From Bad to Worse: The Impact of Work-From-Home on Sedentary Behaviors and Exercising

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1. Introduction

Studies have shown that Americans today are spending more time sitting and less time exercising than in the past. We have become more inactive at work, during the commute to work, and in our leisure time. The contributing factors include watching TV or videos, computer use outside school or work, and the use of automobiles or public transit in long commuting hours. Many research studies have warned the general public of the harm of excessive sitting and inadequate exercising. Prolonged sedentary behaviors contribute to higher mortality and weight gain, and disease incidence (Thorp et al. 2011). A lack of physical activity is found to be positively associated with all-cause mortality (Stewart et al. 2017).

Despite the empirical evidence for health risks, the trend of increased sitting and decreased exercising continues. Between 2007 and 2016, the total sitting time increased from 5.5 to 6.4 hours per day among American adults (Yang et al. 2019). The percentage of men and women reporting no leisure-time physical activity in 2010 were 52% and 44%, respectively, compared to 19% and 11% in 1988 (Ladabaum et al. 2014).

Although the trend of increased inactivity was observed long before 2020, the COVID-19 pandemic has brought new challenges. Overall, people have become even more inactive during the lockdown, with increased sedentary behaviors and decreased physical activity (Gallè et al. 2020; Hall et al. 2020; López-Valenciano et al. 2021). One study in April 2020 showed that over 40% of US adults sat more than 8 hours a day and that younger adults appeared to be more inactive than older adults (Meyer et al. 2020).

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To our knowledge, no existing studies have examined the extent to which the general patterns of sitting and exercising are affected by the now widespread work-from-home structure, which has increased in popularity among both workers and employers. For the first time in US history, a large proportion of the labor force is working remotely. Work-from-home provides some advantages to both employers and employees. It reduces commuting stress during rush hours and allows workers more time flexibility in accomplishing tasks. According to a Gallup poll, nearly two-thirds of US workers who have been working remotely during the pandemic would like to continue to do remote work (Gallup 2020) and a large proportion of workers who had switched to remote work believe that remote work will remain more common at their company even after the pandemic (Bartik et al. 2020). To many employers' relief, productivity didn't decline in this new work environment, especially in better educated and higher paid industries. A majority of employers and employees believed remote working didn't involve any productivity loss and 28 percent thought that workers had become more productive through remote working (Bartik et al. 2020; Boland et al. 2020). Many companies have announced plans to allow workers to continue working remotely, either partially or entirely, after the end of the pandemic. As a new work mode, work-from-home is here to stay.

Work-from-home is not perfect. Studies have shown that it increases social isolation, fatigue, and anxiety related to an overload of virtual meetings (Bailenson 2021; Cohen and Hoskins 2020). Further, there is concern that working from home will exacerbate the trend towards increased sedentary behavior. To investigate this concern, we analyzed data from a survey we designed to learn about the impact of remote work on inactivity, specifically increased sitting and decreased exercising. We asked respondents questions about their ability to work from home, their activity patterns, as well as many other questions on their sociodemographic background.

Our results show that work-from-home is associated with two more hours per day spent sitting. Moreover, people who could complete their work entirely from home during the pandemic were more likely to sit more and exercise less than before the pandemic.

2. Survey Data

Between December 12th, 2020 and January 4th, 2021, we deployed a survey assessing the experiences of a nationally representative sample of American adults aged 25 to 74 years old. The study was approved by Stanford University's Institutional Review Board, and informed consent was obtained from all survey participants. We used Prolific (www.prolific.co) to recruit an online sample of 1700 individuals between age 25 and 74 who were currently living in the United States. We stratified the sampling by age, sex, race/ethnicity, and employment status. Participants were invited to complete a study entitled "Sightlines Survey: Assess the Impact of COVID-19." Data from all participants were collected using Qualtrics survey software between December 12, 2020, and January 4, 2021.

