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# Fatty Liver and the Coronavirus Disease 2019 Pandemic: Health Behaviors, Social Factors, and Telemedicine Satisfaction in Vulnerable Populations

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The coronavirus disease 2019 (COVID-19) pandemic has impacted health-related behaviors that influence fatty liver disease (FLD) management. We evaluated the impact of the pandemic on FLD management and satisfaction with care delivery in this population. In the San Francisco safety-net hepatology clinics, we evaluated health-related behaviors and factors associated with self-reported weight gain during the COVID-19 pandemic as well as satisfaction with telemedicine in adults with FLD by using multivariable modeling. From June 1, 2020, to May 5, 2021, 111 participants were enrolled. Median age was 52 years, 30% were men, 63% were Hispanic, 21% were Asian/Pacific Islander, and 9% were White. Eating habits were unchanged or healthier for 80%, physical activity decreased in 51%, 34% reported weight gain, and 5% reported increased alcohol intake. Forty-five percent had severe depressive symptoms, 38% in those without diagnosed depression and 60% of individuals with heavy alcohol use. On multivariable analysis, decreased physical activity (odds ratio [OR], 4.8) and heavy alcohol use (OR, 3.4) were associated with weight gain (all  $P < 0.05$ ). Among those with telemedicine visits ( $n = 66$ ), 62% reported being very satisfied. Hispanic ethnicity was associated with a 0.8-unit decrease in the telemedicine satisfaction score ( $P = 0.048$ ) when adjusting for sex, age, and pandemic duration. **Conclusion:** During the pandemic, decreased physical activity and heavy alcohol use were most influential on self-reported weight gain in FLD. Maintenance of healthy eating and increased physical activity, alcohol cessation counseling, and mental health services are critical in preventing poor FLD-associated outcomes during the pandemic recovery. Dissatisfaction with telemedicine should be explored further to ensure equitable care, especially among the vulnerable Hispanic population. (*Hepatology Communications* 2022;6:1045-1055).

The spread of coronavirus disease 2019 (COVID-19) has posed challenges to the systems of care in continuing to deliver safe and effective management of chronic diseases. Fatty liver disease (FLD) from nonalcoholic fatty liver disease (NAFLD) and alcohol-associated liver disease (ALD) is a chronic disease that represents a significant cause

of morbidity and mortality among adults in the United States.<sup>(1)</sup> Although they each have unique risk factors, NAFLD and ALD often coexist.<sup>(2)</sup> Importantly, the prevalence and severity of FLD and its risk factors differ by race/ethnicity and socioeconomic status.<sup>(1,3-8)</sup> In order to address the potential negative impact of the COVID-19 pandemic on disparate and adverse

*Abbreviations:* CES-D-10, Center for Epidemiological Studies Depression 10-question survey; CI, confidence interval; COVID-19, coronavirus disease 2019; FLD, fatty liver disease; NAFLD, nonalcoholic fatty liver disease; OR, odds ratio; SDOH, social determinants of health.

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outcomes of FLD, investigation into factors that influence FLD management, such as adherence to lifestyle modifications and perceived satisfaction with FLD care delivery, especially among at-risk minority groups, is critical.

Mitigating strategies for infection prevention during the pandemic challenged norms of daily living, including group socializing, physical activity, and dietary/substance habits.<sup>(9,10)</sup> These represent critical pillars in recommended lifestyle modifications that decrease the risk of FLD.<sup>(11)</sup> Equally important, the COVID-19 pandemic has resulted in a strained economy<sup>(12)</sup> that invariably affects the most vulnerable populations through food insecurity, unstable housing, and loss of employment, among other social determinants of health (SDOH).<sup>(13,14)</sup> Since the start of the pandemic, alcohol consumption, alcohol use disorder, and reported symptoms of depression and anxiety have increased.<sup>(15-17)</sup> To date, little is known about the impact of the pandemic on these challenges faced by vulnerable populations, particularly the effect on those with FLD, including their health-related behaviors, alcohol use, and mental health.

In addition to the potential impact on health behaviors, the COVID-19 pandemic also prompted health care systems to redesign the delivery of chronic disease care, including FLD.<sup>(18)</sup> It catalyzed the wide implementation of a distanced yet readily accessible link between patients and providers beyond the standard in-person medical visit, namely telemedicine to manage liver disease. Perceived satisfaction with telemedicine delivery of FLD management likely influences adherence to provider recommendations, including lifestyle

modification. The use of hepatology-related telemedicine during the pandemic has been studied,<sup>(19-22)</sup> and disparities in use of and satisfaction with telemedicine modalities have been observed across racial groups and by socioeconomic factors.<sup>(21,22)</sup> Satisfaction with telemedicine among vulnerable patients receiving care for FLD, however, remains unclear.

