frontiers in Sustainable Cities

ORIGINAL RESEARCH
published: 31 March 2022
doi: 10.3389/frsc.2022.709982

Changes and Disparities in Nature Access During the COVID-19 Pandemic

Hilary Byerly Flint[1*†], *Courtney Hammond Wagner*[2] *and Keri Watson*[3]

[1] *Institute of Behavioral Science, University of Colorado, Boulder, CO, United States,* [2] *Water in the West, Woods Institute for the Environment, Stanford University, Stanford, CA, United States,* [3] *Department of Earth and Environmental Systems, University of the South, Sewanee, TN, United States*

Time in nature is associated with a range of physical and psychological benefits. These benefits tend to be unevenly distributed, with non-white and low-income communities often having lower access to nature than richer, more white neighborhoods. When the COVID-19 pandemic hit the United States in Spring 2020, changes in daily routines, restrictions on public nature access, and risk perceptions may have affected whether and how much people spent time in nature. We explore how nature access changed during the COVID-19 pandemic and how those changes were experienced by different demographic groups. We surveyed representative samples of California and New York residents ($n = 2{,}036$) in May and June of 2020 and examined differences in nature access and nature-related COVID restrictions and risks by gender, income and race. We find that, on average, the pandemic was associated with reductions in frequency of nature access and less time in nature for all respondents. However, these trends were greatest for women, people of color and people who are low-income. Moreover, the pandemic seems to have widened prior inequalities: low-income and non-white people accessed nature even less frequently and had fewer nature access options than they did prior to the pandemic. Given the disparities in broader pandemic impacts by gender, income, and race, these results further demonstrate the inequalities laid bare by COVID-19.

Keywords: nature, equity, COVID, environment, greenspace

OPEN ACCESS

Edited by:
Lindsay Kathleen Campbell, United States Forest Service (USDA), United States

Reviewed by:
Elizabeth Cook, Columbia University, United States
Michelle Kondo, US Forest Service Research and Development, United States

****Correspondence:***
Hilary Byerly Flint
hflint1@uwyo.edu

†Present address:
Hilary Byerly Flint, Haub School of Environment and Natural Resources, University of Wyoming, Laramie, WY, United States

Specialty section:
This article was submitted to Urban Resource Management, a section of the journal Frontiers in Sustainable Cities

Received: *14 May 2021*
Accepted: *03 March 2022*
Published: *31 March 2022*

Citation:
Byerly Flint H, Hammond Wagner C and Watson K (2022) Changes and Disparities in Nature Access During the COVID-19 Pandemic. Front. Sustain. Cities 4:709982. doi: 10.3389/frsc.2022.709982

INTRODUCTION

In Spring 2020, the COVID-19 pandemic upended routine across much of the United States. People were forced to adapt to changes in daily movement to reduce the spread of the disease. These included reductions in work hours for non-essential workers, remote work for those who were able, and closure of schools and public gathering spaces. Spending time outdoors became one of the few options for leisure outside the home. At the same time, pandemic-related restrictions and risk perceptions may have influenced whether and how people spent time in nature.

Time in nature can benefit human wellbeing. Contact with various types of nature is associated with increases in positive affect, happiness, repetitive, and other measures of psychological health (Bratman et al., 2019). These benefits may be accrued through multiple pathways, including air quality, physical activity, repetitive, and stress reduction (Hartig et al., 2014). Public open spaces, such as parks, can provide areas to gather, enabling a sense of community and social cohesion (Fan et al., 2011; Francis et al., 2012). Residents of neighborhoods with more greenness tend to have better mental health and mortality outcomes (van den Berg et al., 2015). However, these neighborhoods also tend to be more white and higher income (Schwarz et al., 2015; Nesbitt et al., 2019). Low-income neighborhoods have

been found to have less greenspace (Astell-Burt et al., 2014), and low-income and non-white people often have fewer acres of urban parks and access to parks of lower quality, safety, and maintenance than higher income and white people (Wolch et al., 2014; Rigolon, 2016). Hispanics, Blacks and Asians are more likely than whites to report safety of the outdoors as a barrier to spending time in nature, even though nature is highly valued across all racial groups (Kellert et al., 2017). Racial discrimination and policing of white boundaries has historically dispossessed or excluded people of color from public nature areas (Schelhas, 2002; Scott and Lee, 2018). Given the benefits of time in nature, these disparities could exacerbate income- and race-related health inequalities.

The COVID-19 pandemic generated widespread psychological stress (Cooke et al., 2020; Boden et al., 2021). For some, nature experience may have functioned as a coping mechanism to manage mental health. Greenspace use and nature views were associated with reduced depression and anxiety during the pandemic (Pouso et al., 2021; Soga et al., 2021b). People who reported spending more time in nature compared to before the pandemic also reported better mental health[1]. At the same time, pandemic-related restrictions and perceptions were likely to influence people's ability to spend time in nature. There is evidence of increased interest in spending time outdoors (Kleinschroth and Kowarik, 2020) and substitutions of outdoor recreation in lieu of pandemic-restricted leisure activities (Day, 2020). In urban cities, those who had private gardens or yards were seen as privileged over those who did not (Blackall, 2020). Closures and restrictions put national park visits at a 40-year low, but 15 national parks set annual visitation records—several of which are near densely populated metropolitans (Ziesler and Spalding, 2021). Global and local analyses of public greenspace usage report increases from 2019 (Geng et al., 2021; Soga et al., 2021a). However, these aggregate numbers do not capture demographic-level changes in nature access during the pandemic.