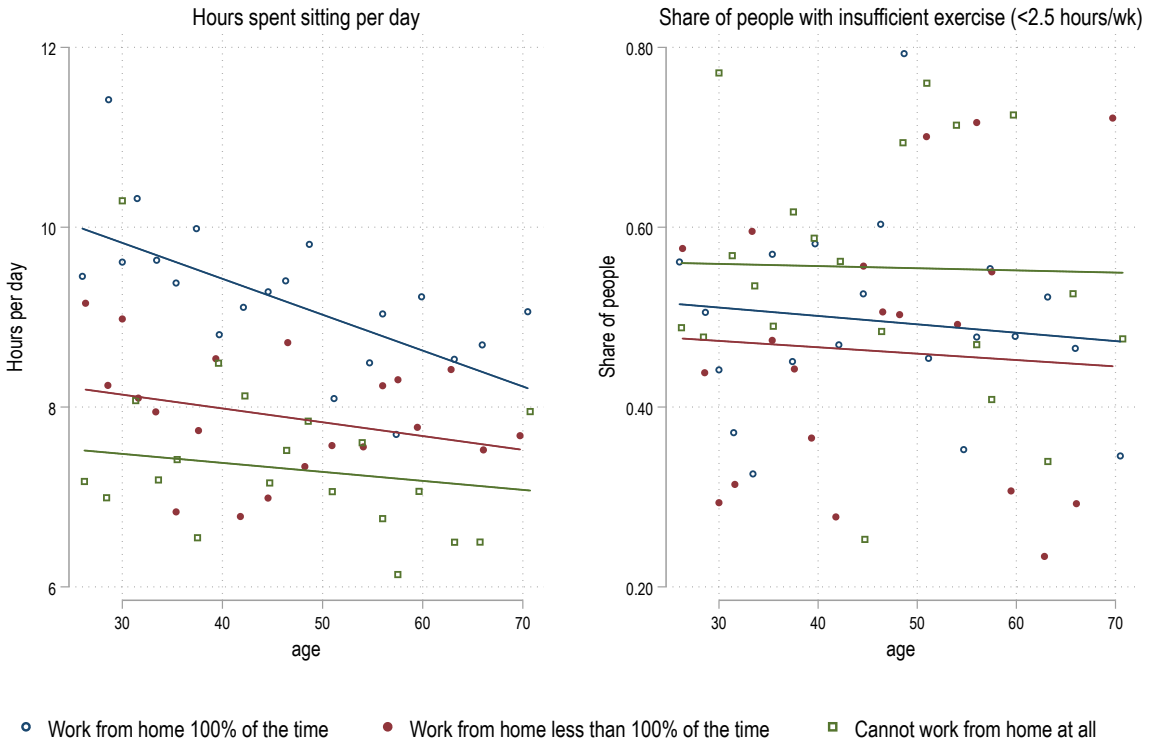
We excluded data from participants who entered their responses twice (caused by time-out and re-entry), who didn't finish the survey, and whose age was below 25 or above 74. This exclusion reduces the sample size to 1648. To understand the implications of work from home on inactivity, we exclude people who didn't work at all in 2020. The final sample size is 1316.

Table (1) in the appendix reports the summary statistics. The survey participants were 49 percent male and ranged in age from 25 to 74 (mean = 45.6, SD=13.1). About 62% reported being non-Hispanic White, 13% non-Hispanic Black, 17% Hispanic, and 7% non-Hispanic Asian. Approximately two-thirds of the participants had a Bachelor's degree or above. 53% were married. During the COVID-19 pandemic, about three-fourths of survey participants can work from home either completely (50%) or partly (23%).

3. Study Results

LEVEL OF INACTIVITY

Figure 1: Work-from-home correlates with more sitting and less exercising



The level of inactivity is highly correlated with the ability to work from home. As shown in Figure (1), across the age span, people who can work from home all of the time sit for around 9.2 hours a day, compared to 7.3 hours for those who cannot work from home at all. People who work from home partly show sedentary behaviors somewhere in between, about 7.9 hours per day. Note the sedentary behaviors decline as age increases. Prior studies have shown that older adults tend to be more inactive than younger ones (Diaz et al. 2016; Yang et al. 2019), but in those studies, severe inactivity was observed among individuals over age 75. Our research focuses on adults younger than 74 years old. Moreover, our sample individuals are all working, making them less comparable to the subjects in prior studies.