In this study, we 1) evaluated the association of change in health-related behaviors, sociodemographic characteristics, and clinical factors with self-reported weight gain among vulnerable populations with FLD (nonalcohol and alcohol related) during the COVID-19 pandemic and 2) assessed factors associated with patient satisfaction with FLD care delivery using telemedicine.

## Participants and Methods

### STUDY PARTICIPANTS

From June 1, 2020, to May 5, 2021, adult patients ( $\geq 18$  years old) were recruited from the hepatology specialty clinic at Zuckerberg San Francisco General Hospital, a safety-net hospital serving the vulnerable population of San Francisco.<sup>(23)</sup> Only participants with a diagnosis of FLD defined by the presence of steatosis on imaging ( $n = 53$ ) or a liver biopsy ( $n = 58$ ) were included in this analysis. Patients with significant psychiatric or medical comorbidities preventing participation in the study or those unwilling or unable to provide consent were excluded. The majority (66%) of the participants resided in southeast neighborhoods

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of San Francisco. The study was approved by the Institutional Review Board of the University of California San Francisco and the Zuckerberg San Francisco General Hospital.

## SURVEY DESIGN

Patient demographic and social characteristics were collected using published surveys.<sup>(24,25)</sup> The COVID-19 survey instrument was developed by study investigators with input from experts in hepatology, survey design, and through resources available from the National Institutes of Health Office of Behavioral and Social Sciences Research list of COVID-19-relevant behavioral and social science domains for clinical research.<sup>(26)</sup> Survey items, which were either used verbatim or modified for use in the FLD population, evaluated mental health, quality of life, financial and food insecurity, health-related behaviors, and experience with telemedicine in the study population.<sup>(27-33)</sup> The survey was piloted before data collection, with modifications made based on feedback from English- and Spanish-speaking participants.

The final four domains of the survey focused on patient-reported experiences since the start of the COVID-19 pandemic (March 1, 2020). These were changes in access to resources (health care, housing, food), changes in health-related behaviors (diet, activity, substance use), mental health (depression and anxiety) and coping strategies, and experience with telemedicine.

Participants also completed the National Institute on Alcohol Abuse and Alcoholism (NIAAA) questionnaire for quantification of alcohol use,<sup>(34)</sup> the validated Center for Epidemiological Studies Depression 10-question survey (CES-D-10),<sup>(31)</sup> and the Patient Reported Outcomes Measurement Information System (PROMIS) Item Bank: Emotional Distress-Anxiety.<sup>(29,30)</sup>

Surveys were translated into Spanish, the most common non-English language spoken by patients with FLD in the Zuckerberg San Francisco General hepatology clinic.

## MEASURES

The primary outcomes of the study were 1) self-reported weight gain since the start of the COVID-19 pandemic and 2) participant satisfaction

with hepatology care using telemedicine. Predictors of interest were identified *a priori* and comprised risk factors of FLD,<sup>(35)</sup> health-related behaviors commonly associated with weight changes,<sup>(36)</sup> social factors, mental health factors impacted by the pandemic (including depression and anxiety),<sup>(16,17)</sup> and substance use (smoking/vaping, alcohol, and nonprescription drug use). All predictors are defined in the Supporting Materials.

Participants completed surveys in English or Spanish, and interpreter services were used for all other languages as needed. Enrolled participants were provided an incentive of US \$25 for survey completion. All demographic and social data were collected directly from participants, and clinical data, including medical history, laboratory, imaging, and histologic data, were obtained through electronic medical record review.

## CLINICAL AND LABORATORY DATA DEFINITIONS

Race and ethnicity were self-reported by all participants during their initial screening survey. Alcohol use in the prior 12 months was estimated using the NIAAA survey.<sup>(34)</sup> See Supporting Materials for additional definitions.<sup>(30,31,37)</sup>

## STATISTICAL ANALYSIS

Descriptive analyses included median (range and interquartile range) and frequency (percentage). Survey responses were summarized using frequencies and percentages. Comparison analyses were conducted using the Kruskal-Wallis test for continuous variables and chi-squared or Fisher's exact test when appropriate for categorical variables. Univariable and three-predictor logistic regression models were used to evaluate demographic, clinical, and social factors associated with self-reported weight gain (compared to those who reported no change in weight or weight loss). Multivariable analysis was adjusted for the duration of the pandemic (weeks since the start of the pandemic, March 1, 2020) at the time of survey completion. Statistical significance was assessed at  $P < 0.05$  (two-sided) in all models. Univariable and multivariable linear regression models (using a Likert scale from 1 to 5 with 1 representing "very dissatisfied" and 5 representing "very satisfied") were used to evaluate the association of factors with

participant-reported satisfaction. Multivariable analysis was adjusted for age, sex, and duration of the pandemic (weeks) at the time of survey completion. All analyses were performed using STATA statistical software package version 14 (STATA Corp LP, College Station, TX).

