnerability of older adults to COVID-19 infection places them at higher risk of anxiety, and subsequently higher stress, thereby leading to a negative impact on health and well-being (Pearman et al. 2021; Steinman et al. 2020).

It is vital for health professionals to be able to provide timely and relevant needs-based health information to community-residing aging adults. Understanding the food, physical activity, and general health needs and preferences of aging adults can help inform the future direction of community-based nutrition and wellness interventions and educational opportunities. Determining how these pandemic-related health outcomes, including food purchasing, physical activity, and stress, are impacted by the social determinants of health (SDH) is important when developing health interventions. The SDH is comprises five constructs, including education access and quality, health care access and quality, neighborhood and built environment, social and community context, and economic stability (Fig. 1; Office of Disease Prevention and Health Promotion n.d.). Each construct plays an integral

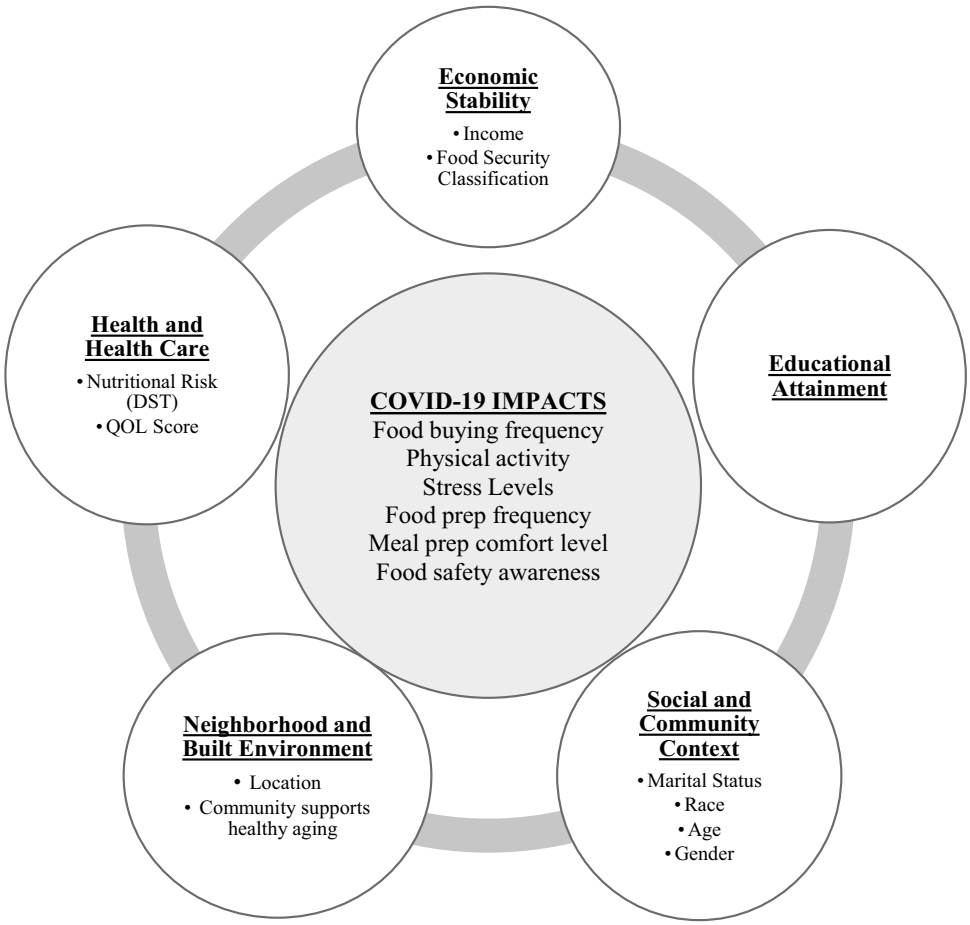

Fig. 1 Social determinants of health influence on COVID-19 impacts

part in how one responds to a health crisis such as a global pandemic.

The purpose of this cross-sectional study was twofold. First, the study examined how the COVID-19 pandemic impacted the food practices, physical activity levels, and stress levels of adults ages 40 years and older. Second, the study explored to what extent the SDH affected the COVID-19 outcomes.

Methods

Participants

This online cross-sectional survey study was conducted through Qualtrics™ from late September 2020 to early November 2020 among adults ages 40 years and older living in six states (Iowa, Illinois, Maryland, Rhode Island, South Dakota, and West Virginia) and Washington DC. These states were selected because they are part of the Iowa State University. Respondents had to be able to read, understand and answer the survey questions, have internet access, and be on one of the market research panels contracted with Qualtrics™ at the time of the study. Based on Qualtrics™ protocols, panel managers randomly chose participants based on the probability of being qualified for the study. To ensure a representative sample of respondents, we oversampled based on age (goal 70% ages 51 to 74 years) and race (goal 40% Black, Indigenous, and Persons of Color [BIPOC] based on census data) (US Census Bureau 2019). In addition, we limited the percentage of Illinois participants from the Chicagoland area to 30% (based on zip codes) to ensure feedback from both rural and urban areas of Illinois. The survey was completed by 1250 respondents. This study was reviewed and deemed exempt by the Iowa State University Institutional Review Board.

Survey

The survey comprised 142 questions addressing sociodemographic attributes, COVID-19 pandemic impact, aging anxiety, nutrition and wellness programming needs, general health, food behaviors, food security, nutritional risk, nutrition and food safety knowledge, physical activity participation, and quality of life (QOL). Various validated and reliable survey tools were used to compile this comprehensive survey. The sociodemographic questions were identified based on the SDH construct they addressed (Fig. 1). Herein, we will explore only the responses to the nine COVID-19 pandemic-related questions and sociodemographic attributes.

The COVID-19 pandemic impact questions focused on food, physical activity, and stress as these topics were emerging as leading issues at the start of the pandemic. These questions were reviewed for face validity by the research team. The questions included grocery shopping frequency, type of food purchased, food procurement, food preparation, eating out frequency, food safety awareness, physical activity level, and stress level. Using five-point Likert scales, respondents rated their pandemic-related grocery shopping frequency (1=shopped much more frequently, 5=shopped much less frequently), physical activity levels (1=a lot less physically active, 5=a lot more physically active), stress levels (1=not at all stressed, 5=very stressed) food preparation (1=much more frequently, 5=much less frequently), and food preparation comfort level (1=extremely comfortable, 5=extremely uncomfortable). Finally, respondents rated their food safety guidelines awareness using a three-point Likert scare (1=increased a lot, 2=increased somewhat, 3=stayed the same).