When controlling for socioeconomic demographic variables, the ability to work from home emerges as a strong predictor for prolonged sedentary behaviors. As shown in Table (2), Compared to those who cannot work from home at all, individuals who can work from home all of the time spend 2.03 more hours per day on sitting (p-value=0.000), and those who can work from home for some of the time spend 0.88 more hours per day on sitting (p-value=0.006). Insufficient exercise is highly correlated with excessive sedentary behaviors. All things being equal, people who don't exercise enough spend 1.04 more hours per day on sitting (p-value = 0.000).

Among other covariates, people with better general health status (self-reported) spend fewer hours sitting. Compared to those who self-reported poor health, people who reported very good health spend 2.02 fewer hours sitting (p-value=0.027), and those with excellent health spend 3 fewer hours sitting (p-value = 0.001).

No statistically significant relationship was found between work-from-home and insufficient exercise. However, a significant correlation emerges between excessive sitting and inadequate exercising (0.18***, p-value = 0.000). Even though work-from-home doesn't influence exercise directly, it can reduce exercise indirectly through excessive sedentary behaviors.

CHANGE OF INACTIVITY

Research studies have shown that individuals are more inactive during the COVID-19 pandemic, compared to the pre-COVID-19 period, due to the lockdown and social distancing orders (Gallè et al. 2020). Since the present study focuses on the effect of work-from-home, we examine whether the change of inactivity from the pre-COVID19 period varies across people with different remote-work statuses.

Figures 2-3 show that people who work from home all of the time are more likely to report an increase in sedentary behaviors from their pre-COVID-19 level, compared to those who cannot work from home at all (65% vs. 46%). Also, people who work from home all of the time are more likely to report a decrease in exercise time from their pre-COVID-19 level, compared to those who cannot work from home at all (40% vs. 26%).

Figure 2: Work-from-home correlates with increases in sedentary behaviors compared to pre-COVID19 time period

