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# Self-perception of health and physical activity among adults before and amidst the COVID-19 pandemic: United States, 2019–2020

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## ABSTRACT

The compounded impact of the COVID-19 lockdowns on self-perception of health (SPoH) and physical activity (PA) levels among U.S. adults remains to be explored. We sought to: (1) describe the SPoH and PA levels among U.S. adults; (2) explore the relationship between SPoH and PA before and amidst the COVID-19 pandemic. We analyzed data from the 2019 and 2020 Health Information National Trends Survey (HINTS). COVID-19 was declared a pandemic by the World Health Organization on March 11th, 2020. This date was chosen to demarcate the responses as *before* and amidst the COVID-19 pandemic. Weighted prevalence estimates were presented alongside adjusted odds ratios from multivariable logistic regression of general SPoH and PA levels for U.S. adults before and amidst COVID-19 pandemic. We analyzed data for 9328 participants. Over half of the U.S. adult population reported performing no muscle strengthening exercise in 2019. The number of inactive people has slightly increased in 2020 (27.8%), compared to 2019 (26.5%). Overall, levels of PA for active people were comparable in 2020 pre and post the WHO pandemic declaration date (36.4% and 39.8%; respectively). Higher odds of negative SPoH were observed among black individuals, current cigarettes smokers, with annual income less than \$35,000, physically inactive individuals, people who do not perform muscle-strengthening exercise, and who were very obese. Negative SPoH were associated with lack of moderate exercise, and lack of muscle-strengthening training among U.S. adults before and amidst the pandemic. Pandemic policies and recommendations should include and facilitate PA, specifically among vulnerable populations.

## 1. Introduction

On March 11th, 2020, the World Health Organization (WHO) COVID-19 a global pandemic (World Health Organization, 2020). Cueing public health authorities to implement a series of preemptive measures such as social distancing, self-quarantine practices, travel restrictions, in addition to cancellation of recreational events (Guidance for COVID-19, 2020). These isolation measures are likely to have resulted in a number of unintended consequences including decreased physical activity (PA) and increased negative self-perception of health (SPoH) in the population (Lesser and Nienhuis, 2020; Dunton et al., 2020).

SPoH refers to the subjective perception of one's health in general (Confortin et al., 2015; Cardoso et al., 2014). It captures the impact of health conditions on various aspects of an individual's health, including but not limited to, physical and mental well-being (Confortin et al.,

2015; Cardoso et al., 2014). SPoH is a reliable, low-cost method to measure individual's well-being and found to be consistent with objective health status (Confortin et al., 2015; Cardoso et al., 2014; Wu et al., 2013). It has also been used as a predictor for mortality and quality of life (Confortin et al., 2015; Cardoso et al., 2014; Idler and Benyamini, 1997). SPoH is also sensitive to income inequality, socioeconomic status, gender and PA levels (Piko, 2000; Kennedy et al., 1998; Thorlindsson et al., 1990). In light of COVID-19 pandemic, decreased PA could negatively impact SPoH through two pathways. Firstly, a sudden reduction in PA might have exacerbated pre-existing physical and mental health conditions (Rodgers et al., 2020). Secondly, evidence suggests that sufficient PA is linked to improved quality of life and lower mental health burden (Physical Activity Guidelines Advisory Committee, 2018; Cherkroud et al., 2018). During the early months of the pandemic, physically active individuals reported greater mental health scores; and those who increased their PA levels experienced lower levels

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of anxiety (Lesser and Nienhuis, 2020).

Prior to the pandemic, about 1 in 4 U.S. adults fully met the PA guidelines for aerobic and muscle-strengthening activities (Fulton et al., 2018). The 2018 Physical Activity Guidelines for Americans include performing moderate-intensity aerobic PA at least 150–300 min a week and muscle-strengthening activities of moderate intensity two or more days a week (US Health and Human Services Department, 2008). Additionally, more than 30 million adults aged 50+ are inactive, performing no PA beyond that of daily living (Fulton et al., 2018). About 11% of U.S. healthcare expenditures (\$117 billions annually), and 1 in 10 premature deaths are associated with inadequate levels of PA (Kochanek et al., 2014; Carlson et al., 2015). With COVID-19 restrictions, PA levels were found to be negatively impacted, globally, with an increase in the average daily sitting time from 5 to 8 h (Ammar et al., 2020). In the US, COVID-19 restrictions reduced PA among adults between 32% and 48% during the early weeks of the pandemic. (Meyer et al., 2020) Additionally, COVID-19 was listed by the CDC as the third-leading cause of death among adults in the US in 2020. (Ahmad et al., 2021) Higher COVID-19 death rates were observed among adults aged  $\geq 85$  years, American Natives, Hispanic persons, and males (Ahmad et al., 2021); which could have influenced their behaviors and SPoH. The compounded impact of COVID-19 lockdown on SPoH and PA levels among U.S. adults remains to be explored. Therefore, we aimed to: (1) describe the general SPoH and PA levels among U.S. adults and, (2) explore the relationship between SPoH and PA, before 2019 and amidst the COVID-19 pandemic in 2020.