Nutritional risk

Nutritional risk was assessed via the Dietary Screening Tool (DST) (Bailey et al. 2007, 2009; Marra et al. 2018). It is a validated screening tool used to evaluate middle-aged and older adults' nutritional risk and dietary intake frequencies (Bailey et al. 2007, 2009). The DST is made up of 25 questions based on dietary intake frequencies during the past 30 days. Participants rated their frequency of consumption in fruit, vegetables, whole grains, lean proteins, added fats and sugars, dairy, processed meats, and supplement use (Bailey et al. 2007, 2009). Total scores totaling 0–100 points were calculated using the DST scoring algorithm (Bailey et al. 2007, 2009). Total scores were categorized into three nutrition risk groups: "at risk" (DST scores <60), "possible risk" (DST scores 60 to 75), and "not at risk" (DST scores >75) (Bailey et al. 2007, 2009).

Food safety adherence

Ten questions related to food safety practices were asked to determine participants' food safety adherence (University of Hawaii Cooperative Extension Service 2006). Respondents answered each question by choosing one of three choices: "yes, all the time" (1 point), "sometimes" (0.5 points), and "no, never" (0 points). All points were tallied for a maximum of 10 points. Total scores were only available for respondents who completed all 10 food safety questions. Food safety adherence was categorized as low (0 to 3 points), moderate (3.5 to 6.5 points), and high (7 to 10 points).

Quality of life

The seven-question Global Health Patient-Reported Outcomes Measurement Information System (PROMIS) scale was used to assess participants' quality of life (QOL) (Hays et al. 2009). Respondents rated their pre-pandemic health, QOL, physical health, mental health, social activities and relationship satisfaction, ability to conduct daily activities, and ability to carry out physical activities via a 5-point Likert scale (1=poor, 5=excellent). The points for each question were totaled; the maximum possible score was 35.

Food security

Respondents' food security status was assessed using the Six-Item Food Security Module (USDA ERS 2012). The maximum score was 6 with three classifications: high or marginal food security (0–1 points), low food security (2–4 points), very low food security (5–6 points).

Physical activity attitudes

Respondents' physical activity attitudes were measured using six theory of planned behavior questions (3 affective attitude questions, 3 instrumental attitude questions) (Ajzen 1991. Affective attitude refers to emotions and increases the likelihood of performing a behavior while instrumental attitude refers to the cognitive consideration of advantages in performing a behavior (French et al. 2005; Breckler and Wiggins 1989). The affective attitude beliefs questions inquired respondents about their enjoyment in the behavior, while instrumental-type questions focused on the advantages and disadvantages of performing the behavior (French et al. 2005). For this study, respondents were asked to rate whether participating in regular physical activity would be useful/useless, healthy/unhealthy, and good/bad to determine their instrumental attitudes. Respondents also rated if participating in regular physical activity would be enjoyable/unenjoyable, interesting/boring, and pleasant/unpleasant to determine their affective attitudes. Each question was presented using a 7-point Likert-scale question (1=positive option, 7=negative option). Total scores were calculated for each participant with a lower score reflecting positive attitudes (minimum=6 points, maximum=42 points).

Data collection

Survey distribution and data collection were managed by Qualtrics™. The majority of Qualtrics'™ samples are from traditional, actively managed market research panels. There were 1301 total responses collected. However, only 1250 responses were identified by Qualtrics™ as "good completes" meaning they met the screening criteria and quotas and passed a quality check. Those who were excluded (n=51) were determined by Qualtrics™ to have either failed the screening criteria, exceeded our quotas, straight lined through the survey, or finished in less than one-third of the average completion time. Thus, data analyses were performed using these 1250 responses.

Data analysis

Statistical analyses were conducted using IBM SPSS Statistics, version 26.0. Descriptive statistics were used to analyze the sociodemographic attributes and COVID-19 responses. The multiple logistic regression (MLR) and one-way analysis of variance (ANOVA) tests were used to evaluate to what extent the SDH variables measured were associated with the reported COVID-19 impacts for grocery buying frequency, physical activity, stress levels, food preparation frequency, food preparation comfort level, and food safety awareness (Fig. 1). The findings from the MLR and one-way ANOVA were almost identical. Thus, the MLR analyses are presented as they provide odds ratio for each subcategory. For the MLR analyses, the COVID-19 Likert scale data were recategorized into fewer variables: grocery shopping was recategorized into "much more" (much more or somewhat more), no change, and "much less frequently" (somewhat and much less); physical activity as "much less" (much less and somewhat less), no change and "much more active" (somewhat more and a lot more); stress levels into "not stress" (not at all and not very), no change, and "much more stress" (somewhat and very stressed); food preparation as "much more" (much more and somewhat more), no change and "much less frequently" (somewhat less and much less); comfort level as "comfortable" (extremely comfortable and somewhat comfortable), neither and "uncomfortable" (somewhat uncomfortable and extremely uncomfortable); and lastly, food safety awareness was recategorized to "increased" (increase a lot and increased somewhat) and "no change." Similarly, the QOL scores were separated into three classifications: poor to fair (< 14 points), good (15 to 21 points), and very good to excellent (> 22 points). Further, four sociodemographic variables were recategorized to dichotomous variables, including race (White and BIPOC), education (high school or less, more than high school), marital status (currently married and not currently married), and community support (supportive and unsupportive).