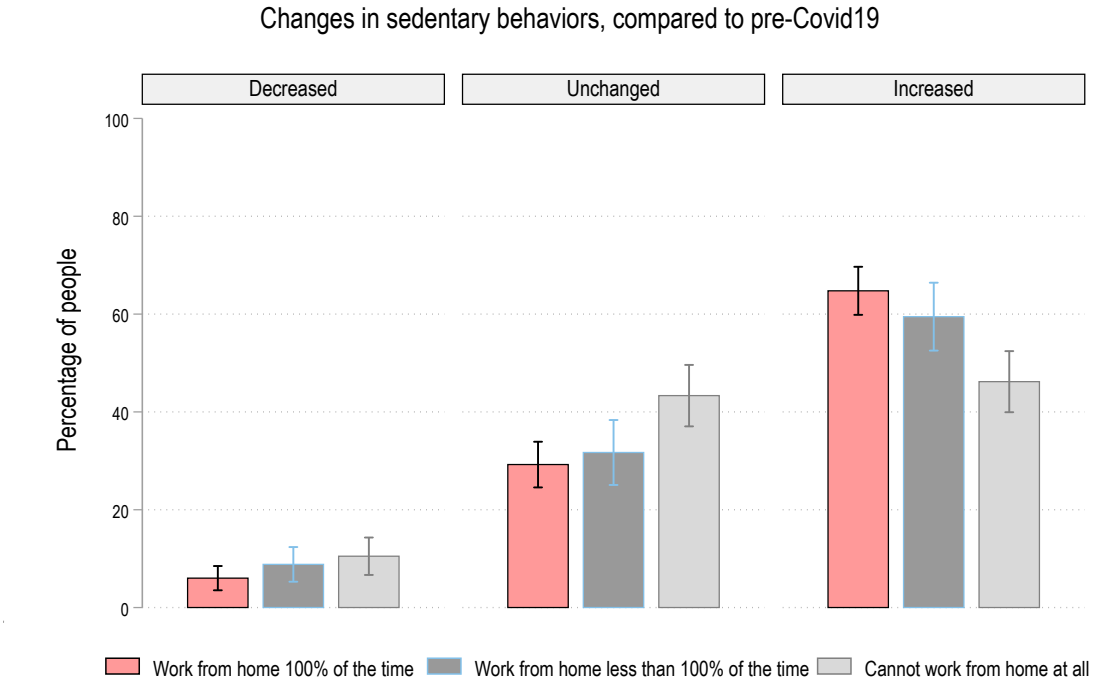
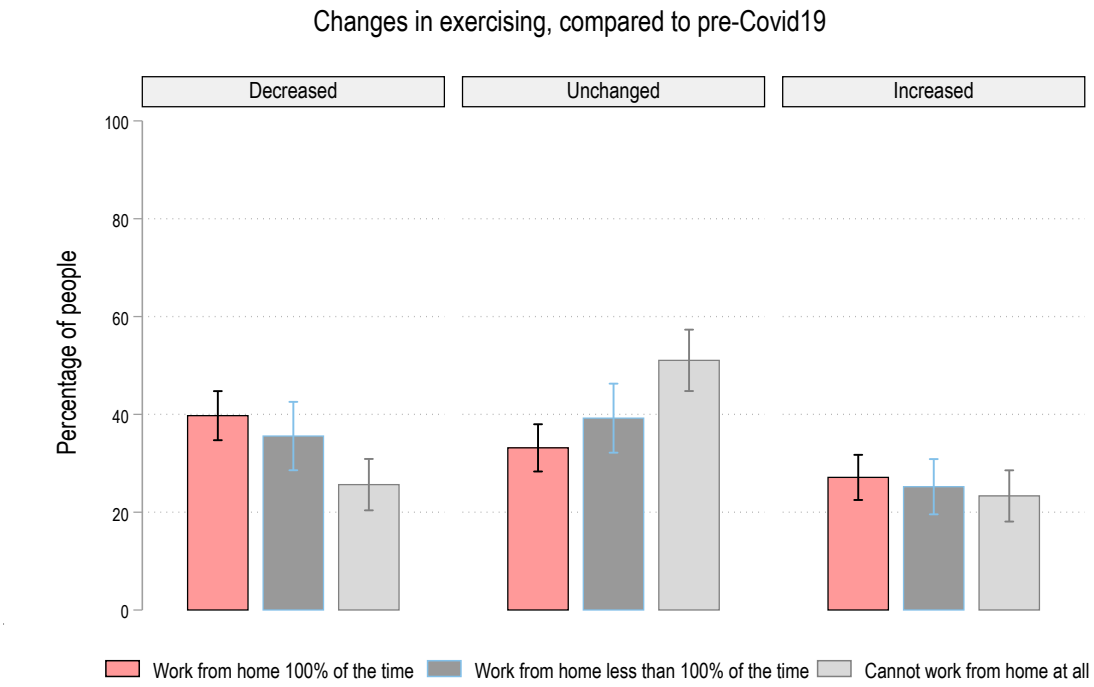


Figure 3: Work-from-home correlates with decreases in exercise, compared to pre-COVID19 time period



When controlling for socioeconomic-demographic variables, work-from-home is still strongly associated with increased inactivity (Table 3). Compared to those who cannot work from home at all, the ability to work from home full-time is associated with a 19-percentage point (or 41 percent) higher likelihood of sitting more and a 16 percentage points (or 62 percent) higher likelihood of exercising less, than pre-COVID-19 period.

Among other covariates, more education is correlated with increased inactivity, possibly because people with a Bachelor's degree or more are more likely to work in occupations that involve a lot of writing, computer usage, and sitting.

General health is still highly correlated with the change in inactivity. Compared to those who self-reported poor health, people with excellent health are less likely to increase sitting during the pandemic (a 26-percentage points difference), and less likely to have cut back on exercise (a 21-percentage point difference). Perhaps people with the best self-reported health status tend to live an active lifestyle, protecting them from external disruptors such as the pandemic. Also, people who self-reported poor health may have chosen to spend more time indoor due to their vulnerability to contracting coronavirus.