## 2. Methods

### 2.1. Study population, design, and settings

We analyzed the nationally representative data from the Health Information National Trends Survey of U.S. adults 18 years or older administered by the National Cancer Institute (HINTS 5 Cycle 3, 2019 and HINTS 5 Cycle 4, 2020). Data collection for Cycle 3 of HINTS 5 began in January 2019 and concluded in April 2019 with a total of 5438 participants completing the survey. Data collection for Cycle 4 of HINTS 5 began on February 24, 2020, and concluded on June 15, 2020, with a total of 3890 participants completing the survey. Fig. 1 illustrates the history and status of COVID-19 pandemic in the US, with HINTS cycles timeline. Both cycles (HINTS 2019 and 2020;  $n = 9328$ ) employed a two-stage sampling design to select participating households; details have been described elsewhere (National Cancer Institute, 2014; Westat., 2015). Overall household response rates were 30.3% for 2019 and 36.7% for 2020, calculated using the new American Association for Public Opinion Research response rate 4 formula (RR4) (American Association for Public Opinion Research, 2016). Harvard Medical School Institutional Review Board exemption was obtained for this study (#IRB21–1321).

### 2.2. Outcome variable

The outcome was the participants' self-rated health perceptions (*healthy* or *unhealthy*). This was determined from the question "In general, would you say your health is...". The responses "excellent", "very good", or "good" were grouped as *healthy*, and *unhealthy* if they were "poor", or "fair".

### 2.3. Measures

#### 2.3.1. Participant characteristics

socio-demographic characteristics included level of education, age, sex, ethnicity/race, rural-urban residence, household annual income and lifestyle characteristics. Level of education was divided into 4 categories: less than high-school, 12 years of education or high school diploma, post-high school or some college, and college graduate or more (post-graduate). Age was grouped into 4 categories as follows: 18 to 34 years, 35 to 49 years, 50 to 64 years, and 65 years or older. Ethnicity and race were categorized as non-Hispanic white, non-Hispanic Black, Hispanic, Non-Hispanic Asian, and Non-Hispanic Other. Residence was defined using the U.S. Department of Agriculture's 2013 Rural-Urban Continuum Codes (Rural-Urban Continuum Codes, 2020). Codes 1 to 3 were designated as urban, while codes 4 to 9 were categorized as rural. Household annual income was categorized into 4 categories: less than \$35,000, \$35,000 to \$49,999, \$50,000 to \$74,999, and \$75,000 or more.

#### 2.3.2. Pandemic return variable

Data collection for HINTS 5 Cycle 4 started before COVID-19 was declared a pandemic and continued after the declaration by WHO March 11th, 2020. There is an assumption that people who returned the survey earlier may have responded in different ways to some of the survey questions than people who responded later. This variable was chosen to demarcate responses as responses *before* and *amidst* the COVID-19 pandemic.

#### 2.3.3. Existing health conditions

Diabetes, high blood pressure, heart condition (heart attack, angina, or congestive heart failure), chronic lung disease (asthma, emphysema, or chronic bronchitis), mental health issues (depression or anxiety disorder). These were assessed by asking "if a doctor or other health professional ever told you that you had any of them".

#### 2.3.4. Smoking status

Derived from two questions, "Have you smoked at least 100 cigarettes in your entire life?" Those who answered *no* were categorized as never smokers. Among those who answered *yes*, a follow-up question was asked: "Do you now smoke cigarettes every day, some days, or not at all?" Those who answered *not at all* were categorized former smokers, while others were considered current smokers.

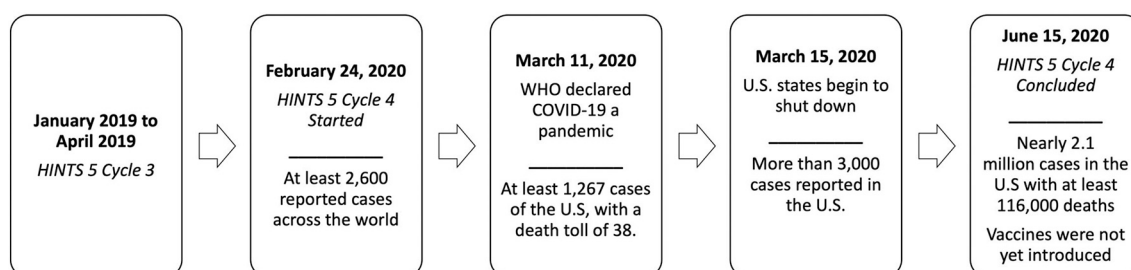


Fig. 1. Illustration of the history and status of COVID-19 pandemic in the United States, alongside the timeline of the Health Information National Trends Survey (HINTS) cycles included in the study. Data were obtained from the CDC Museum of COVID-19 Timeline and the John Hopkins Coronavirus Resource Center.

2.3.5. Body Mass Index (BMI)

BMI variable was created with weight in pounds and height in inches (Weight\*703) / (Height in inches\*2). Following the CDC interpretation (About Adult BMI, 2021), BMI was categorized into 5 groups: Below 18.5 (Underweight), 18.5–24.9 (Normal or Healthy Weight), 25.0–29.9 (Overweight), 30.0–34.9 (Obese), 35 or higher (Very Obese).