## Results

### COHORT CHARACTERISTICS

Of the 124 people contacted regarding the study, 119 agreed to participate (96% participation rate) and 8 were excluded from analysis due to the absence of confirmed FLD. Of the 111 final participants, the median age was 52 years, 30% were men, and the majority of patients (63%) identified as Hispanic (Table 1). Most participants were born outside the United States and were non-English speakers. The most common preferred language was Spanish. Less than half the study population completed education beyond a high school degree, and 61% reported a household annual income less than US \$30,000 per year. Most participants (63%) were categorized as obese, and 41% had diabetes. The majority (72%) of the participants had minimal or no alcohol use, but 16% reported heavy alcohol use within the prior year. Seventeen participants had coexisting chronic liver disease (16 with viral hepatitis, 1 with primary biliary cholangitis). Baseline sociodemographic and clinical characteristics are further categorized by self-reported change in weight in Table 1.

### HEALTH-RELATED BEHAVIORS, CHANGE IN RESOURCES, AND MENTAL HEALTH

#### Eating Habits

Participants reported where their meals were predominantly prepared. Of 104 respondents, 81%, 14%, and 5% reported eating 0-1, 2-3, or >3 meals prepared at restaurants on average per week, respectively. Two thirds of participants reported eating meals prepared at home more than 5 times per week. Following the start of the pandemic, overall eating habits were described as less healthy, unchanged, and healthier by 20%, 40%, and 40%, respectively (Table 2). Interestingly, unhealthy snacking (e.g., chips, cookies, crackers) was

described as increased by 18% and decreased by 25% of participants, while healthy snacking with fruits and vegetables increased in 31% and decreased in 13% during the pandemic.

#### Physical Activity and Changes in Weight

Compared to the prepandemic period, half of participants reported decreased physical activity, 30% reported no change, and 19% reported increased physical activity (Table 2). Self-reported weight gain occurred in 34% of participants, while 36% had no change and 30% reported weight loss (Table 1).

#### Coping Mechanisms

From a list of coping mechanisms, participants were asked to select which approaches they used during the pandemic (Fig. 1). The most common strategy (68%) was the use of healthy behaviors, defined as “trying to eat well-balanced meals, exercising regularly, getting plenty of sleep, avoiding alcohol and drugs.” Making time to relax, taking breaks from the news, breathing/stretching, and connecting with others were all common responses reported by over 50% of participants. Negative coping behaviors were less often selected. The most common were eating more (25%), eating less (17%), and eating more high-fat or sugary foods (13%). Few participants reported an increase in substance use (i.e., alcohol, vaping/smoking, marijuana, nonprescription drug use) (Fig. 1).

#### Change in Resources

Participants were asked questions regarding financial insecurity. Difficulty paying rent was reported by 38%, and 28% reported difficulty paying for food in the prior 2 weeks. When asked if their ability to afford basic needs, including clothing and shelter, changed during the pandemic, 47% reported yes. Additionally, 3 participants (3%) reported loss of housing. Conversely, 49% denied any financial difficulty related to COVID-19.

#### Mental Health and Substance Use

Of our total population, 31% had previously been diagnosed with depression. However, at the time of

