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

Loo Yee Wong1 · Sarah L. Francis1 · Ulrike Genschel1 · Anna Arthur2 · Furong Xu3 · Lee Weidauer4 · Lillie Monroe-Lord5 · Melissa Ventura-Marra6 · Nadine R. Sahyoun7 · Chandler Kendall1

Received: 29 March 2022 / Accepted: 20 July 2022 / Published online: 5 August 2022
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2022

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 linear 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...
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; Vissier 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 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 role in shaping the health outcomes of older adults during the pandemic (Fig. 1; Office of Disease Prevention and Health Promotion n.d.).

**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 scale (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 sociodemographic variable.

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 | 1      | 0.1             |
| Islander                      | 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 |
| 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 |
| Low food security (2–4 points) | 105 | 8.4 |
| Very low food security (5–6 points) | 7 | 0.6 |
| Missing                       |        |                 |

aTotal percentage may not equal to 100 due to rounding.

bUnited States Department of Agriculture, Economic Research Service 2012

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 (32.1%) purchased 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
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

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

| Characteristics                                      | Number | Percentage (%) |
|------------------------------------------------------|--------|----------------|
| Food procurement methodb                             |        |                |
| 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 classificationc                 |        |                |
| 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           |
| Missingd                                             | 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            |

aTotal percentage may not equal to 100 due to rounding.

bParticipants could select multiple methods of food procurement.

cUniversity of Hawaii Cooperative Extension Service 2006

dTotal scores were tabulated only for respondents who completed all 10 questions in this tool.
(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).
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 4. Social determinants of health predictors for food buying (n = 1250)

| Variable         | Category                  | β   | S.E. | Wald | df | p-value | Odds ratios | 95% C.I. for odds ratios |
|------------------|---------------------------|-----|------|------|----|---------|-------------|--------------------------|
|                  |                           |     |      |      |    |         |             | 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 | -0.16 | 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 riska| 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 scoreb       | 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 securityc   | 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    |

*aSignificant differences detected between groups.

*bDietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

*cSix-Item Food Security Module (USDA ERS 2012).
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 5 Social determinants of health predictors for physical activity levels (n = 1250)

| Variable      | Category                              | β   | S.E. | Wald  | df | p-value | Odds ratios | 95% C.I. for odds ratios |
|---------------|---------------------------------------|-----|------|-------|----|---------|-------------|--------------------------|
|               |                                       |     |      |       |    |         |             |                          |
| 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| 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     | 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 | 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                |

*aSignificant differences detected between groups.

bDietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

bGlobal Health PROMIS scale (Hays et al. 2009).

cSix-Item Food Security Module (USDA ERS2012).
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

| Variable       | Category            | β     | S.E.  | Wald | df | p   | Odds ratios | 95% C.I. for odds ratios |
|----------------|---------------------|-------|-------|------|----|-----|-------------|--------------------------|
| 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 | 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      | 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  | 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.

aDietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).
bGlobal Health PROMIS scale (Hays et al. 2009).
cSix-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 7 Social determinants of health predictors for food preparation frequency ($n = 1250$)

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

*aSignificant differences detected between groups.

b*Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018).

c*Global Health PROMIS scale (Hays et al. 2009).

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

| Variable        | Category            | Reduced model | χ²  | df | p-value | 95% C.I. for odds ratios | Odds ratios |
|-----------------|---------------------|---------------|-----|----|---------|--------------------------|------------|
| Age             | Comfortable         | -0.19         | 0.07| 6.99| 1       | 0.008*                   | 0.72       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Gender          | Comfortable         | 0.03          | 0.13| 0.05| 1       | 0.832                    | 0.80       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Race            | Comfortable         | 0.10          | 0.12| 0.69| 1       | 0.408                    | 0.87       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Marital status  | Comfortable         | -0.10         | 0.21| 0.21| 1       | 0.647                    | 0.60       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Education       | Comfortable         | 0.03          | 0.16| 0.02| 1       | 0.877                    | 0.74       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Location        | Comfortable         | -0.08         | 0.15| 0.27| 1       | 0.607                    | 0.68       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Community       | Comfortable         | 0.03          | 0.15| 0.00| 1       | 0.973                    | 0.74       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Nutritional risk | Comfortable         | -0.19         | 0.27| 0.52| 1       | 0.473                    | 0.49       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| QOL score       | Comfortable         | 0.07          | 0.15| 0.20| 1       | 0.657                    | 0.80       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Food security   | Comfortable         | -0.07         | 0.08| 0.64| 1       | 0.424                    | 0.79       |
|                 | Neither (reference) |               |     |     |         |                          |            |
| Income          | Comfortable         | -0.07         | 0.15| 0.20| 1       | 0.657                    | 0.80       |
|                 | Neither (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.