Results

Table 1 describes the sociodemographic characteristics of the respondents. Respondents were mostly White (75.9%), married (58.7%), age 60 years and older (61.8%), with a high school education or higher (97.4%). The majority of

Table 1 Sociodemographic characteristics of respondents ($n = 1250$)

Sociodemographic variable	Number	Percentage (%)[a]
Age (years)		
40–49	242	19.4
50–59	233	18.6
60–69	394	31.5
>70	379	30.3
Missing	2	0.2
Gender		
Female/Transgender Female	609	48.7
Male/Transgender Male	629	50.3
Missing	2	0.2
Race		
American Indian/Alaska Native	20	1.6
Asian	51	4.1
Black/African American	178	14.2
White	949	75.9
Native Hawaiian/Other Pacific Islander	1	0.1
	8	0.6
Latino/Hispanic	21	1.7
More than One	17	1.4
Other	5	0.4
Missing		
Education level attained		
Less than High School	31	2.5
High School/GED	258	20.6
Some College, including Associate's degree	333	26.6
	285	22.8
Bachelor's degree	342	27.4
Some Post-Graduate Work/Advanced degree	1	0.1
Missing		
Marital status		
Divorced	160	12.8
Single, Never married	213	17.0
Now married	746	58.7
Separated	17	1.4
Widowed	113	9.0
Missing	1	0.1
Location		
Rural	304	24.3
Suburban	553	44.2
Urban	391	31.3
Missing	2	0.2
Income category		
< $20,000	269	21.5
$20,001 to $30,000	131	10.5
$30,001 to $50,000	232	18.6
> $50,001	596	47.7
Missing	11	1.8
Food security (max score=6) [b]		
High or marginal food security (0–1 points)	954	76.3
	184	14.7
Low food security (2–4 points)	105	8.4
Very low food security (5–6 points)	7	0.6
Missing		

[a]Total percentage may not equal to 100 due to rounding.

[b]United States Department of Agriculture, Economic Research Service 2012

respondents (85.8%) live in areas that the respondents perceived as supportive of health and well-being opportunities for middle age and older adults. More than three-quarters (76.3%) had "high or marginal" food security.

Respondents' health attributes prior to the pandemic are described in Table 2. Over one-half (56%) described their health as "somewhat good" or "very good." Additionally, 60% were classified as "at nutritional risk." Finally, the majority (74.8%) reported "very good to excellent" QOL.

Figure 2 shows the COVID-19 pandemic food buying frequency among respondents. Nearly one-half of the respondents (44.7%) maintained their pre-pandemic grocery shopping/food buying frequency. Respondents' perspective of physical activity was positive as indicated by the mean instrumental attitude (5.73 ± 4.9 out of 21) and the mean affective attitude score (8.44 ± 5.6 out of 21). Many respondents (48.1%) stated their physical activity levels stayed the same during the pandemic (Fig. 2b). Finally, nearly one-half of respondents (48.6%) reported being "somewhat or very stressed" due to the pandemic (Fig. 2).

Table 3 displays the pandemic food procurement and meal preparation characteristics of the respondents. Purchasing food from a grocery store was the most commonly cited method of procuring food (67.4%). More than one-half (53.6%) reported an increase in at-home food preparation due to the pandemic. Subsequently, 63.2% were "somewhat or extremely" comfortable with preparing food at home multiple times each day. Approximately one-half (49.6%) ate meals outside from home 1 to 2 times weekly. Nearly all respondents (91.1%) reported high food safety adherence prior to the pandemic. Pandemic-related food safety guidelines awareness was evenly divided between the three categories (stayed the same, increased somewhat, and increased a lot).

Figures 3 illustrates the impact the pandemic had on the types of food purchased. Across all food types, more than one-half of the respondents (56.5% to 65.0%) reported that the types of foods they purchased during the pandemic stayed the same as to what they typically purchased prior to the pandemic. Approximately one-third of respondents reported purchasing dry goods/shelf-stable (35.0%), frozen foods (32.9%), canned foods (31.1%), and snacks (30.7%) "somewhat" or "a lot" more often than pre-pandemic.

The SDH variables measured were correlated with food buying, physical activity, self-reported stress levels, food preparation, cooking comfort level, and food safety awareness ($p < 0.05$) (Tables 4, 5, 6, 7, 8, and 9). The SDH predictors ($p < 0.05$) for food buying frequency were gender ($p = 0.006$), race ($p = 0.001$), location ($p = 0.001$), community health support ($p = 0.004$), QOL ($p < 0.0001$), and food security ($p < 0.0001$) (Table 4). The odds of shopping much less frequently for groceries during the pandemic were detected among respondents who were younger in age,

Table 2 Health attributes of respondents prior to the pandemic ($n = 1250$)

Health attributes	Number	Percentage (%)[a]
Perceived community support for health and well-being		
Very supportive	236	18.9
Supportive	379	30.3
Somewhat supportive	457	36.6
Unsupportive	126	10.1
Very unsupportive	52	4.2
Self-reported health		
Very poor	33	2.6
Somewhat poor	157	12.6
Average	360	28.8
Somewhat good	404	32.3
Very good	296	23.7
Nutritional risk categories [a]		
At nutritional risk (<60 points)	741	59.3
At possible nutritional risk (60 to 75 points)	415	33.2
Not at nutritional risk (> 75 points)	78	6.2
Missing	16	1.3
Quality of life[b]		
Poor to fair (< 14 points)	41	3.3
Good (15–21 points)	265	21.2
Very good to excellent (>22)	935	74.8
Missing	9	0.7

[a]Dietary Screening Tool (Bailey et al. 2007; Bailey et al. 2009; Marra et al. 2018)

