



Effects of COVID-19 shelter-in-place confinement on diabetes prevention health behaviors among US adults with prediabetes: A cross-sectional survey

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ARTICLE INFO

Keywords:

Prediabetes
Diabetes prevention
COVID-19
Health promotion
Behavior change

ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has resulted in significant lifestyle changes due to shelter-in-place confinement orders. The study's purpose was to assess if the COVID-19 pandemic affected self-reported diabetes prevention behaviors among American adults with prediabetes. As part of a randomized clinical trial among adults with prediabetes and overweight/obesity, questions were added to existing study surveys to assess the effect of the COVID-19 pandemic on diabetes prevention behaviors and stress. Survey responses were summarized using frequencies. 259 study participants completed seven COVID-19 survey questions from June 2020 to June 2021. Participants were 62.9% female, 42.5% White, 31.3% Black, 11.6% Asian, 8.1% Hispanic, and 6.6% Other. Over 75% of participants reported that the COVID-19 pandemic affected physical activity levels, with 82.1% of those affected reporting decreased physical activity; 70.3% reported that the pandemic affected their eating habits, with 61.7% of those affected reporting their eating habits became less healthy; 73.7% reported that the pandemic affected their level of stress, with 97.4% of those affected reporting that their level of stress had increased; 60% reported that the pandemic affected their motivation to adopt/maintain healthy habits, with 72.9% of those affected reporting their motivation decreased. A high percentage of study participants with prediabetes reported decreases in health promotion behaviors and increases in stress due to the COVID-19 pandemic. Consequently, the pandemic could lead to increased diabetes incidence. Strategies to improve diabetes prevention behaviors and address mental health concerns among those at-risk for diabetes are critical during and after the COVID-19 pandemic.

1. Introduction

As of 2020, 37.3 million people had been diagnosed with diabetes in the United States ([Centers for Disease Control and Prevention, 2020](#)) (US) and the number of Americans with diabetes is projected to triple by 2060 ([Lin et al., 2018](#)). Diabetes prevention during the coronavirus disease 2019 (COVID-19) pandemic is essential given hyperglycemia is a risk factor for SARS-CoV-2 infection and is associated with poorer outcomes for those infected. ([Gianchandani et al., 2020](#)) Unfortunately, the COVID-19 pandemic has resulted in significant lifestyle changes due to

mandated shelter-in-place confinement orders and economic shut-downs. ([California Governor, 2020](#)) Research has shown that these pandemic-related restrictions have negatively impacted health behaviors and outcomes, leading to decreases in physical activity, weight gain, and increases in stress and anxiety. ([Chew and Lopez, 2021](#); [Park et al., 2020](#); [Zachary et al., 2020](#)) Most of the existing research on shelter-in-place restrictions and health behaviors has been conducted outside of the United States ([Salman et al., 2021](#); [Scarmozzino and Visioli, 2020](#); [Sidor and Rzymiski, 2021](#)) or with a broadly defined adult study population. ([Bhutan et al., 2021](#); [Park et al., 2022](#); [Sobba et al., 2021](#)) However,

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<https://doi.org/10.1016/j.pmedr.2023.102139>

Received 30 August 2022; Received in revised form 21 December 2022; Accepted 10 February 2023

Available online 13 February 2023

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Table 1
Frequency of COVID-19 Survey Responses by Race/Ethnicity.