2.3.6. Physical activity (PA)

Weekly moderate exercise in minutes, was assessed with the frequently used scoring algorithm in U.S. national surveys (US Health and Human Services Department, 2008). Individual survey respondents are classified into three basic levels: Active (meeting the guidelines): reporting 150 min or more of moderate exercise per week. Insufficiently active (some reported PA but not enough to meet existing recommendations): those who reported 1–149 min of moderate exercise per week. Inactive (no reported PA): respondents reporting no moderate exercise (Physical Activity, 2021). Frequency of Strength Training, muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms). Was assessed with the following question "In a typical week, outside of your job or work around the house, how many days do you do leisure-time physical activities specifically designed to strengthen your muscles?" Answer choices were grouped into No strength training (0 days), Some strength training (1 day), Recommended amount strength training or more (2 days or more) (Physical Activity, 2021).

2.4. Statistical analysis

We performed secondary data analysis of cross-sectional data. Descriptive statistics were used for categorical variables including participants' SPoH and sociodemographic characteristics. Weighted percentages were used to report nationally representative results and to account for the complex survey design. We performed unadjusted and adjusted logistic regression models to evaluate the association between negative perception of health and: (Model 1) Weekly moderate exercise, and (Model 2) Muscle strengthening exercise as main predictors. In both models we adjusted for the demographic (age, sex, race-ethnicity, rural-urban residence, household annual income, and highest education achieved) and lifestyle characteristics (smoking status, PA, and BMI), and existing health conditions (diabetes, heart diseases, high blood pressure, chronic lung conditions, depression, and anxiety disorders) of respondents. We calculated odds ratios (OR), adjusted odds ratios (AOR) and 95% confidence intervals (95%CI). Statistical significance was defined as a P value less than 0.05, and all statistical analyses were performed using STATA version 14 (StataCorp).

3. Results

3.1. Study population

Table 1 presents the demographic characteristics and the prevalence of PA levels and SPoH among U.S. adults in 2019 and 2020. In 2019 and 2020, over half of the samples were women (51.2% in 2019 and 51.4% in 2020), and predominantly of non-Hispanic white ethnicity (63.5%). In both years, most of the respondents had an income above.

\$75 K (39.6%, 42.5% respectively), and were living in urban areas (86.7% and 87.8% respectively). In 2020, 13.8% reported being a current smoker compared to 12.5% in 2019. In both years, 36.0% of the sample reported having high blood pressure and 8.1% reported having a heart condition (Table 1).

3.1.1. Self-perception of health (SPoH)

In 2019, 15.2% of U.S. adults perceived themselves as unhealthy. Negative perceptions were higher among the non-Hispanic black population (21.8%), compared to 12.8% of the non-Hispanic whites and 9.8% of Asians in 2019. In 2020, 14.1% of adults perceived themselves

Table 1

Demographics, physical activity levels and self-perception of health among U.S. adults - Health Information National Trends Survey (HINTS) 2019 and 2020.

Characteristics	2019		2020 (*)	
	Weighted US population % (SE)	Self-perception of health (unhealthy) % (SE)	Weighted US population % (SE)	Self-perception of health (unhealthy) % (SE)
Overall	(n = 5438, 100%)	(n = 853, 15.2%)	(n = 3890, 100%)	(n = 627, 14.1%)
Weekly moderate exercise in minutes				
Inactive	26.5 (0.01)	28.9 (0.02)	27.8 (0.01)	24.2 (0.02)
Insufficiently active	35.6 (0.01)	12.3 (0.01)	33.7 (0.01)	10.9 (0.02)
Active	38.0 (0.01)	8.3 (0.01)	38.6 (0.01)	9.5 (0.01)
Muscle-strengthening activities				
No training	53.1 (0.01)	20.5 (0.01)	54.4 (0.01)	18.6 (0.01)
Some training	10.4 (0.01)	6.1 (0.01)	9.6 (0.01)	11.0 (0.03)
≥Adequate training	36.5 (0.01)	9.9 (0.01)	36.1 (0.01)	7.8 (0.01)
Sex				
Male	48.8 (0.002)	15.6 (0.01)	48.7 (0.002)	15.3 (0.01)
Female	51.2 (0.002)	14.7 (0.01)	51.4 (0.002)	12.8 (0.01)
Age category (years)				
18–34	24.3 (0.01)	10.9 (0.02)	26.2 (0.01)	7.1 (0.02)
35–49	24.5 (0.01)	12.8 (0.01)	25.5 (0.01)	12.4 (0.02)
50–64	31.1 (0.01)	19.1 (0.02)	27.7 (0.01)	17.0 (0.02)
65+	20.2 (0.001)	17.4 (0.01)	20.6 (0.001)	21.3 (0.02)
Ethnicity/race				
Non-Hispanic White	63.5 (0.003)	12.8 (0.01)	63.4 (0.003)	10.8 (0.01)
Non-Hispanic Black	11.3 (0.002)	21.8 (0.02)	11.1 (0.002)	20.8 (0.03)
Hispanic	16.8 (0.001)	19.3 (0.03)	17.0 (0.001)	15.6 (0.02)
Non-Hispanic Asian	5.3 (0.002)	9.8 (0.03)	5.2 (0.003)	12.9 (0.07)
Other	3.1 (0.001)	18.6 (0.07)	3.3 (0.003)	36.6 (0.10)
Education level				
<High school	7.0 (0.01)	31.5 (0.04)	8.0 (0.01)	20.4 (0.03)
High school	23.4 (0.01)	18.6 (0.02)	22.5 (0.01)	20.0 (0.02)
Some college	40.2 (0.01)	17.0 (0.01)	39.2 (0.01)	16.0 (0.02)
≥College degree	29.5 (0.01)	6.4 (0.01)	30.3 (0.01)	5.5 (0.01)
Annual household income (US\$)				
< 35 K	29.5 (0.01)	25.9 (0.02)	26.6 (0.01)	24.8 (0.02)
35–50 K	13.5 (0.01)	19.2 (0.03)	12.7 (0.01)	17.4 (0.03)
50–75 K	17.4 (0.01)	12.4 (0.02)	18.3 (0.01)	12.4 (0.03)
> 75 K	39.6 (0.02)	6.6 (0.01)	42.5 (0.02)	7.2 (0.01)
Residence				
Urban	86.7 (0.01)	14.6 (0.01)	87.8 (0.01)	13.7 (0.01)
Rural	13.3 (0.01)	18.9 (0.03)	12.2 (0.01)	17.4 (0.03)
Tobacco smoking status				
Current	12.5 (0.01)	26.3 (0.03)	13.8 (0.01)	21.0 (0.04)
Former	23.2 (0.01)	17.8 (0.01)	23.0 (0.01)	19.3 (0.02)
Never	64.3 (0.01)	12.0 (0.01)	63.1 (0.01)	10.5 (0.01)
Body Mass Index				
Underweight	1.6 (0.004)	14.7 (0.06)	1.2 (0.002)	16.1 (0.06)
Normal	30.0 (0.01)	8.17 (0.01)	32.9 (0.01)	10.8 (0.01)
Overweight	34.8 (0.01)	12.1 (0.01)	31.7 (0.01)	10.9 (0.02)
Obese	18.3 (0.01)	19.1 (0.02)	19.8 (0.01)	16.1 (0.02)
Very obese	15.3 (0.01)	31.6 (0.03)	14.4 (0.01)	24.9 (0.03)
Medical condition				
Diabetes	17.0 (0.01)	33.7 (0.02)	17.9 (0.01)	30.7 (0.03)