[b]Hays et al. 2009

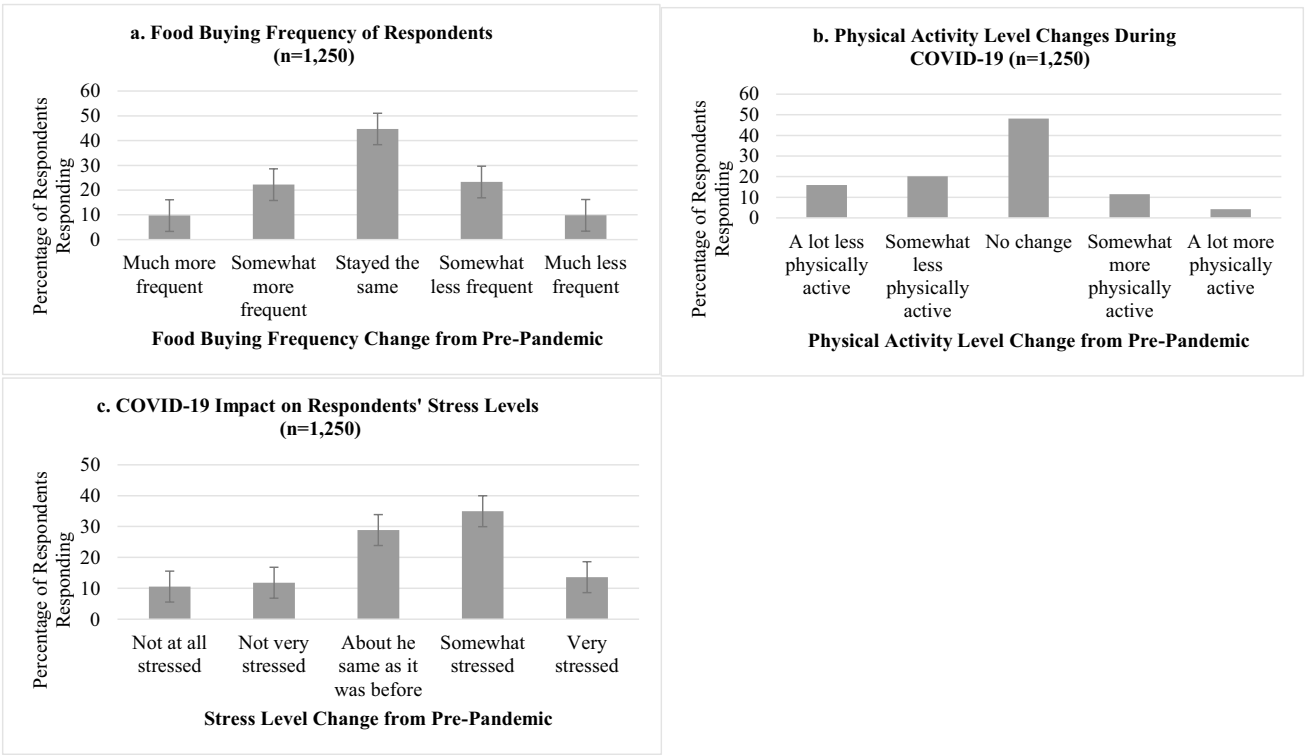

Fig. 2 **a–c** Pandemic impact on respondents' food buying frequency, physical activity levels, and stress compared to pre-pandemic

Table 3 COVID-19 impact on food procurement and meal preparation of respondents (n = 1250)

Characteristics	Number	Percentage (%)[a]
Food procurement method[b]		
In grocery store (including during special hours)	1,112	88.9
Grocery store website (Pick-up or Delivery)	361	28.9
Restaurants/Fast Food (take-out/delivery)	293	23.4
Friends/Family/Neighbors	228	18.2
Non-grocery store website (e.g., Amazon)	135	10.8
Home meal delivery (e.g., Blue Apron, Hello Fresh)	63	5.0
Home delivered meals (e.g., Meals on Wheels)	38	3.0
Other	20	1.6
None of the above	22	1.8
Frequency of at-home food preparation		
Increased a lot	382	30.6
Increased somewhat	288	23.0
Stayed the same	539	43.1
Decreased somewhat	27	2.2
Decreased a lot	13	1.0
Missing	1	0.1
Comfort level with preparing food multiple times daily		
Extremely comfortable	458	36.6
Somewhat comfortable	332	26.6
Neither comfortable nor uncomfortable	363	29.0
Somewhat uncomfortable	75	6.0
Extremely uncomfortable	22	1.8
Frequency of eating meals from outside home		
None	418	33.4
1–2 times weekly	620	49.6
3–4 times weekly	153	12.2
5–6 times weekly	28	2.2
More than 6 times weekly	31	2.5
Food safety adherence classification[c]		
Low (0 to 3 points)	7	0.6
Moderate (3.5 to 6.5 points)	104	8.3
High (7 to 10 points)	952	76.2
Missing[d]	187	15.0
Food safety awareness		
Increased a lot	398	31.8
Increased somewhat	384	30.7
Stayed the same	466	37.3
Missing	2	0.2

[a]Total percentage may not equal to 100 due to rounding.

[b]Participants could select multiple methods of food procurement.

[c]University of Hawaii Cooperative Extension Service 2006

[d]Total scores were tabulated only for respondents who completed all 10 questions in this tool.

female, white, urban residing, living in a community viewed as "not supportive" to health, with lower QOL, or had high food security.

The SDH predictors ($p < 0.05$) for pandemic-related physical activity frequency were age ($p = 0.001$), race ($p = 0.013$), education ($p < 0.0001$), income ($p = 0.003$), QOL ($p = 0.020$), food security ($p < 0.0001$), and nutritional risk ($p = 0.029$) (Table 5). The odds of having lower physical activity levels during the pandemic were detected among older respondents, identified as BIPOC, reported less than a high school education, were at nutritional risk, reported lower QOL, had lower food security or were earning less income annually.

Self-reported stress levels SDH predictors ($p < 0.05$) were gender ($p < 0.0001$), race ($p = 0.013$), education ($p = 0.001$), QOL ($p < 0.0001$), and food security ($p < 0.0001$) (Table 6). The odds of reporting higher stress levels were greater among respondents who were males, BIPOC, had a higher education background, reported lower QOL, or had low food security.

The SDH predictors ($p < 0.05$) for frequency of home food preparation were education ($p = 0.001$), marital status

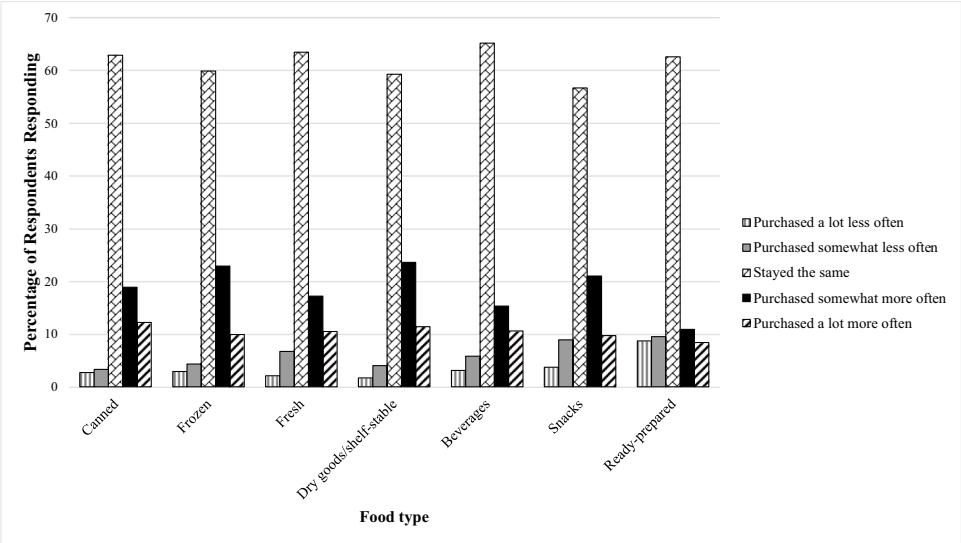

Fig. 3 Changes in types of food purchased during the pandemic ($n = 1250$ respondents)

($p = 0.023$), community health support ($p = 0.045$), and food security ($p < 0.0001$) (Table 7). There were higher odds of an increase in home food preparation frequency reported by respondents who had a higher education background, were married, lived in unsupportive communities, or had lower food security status.