Question	Total (N = 259)	Black (n = 81, 31.3 %)	Asian/HI/ PI (n = 30, 11.6 %)	Hispanic (n = 21, 8.1 %)	Other (n = 17, 6.6 %)	White (n = 110, 42.4 %)	p-value
Has the COVID-19 pandemic affected how much exercise or physical activity you are getting?, n (%)							0.1504 ^a
Changed	195 (75.3)	63 (77.8)	22 (73.3)	19 (90.5)	15 (88.2)	76 (69.1)	
Has your exercise or physical activity changed positively or negatively?, n (%)							0.3755 ^b
Negative change	160 (82.1)	56 (88.9)	16 (72.7)	16 (84.2)	12 (80.0)	60 (78.9)	
Has the pandemic affected your eating habits?, n (%)							0.4594 ^a
Changed	182 (70.3)	60 (74.1)	22 (73.3)	15 (71.4)	14 (82.4)	71 (64.5)	
Have your eating habits overall changed positively or negatively?, n (%)							0.1219 ^a
Negative change	111 (61.7)	38 (65.5)	10 (45.5)	13 (86.7)	9 (64.3)	41 (57.7)	
Has the pandemic affected your motivation to adopt or maintain healthy habits?, n (%)							0.5057 ^a
Changed	155 (59.8)	45 (55.6)	20 (66.7)	13 (61.9)	13 (76.5)	64 (58.2)	
Has your motivation changed positively or negatively?, n (%)							0.7579 ^a
Negative change	113 (72.9)	32 (71.1)	15 (75.0)	11 (84.6)	8 (61.5)	47 (73.4)	
Has the pandemic affected your ability to manage your health?, n (%)							0.2462 ^a
Changed	121 (46.7)	39 (48.1)	13 (43.3)	11 (52.4)	12 (70.6)	46 (41.8)	
Has your ability to manage your health changed positively or negatively?, n (%)							0.4638 ^b
Negative change	84 (70.6)	26 (68.4)	9 (69.2)	9 (81.8)	6 (50.0)	34 (75.6)	
Has the pandemic affected your level of stress or anxiety?, n (%)							0.0098^a
Changed	191 (73.7)	53 (65.4)	17 (56.7)	19 (90.5)	14 (82.4)	88 (80.0)	
Has your level of stress or anxiety changed positively or negatively?, n (%)							0.0048^b
Negative change	186 (97.4)	53 (100.0)	14 (82.4)	19 (100.0)	13 (92.9)	87 (98.9)	
Please indicate the extent to which you view the pandemic as having either an overall positive or negative impact on your life., n (%)							0.0092^b
Negative change	173 (67.1)	41 (51.3)	19 (63.3)	18 (85.7)	12 (70.6)	83 (75.5)	
Has the pandemic affected your interactions with your UPSTART coach?, n (%)							0.3339 ^b
Changed	15 (18.8)	5 (18.5)	1 (16.7)	3 (50.0)	0 (0.0)	6 (15.4)	

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Chi-square tests.

^b Fisher's exact tests.

researchers have identified public health challenges related to understanding the impact of the pandemic on chronic disease prevention, explicitly highlighting the need to understand pandemic-related health behaviors for those at high risk for chronic disease. (Hacker et al., 2021) Unfortunately, little is known about how patients with prediabetes, who are at a significant risk of developing diabetes, experienced COVID-19. Understanding how patients who have not yet developed diabetes but who are at high-risk for progression to diabetes engage in preventative health behaviors and experience stress during the pandemic can help researchers identify leverage points for intervention to help stem projected increases in diabetes incidence. Therefore, the objective of this study was to assess how the COVID-19 pandemic affected diabetes prevention behaviors among adults with prediabetes. We also assessed if this association varied by patient race, ethnicity, or sex.

2. Methods

This study uses cross-sectional data from the Using Peer Support To Aid in Prevention and Treatment in Prediabetes (UPSTART) study. UPSTART's objectives and design have been previously described. (Heisler et al., 2020) Briefly, UPSTART is a parallel, two-armed,

randomized controlled pragmatic clinical trial among adults with pre-diabetes at Kaiser Permanente Northern California and Michigan Medicine beginning recruitment in 2018 and continuing through 2021. UPSTART eligibility criteria included patients aged 18–85 with body mass index (BMI) ≥ 25 (≥ 23 for Asian Americans) and at least one HbA1c between 5.7 and 6.4 % in the previous 3 months. Study participants completed baseline, six- and twelve-month surveys. Beginning in June of 2020, seven additional COVID-19-related survey questions were added to all study surveys to assess the effect of the COVID-19 pandemic on health, diabetes prevention behaviors (e.g., physical activity, eating habits), and stress. To analyze COVID-19 survey data, we summarized responses to survey questions using frequencies and conducted Chi-square or Fisher Exact tests to compare differences between race/ethnic groups and gender groups. UPSTART was reviewed and approved by KPNC (November 20, 2018 IRB 1301009) and the University of Michigan (August 31, 2017 IRB HUM00135745).

3. Results

A total of 308 study participants received a study survey with the COVID-19 research questions between 6/1/2020 and 5/31/2021 and

Table 2
Frequency of COVID-19 Survey Responses by Sex.