(continued on next page)

Table 1 (continued)

Characteristics	2019		2020 (*)	
	Weighted US population % (SE)	Self-perception of health (unhealthy) % (SE)	Weighted US population % (SE)	Self-perception of health (unhealthy) % (SE)
High blood pressure	36.0 (0.01)	25.7 (0.02)	36.1 (0.01)	22.5 (0.02)
Heart condition	8.1 (0.01)	40.9 (0.04)	8.1 (0.01)	37.1 (0.04)
Lung disease	11.2 (0.01)	35.8 (0.03)	12.7 (0.01)	27.8 (0.03)
Depression	23.4 (0.01)	27.3 (0.02)	24.3 (0.01)	25.5 (0.02)

Note. (\*) Refer to Supplemental Table 1 for demographics, physical activity levels results and self-perception of health before and after WHO pandemic declaration date March 11th, 2020. The percentages reported are weighted columns to account for complex survey design. The weighted population counts are rounded to the nearest 100; SE: Standard Error; (%): Weighted Percentages=.

as unhealthy (Table 1). However, in 2020, Hispanics and Asians reported higher unhealthy perceptions after the pandemic declaration date of March 11th (17.1%, and 15.5% respectively; Supplementary Table 1). There were higher perceptions of being unhealthy among adults with less than high-school education (32.0% in 2019 and 20.4% in 2020; Table 1). In 2020, after the pandemic declaration date, 21.0% of current smokers had negative SPoH, compared to 26.6% post declaration date (Supplementary Table 1). In 2019 and 2020, adults who were physically inactive, and adults who do not perform any muscle-strengthening exercise, and those who were very obese have consistently higher negative health perceptions (Table 1). Overall, poor SPoH was higher among people with chronic medical conditions both before and amidst the pandemic (Table 1).

3.2. Physical activity

In 2019, 26.5% of adults reported being inactive, and over half of the U.S. population (53.1%) reported no muscle-strengthening exercise. The prevalence of inactive people has slightly increased in 2020 (Table 1). Fig. 2 summarizes PA levels among different age categories before and

amidst the COVID-19 pandemic. In 2020, 27.6% of adults who reported being inactive were 65+ years, compared to 28.2% in 2019. In 2019, adults aged 50–64 years were the most active age group (29.5%), and 28.9% of them performed adequate muscle-strengthening exercise. In 2020, 27.1% of young adults below the age of 35 reported performing adequate muscle training exercises compared to 29.1% in 2019.

3.3. The relationships between self-perception of health and physical activity among US adults before and amidst the COVID-19 pandemic

The unadjusted odds of negative health perceptions were higher among adults who were inactive (OR 4.50, 95%CI 3.06–6.61,  $P \leq 0.0001$ ) and (OR 3.04, 95%CI 1.95–4.74,  $P \leq 0.0001$ ) compared to active adults in 2019 and 2020, respectively. The odds of negative SPoH were higher among adults who did not perform any muscle-strengthening exercise (OR 2.35, 95%CI 1.71–3.23,  $P \leq 0.001$ ) and (OR 2.68, 95%CI 2.05–3.50,  $P \leq 0.0001$ ) compared to active adults in both 2019, 2020 respectively.