TABLE 1. PARTICIPANT CHARACTERISTICS BY SELF-REPORTED CHANGE IN WEIGHT

Characteristic	All Participants (n = 111)*	No Change in Weight (n = 39)	Lost Weight (n = 32)	Gained Weight (n = 37)
Age in years, median (range)	52 (42-62)	50 (41-62)	55 (49-68)	54 (42-60)
Male sex, n (%)	32 (29.6)	10 (25.6)	10 (31.3)	12 (32.4)
Race/ethnicity, n (%)				
White, non-Hispanic	10 (9)	3 (7.7)	3 (9.4)	3 (8.1)
Asian/Pacific Islander	23 (20.7)	10 (25.6)	3 (9.4)	10 (27)
Hispanic	70 (63.1)	25 (64.1)	21 (65.6)	23 (62.2)
Black, non-Hispanic	3 (2.7)	1 (2.6)	2 (6.3)	--
Other	5 (4.5)	--	3 (9.4)	1 (2.7)
Birth country, n (%)	(n = 106)	(n = 37)	(n = 31)	(n = 35)
United States	23 (21.7)	8 (21.6)	8 (25.8)	6 (17.1)
Other	81 (78.3)	29 (78.4)	23 (74.2)	29 (82.9)
Primary language, n (%)				
English	24 (21.6)	8 (20.5)	8 (25)	6 (16.2)
Spanish	61 (55)	21 (53.8)	20 (62.5)	19 (51.4)
Cantonese/Mandarin	13 (11.7)	7 (17.9)	--	6 (16.2)
Other	13 (11.7)	3 (7.7)	4 (12.5)	6 (16.2)
Education level completed, n (%)	(n = 106)	(n = 37)	(n = 31)	(n = 35)
High school education or less	58 (54.7)	23 (62.2)	14 (45.2)	19 (54.3)
More than high school	48 (45.3)	14 (37.8)	17 (54.8)	16 (45.7)
Annual income, n (%)	(n = 105)	(n = 37)	(n = 31)	(n = 34)
<\$10,000	27 (25.7)	12 (32.4)	6 (19.4)	9 (26.5)
\$10,000-\$30,000	37 (35.2)	12 (32.4)	12 (38.7)	13 (38.2)
\$30,000-\$50,000	10 (9.5)	3 (8.1)	3 (9.7)	3 (8.8)
>\$50,000	5 (4.8)	2 (5.4)	1 (3.2)	2 (5.9)
Unknown/declined to answer	26 (24.7)	8 (21.6)	9 (29)	7 (20.6)
Unemployed in prior year, n (%)	52 (46.9)	18 (46.2)	9 (28.1)	22 (59.5)
Alcohol use in prior year, n (%)				
None/minimal	80 (72.1)	29 (74.4)	26 (81.3)	23 (62.2)
Moderate	13 (11.7)	5 (12.8)	4 (12.5)	4 (10.8)
Heavy	18 (16.2)	5 (12.8)	2 (6.3)	10 (27)
BMI, median (IQR), kg/m <sup>2</sup>	32.2 (28-36.6)	30.7 (28-36.1)	32.7 (28.8-37.5)	32.4 (26-36.1)
Race-based BMI category <sup>†</sup> , n (%)				
Normal	7 (6.3)	2 (5.1)	1 (3.1)	3 (8.1)
Overweight	34 (30.6)	11 (28.2)	11 (34.4)	11 (29.7)
Obese	70 (63.1)	26 (66.7)	20 (62.5)	23 (62.2)
ALT, median (IQR), units/L	49 (38-94)	53 (42-83)	40 (30-89)	56 (43-106)
AST, median (IQR), units/L	40 (28-62)	40 (33-60)	37 (25-62)	37 (31-70)
Diabetes, n (%)	46 (41.4)	16 (41)	17 (53.1)	12 (32.4)
Coexisting liver disease, n (%)	17 (15.3)	4 (10.3)	2 (6.3)	10 (27)

Abbreviations: ALT, alanine aminotransferase; API, Asian/Pacific Islander; AST, aspartate aminotransferase; BMI, body mass index; IQR, interquartile range.

\*Unless otherwise specified in the table.

<sup>†</sup>Race-based BMI categories: normal weight <25 kg/m<sup>2</sup> (<23 kg/m<sup>2</sup> for API), overweight 25-29 kg/m<sup>2</sup> (23-27.4 kg/m<sup>2</sup> for API), and obese >30 kg/m<sup>2</sup> (≥27.5 kg/m<sup>2</sup> for API).

data collection, of the 78 who answered all 10 CES-D questions, 45% screened positive for depression (14 participants with known depression and 21 without a prior diagnosis). Of those with heavy alcohol use

who completed the survey, 60% screened positive for depression compared to 31% with moderate alcohol use and 45% with no or minimal alcohol use; however, this relationship did not reach statistical significance

( $P = 0.37$ ). Additionally, a greater proportion of individuals who screened positive for depression reported decreased physical activity compared to those without depression (56% vs. 44%,  $P = 0.31$ ), but this did not reach statistical significance. Notably, participants with severe depressive symptoms were significantly

more likely to report unhealthy eating (31% vs. 7%,  $P = 0.007$ ) compared to those without depressive symptoms.