4. Discussions

We found that work-from-home environments are associated with increased sedentary behavior in a dose-response relationship: individuals who complete more work from home report increased time per day spent sitting. COVID-19 restrictions have reshaped how we conceptualize work environments. Going forward, it is likely that a higher percentage of the workforce will continue to work from home. Given the negative impacts of sedentary behavior on physical and mental health, we have to prioritize solutions for decreasing sedentary behaviors and increasing exercise within the context of the work-from-home environment.

HEALTH IMPACTS OF SEDENTARY BEHAVIOR

Sedentary behavior is associated with increased cardiovascular and all-cause mortality, independent of physical activity (Booth, Roberts, and Laye 2012). Many studies have examined the relationship between sedentary behavior and increased blood pressure, reduced insulin sensitivity, and increased obesity rates. Further, muscular inactivity during sedentary behavior is associated with impaired skeletal muscle metabolism of lipids and glucose (Owen et al. 2020). However, Owen et al. highlighted that many of the studies assessing the relationship between health outcomes and sedentary behaviors are done in cross-sectional studies, and more prospective, mechanistic, or intervention-based studies are needed to understand causal mechanisms.

Recent studies examining interrupting prolonged sitting with movement patterns found benefits in cardiometabolic risk factors such as improved insulin sensitivity and better blood pressure control (Roberts et al. 2019). Many public health recommendations center around moderate-to-vigorous physical activity, but more recent updates to the recommendations have added strategies to reduce sitting time and increase incidental walking or standing behaviors to improve public health (Owen et al. 2010).

ROLE OF TECHNOLOGY

Over the last couple of years, sedentary behavior research has benefited from data available from wearable devices. With wearable devices, researchers can better identify time spent in sedentary behavior and time spent completing physical activity (Owen et al. 2020). Wearable devices also extend beyond research to the arms of the consumer. Although studies indicate that long-term wearable device efficacy for reducing sedentary behavior may be challenged by consumer bias and adherence, wearable devices may provide a substantial opportunity for future development.

Wearable devices that incorporate behavioral change techniques through goal-setting and self-monitoring may help individuals reduce sedentary behaviors. Vibrations or sounds on the devices can remind people to stand and move around regularly, thus interrupting sitting time. Gamification strategies with points, badges, and leaderboards can create additional incentives for adherence. Built-in social communities may help individuals stay accountable to behavioral change (Patel, Asche, and Volpp 2015).

ROLE OF EMPLOYERS

Given that a substantial percentage of sedentary behavior occurs during the workday, employers can take part in encouraging their employees to stand, walk, or creatively move. Workspace environments at home or in the office can be redesigned to promote added movement. For example, standing desks or active-sitting chairs increase muscle activation during the workday. Readily accessible stairs or exercise equipment such as dumbbells or yoga mats in the home or work setting can make exercise easier.

Further, employers can consider the structure of virtual work meetings. Work meetings longer than 30 minutes can incorporate breaks for standing, walking, or movement. When visuals are not necessary, reverting to audio calls rather than video meetings or making it acceptable to turn off video during virtual meetings can allow discussions while standing, moving, or even walking outside.

Finally, similar suggestions that apply to fostering a culture that promotes healthy behaviors like physical activity while working in the office will likely impact remote work as well. Top-down leadership that not only allows standing during meetings, taking movement breaks, and supporting flexible schedules, but encourages it by providing appropriate education and modeling the behavior themselves can be effective.

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Appendix

Table 1: Summary statistics of survey respondents who worked during the COVID19 pandemic