Tables 2 and 3 present the adjusted results of the multivariable logistic regression models of the association between negative SPoH and both, weekly moderate exercise, and muscle-strengthening activities in 2019 and 2020. After adjusting for potential confounding factors, the association between the lack of moderate exercise and negative SPoH were significant. People who were inactive had three folds the odds of perceiving themselves as unhealthy compared to those who were sufficiently active in 2019 (AOR 2.97, 95%CI 1.94–4.55;  $P \leq 0.0001$ ), and similarly in 2020 (AOR 1.92, 95%CI 1.92–3.44;  $P = 0.029$ ; Table 2). Furthermore, adults who did not perform any muscle-strengthening exercise had over twice the odds of perceiving their health as poor or fair in 2019 (AOR 1.94, 95%CI 1.35–2.78;  $P = 0.001$ ), similarly in 2020 (AOR 2.43, 95%CI 1.70–3.48;  $P \leq 0.0001$ ), compared to adults who were sufficiently active that respective year (Table 3). Those with medical conditions, such as diabetes, had over twice the odds of perceiving their health to be negative, compared to non-diabetics (AOR 2.09, 95%CI 1.50–2.92;  $P \leq 0.0001$ ) and (AOR 2.48, 95%CI 1.34–4.58;  $P = 0.004$ ) in 2019 and 2020, respectively (Table 3). Similar trends were seen among adults with depression, with over two times the odds of negative health perceptions (AOR 2.42, 95%CI 1.66–3.52;  $P \leq 0.0001$ ) and (AOR 2.78, 95%CI 1.77–4.36;  $P \leq 0.0001$ ) in 2019 and 2020,

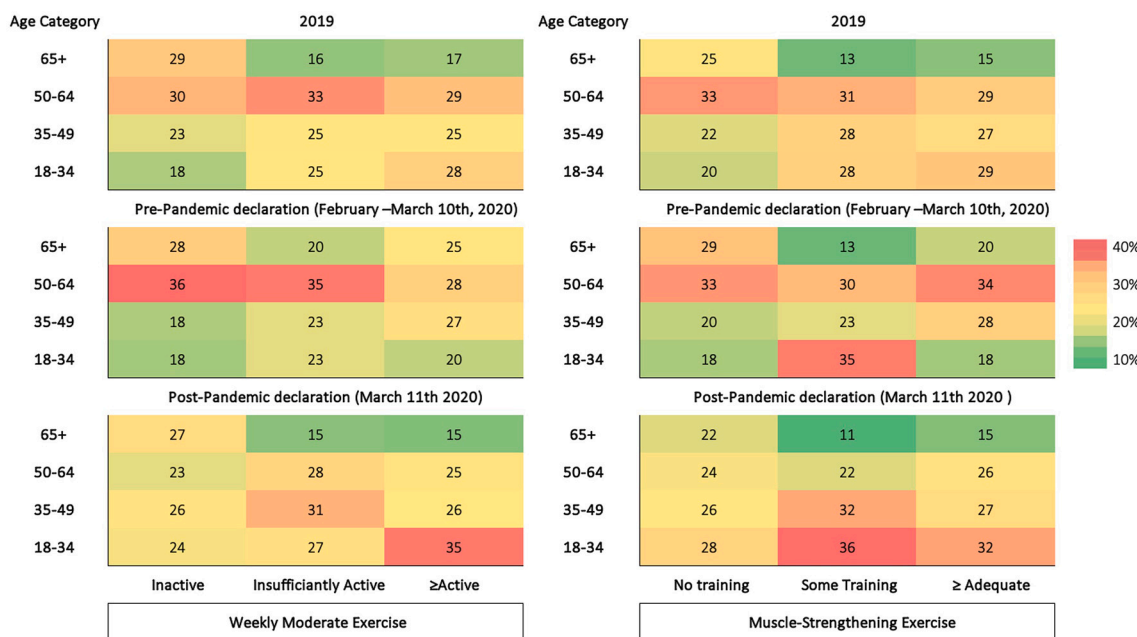


Fig. 2. Prevalence of the reported weekly moderate exercise and muscle-strengthening activities, stratified by participants age. Health Information National Trends Survey (HINTS) 2019 and 2020.

**Table 2**  
Logistic regression analysis of the association between negative self-perception of health and physical activity among U.S. adults - Health Information National Trends Survey (HINTS) 2019–2020.