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       | 1.06        | 0.93  | 1.21  |
|              | Stayed the same (reference)|       |       |     |         |             |       |       |
| Gender       | More frequent             | -0.14 | 0.12  | 1.53| 1       | 0.216       | 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<sup>a</sup> | More frequent             | 0.40  | 0.11  | 13.85| 1     | <0.001*     | 1.50  | 1.21  | 1.85  |
|              | Stayed the same (reference)|       |       |     |         |             |       |       |
| QOL score<sup>b</sup> | More frequent             | -0.06 | 0.13  | 0.20| 1       | 0.652       | 0.94  | 0.73  | 1.22  |
|              | Stayed the same (reference)|       |       |     |         |             |       |       |
| Food security<sup>c</sup> | 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)|       |       |     |         |             |       |       |

<sup>a</sup>Significant differences detected between groups
<sup>b</sup>Dietary Screening Tool (Bailey et al. 2007, 2009; Marra et al. 2018)
<sup>c</sup>Global Health PROMIS scale (Hays et al. 2009)
<sup>c</sup>Six-Item Food Security Module (USDA ERS 2012)
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 underdetermined 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.

Acknowledgments This work was completed as part of the U.S. Department of Agriculture NE-1939 Multistate Project “Improving the health span of aging adults through diet and physical activity.” The research was supported by the Lura M. Lovell Fellowship (S. Francis); SD00R691-20: United States Department of Agriculture – National Institute of Food and Agriculture (L. Weidauer); USDA/NIFA Hatch Project #1011487; University of the District of Columbia Multistate Project (L. Monroe-Lord); West Virginia Agricultural and Forestry Experiment Station, National Institute of Food and Agriculture, US Department of Agriculture, Hatch/Multi-State #1021322 (M. Marra).

Authors’ contributions Wong—data analysis and manuscript preparation
Francis—study design, implementation, data analysis, and manuscript preparation
Gensche—assisted with data analysis and interpretation
Arthur, Xu, Weidauer, Monroe-Lord, Ventura-Marra, Sahyoun—study design, implementation, manuscript review and revision
Kendall—survey development, data entry, manuscript review and revision

Funding This work was completed as part of the USDA NE-1939 Multistate Project “Improving the health span of aging adults through diet and physical activity.” The research was supported by the Lura M. Lovell Fellowship (S. Francis); SD00R691-20: United States Department of Agriculture – National Institute of Food and Agriculture (L. Weidauer); USDA/NIFA Hatch Project #1011487; University of the District of Columbia Multistate Project (L. Monroe-Lord); West Virginia Agricultural and Forestry Experiment Station, National Institute of Food and Agriculture, US Department of Agriculture, Hatch/Multi-State #1021322 (M. Marra).

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.

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.

References

Adams EL, Smith D, Caccavale LJ, Bean MK (2021) Parents are stressed! Patterns of parent stress across COVID-19. Front Psychiatry 12. https://doi.org/10.3389/fpsyt.2021.626456
Ajzen I (1991) The Theory of Planned Behavior. Organ Behav Hum Decis Process 50:179–211. https://doi.org/10.1016/0749-5978(91)90020-T
Althubaiti A (2016) Information bias in health research: Definition, pitfalls, and adjustment methods. J Multidiscip Healthc 211. https://doi.org/10.2147/jmdh.s104807
Arafat SM, Kar SK, Kabir R (2021) Possible controlling measures of panic buying during Covid-19. Int J Ment Heal Addict 19:2289–2291. https://doi.org/10.1007/s11469-020-00320-1
Armstrong S, Wong CA, Perrin E, Page S, Sibley L, Skinner A (2018) Association of physical activity with income, race/ethnicity, and sex among adolescents and young adults in the United States. JAMA Pediatr 172(8):732. https://doi.org/10.1001/jamapediatrics.2018.1273
Ashbrook A (2020) Nearly 60 percent increase in older adult food insecurity during COVID-19: federal action on snap needed now. Food Research & Action Center. https://frac.org/blog/nearly-60-percent-increase-in-older-adult-food-insecurity-during-covid-19-federal-action-on-snap-needed-now. Accessed 15 Nov 2021
Bahl M, Francis SL, Litchfield R, Coleman S, Naig A. (2021) Assessing and responding to COVID-19 pandemic nutrition and wellness impacts on Iowans. J Ext 58(6). https://tigerprints.clemson.edu/joe/vol58/iss6/12/. Accessed 4 May 2022