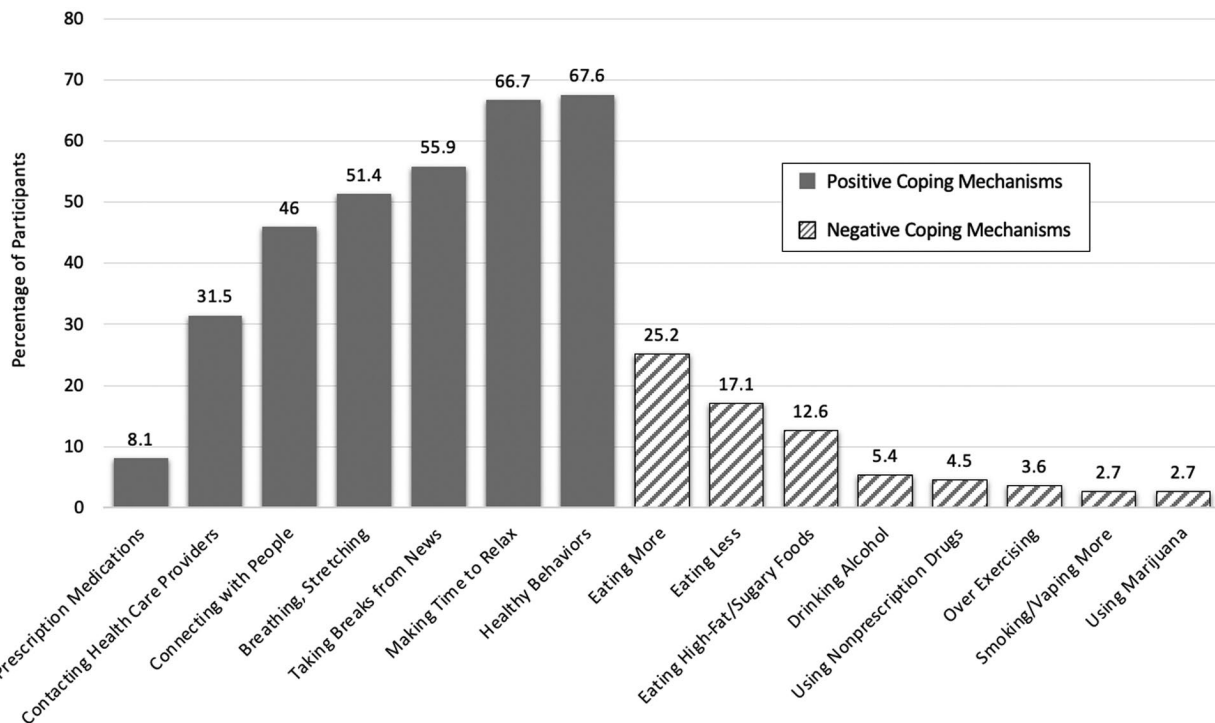
To assess participants' anxiety, an abbreviated version of the Emotional Distress-Anxiety PROMIS survey was used.<sup>(30)</sup> Participants were asked the frequency with which they 1) felt overwhelmed by their worries and 2) felt uneasy. The median anxiety score was 3 out of a total score of 8; 47% of respondents reported minimal anxiety (anxiety score 2) and 5% reported significant anxiety (anxiety score 8). Anxiety score was not statistically significantly associated with self-reported weight gain, decreased physical activity, change in overall eating habits, or frequency of alcohol use (data not shown).

**TABLE 2. PARTICIPANT-REPORTED HEALTH-RELATED BEHAVIOR DURING THE COVID-19 PANDEMIC**

Question	Total Population (n = 109)
Change in eating habits, n (%)	
Eating about the same	43 (39.5)
Eating less healthy now	22 (20.2)
Eating healthier now	44 (40.4)
Change in physical activity, n (%)	
Physical activity has remained the same	33 (30.3)
Physical activity has decreased	55 (50.5)
Physical activity has increased	21 (19.3)

### FACTORS ASSOCIATED WITH SELF-REPORTED WEIGHT GAIN

On univariable analysis, unemployment within the last year (odds ratio [OR], 2.4; 95% confidence



**FIG. 1.** Participant-reported stress reduction and coping strategies used during the COVID-19 pandemic. The proportion of participants who selected each coping strategy is shown in the bar graph. Behaviors represented by solid color bars are considered positive coping strategies; those with stripes are considered negative coping strategies. Each participant could select multiple answers. Healthy behaviors include “trying to eat healthy well-balanced meals, exercising regularly, getting plenty of sleep, avoiding alcohol and drugs.”

**TABLE 3. UNIVARIATE ANALYSIS OF FACTORS ASSOCIATED WITH SELF-REPORTED WEIGHT GAIN (GAINED WEIGHT VS. ALL OTHERS), N = 108\***

Characteristic	OR	95% CI	P Value
Duration of pandemic, by week	1.0	1.0-1.0	0.6
Age, by decade	0.9	0.6-1.2	0.36
Sex, female	0.8	0.3-1.9	0.65
Hispanic (vs. non-Hispanic) (n = 107)	0.9	0.4-2	0.72
Less than high school education (n = 103)	1.0	0.4-2.3	0.99
Annual income <\$30,000 (n = 103)	0.9	0.3-3.2	0.92
Unemployed within last year	2.4	1.1-5.4	0.036
Alcohol use (vs. none/minimal)			
Moderate	1.1	0.3-3.8	0.093
Heavy	3.4	1.2-10.1	0.026
Decreased physical activity (n = 107)	4.9	2-11.9	0.001
Unhealthy eating (reference unchanged)	2.9	1.1-7.5	0.031
Stable housing (n = 101)	2.8	0.3-24.8	0.36
Not enough money for food	0.9	0.4-2.1	0.78
Not enough money for rent	1.8	0.8-4	0.17
Difficulty paying for basic needs (n = 107)	0.9	0.4-1.9	0.74
Neighborhood unsafe for exercise	0.5	0.2-1.8	0.32
Race-based BMI category† (obese reference)			
Overweight	0.4	0.4-2.4	1.0
Normal weight	1.7	0.4-10.7	0.42
Diabetes	0.6	0.2-1.3	0.16
Depression (n = 76)	1.5	0.6-3.9	0.43
Anxiety score (n = 85)	1.0	0.8-1.3	0.92
Advanced fibrosis	0.6	0.2-1.6	0.3