In terms of comfort level for preparing food at home, the SDH predictors ($p < 0.05$) were age ($p = 0.014$), nutritional risk ($p < 0.0001$), QOL ($p < 0.0001$), and food security ($p < 0.0001$) (Table 8). Those who were younger, not at nutritional risk, who had higher QOL, or lower food security status had increased odds of being comfortable with preparing food at home.

Lastly, the SDH predictors ($p < 0.05$) for food safety guidelines awareness were race ($p < 0.0001$), nutritional risk ($p < 0.0001$), and food security ($p < 0.0001$) (Table 9). There were higher odds of increases in food safety awareness among those who identified as white, were not at nutritional risk, or reported lower food security status.

Discussion

These findings revealed that the food practices, the physical activity frequency, and stress levels of community-residing aging adults have been impacted by the COVID-19 pandemic and that the SDH affected the extent of these impacts.

Food behaviors

Our findings revealed minimal change to respondents' food procurement practices with most relying on shopping in person at grocery stores. This was surprising, as others have noted an increase in online grocery buying after the onset of the COVID-19 pandemic (Li et al. 2020; Zhang et al. 2020). Interestingly, most respondents reported no change in grocery buying frequency. This may be due to the timing of our survey, which was early Fall 2020. Conversely, Polacsek and others (Polacsek et al. 2020) reported the majority of those they surveyed at the beginning of the pandemic (May 2020) were reducing the number of their grocery trips.

Our finding that meal preparation at home increased during the pandemic is similar to that of Polacsek et al. (2020) and Zhang et al. (2020) who reported an increase in at-home cooking at home as a result of the pandemic. This may be attributed to increased time availability and mandated stay-at-home policies (De Backer et al. 2021). In addition, given the average age of our sample, it is likely that the food preparation comfort level may be due to the respondents having cooking repertoires and skill sets that they have acquired over time (Bostic and McClain 2017).

Further, although we report limited changes to the types of food purchased, one-third of our respondents reported purchasing snacks more regularly. Similarly, Bahl and others (Bahl et al. 2021) reported increased snacking frequency among adults 18 years and older due to COVID-19. The increase in snacking may also result from people facing temptations at home, being bored, having more leisure time, and stress (Poelman et al. 2021).

Our respondents reported high food safety adherence prior to the pandemic and increased food safety awareness due to COVID-19. This was not surprising given the educational level and age of our sample. Participants with increased age and education levels have been shown to be likely to adhere to food safety practices and more aware of food safety risks (Byrd-Bredbenner et al. 2013; Yap et al. 2019). In addition, older adults are reported to have better food safety insights attributing to increased experiences in dealing with food safety issues (Ruby et al. 2019).

Table 4. Social determinants of health predictors for food buying ($n = 1250$)

Reduced model									
		β	S.E.	Wald	*df*	*p-value*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	More frequent	–0.11	0.09	1.75	1	0.186	0.89	0.75	1.06
	Stayed the same (reference)								
	Less frequent	0.05	0.07	0.43	1	0.529	1.05	0.91	1.21
Gender	More frequent	–0.43	–.16	7.19	1	0.007*	0.65	0.48	0.89
	Stayed the same (reference)								
	Less frequent	–0.30	0.12	5.81	1	0.015*	0.74	0.58	0.95
Race	More frequent	0.56	0.18	9.40	1	0.002*	1.76	1.23	2.52
	Stayed the same (reference)								
	Less frequent	–0.18	0.17	1.16	1	0.282	0.83	0.60	1.16
Marital status	More frequent	–0.79	0.18	0.19	1	0.667	0.92	0.65	1.32
	Stayed the same (reference)								
	Less frequent	0.15	0.15	1.00	1	0.317	1.17	0.86	1.57
Education	More frequent	0.20	0.18	1.29	1	0.256	1.23	0.86	1.74
	Stayed the same (reference)								
	Less frequent	0.31	0.15	4.23	1	0.040*	1.36	1.01	1.82
Location	More frequent	–0.09	0.10	0.94	1	0.332	0.91	0.75	1.10
	Stayed the same (reference)								
	Less frequent	0.25	0.09	8.58	1	0.003*	1.28	1.09	1.51
Community	More frequent	0.20	0.24	0.70	1	0.403	1.22	0.76	1.97
	Stayed the same (reference)								
	Less frequent	0.63	0.19	10.52	1	0.001*	1.87	1.28	2.74
Nutritional risk[a]	More frequent	–0.04	0.14	0.10	1	0.755	0.96	0.72	1.27
	Stayed the same (reference)								
	Less frequent	0.16	0.11	1.98	1	0.159	1.17	0.94	1.46
QOL score[b]	More frequent	0.58	0.18	10.16	1	0.001*	1.78	1.25	2.55
	Stayed the same (reference)								
	Less frequent	–0.27	0.14	3.98	1	0.046*	0.76	0.59	1.00
Food security[c]	More frequent	1.06	0.16	44.21	1	<0.001*	2.87	2.11	3.92
	Stayed the same (reference)								
	Less frequent	0.25	0.16	4.86	1	0.027*	1.41	1.04	1.93
Income	More frequent	–0.05	0.79	0.40	1	0.53	0.95	0.82	1.11
	Stayed the same (reference)								
	Less frequent	0.06	0.07	0.69	1	0.406	1.06	0.92	1.22

*Significant differences detected between groups.

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

[b]Global Health PROMIS scale (Hays et al. 2009).

[c]Six-Item Food Security Module (USDA ERS 2012).