Question	Total (N = 259)	Female (n = 163)	Male (n = 96)	p-value
Has the COVID-19 pandemic affected how much exercise or physical activity you are getting?, n (%)				0.2020 ^a
Changed	195 (75.3)	127 (77.9)	68 (70.8)	
Has your exercise or physical activity changed positively or negatively?, n (%)				0.1373 ^a
Negative change	160 (82.1)	108 (85.0)	52 (76.5)	
Has the pandemic affected your eating habits?, n (%)				0.4888 ^a
Changed	182 (70.3)	117 (71.8)	65 (67.7)	
Have your eating habits overall changed positively or negatively?, n (%)				0.3597 ^a
Negative change	111 (61.7)	75 (64.1)	36 (57.1)	
Has the pandemic affected your motivation to adopt or maintain healthy habits?, n (%)				0.7032 ^a
Changed	155 (59.8)	99 (60.7)	56 (58.3)	
Has your motivation changed positively or negatively?, n (%)				0.0102^a
Negative change	113 (72.9)	79 (79.8)	34 (60.7)	
Has the pandemic affected your ability to manage your health?, n (%)				0.9690 ^a
Changed	121 (46.7)	76 (46.6)	45 (46.9)	
Has your ability to manage your health changed positively or negatively?, n (%)				0.3537 ^a
Negative change	84 (70.6)	50 (67.6)	34 (75.6)	
Has the pandemic affected your level of stress or anxiety?, n (%)				0.9523 ^a
Changed	191 (73.7)	120 (73.6)	71 (74.0)	
Did not change	68 (26.3)	43 (26.4)	25 (26.0)	
Has your level of stress or anxiety changed positively or negatively?, n (%)				0.6527 ^b
Negative change	186 (97.4)	116 (96.7)	70 (98.6)	
Please indicate the extent to which you view the pandemic as having either an overall positive or negative impact on your life., n (%)				0.0057^a
Negative change	173 (67.1)	97 (59.9)	76 (79.2)	
Has the pandemic affected your interactions with your UPSTART coach?, n (%)				0.4850 ^a
Changed	15 (18.8)	8 (16.3)	7 (22.6)	

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Chi-square tests.

^b Fisher's exact tests.

259 study participants (84.1 % response rate) completed the COVID-19 survey questions. Participants were 62.9 % female, 42.5 % White, 31.3 % Black, 11.6 % Asian/HI/PI, 8.1 % Hispanic, and 6.6 % Other race. Over 75 % of participants reported that the COVID-19 pandemic affected how much physical activity they were getting; of those affected, 82.1 % reported that their physical activity had decreased. Seventy percent of participants reported that the COVID-19 pandemic affected their eating

habits; of those affected, 61.7 % reported that their overall eating habits had become less healthy. Almost 60 % of participants reported that the pandemic affected their motivation to adopt or maintain healthy habits; of those affected, 72.9 % reported that their motivation decreased. Approximately half of participants (46.7 %) reported that the pandemic affected their ability to manage their health; of those affected, 70.6 % reported that their ability to manage their health worsened. Nearly 75 % of participants reported that the pandemic affected their level of stress or anxiety; of those affected, 97.4 % reported that their level of stress/anxiety has increased. The most common areas of increased stress were social distancing/being quarantined (79.6 %), impact on family members (75.3 %), impact on physical activity levels (69.4 %), health concerns (65.1 %), and impact on their community (59.1 %).

Asian/HI/PI and Black participants were less likely, and Hispanic participants the most likely to report changes in level of stress and anxiety as a result of the pandemic compared to other races (Asian/HI/PI: 56.7 % vs Black: 65.4 % vs Hispanic: 90.5 % vs Other race: 82.4 % vs White: 80.0 %, $p = 0.0098$) (Table 1). Among participants who reported a change in stress/anxiety levels, Asian/HI/PI participants were more likely to report a positive change in stress/anxiety compared to other races (Asian/HI/PI: 17.6 % vs Other race: 7.1 % vs White: 1.1 % vs Black: 0 % vs Hispanic: 0 %, $p = 0.0048$). Regarding the overall impact of the pandemic, Asian participants were more likely to report a positive impact compared to other races (Asian/HI/PI: 13.3 % vs Black: 7.5 % vs Other race: 5.9 % vs Hispanic: 4.8 % vs 3.6 % White, $p = 0.0092$). Women reported more negative changes in motivation as a result of the pandemic compared to men (women: 79.8 % vs men: 60.7 %, $p = 0.0102$); men were more likely to report a negative overall impact of the pandemic on their lives compared to women (men: 79.2 % vs women: 59.9 %, $p = 0.0057$) (Table 2).