Covariates	2019 AOR (95% CI)	P-value	2020* AOR (95%CI)	P-value
Weekly moderate exercise in minutes				
≥ sufficient activity	[reference]		[reference]	
Insufficiently active	1.22 (0.81–1.84)	0.33	0.90 (0.52–1.55)	0.687
Inactive	<b>2.97 (1.94–4.55)</b>	<b>≤0.0001</b>	<b>1.92 (1.07–3.44)</b>	<b>0.029</b>
Sex				
Male	[reference]		[reference]	
Female	0.80 (0.56–1.14)	0.216	1.05 (0.65–1.70)	0.837
Age category (years)				
18–34	[reference]		[reference]	
35–49	1.11 (0.54–2.27)	0.770	1.56 (0.74–3.31)	0.238
50–64	1.28 (0.57–2.87)	0.537	1.70 (0.76–3.78)	0.190
65+	0.92 (0.46–1.82)	0.801	2.05 (0.92–4.56)	0.078
Ethnicity/race				
Non-Hispanic White	[reference]		[reference]	
Non-Hispanic Black	<b>1.82 (1.09–3.04)</b>	<b>0.022</b>	1.76 (0.91–3.40)	0.092
Hispanic	<b>1.59 (1.06–2.41)</b>	<b>0.027</b>	<b>2.21 (1.26–3.86)</b>	<b>0.007</b>
Non-Hispanic Asian	2.08 (0.88–4.92)	0.096	2.54 (0.27–23.46)	0.404
Other	2.09 (0.49–8.92)	0.310	<b>6.10 (1.10–33.93)</b>	<b>0.039</b>
Education level				
≥College degree	[reference]		[reference]	
Some college	<b>1.74 (1.08–2.82)</b>	<b>0.025</b>	<b>2.07 (1.05–4.08)</b>	<b>0.036</b>
High school	1.35 (0.79–2.32)	0.270	<b>2.28 (1.21–4.31)</b>	<b>0.012</b>
<high school	<b>2.38 (1.09–5.18)</b>	<b>0.030</b>	1.07 (0.44–2.61)	0.882
Annual household income (US\$)				
> 75 K	[reference]		[reference]	
50–75 K	1.50 (0.84–2.71)	0.169	1.21 (0.54–2.71)	0.636
35–50 K	1.97 (0.97–4.01)	0.061	1.55 (0.76–3.15)	0.219
< 35 K	<b>2.41 (1.35–4.28)</b>	<b>0.003</b>	1.83 (0.96–3.50)	0.067
Residence				
Urban	[reference]		[reference]	
Rural	1.23 (0.72–2.11)	0.444	1.26 (0.53–2.99)	0.601
Tobacco smoking status				
Never	[reference]		[reference]	
Former	1.29 (0.83–2.01)	0.244	<b>1.69 (1.02–2.81)</b>	<b>0.041</b>
Current	1.61 (0.99–2.62)	0.055	1.67 (0.84–3.31)	0.140
Body Mass Index				
Normal	[reference]		[reference]	
Underweight	1.33 (0.43–4.05)	0.611	1.07 (0.23–5.05)	0.935
Overweight	1.16 (0.77–1.72)	0.463	0.89 (0.50–1.61)	0.701
Obese	<b>1.71 (1.09–2.67)</b>	<b>0.020</b>	1.08 (0.57–2.05)	0.803
Very obese	<b>2.36 (1.28–4.34)</b>	<b>0.007</b>	1.28 (0.72–2.27)	0.401
Existing medical conditions				

**Table 2 (continued)**

Covariates	2019 AOR (95% CI)	P-value	2020* AOR (95%CI)	P-value
Diabetes	<b>1.96 (1.38–2.77)</b>	<b>≤0.0001</b>	<b>2.46 (1.27–4.76)</b>	<b>0.008</b>
High blood pressure	<b>1.56 (1.10–2.21)</b>	<b>0.031</b>	1.26 (0.75–2.11)	<b>0.373</b>
Heart condition	<b>2.35 (1.32–4.19)</b>	<b>0.005</b>	<b>2.14 (1.09–4.22)</b>	<b>0.029</b>
Lung disease	<b>2.38 (1.54–3.67)</b>	<b>≤0.0001</b>	<b>1.80 (1.06–3.04)</b>	<b>0.030</b>
Depression	<b>2.20 (1.49–3.25)</b>	<b>≤0.0001</b>	<b>2.68 (1.68–4.28)</b>	<b>≤0.0001</b>

Note. AOR: adjusted odds ratio; CI: confidence interval; Reference: reference group. The bold values are significant,  $p < 0.05$ . (\*) Refer to Supplemental Table 2 for Logistic regression analysis of the association between Self-Perception of Health and Physical Activity among before and after WHO pandemic declaration date March 11th, 2020.

respectively. **Supplementary Table 2** presents the adjusted results of the logistic regression models of the association between SPoH and PA before and after WHO pandemic declaration date March 11th, 2020.

#### 4. Discussion

This is the first national study to explore SPoH, PA levels, and their associations among U.S. adults, before and amidst the COVID-19 pandemic. We identified that over half of U.S. adults did not perform any muscle-strengthening exercise in 2019. The number of inactive people has slightly increased in 2020. In general, levels of PA for active people were comparable in 2020 pre and post pandemic declaration dates. We also identified high levels of negative SPoH among non-Hispanic black individuals, current smokers, people with heart conditions, those with annual income less than \$35,000, physically inactive individuals, people who do not perform muscle-strengthening exercise, and who were very obese.