Abbreviations: API, Asian/Pacific Islander; BMI, body mass index.  
 \*Unless otherwise specified in the table.  
 †Race-based BMI categories: normal weight <25 kg/m<sup>2</sup> (<23 kg/m<sup>2</sup> for API), overweight 25-29 kg/m<sup>2</sup> (23-27.4 kg/m<sup>2</sup> for API), and obese >30 kg/m<sup>2</sup> (≥27.5 kg/m<sup>2</sup> for API).

interval [CI], 1.1-5.4; *P* = 0.036), heavy alcohol use (OR, 3.4; 95% CI, 1.2-10.2; *P* = 0.026), decreased physical activity (OR, 4.9; 95% CI, 2-11.9; *P* = 0.001), and unhealthy eating (OR, 2.9; 95% CI, 1.1-7.5; *P* = 0.031) were significantly associated with greater odds of reporting weight gain (Table 3).

Three-predictor models were adjusted for pandemic duration (weeks) at the time of the survey. On multivariable analysis, decreased physical activity (OR, 4.8; 95% CI, 1.9-12; *P* = 0.001) and heavy alcohol use (vs. none/moderate; OR, 3.4; 95% CI, 1.0-10.9; *P* = 0.042) were independently associated with self-reported weight gain (Table 4). Additional models are also included in Table 4. The overall results of these

**TABLE 4. MULTIVARIABLE ANALYSIS OF FACTORS ASSOCIATED WITH SELF-REPORTED WEIGHT GAIN (GAINED WEIGHT VS. ALL OTHERS), N = 107\***

Characteristic	Model 1			Model 2 (n = 106)			Model 3			Model 4 (n = 75)			Model 5		
	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value	OR	95% CI	P Value
Decreased physical activity	4.8	1.9-12	0.001	4.4	1.8-11	0.001	4.9	2-12.2	0.001	4.8	1.6-15	0.006	4.6	1.9-11.4	0.001
Heavy alcohol (vs. not heavy)	3.4	1.0-10.9	0.042	-	-	-	-	-	-	-	-	-	-	-	-
Unhealthy eating	-	-	-	2.5	0.9-6.9	0.084	-	-	-	-	-	-	-	-	-
Unemployed within past year	-	-	-	-	-	-	2.3	0.95-5.5	0.064	-	-	-	-	-	-
Depression†	-	-	-	-	-	-	-	-	-	1.3	0.4-3.8	0.64	-	-	-
Diabetes	-	-	-	-	-	-	-	-	-	-	-	-	0.6	0.2-1.5	0.28

All multivariable models are adjusted for the number of weeks from the start of the pandemic (designated at March 1, 2020) to the date the questionnaire was completed.  
 \*Unless otherwise specified in the table.  
 †Defined as severe depressive symptoms at time of survey.



**TABLE 5. PARTICIPANTS' APPROACH TO HEALTH CARE AND TELEMEDICINE SATISFACTION DURING THE COVID-19 PANDEMIC**

Characteristic	All participants (n = 111)*
Chose not to attend in-person visit due to COVID-19, n, (%)	
Hepatology visit	(n = 109)
No	73 (67)
Yes	30 (27.5)
Not applicable	6 (5.5)
Primary care visit	(n = 110)
No	72 (66.1)
Yes	31 (28.4)
Not applicable	6 (5.5)
Chose not to seek emergency/urgent care, n, (%)	(n = 108)
No	73 (67.6)
Yes	25 (23.2)
Not applicable	10 (9.3)
Participated in telehealth/telephone visit, n, (%)	(n = 110)
No	24 (21.8)
Yes	86 (78.2)
Number of remote visits for fatty liver, n, (%)	(n = 83)
0	15 (18.1)
1-2	43 (51.8)
3-4	18 (21.7)
5+	5 (6.0)
Do not remember	2 (2.4)
Satisfaction score for remote visit for fatty liver, n, (%)	(n = 66)
Very satisfied	41 (62.1)
Somewhat satisfied	10 (15.2)
Neutral	4 (6.1)
Somewhat dissatisfied	4 (6.1)
Very dissatisfied	7 (10.6)

\*Unless otherwise specified in the table.

multivariable models did not change when adjusting for age and sex (data not shown).