4. Discussion

In a sample of adults with prediabetes and overweight/obesity participating in a peer-support diabetes prevention program, we found that a high percentage of participants reported their health promotion behaviors had decreased and their stress/anxiety had increased as a result of the COVID-19 pandemic. These findings contribute to a growing body of research examining the effects of the COVID-19 confinement on health promotion behaviors. For example, in a cross-sectional, retrospective survey of 589 California Bay area adults, researchers found that increased snacking activity was strongly related to increases in ultra-processed food consumption and weight gain (Sobba et al., 2021) during shelter-in-place confinement. Furthermore, in a longitudinal study assessing changes in body weight and lifestyle behaviors in US adults ($n = 727$) during the pandemic, Bhutani et al. found that participants gained significant body weight (0.62 kg) during the pandemic and that those who gained weight engaged in riskier nutritional behaviors (i.e., more frequent snacking and alcohol intake) and were less active during peak shelter-in-place (April/May 2020) and that these behaviors persisted after confinement ended. (Bhutani et al., 2021) Our study adds to the evidence base that there has been a reduction in health promotion behaviors during the COVID-19 pandemic, particularly among those most at risk for experiencing negative health outcomes such as developing diabetes. Furthermore, research has demonstrated that almost 1 in 3 adults in the United States reported delaying or avoiding routine medical care because of COVID-19 concerns. (Sobba et al., 2021) This combination of decreased health promotion behaviors and decreased routine healthcare utilization that could promote screening may result in an increase in undiagnosed diabetes.

5. Limitations

Our study has several limitations. While we measured self-reported perceptions of changes in overall health behaviors related to the

COVID-19 pandemic, this analysis does not report actual changes in health behaviors assessed by validated scales for physical activity, eating behaviors, or anxiety/depression. Furthermore, we were unable to conduct a reliability assessment of the survey questions we developed, given the need to conduct assessments on the COVID-19 pandemic in real time. Additionally, our cohort of patients with prediabetes agreed to be randomized to a diabetes prevention intervention which could indicate a higher level of engagement in or motivation for diabetes prevention behaviors compared to the general population. Finally, insufficient time has elapsed since the start of the COVID-19 pandemic to determine whether these self-reported behavior changes due to COVID-19 are related to diabetes incidence; this question will be addressed in future analyses.

6. Conclusion

Our study is one of the few conducted with adults with prediabetes across multiple health systems that assesses the effect of the COVID-19 pandemic on diabetes prevention behaviors. Having overweight/obesity, experiencing weight gain, and being physically inactive are risk factors for type 2 diabetes. Therefore, it is possible that the COVID-19 pandemic could lead to increased diabetes incidence post-pandemic. Further research and public health efforts are necessary to quantify the impact of the COVID-19 pandemic on health behaviors and determine strategies to lessen the impact on individual and population health.

7. Trial registration

The [ClinicalTrials.gov](https://clinicaltrials.gov) registration number is NCT03689530.

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.

Data availability

The data that has been used is confidential.

Acknowledgements

Disclaimer: The research presented in this paper is that of the authors and does not reflect the official policy of the NIH.

Disclosure of funding and conflicts of interest: The authors declare no conflicts of interest. This work was supported by the National Institute of Diabetes and Digestive and Kidney Diseases, R18DK113403. Support

was also provided by the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development Service. Drs. Rodriguez and Thomas received support from The Permanente Medical Group (TPMG) Delivery Science Fellowship Program and the National Institute of Diabetes and Digestive and Kidney Diseases grant T32DK11668401. Dr. Schmittiel received additional support from the NIDDK-funded DREAMS Center for Diabetes Translational Research (P30 DK92924).

Guarantor: Tainayah Thomas and Julie Schmittiel take full responsibility for the work as a whole, including the study design, access to data, and the decision to submit and publish the manuscript.

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