Physical activity

While most respondents reported no change in physical activity frequency, 36.2% stated their physical activity levels decreased. In a systematic review, Oliveira et al. (2022) reported that physical activity levels in the older adult population worldwide decreased during the isolation period of COVID-19. Our data on physical activity are based on self-report while the data collected by the studies in the systematic review are based on validated physical activity assessment questionnaires, although they were different for each study reviewed. However, the percentage of our sample reporting a decrease in physical activity levels was not as high as

Table 5 Social determinants of health predictors for physical activity levels ($n = 1250$)

Reduced model									
		β	S.E.	Wald	*df*	*p-value*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	More frequent	–0.29	0.09	9.89	1	0.002*	0.75	0.63	0.90
	Stayed the same (reference)								
	Less frequent	0.05	0.07	0.44	1	0.508	1.05	0.91	1.21
Gender	More frequent	–0.31	0.17	3.34	1	0.068	0.74	0.53	1.02
	Stayed the same (reference)								
	Less frequent	–0.15	0.12	1.50	1	0.222	0.86	0.67	1.10
Race	More frequent	0.47	0.21	5.18	1	0.023*	1.60	1.07	2.40
	Stayed the same (reference)								
	Less frequent	0.41	0.16	6.57	1	0.010*	1.52	1.10	2.09
Marital status	More frequent	0.22	0.20	1.23	1	0.268	1.24	0.85	1.18
	Stayed the same (reference)								
	Less frequent	–0.04	0.15	0.08	1	0.780	0.96	0.71	1.29
Education	More frequent	0.60	0.20	9.18	1	0.002*	1.81	1.23	2.67
	Stayed the same (reference)								
	Less frequent	0.56	0.15	14.19	1	<0.001*	1.76	1.31	2.35
Location	More frequent	–0.07	0.11	0.48	1	0.488	0.93	0.75	1.15
	Stayed the same (reference)								
	Less frequent	–0.11	0.08	1.63	1	0.202	0.90	0.77	1.06
Community	More frequent	0.43	0.24	3.17	1	0.075	1.53	0.96	2.45
	Stayed the same (reference)								
	Less frequent	0.11	0.20	0.33	1	0.569	1.12	0.76	1.65
Nutritional risk[a]	More frequent	0.37	0.14	6.72	1	0.010*	1.44	1.09	1.90
	Stayed the same (reference)								
	Less frequent	0.03	0.12	0.06	1	0.801	1.03	0.82	1.29
QOL score[b]	More frequent	0.34	0.21	2.74	1	0.098	1.41	0.94	2.11
	Stayed the same (reference)								
	Less frequent	–0.20	0.14	2.19	1	0.139	0.82	0.63	1.07
Food security[c]	More frequent	0.92	0.19	22.74	1	<0.001*	2.50	1.71	3.64
	Stayed the same (reference)								
	Less frequent	1.12	0.15	53.14	1	<0.001*	3.07	2.27	4.15
Income	More frequent	0.26	0.10	7.48	1	0.006*	1.30	1.08	1.56
	Stayed the same (reference)								
	Less frequent	–0.05	0.07	0.56	1	0.455	0.95	0.83	1.09

*Significant differences detected between groups.

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

[b]Global Health PROMIS scale (Hays et al. 2009).

[c]Six-Item Food Security Module (USDA ERS2012).

other studies that were conducted earlier in the pandemic, where 50% or more of participants reported being less physically active (Bahl et al. 2021). Our findings are similar to Harrison and others (Harrison et al. 2021) who noted many urban-residing middle age and older adults were able to maintain some normalcy in terms of physical activity. These two studies used the same questions as we did. This may be due to the timeframe of these surveys, which took place after August 2020 at which time lockdowns were gradually being lifted, exercise facilities reopening, and individuals feeling safer in exercising outdoors.

Table 6 Social determinants of health predictors for stress levels ($n = 1250$)

Reduced model									
		β	S.E.	Wald	*df*	*p*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	More stress	–0.001	0.08	0.00	1	0.994	1.00	0.86	1.16
	Stayed the same (reference)								
	Less stress	0.07	0.09	0.58	1	0.445	1.07	0.90	1.28
Gender	More stress	–0.27	0.13	4.02	1	0.045*	0.77	0.59	0.99
	Stayed the same (reference)								
	Less stress	0.41	0.15	7.82	1	0.005*	1.52	1.13	2.04
Race	More stress	0.05	0.18	0.07	1	0.794	1.05	0.74	1.48
	Stayed the same (reference)								
	Less stress	0.52	0.20	6.91	1	0.009*	1.68	1.14	2.46
Marital status	More stress	0.07	0.16	0.16	1	0.685	1.07	0.78	1.46
	Stayed the same (reference)								
	Less stress	0.01	0.19	0.00	1	0.963	1.01	0.70	1.46
Education	More stress	0.55	0.16	12.21	1	<0.001*	1.73	1.27	2.35
	Stayed the same (reference)								
	Less stress	0.11	0.18	0.34	1	0.562	1.11	0.78	1.59
Location	More stress	0.07	0.09	0.70	1	0.404	1.08	0.91	1.28
	Stayed the same (reference)								
	Less stress	–0.04	0.10	0.14	1	0.710	0.96	0.79	1.17
Community	More stress	0.31	0.21	2.23	1	0.135	1.37	0.91	2.06
	Stayed the same (reference)								
	Less stress	–0.11	0.26	0.18	1	0.674	0.90	0.54	1.49
Nutritional risk[a]	More stress	0.25	0.12	4.14	1	0.042*	1.28	1.01	1.62
	Stayed the same (reference)								
	Less stress	0.05	0.14	0.14	1	0.709	1.05	0.80	1.39
QOL score[b]	More stress	–0.62	0.15	16.61	1	<0.001*	0.54	0.40	0.73
	Stayed the same (reference)								
	Less stress	0.52	0.21	6.03	1	0.014*	1.68	1.11	2.53
Food security[c]	More stress	1.09	0.18	37.06	1	<0.001*	2.96	2.09	4.20
	Stayed the same (reference)								
	Less stress	0.57	0.21	7.65	1	0.006*	1.77	1.18	6.66
Income	More stress	–0.07	0.08	0.91	1	0.340	1.07	0.93	1.25
	Stayed the same (reference)								
	Less stress	–0.08	0.09	0.92	1	0.338	0.92	0.78	1.09

*Significant differences detected between groups.

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

[b]Global Health PROMIS scale (Hays et al. 2009).

[c]Six-Item Food Security Module (USDA ERS 2012).