	mean	sd
Age	45.62	13.10
Male	0.49	0.50
Raceethnicity		
Non-hispanic White	0.62	0.48
Non-hispanic Black	0.13	0.33
Hispanic	0.17	0.38
Non-hispanic Asian	0.07	0.25
Non-hispanic Others	0.01	0.10
Education		
High school or less	0.06	0.23
Some college or Associate degree	0.26	0.44
Bachelor's degree	0.40	0.49
Graduate degrees	0.28	0.45
Marital status		
Married	0.53	0.50
Widowed Separated/	0.01	0.11
divorced Never	0.11	0.31
married Cohabiting	0.21	0.41
	0.13	0.34
Family structure		
Family size	2.70	1.36
Have child<12yr	0.25	0.44
Health status		
Poor Fair	0.03	0.17
Good Very	0.19	0.39
good	0.41	0.49
Excellent	0.28	0.45
	0.08	0.28
Family income ($)		
Mean	103,174	94,790
Median	75,000	.
Location		
Small city/town	0.16	0.36
City/urban Suburb	0.43	0.50
Rural area	0.33	0.47
	0.08	0.27
Region		
Northwest	0.21	0.41
Midwest	0.17	0.38
West South	0.38	0.49
	0.23	0.42
Remote work status		
Can work from home 100 percent of time during Covid19 Can	0.50	0.50
work from home sometimes during Covid19 Cannot work from	0.23	0.42
home at all during Covid19	0.27	0.44
Activity		
Hours per day sitting	8.39	3.70
Inadequate exercise (< 2.5 hours per week)	0.50	0.50
Sit less than pre-Covid19 period	0.08	0.27
Sit the same amount as per-Covid19 period	0.34	0.47
Sit more than pre-Covid19 period	0.59	0.49
Exercise less than pre-Covid19 period	0.35	0.48
Exercise the same amount as pre-Covid19 period/never exercise Exercise	0.39	0.49
more than pre-Covid19 period	0.26	0.44
Observations	1316	

Note: Data are from the Stanford Center on Longevity Sightlines 2021 Survey. To understand the implications of work from home on inactivity, we exclude people who didn't work at all in 2020.

Table 2: Regressions for the levels of inactivity

	Hours sitting (OLS)		Inadequate exercise (Logit) (Marginal effect)	
Remote work situation: baseline Cannot work from home at all				
I can work from home 100 percent of the time.	2.03***	(0.28)	-0.09	(0.05)
I can work from home, but less than 100 percent of the time.	0.88***	(0.32)	-0.08	(0.06)
Inadequate exercise (< 2.5 hours per week)	1.04***	(0.22)		
Sitting>320 minutes a day (Yes/no)			0.18***	(0.05)
Female	0.21	(0.22)	0.19***	(0.04)
Age: baseline age 25-34				
35-44	-0.63**	(0.32)	0.01	(0.05)
45-54	-1.24***	(0.34)	0.01	(0.06)
55-64	-1.40***	(0.36)	-0.08	(0.06)
65-74	-1.18***	(0.46)	-0.06	(0.09)
Race and ethnicity: baseline Non-Hispanic Whites				
NH Black	-0.31	(0.31)	-0.08	(0.05)
Hispanic	-0.74**	(0.31)	-0.04	(0.05)
Asian	-0.89***	(0.30)	-0.03	(0.07)
Others	-0.22	(1.27)	-0.13	(0.16)
Education: baseline High school or less				
Some college	0.21	(0.49)	-0.03	(0.08)
Bachelor's degree	0.43	(0.48)	-0.05	(0.08)
Graduate degree	0.33	(0.52)	-0.13	(0.09)
Marital status: baseline Married				
Widowed Divorced/	-0.75	(0.85)	0.11	(0.18)
separated Never	0.50	(0.43)	0.21***	(0.07)
married Cohabiting	-0.21	(0.34)	0.07	(0.06)
	0.59*	(0.34)	-0.00	(0.06)
Family size: baseline single household				
2-4	-0.33	(0.34)	0.02	(0.06)
5+	0.46	(0.49)	0.23***	(0.09)
Have children under age 12 Health	-0.73**	(0.31)	0.02	(0.05)
status: baseline poor health				
Fair	-0.42	(0.91)	-0.27*	(0.16)
Good	-1.97**	(0.89)	-0.48***	(0.16)
Very good	-2.02**	(0.91)	-0.63***	(0.16)
Excellent	-3.11***	(0.96)	-0.72***	(0.17)
Family income: baseline lowest income quartile				
Second income quartile	0.10	(0.34)	-0.01	(0.05)
Third income quartile	-0.42	(0.34)	-0.04	(0.05)
Highest income quartile	0.14	(0.33)	0.06	(0.06)
Residence: baseline Cityurban area				
Small city/town	-0.59*	(0.33)	0.07	(0.05)
Suburb	0.18	(0.26)	0.06	(0.05)
Rural area	-0.37	(0.50)	0.08	(0.08)
Residence: baseline Northwest				
Midwest	0.69*	(0.39)	-0.06	(0.06)
South	-0.19	(0.30)	-0.08	(0.05)
West	0.02	(0.33)	-0.07	(0.06)
Mean of Dep. Var. Std.	8.4		0.5	
Dev of Dep. Var. Obs	3.7		0.5	
	1295		1295	