Albeit high, we found that the overall proportion of individuals reporting negative SPoH was relatively lower in 2020 compared to 2019. A possible explanation could be that early media messages consistently emphasized that people who are at risk of COVID-19 infection are older adults and individuals with multiple morbidities. These messages might have created a sense of ‘optimism bias’, that is the belief that bad outcomes are less likely to occur to oneself than others (Sharot, 2011; Wise et al., 2020). Therefore, optimism bias could have caused younger and healthier individuals to underestimate their likelihood of contracting diseases and elevated their self-awareness of health (Sharot, 2011; Wise et al., 2020). Additionally, there is a conceptual contrast between “internal” views of health (one’s self perceptions) and “external” views (based on the observations of experts) (Sen, 2002). Evaluating general health status is complicated by the fact that a person’s own understanding of their health may not accord with the appraisal of medical experts (Sen, 2002).

Levels of PA for active people were comparable in 2020 pre and post pandemic declaration dates. In response to stress, some active individuals tend to increase PA engagement, meanwhile, stress negatively impacts PA levels among inactive individuals (Stults-Kolehmainen and Sinha, 2014). Active people usually exhibit autonomous motivation to physical exercise compared to inactive individuals; maintaining their activity levels during the pandemic (Nielsen and Reiss, 2012). We also found that physical inactivity was associated with increased odds of negative health perception among adults in both 2019 and 2020. The association was stronger between lack of muscle-strengthening exercise and negative self-perception in 2020 compared to 2019. These findings are aligned with the evidence suggesting that PA, specifically resistance training, has a clear impact on a range of health and morbidity related risk factors (Loprinzi et al., 2015; Loprinzi and Loenneke, 2015) and quality of life (Physical Activity Guidelines Advisory Committee, 2018). Physical

**Table 3**  
Logistic regression analysis of the association between negative self-perception of health and Muscle-strengthening exercise among U.S. adults - Health Information National Trends Survey (HINTS) 2019–2020.

Covariates	2019 AOR (95% CI)	P-value	2020* AOR (95%CI)	P-value
Muscle-strengthening exercise				
≥Adequate training	[reference]		[reference]	
Insufficient training	<b>0.43 (0.19–0.98)</b>	<b>0.045</b>	1.61 (0.65–3.96)	0.294
No training	<b>1.94 (1.35–2.78)</b>	<b>0.001</b>	<b>2.43 (1.70–3.48)</b>	<b>≤0.0001</b>
Sex				
Male	[reference]		[reference]	
Female	0.80 (0.56–1.14)	0.211	0.98 (0.62–1.56)	0.942
Age category (years)				
18–34	[reference]		[reference]	
35–49	1.05 (0.55–2.01)	0.878	1.76 (0.81–3.80)	0.149
50–64	1.13 (0.56–2.28)	0.734	1.98 (0.90–4.33)	0.084
65+	0.91 (0.49–1.67)	0.750	<b>2.37 (1.04–5.38)</b>	<b>0.040</b>
Ethnicity/race				
Non-Hispanic white	[reference]		[reference]	
Non-Hispanic black	<b>1.87 (1.13–3.11)</b>	<b>0.016</b>	1.92 (0.97–3.77)	0.060
Hispanic	<b>1.60 (1.03–2.48)</b>	<b>0.037</b>	<b>2.37 (1.41–3.99)</b>	<b>0.002</b>
Non-Hispanic Asian	<b>2.33 (0.99–5.44)</b>	<b>0.050</b>	2.76 (0.38–19.82)	0.306
Other	2.56 (0.77–8.47)	0.122	<b>6.71 (1.19–37.93)</b>	<b>0.032</b>
Education level				
≥College degree	[reference]		[reference]	
Some college	<b>1.90 (1.20–3.03)</b>	<b>0.008</b>	<b>1.99 (1.04–3.93)</b>	<b>0.039</b>
High school	1.53 (0.93–2.52)	0.089	<b>2.25 (1.17–4.32)</b>	<b>0.016</b>
<High school	<b>2.24 (1.03–4.85)</b>	<b>0.041</b>	1.20 (0.47–3.08)	0.705
Annual household income (US\$)				
> 75 K	[reference]		[reference]	
50–75 K	1.45 (0.80–2.63)	0.211	1.19 (0.51–2.76)	0.676
35–50 K	<b>2.19 (1.13–4.22)</b>	<b>0.021</b>	1.55 (0.76–3.15)	0.218
< 35 K	<b>2.46 (1.44–4.20)</b>	<b>0.001</b>	<b>1.95 (1.03–3.66)</b>	<b>0.040</b>
Residence				
Urban	[reference]		[reference]	
Rural	1.20 (0.70–2.05)	0.501	1.14 (0.50–2.69)	0.755
Tobacco smoking status				
Never	[reference]		[reference]	
Former	1.34 (0.88–2.06)	0.171	<b>1.69 (1.02–2.82)</b>	<b>0.043</b>
Current	<b>1.69 (1.05–2.72)</b>	<b>0.031</b>	1.70 (0.91–3.19)	0.095
Body Mass Index				
Normal	[reference]		[reference]	
Underweight	0.96 (0.32–2.89)	0.940	1.09 (0.25–4.70)	0.908
Overweight	1.15 (0.82–1.61)	0.402	0.86 (0.47–1.55)	0.607
Obese	<b>1.81 (1.19–2.75)</b>	<b>0.007</b>	1.12 (0.63–1.99)	0.704
Very obese	<b>2.77 (1.52–5.04)</b>	<b>0.001</b>	1.30 (0.74–2.30)	0.350