Stress levels

The higher reported stress levels of our sample were anticipated. Social isolation caused by quarantine restrictions and stay-at-home orders has been reported by other researchers to have increased stress among adults (Harrison et al. 2021; Bahl et al. 2021; De Backer et al. 2021), particularly for individuals with low socioeconomic status (Kantamneni 2020). This can be attributed to fear of the COVID-19 outbreak, vulnerability to being infected, social distancing requirements, exposure, or close contact with someone who has been infected, and changes to social and personal daily care routines (Park et al. 2020). In addition, some respondents who are not at retirement age may have children at

Table 7 Social determinants of health predictors for food preparation frequency ($n = 1250$)

Reduced model									
		β	S.E.	Wald	*df*	*p*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	Increase	–0.05	0.07	0.48	1	0.490	0.96	0.84	1.09
	Stayed the same (reference)								
	Decrease	–0.06	0.18	0.12	1	0.731	0.94	0.66	1.34
Gender	Increase	–0.25	0.12	4.69	1	0.030*	0.78	0.63	0.98
	Stayed the same (reference)								
	Decrease	–0.32	0.32	0.97	1	0.324	0.73	0.39	1.37
Race	Increase	0.20	0.15	1.76	1	0.185	1.22	0.91	1.64
	Stayed the same (reference)								
	Decrease	0.70	0.38	3.48	1	0.062	2.02	0.97	4.23
Marital status	Increase	–0.33	0.14	10.73	1	0.001*	0.72	0.55	0.95
	Stayed the same (reference)								
	Decrease	0.34	0.39	0.75	1	0.387	1.41	0.65	3.04
Education	Increase	0.44	0.14	10.73	1	0.001*	1.56	1.20	2.03
	Stayed the same (reference)								
	Decrease	0.82	0.39	4.48	1	0.034*	2.27	1.06	4.83
Location	Increase	0.05	0.08	0.47	1	0.491	1.05	0.91	1.22
	Stayed the same (reference)								
	Decrease	0.19	0.21	0.81	1	0.367	1.21	0.80	1.85
Community	Increase	0.44	0.18	5.71	1	0.017*	1.55	1.08	2.22
	Stayed the same (reference)								
	Decrease	0.53	0.46	1.37	1	0.242	1.71	0.70	4.17
Nutritional risk[a]	Increase	0.24	0.11	5.22	1	0.022*	1.27	1.04	1.56
	Stayed the same (reference)								
	Decrease	–0.06	0.32	0.03	1	0.863	0.95	0.50	1.78
QOL score[b]	Increase	0.001	0.13	0.00	1	0.994	1.00	0.78	1.29
	Stayed the same (reference)								
	Decrease	–0.47	0.31	2.36	1	0.125	0.63	0.34	1.14
Food security[c]	Increase	0.87	0.14	37.30	1	<0.001*	2.39	1.81	3.16
	Stayed the same (reference)								
	Decrease	0.66	0.33	3.89	1	0.048*	1.93	1.00	3.70
Income	Increase	0.11	0.07	2.63	1	0.105	1.11	0.98	1.26
	Stayed the same (reference)								
	Decrease	–0.10	0.17	0.37	1	0.546	0.90	0.64	1.26

*Significant differences detected between groups.

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

[b]Global Health PROMIS scale (Hays et al. 2009).

[c]Six-Item Food Security Module (USDA ERS 2012).

home, which may be a factor for increased stress. Studies have reported elevated parenting-specific stress, such as changes in children's routines, online schooling demands, and COVID-19 (Adams et al. 2021). This can be further supported by our ANOVA analyses that reported those who were ages 40 to 59 had higher stress levels compared to other age groups.

SDH impacts on pandemic outcomes

Our findings reveal that all the SDH variables we collected were associated with the pandemic health outcomes measured in this study. The SDH construct of social and community context (i.e., gender, age, race) influenced all areas measured: grocery shopping, physical activity, stress, home

Table 8 Social determinants of health predictors for food preparation comfort level (n = 1250)

Reduced model									
		β	S.E.	Wald	*df*	*p-value*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	Comfortable	–0.19	0.07	6.99	1	0.008*	0.83	0.72	0.95
	Neither (reference)								
	Uncomfortable	0.03	0.13	0.05	1	0.832	1.03	0.80	1.32
Gender	Comfortable	0.10	0.12	0.69	1	0.408	1.11	0.87	1.42
	Neither (reference)								
	Uncomfortable	–0.10	0.21	0.21	1	0.647	0.91	0.60	1.37
Race	Comfortable	0.03	0.16	0.02	1	0.877	1.03	0.74	1.42
	Neither (reference)								
	Uncomfortable	–0.06	0.29	0.04	1	0.837	0.94	0.54	1.66
Marital status	Comfortable	–0.08	0.15	0.27	1	0.607	0.92	0.68	1.25
	Neither (reference)								
	Uncomfortable	0.52	0.27	3.67	1	0.055	1.67	0.99	2.83
Education	Comfortable	–0.005	0.15	0.00	1	0.973	1	0.74	1.33
	Neither (reference)								
	Uncomfortable	–0.19	0.27	0.52	1	0.473	0.83	0.49	1.39
Location	Comfortable	–0.07	0.08	0.64	1	0.424	0.94	0.79	1.10
	Neither (reference)								
	Uncomfortable	0.07	0.15	0.20	1	0.657	1.07	0.80	1.43
Community	Comfortable	0.12	0.20	0.35	1	0.552	1.13	0.76	1.69
	Neither (reference)								
	Uncomfortable	0.69	0.30	5.19	1	0.023*	1.98	1.10	3.58
Nutritional risk[a]	Comfortable	0.56	0.12	21.23	1	<0.001*	1.75	1.38	2.21
	Neither (reference)								
	Uncomfortable	–0.03	0.23	0.01	1	0.914	0.98	0.62	1.53
QOL score[b]	Comfortable	0.73	0.14	27.72	1	<0.001*	2.07	1.58	2.71
	Neither (reference)								
	Uncomfortable	–0.35	0.20	3.00	1	0.083	0.71	0.48	1.05
Food security[c]	Comfortable	0.77	0.16	22.68	1	<0.001*	2.17	1.58	2.98
	Neither (reference)								
	Uncomfortable	0.32	0.27	1.39	1	0.238	1.37	0.81	2.31
Income	Comfortable	0.10	0.07	1.80	1	0.179	1.10	0.96	1.26
	Neither (reference)								
	Uncomfortable	0.14	0.13	1.32	1	0.250	1.16	0.91	1.48

*Significant differences detected between groups

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018)

[b]Global Health PROMIS scale (Hays et al. 2009)

[c]Six-Item Food Security Module (USDA ERS 2012)

food preparation frequency, food preparation, comfort levels, and food safety awareness. Of note is the relationships we detected between food security classification and grocery shopping frequency and food security and stress. This was anticipated as there is a higher likelihood of being concerned with the effect of COVID-19 on health, income, and ability to feed their family if one is food insecure (Wolfson et al. 2021). Home food preparation frequency was influenced by marital status. Our findings indicate that those who were married were more likely to make food at home has been supported by Blake et al. (2011) and Virudachalam et al. (2013).