## SATISFACTION WITH TELEMEDICINE

Overall, most (78%) participants had some experience with telemedicine (primary care or hepatology), and of these, 68 (82%) had attended a hepatology telemedicine visit for FLD (Table 5). Participants reported attending anywhere from 1 to 2 (52%) through 5+ (6%) telemedicine visits for their FLD. Telemedicine visits were conducted in participants' preferred languages with use of hospital medical interpreters if needed per

standard of care. The majority (62%) reported being very satisfied with their telemedicine experience for FLD; 10 (15%) were somewhat satisfied, 4 (6%) felt neutral, 4 (6%) were somewhat dissatisfied, and 7 (11%) reported being very dissatisfied. Interestingly, of the 15 participants who selected neutral, dissatisfied, or very dissatisfied, 14 (93%) were Hispanic individuals, 13 (87%) were surveyed in the latter half of the study time course, and overall they were more likely to have severe depressive symptoms (73% vs. 40%,  $P = 0.088$ ) compared to satisfied individuals, although this did not reach statistical significance.

Participants were asked about their approach to seeking health care during the pandemic. Nearly one third (28%) had chosen not to attend an in-person visit for either FLD or primary care. Importantly, 25 individuals (23%) had chosen not to seek urgent or emergency care due to the COVID-19 pandemic (Table 4).

## FACTORS ASSOCIATED WITH SATISFACTION WITH TELEMEDICINE

On univariable analysis, only Hispanic (vs. non-Hispanic) ethnicity was independently associated with lower telemedicine satisfaction (coefficient,  $-0.8$ ; 95% CI,  $-1.5$  to  $-0.2$ ;  $P = 0.016$ ). Age, a factor likely associated with confidence in technology use,<sup>(38,39)</sup> including cutoffs of 50 and 65 years, was not associated with telemedicine satisfaction (data not shown). Moreover, other factors that may influence digital literacy, including self-reported English language fluency (vs. non-English speaking; coefficient,  $0.52$ ; 95% CI,  $-0.7$  to  $1.8$ ;  $P = 0.83$ ) and use of an interpreter to conduct telemedicine visit (vs. no interpreter use; coefficient,  $-0.12$ ; 95% CI,  $-0.9$  to  $0.6$ ;  $P = 0.74$ ) were also not associated with telemedicine satisfaction. Our final multivariable model was adjusted for the duration of pandemic, sex, and age. Hispanic ethnicity remained associated with lower telemedicine satisfaction (coefficient,  $-0.8$ ; 95% CI,  $-1.7$  to  $-0.01$ ;  $P = 0.048$ ). This final model was run with the inclusion of all previously listed factors. The relationship between ethnicity and telemedicine satisfaction remained statistically significant, with the exception of the addition of depression, anxiety, education level, or annual income when the coefficient remained similar but the  $P$  value increased to  $>0.07$  (data not shown).

## Discussion

The COVID-19 pandemic has challenged norms of daily living, led to a strained economy, and forced the overhaul of health care delivery. These have each greatly impacted the general population<sup>(9,28,40,41)</sup> but have also disproportionately affected vulnerable populations and individuals with chronic diseases.<sup>(5,9,10,18)</sup> In this study, we show that, among participants with FLD receiving care in San Francisco safety-net hepatology clinics during the COVID-19 pandemic, decreased physical activity and heavy alcohol were associated with self-reported weight gain. Patient experience of care, including satisfaction, is known to impact health outcomes. In our study, satisfaction with telemedicine FLD care delivery was high but Hispanic ethnicity was associated with lower satisfaction scores.

COVID-19 mitigation strategies, including social distancing and stay-at-home orders, resulted in reported weight gain by a third and decreased physical activity in half of the participants. Our results are similar to prior studies of the general population reporting a decline in physical activity<sup>(9,28,40)</sup> and a proportion with weight gain<sup>(28)</sup> during the pandemic in addition to positive eating habits, namely less reliance on restaurant-prepared foods and healthier snacking.<sup>(28)</sup> Based on these findings, interventions to increase physical activity to recommended levels<sup>(35)</sup> and maintenance of these positive eating habits should be a focus in the management of patients with FLD as we move beyond the pandemic.