Bailey R, Mitchell D, Miller C, Still C, Jensen G, Tucker K, Smiciklas-Wright H. (2007) A dietary screening questionnaire identifies dietary patterns in older adults. J Nutr 137:421–426. https://doi.org/10.1093/jn/137.2.421

Bakalis S, Valdramiadis VP, Argyropoulos D, Ahnre L, Chen J, Cullen P et al. (2020) Perspectives from CO+RE: How COVID-19 changed our food systems and food security paradigms. Curr Res Nutr Food Sci 3:166–172. https://doi.org/10.1007/s42103-020-00033-1

Blake CE, Wethington E, Farrell TJ, Bisogni CA, Devine CM (2011) Behavioral contexts, food-choice coping strategies, and dietary quality of a multiethnic sample of employed parents. J Am Diet Assoc 111(3):401–407. https://doi.org/10.1016/j.jada.2010.11.012

Bollwein J, Diekmann R, Kaiser MJ, Bauer JM, Uter W, Sieber CC, Volkert D (2012) Dietary quality is related to frailty in community-dwelling older adults. J Gerontol A Biol Sci Med Sci 68(4):483–489. https://doi.org/10.1093/gerona/gls204

Bostic SM, McClain AC (2017) Older adults’ cooking trajectories: Shifting skills and strategies. Brit Food J 119(5):1102–1115. https://doi.org/10.1108/BFJ-09-2016-0436

Breckler SJ, Wiggins EC (1989) Affect versus evaluation in the structure of attitudes. J Exp Soc Psychol 25(3):253–271. https://doi.org/10.1016/0022-1031(89)90022-X

Buckland NJ, Swinerton LF, Ng K, Price M, Wilkinson LL, Myers A, Dalton M (2021) Susceptibility to increased high energy dense sweet and savory food intake in response to the COVID-19 lockdown: the role of craving control and acceptance coping strategies. Appetite 158:105017. https://doi.org/10.1016/j.appet.2020.105017

Byrd-Bredbenner C, Berning J, Martin-Biggers J, Quick V (2013) Food safety in home kitchens: a synthesis of the literature. Int J Environ Res Public Health 10(9):4060–4085. https://doi.org/10.3390/ijerph10094060

Campbell AD (2020) Practical implications of physical distancing, social isolation, and reduced physicality for older adults in response to COVID-19. J Gerontol Soc Work 63(6-7):666–670. https://doi.org/10.1080/01634372.2020.1772931

Constandt B, Thibaut E, De Bosscher V, Scheerder J, Ricour M, Willem A (2020) Exercising in times of lockdown: an analysis of the impact of COVID-19 on levels and patterns of exercise among older adults. PLoS One 15(3). https://doi.org/10.1371/journal.pone.0229840

Curtis MJ, Harrison C, Moreau D, Nag R, England J (2021) Perspectives from CO+RE: How COVID-19 changed our food systems and food security paradigms. Curr Res Nutr Food Sci 3:166–172. https://doi.org/10.1007/s42103-020-00033-1

De Backer C, Teunissen L, Cuykx I, Decorte P, Pabian S, Gerritsen S, Constandt B, Thibaut E, De Bosscher V, Scheerder J, Ricour M, Willem A (2020) Exercising in times of lockdown: an analysis of the impact of COVID-19 on levels and patterns of exercise among older adults. PLoS One 15(3). https://doi.org/10.1371/journal.pone.0229840