**Table 3 (continued)**

Covariates	2019 AOR (95% CI)	P-value	2020* AOR (95%CI)	P-value
Existing medical conditions				
Diabetes	<b>2.09 (1.50–2.92)</b>	<b>≤0.0001</b>	<b>2.48 (1.34–4.58)</b>	<b>0.004</b>
High blood pressure	<b>1.53 (1.11–2.12)</b>	<b>0.010</b>	1.25 (0.77–2.04)	0.365
Heart condition	<b>2.56 (1.44–4.56)</b>	<b>0.002</b>	1.90 (1.0–3.63)	0.050
Lung disease	<b>2.34 (1.57–3.48)</b>	<b>≤0.0001</b>	<b>1.87 (1.16–3.03)</b>	<b>0.012</b>
Depression	<b>2.42 (1.66–3.52)</b>	<b>≤0.0001</b>	<b>2.78 (1.77–4.36)</b>	<b>≤0.0001</b>

Note. AOR: adjusted odds ratio; CI: confidence interval; Reference: reference group. The bold values are significant,  $p < 0.05$ . (\*) Refer to Supplemental Table 2 for Logistic regression analysis of the association between Self-Perception of Health and Physical Activity among before and after WHO pandemic declaration date March 11th, 2020.

inactivity coupled with the heightened anxiety during the early months of the pandemic might have exacerbated negative SPoH among inactive people.

Furthermore, the associations between PA and general SPoH in 2020 highlighted some inequities among vulnerable populations. Similar to other studies, we found that Hispanics, Asians, people who are 65+ of age, those with lower income, and people with high school education had higher odds of negative self-perceptions of health compared to their reference groups (Piko, 2000; Kennedy et al., 1998; Thorlindsson et al., 1990). Minorities and vulnerable populations have been disproportionately affected by the negative consequences of the COVID-19 pandemic such as unemployment, non-essential businesses closure, and significant reduction in access to healthcare (Health Equity Considerations and Racial and Ethnic Minority Groups, 2020; Kirby, 2020; Williamson et al., 2020). The spillover effect of the upstream social determinants of health for various inequalities has been associated with psychosocial stress and negative health outcomes (Health Equity Considerations and Racial and Ethnic Minority Groups, 2020; Kirby, 2020; Williamson et al., 2020). Thus, in addition to the major consequences of COVID-19 to the economy, communities, and existing inequalities, COVID-19 may have disproportionately exacerbated negative self-perceptions of health.

The strengths of this study include the nationally representative sample from 2019 and 2020. Furthermore, we were able to explore the data before and after WHO pandemic declaration date for various demographics and health conditions. This study was also subjected to some limitations. Respondents who returned the surveys in 2020 after the declaration date could have completed them before March. Additionally, major changes in behaviors and SPoH might have not come on effect in the early weeks after declaration date. A follow up study using longitudinal data would be of interest. The study was also susceptible to response bias because it relied on self-reported information (e.g., medical conditions and level of PA). Causal links between the outcome and predictors cannot be assumed because of the observational nature of the study. Furthermore, some confounders were not included such as pre-existing eating disorders and employment status, which might have been greatly disturbed during COVID-19 lockdown. (Phillipou et al., 2020; Ammar et al., 2021) Finally, HINTS data collection periods were slightly different for 2019 (January to April) and 2020 (February to June). This difference in seasons could have relatively impacted our PA levels findings.

Daily lives disruption during national emergencies are inevitable. However, in the case of an extended disruption period, maintaining PA becomes more vital to preserve one’s well-being and in achieving the goal of “Active People, Healthy Nation”, which is a national initiative led by the CDC to help Americans become more physically active by

2027 (Active People, Healthy Nation, 2021). The bidirectional relationship between PA and health has also been demonstrated in a study where meeting PA guidelines was strongly associated with a reduced risk for severe COVID-19 outcomes among infected adults (Sallis et al., 2021). Our study highlights physical inactivity as a modifiable risk indicator for negative SPoH. These findings are contrasted by the limited efforts of public health authorities to promote the benefits of PA during the pandemic. The potential for habitual PA to lower negative SPoH should be promoted by the medical community and public health agencies. Additionally, pandemic policies and recommendations should include and facilitate regular PA, specifically among vulnerable populations.

## 5. Conclusion

Negative SPoH was associated with lack of moderate exercise and lack of muscle-strengthening exercise among adults in the U.S. before and amidst the COVID-19 pandemic. Higher odds of reporting negative SPoH were found among non-Hispanic black individuals, current cigarettes smokers, people with heart conditions, those with annual income less than \$35,000, and who were very obese. Our study highlights physical inactivity as a modifiable risk indicator for negative SPoH. Pandemic policies and recommendations should include and facilitate regular PA, specifically among vulnerable populations.

## Authors contribution

S.A. analyzed the data. S.A. and D.B., were involved in article's conception and design, interpreted the data, drafted the manuscript, provided final approval of the version and agreed to be accountable for all aspects of this work. No financial disclosures were reported by the authors of this paper.

## CRedit authorship contribution statement

**Shaikha AlDukhail:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Dania Bahdila:** Conceptualization, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ypmed.2022.107037>.

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