Concerns about the impact of alcohol use on liver disease during the pandemic have been expressed but data are limited.<sup>(15)</sup> In our study, most participants did not report heavy alcohol use; however, 5% reported drinking alcohol as a coping strategy. The concerning rise in depression and anxiety observed during the pandemic<sup>(16,17)</sup> is likely contributing to increased alcohol use as these are known to be linked.<sup>(42)</sup> Indeed, in our study population, 5% of participants reported severe anxiety, 45% screened positive for severe depressive symptoms (among them less than half had a prior diagnosis of depression), and an even greater proportion of those with heavy alcohol use screened positive for severe depressive symptoms (60%). Although there is a known relationship of severe depressive symptoms with decreased physical activity and unhealthy eating,<sup>(41)</sup> no statistical significance between depression and physical activity was noted in our study. Unhealthy eating and depression were, however, significantly associated, and they may have each contributed to the association

between heavy alcohol use and self-reported weight gain observed in this population. These findings are pertinent to those with FLD because anxiety and depression are linked to NAFLD<sup>(43)</sup> and are associated with worse NAFLD-related histologic findings.<sup>(44,45)</sup> Moreover, heavy alcohol use and weight gain adversely affect FLD-related outcomes<sup>(35,46)</sup> and have a synergistic effect on fibrosis progression in FLD.<sup>(47)</sup> Therefore, mental health management and alcohol cessation along with lifestyle modification are critical strategies for FLD care as we recover from the pandemic.

The transition to telemedicine and its impact on various populations have been reported,<sup>(19,20,38,39,48,49)</sup> including among individuals with liver disease,<sup>(19-22,48,49)</sup> although studies that include vulnerable populations are limited. While we observed overall high satisfaction scores with telemedicine, Hispanic ethnicity (vs. non-Hispanic) was associated with a lower satisfaction score. In fact, 93% of individuals reporting the lowest satisfaction with telemedicine were Hispanic ethnicity, 87% of them were surveyed in the latter half of the pandemic, and 73% (of 11 who completed all CES-D-10 questions) had severe depressive symptoms. As participants' reasons for reporting dissatisfaction were not explored and cannot specifically be known, it is possible that the extended time spent in the pandemic may have resulted in technology fatigue and potential loss of the positive patient-provider interactions that are more easily gained through in-person visits. Additionally, the presence of an underlying mood disorder or the overwhelming challenge of coping with the pandemic may have contributed to dissatisfaction. Lastly, when we adjusted for SDOH factors, such as education level and annual income, in our multivariable model, we no longer saw a significant association between Hispanic ethnicity and lower satisfaction score. It is possible that SDOH along with depression and anxiety play a role in an individual's negative telemedicine experience, and these factors must be explored further in future studies. With ongoing use of telemedicine in health care delivery after the pandemic, any indication of disparate care as a result of telemedicine, especially among racial/ethnic minority groups, must be evaluated and addressed.

The strengths of this study include the emphasis on a vulnerable population that requires ongoing chronic disease management and a broader range of support given their SDOH. This population is also underrepresented in research, and evaluation of their experiences enriches the currently existing scientific literature. In addition, our surveys included a

comprehensive assessment of SDOH and health-related behavior changes in response to the pandemic.

Limitations of the study are the cross-sectional study design and the resulting challenges in interpreting a single assessment of complex factors on clinical outcomes. In addition, our findings may not be generalizable to other FLD populations. Other limitations include those inherent to survey studies, including self-report and recall and response bias, as well as sample size. Additionally, we aimed to understand numerous complex topics and relationships; therefore, our study would have been enhanced with the inclusion of qualitative data in the form of focus groups or interviews. Nevertheless, we report important patient-reported experiences during the pandemic with respect to FLD risks, management, and care delivery.

In summary, since the start of the COVID-19 pandemic, decreased physical activity and heavy alcohol use were associated with increased odds of self-reported weight gain in a vulnerable population served by safety-net hepatology clinics. In addition to existing clinical practices, hepatology providers must continue to offer resources to optimize metabolic risk factors, screen for and treat heavy alcohol use, and counsel patients regarding health-related behaviors. Due to the prevalence of anxiety and depression during the pandemic, mental health screening and discussion of coping strategies should be incorporated into hepatology visits. In an era in which telemedicine has become a leading form of health care delivery, the majority of participants in this study were satisfied with their hepatology-related telemedicine visit, thus providing rich insight on possible expansion of this modality as a standard of care delivery. Nevertheless, any dissatisfaction with telemedicine should be explored to ensure equitable care, especially among the vulnerable Hispanic population. As we recover from the pandemic, the critical areas of focus are encouraging maintenance of healthy eating habits, interventions to increase physical activity, mental health management, alcohol cessation, and ongoing assessment of patient satisfaction with telemedicine.

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## Supporting Information

Additional Supporting Information may be found at [onlinelibrary.wiley.com/doi/10.1002/hep4.1873/supinfo](https://onlinelibrary.wiley.com/doi/10.1002/hep4.1873/supinfo).