Dunton GF, Wang SD, Do B, Courtney J (2020) Early effects of the COVID-19 pandemic on physical activity locations and behaviors in adults living in the United States. Prev Med Rep 20:101241. https://doi.org/10.1016/j.pmedr.2020.101241

French DP, Sutton S, Hennings SJ, Mitchell J, Wareham NJ, Griffith S, Hardeman W, Kinmonth AL (2005) The importance of affective beliefs and attitudes in the theory of planned behavior: predicting intention to increase physical activity. J Appl Soc Psychol 35(9):1824–1848. https://doi.org/10.1111/j.1559-1816.2005.tb02197.x

Frith E, Loprinzi PD (2018) Food insecurity and cognitive function in older adults: brief report. Clin Nutr 37(5):1765–1768. https://doi.org/10.1016/j.clnu.2017.07.001

Gautam S, Gaire D, Baigain BB, Acharya D, Gautam K, Baigain KT, Singh JK (2019) Socio-demographic factors of household heads associated with knowledge of food safety among residents of Butwal sub-municipal city of Nepal. Int J Health Sci 9(1):13–20

Gyasi RM, Obeng B, Yeboah JY (2020) Impact of food insecurity with hunger on mental distress among community-dwelling older Americans. BMC Public Health 21(1). https://doi.org/10.1186/s12889-021-10825-6

Hawash MM, Alhzam AH, Wafik W, Muzammil K, Mushiqi S, Ahmed HA (2021) The association of COVID-19 pandemic stress with health related quality of life in the Kingdom of Saudi Arabia: a cross-sectional analytical study. Public Health Front 9. https://doi.org/10.3389/fpubh.2021.600330

Hays RD, Bjorner J, Revicki RA, Spritzer KL, Cella D (2016) Shifting skills and strategies. Brit Food J 119(5):1102–1115. https://doi.org/10.1108/BFJ-09-2016-0436

Jones AD (2017) Food insecurity and mental health status: a global analysis of 149 countries. Am J Prev Med 53(2):264–273. https://doi.org/10.1016/j.amepre.2017.04.008

Kantamneni N (2020) The impact of the COVID-19 pandemic on marginalized populations in the United States: a research agenda. J Vocat Behav 119:103439. https://doi.org/10.1016/j.jvbev.2020.103439

Li J, Hallsworth AG, Coca-Stefanian JA (2020) Changing grocery shopping behaviours among Chinese consumers at the outset of the COVID-19 outbreak. Tijdschr Econ Soc Geogr 111(3):574–583. https://doi.org/10.1111/tesg.12420

Ma ZF, Zhang Y, Luo X, Li X, Li Y, Liu S, Zhang Y (2020) Increased stressors during the COVID-19 pandemic: a nationwide cross-sectional study conducted after Wuhan city’s travel ban was lifted. Int J Soc Psychiatry 66(8):770–779. https://doi.org/10.1177/00207130209305489

Marra MV, Thuppal S, Johnson E, Bailey R (2018) Validation of a dietary screening tool in a middle-aged Appalachian population. Nutrients 10(3):345. https://doi.org/10.3390/nu10030345

Marty L, De Lauzom-Guillain B, Labesse M, Nicklaus S (2021) Food choice motives and the nutritional quality of diet during the Covid-19 lockdown in France. Appetite 157:105005. https://doi.org/10.1016/j.appet.2020.105005

Milanovic Z, Pantelic S, Trajkovic N, Sporič G, Kostić R, James N, Jorgic B (2013) (2013) Age-related decrease in physical activity and functional fitness among elderly men and women. Clin Interv Aging 8:549–556. https://doi.org/10.2147/cia.s44112

Morgan B (2021) 3 lasting changes to grocery shopping after covid-19. Forbes. https://www.forbes.com/sites/blakemorgan/2021/12/14/3-lasting-changes-to-grocery-shopping-after-covid-19/?sh=5b854e7. Accessed 15 Nov 2021.

Office of Disease Prevention and Health Promotion. (n.d.) Social Determinants of Health. Healthy People 2030. U.S. Department of Health and Human Services. https://health.gov/healthepeople/objectives-and-data/social-determinants-health. Accessed 4 May 2022