Note: Data are from the Stanford Center on Longevity Sightlines 2021 Survey. Dependent variables are (1) hours spent sitting per day; (2) an indicator variable on whether exercising less than 2.5 hours per week.

Table 3: Regressions for whether sitting more or exercising less than pre-COVID19 time period

	Sitting more (Logit) (Marginal effect)		Exercise less (Logit) (Marginal effect)	
Remote work situation: baseline Cannot work from home at all				
I can work from home 100 percent of the time. 0.19***		(0.04)	0.16***	(0.04)
I can work from home, but less than 100 percent of the time. 0.13** Female 0.04 Age:		(0.05)	0.13**	(0.05)
baseline age 25-34		(0.04)	-0.02	(0.03)
35-44	-0.06	(0.05)	0.02	(0.05)
45-54	-0.09*	(0.06)	-0.02	(0.05)
55-64	-0.03	(0.06)	-0.05	(0.06)
65-74	-0.04	(0.08)	-0.07	(0.08)
Race and ethnicity: baseline Non-Hispanic Whites				
NH Black	0.08*	(0.05)	0.06	(0.05)
Hispanic	0.04	(0.05)	0.05	(0.05)
Asian	-0.01	(0.06)	0.04	(0.05)
Others	0.03	(0.19)	0.13	(0.16)
Education: baseline High school or less				
Some college	0.05	(0.08)	0.14*	(0.08)
Bachelor's degree	0.05	(0.08)	0.22***	(0.08)
Graduate degree	0.16*	(0.08)	0.18**	(0.09)
Marital status: baseline Married				
Widowed Divorced/	-0.17	(0.14)	-0.40**	(0.18)
separated Never	-0.02	(0.06)	0.09	(0.07)
married Cohabiting	-0.00	(0.06)	-0.08	(0.06)
	0.07	(0.06)	-0.01	(0.05)
Family size: baseline single household				
2-4	-0.01	(0.05)	-0.04	(0.05)
5+	0.07	(0.08)	0.12	(0.08)
Have children under age 12 Health	-0.05	(0.05)	-0.11**	(0.05)
status: baseline poor health				
Fair	0.02	(0.10)	0.11	(0.08)
Good	-0.09	(0.10)	0.02	(0.08)
Very good	-0.11	(0.10)	-0.10	(0.09)
Excellent	-0.26**	(0.11)	-0.21**	(0.10)
Family income baseline lowest income quartile				
Second income quartile	-0.02	(0.05)	0.01	(0.05)
Third income quartile	-0.08	(0.05)	-0.13**	(0.05)
Highest income quartile	-0.04	(0.06)	-0.05	(0.06)
Residence: baseline Urban centers				
Small city/town	-0.12**	(0.05)	-0.05	(0.05)
Suburb	-0.03	(0.04)	0.00	(0.04)
Rural area	-0.04	(0.07)	0.04	(0.07)
Region: baseline Northeast				
Midwest	0.03	(0.06)	0.03	(0.06)
South	-0.06	(0.05)	-0.04	(0.05)
West	0.04	(0.06)	0.03	(0.06)
Mean of Dep. Var. Std.	0.6		0.3	
Dev of Dep. Var. Obs	0.5		0.5	
	1304		1304	

Note: Data are from the Sightlines in COVID19 Survey collected by the Stanford Center on Longevity. Dependent variables are (1) an indicator variable for sitting more than pre-COVID19; (2) an indicator variable for exercising less than pre-COVID19. The results in the table are estimated marginal effects from the Logit regression models.