Educational attainment effected pandemic-related physical activity levels, QOL, and stress levels. Comparably, Constandt et al. (2020) found adults ages 55 years and older with lower education attainment exercised less during lockdown. The inverse relationship we detected between stress levels and QOL is supported by Hawash et al. (2021) who found

Table 9 Social determinants of health predictors for food safety awareness ($n = 1250$)

Reduced model									
		β	S.E.	Wald	*df*	*p-value*	Odds ratios	95% C.I. for odds ratios	
Variable	Category							Lower	Upper
Age	Increase	0.06	0.07	0.85	1	0.356	1.06	0.93	1.21
	Stayed the same (reference)								
Gender	More frequent	–0.14	0.12	1.53	1	0.216	0.87	0.69	1.08
	Stayed the same (reference)								
Race	More frequent	0.66	0.16	16.86	1	<0.001*	1.93	1.41	2.63
	Stayed the same (reference)								
Marital status	More frequent	–0.28	0.14	3.74	1	0.043*	0.76	0.58	1.00
	Stayed the same (reference)								
Education	More frequent	0.23	0.14	2.80	1	0.094	1.26	0.96	1.65
	Stayed the same (reference)								
Location	More frequent	0.03	0.08	0.14	1	0.708	1.03	0.88	1.20
	Stayed the same (reference)								
Community	More frequent	0.06	0.18	0.09	1	0.761	1.06	0.74	1.52
	Stayed the same (reference)								
Nutritional risk[a]	More frequent	0.40	0.11	13.85	1	<0.001*	1.50	1.21	1.85
	Stayed the same (reference)								
QOL score[b]	More frequent	–0.06	0.13	0.20	1	0.652	0.94	0.73	1.22
	Stayed the same (reference)								
Food security[c]	More frequent	1.28	0.16	61.58	1	<0.001*	3.59	2.61	4.94
	Stayed the same (reference)								
Income	More frequent	0.11	0.07	2.95	1	0.086	1.12	0.98	1.28
	Stayed the same (reference)								

*Significant differences detected between groups

[a]Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018)

[b]Global Health PROMIS scale (Hays et al. 2009)

[c]Six-Item Food Security Module (USDA ERS 2012)

an inverse relationship between stress and QOL during the pandemic. We found that having more education resulted in higher home food preparation frequency, which is in favor of other studies (Philippe et al. 2021; Gautam et al. 2019). In terms of health, participants who are not at nutritional risk reported the highest physical activity levels. This finding is not surprising since good nutrition and dietary intake is associated with higher physical activity levels (Štefan et al. 2018; Bollwein et al. 2012). Age was a significant factor for physical activity based on our MLR analyses. Further, our ANOVA analyses reported specifically those who were older than 70 years reported lower physical activity levels during the pandemic than the other age groups. This may be attributed to the reduction of muscle strength, changes in flexibility, endurance, and agility (Milanović et al. 2013).

Middle age and older adults with food insecurity reported experiencing higher stress levels than those with food security, consistent with other studies with similar findings (Ma et al. 2020; Wolfson et al. 2021). There was a higher likelihood of being concerned with the effect of COVID-19 on health, income, and daily life with food insecurity (Wolfson et al. 2021). Middle age and older adults with higher income levels reported higher physical activity, which shows a similar trend with other studies that reported an association between lower-income and lower physical activities (Armstrong et al. 2018; Pirrie et al. 2020), as individuals with lower socioeconomic status are likely to perform more unhealthy behaviors such as smoking, insufficient dietary and physical activity levels (Stringhini 2010).

Finally, respondents who resided in communities they perceived as supportive of health and well-being reported more frequent grocery buying. This may be attributable to respondents feeling safer traveling to get groceries in supportive communities as there may be trust among neighbors to practice social distancing.

The generalizability of these findings is limited due to the sample being from only six states and Washington DC that are part of the NE1939 research area and the technology requirements of the respondents. However, these states represent various geographic regions of the United States. In addition, the sample is racially and economically diverse, which is reflective of the US nationally (US Census Bureau 2019), and equally distributed by gender. Further, this sample is limited to aging adults who were enrolled in the Qualtrics™ panels and had access to a computer or smart phone to complete the online survey. Moreover, although the ten COVID-19 related questions were not validated for reliability; they were reviewed for face validity. Lastly, data were self-reported by respondents, which could lead to recall bias and social desirability as they may opt for answers that adhere to current stigmas (Althubaiti 2016). Despite these potential limitations, these findings provide valuable insights into how the COVID-19 pandemic has impacted aging adults' food practices, physical activity, stress levels, and how the SDH affected these outcomes.

Conclusion

When developing health interventions for middle age and older adults, it is critical to consider the SDH in its design. Per our findings, it is apparent the SDH play a critical role in how people react to health crises and health interventions. This study discovered that the COVID-19 pandemic had affected middle age and older adults' health and well-being based on the SDH. All five SDH constructs had an effect on the pandemic-related behaviors examined in this study with the SDH construct, social and community context having the strongest correlation. The valuable information obtained from the study serves as a blueprint for developing and implementing health interventions. Despite the undetermined long-term effects of the pandemic, the existing impact underlines the necessity for health programs to support middle age and older adults to achieve positive health behaviors.

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Genschel—assisted with data analysis and interpretation

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Kendall—survey development, data entry, manuscript review and revision

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Data availability Nonapplicable

Code availability Nonapplicable

Declarations

The authors declare that there is no conflict of interest.

Ethics approval The Iowa State University Institutional Review Board approved this study protocol, which was deemed exempt with the ID 20-384.

Consent to participate This study was deemed exempt so informed consent was not required.

Consent for publication Nonapplicable

Conflict of interest The authors declare that there is no conflict of interest. The Iowa State University Institutional Review Board approved this study protocol, which was deemed exempt with the ID 20-384.

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