Research focused on other aspects of the pandemic has established its disparate effects across different populations in the United States. People of color were more likely to suffer adverse COVID-19 outcomes and morbidity than whites (Bui, 2020; Andrasfay and Goldman, 2021; Karaca-Mandic et al., 2021; Poulson et al., 2021). While many workers switched to working from home, frontline "essential" workers were forced to continue working on site and in close contact with colleagues. People of color and women are disproportionately represented in frontline industries, including healthcare, grocery, childcare, public transit, warehouse, and cleaning services (Rho et al., 2020). The burden of this work has also been borne by low income workers (Blundell et al., 2020). Women have experienced greater employment disruption from the pandemic than men, as well as negative outcomes related to violence and health (McKinsey Company, 2021; United Nations, United Nations). These differences may be exacerbated by household characteristics. U.S. Census Bureau data shows an increase of 1.4 million mothers with school-age children not actively working in January 2021, compared to January 2020 (Heggeness et al., 2021). During the pandemic, childcare demands were cited as the reason for not working among three times as many women than men (Heggeness and Fields, 2020).

In this study, we examine changes in nature access during the pandemic and whether those changes vary across three demographics: gender, income, and race. In Spring 2020, we surveyed demographically representative samples of Californians and New Yorkers. The survey asked participants about their frequency of time spent in nature before and during the pandemic, changes in time in nature since the pandemic started, types of nature access, and perceptions of COVID restrictions and risks related to nature access. We tested how those measures differed for respondents who were female, low-income, or non-white, compared to those who were male, higher income, or white. Many of the studies on nature use during the pandemic use convenience sampling and acknowledge their samples' bias toward high-income or frequent nature users (e.g., Derks et al., 2020; Grima et al., 2020; Venter et al., 2020; Maurer et al., 2021). The goal of our study is to provide evidence from a demographically representative sample on changes in nature access during the COVID-19 pandemic along gender, income, and racial divides, and whether the pandemic seems to have exacerbated or assuaged prior inequalities. The investigation was guided by four research questions.

RQ1. How did frequency of nature access change during the pandemic?

First, we explored how time spent outside changed overall during the pandemic and within demographic groups, as well as demographic differences before the pandemic and whether those differences grew or shrank during the pandemic. We used responses about frequency of time spent in nature before and during the pandemic to test for differences over time and within demographic groups.

RQ2. How did time in nature change during the pandemic?

Next, we explored how participants reported changes in the time they were able to spend in nature. Participants reported whether they were spending less, more or the same amount of time outside, compared to before the pandemic. We tested for differences in experiences overall and within demographic groups.

RQ3. How did the type of nature (public vs. private) people accessed change during the pandemic?

Third, we investigated where people spent time in nature. Participants reported on whether they spent time in a private yard, in a public park, both, or neither (had no access to nature). We tested for changes in types of nature accessed and demographic differences in private vs. public nature access before and during the pandemic.

RQ4. Did perceptions of nature-related COVID restrictions and risks vary within demographic groups?

Finally, we explored whether perceptions of nature-related COVID restrictions and risks were different for women, low-income participants, and non-white participants, as these might help explain differences observed above. Using responses to questions about stay-at-home requirements, nature closures, and

[1]Watson, K. B., HammondWagner, C., Byerly, H., Niles, M. T., and Ricketts, T. H. (In preparation). *Nature Exposure and Mental Health During COVID-19.*

discomfort with pandemic risks outdoors, we tested whether responses varied within demographic groups.

Additionally, we explored whether demographic group membership (i.e., being female, low-income, or non-white) predicted changes in time spent in nature when controlling for one-another, and whether those relationships held when accounting for other household characteristics, nature preferences, and pandemic-related variables. We also examined whether being a woman with children at home was associated with changes in time spent in nature and moderated any observed effect of gender.

METHODS

Sample

In May and June 2020, when COVID-19 pandemic lockdown measures were in effect for much of the United States, we surveyed demographically representative samples of New York and California residents ($n = 2{,}036$). These two states were two of the earliest to experience the pandemic in the United States and experienced the pandemic onset around the same. The states also enacted broadly similar quarantine policies, although California enacted a stay-at-home policy a few days earlier than New York (Jalali et al., 2020). These samples provide insight into the diversity of experiences for two states with large metropolitan areas and diverse populations. The sample size was determined by a power analysis for the effect sizes sought in another study that examines the relationship between nature access and mental health (see text footnote 1).

Survey participants were recruited through Qualtrics (www.qualtrics.com), which uses a variety of sources to find participants, including website intercept recruitment, email lists, customer loyalty web portals, and social media. We instructed Qualtrics to set quotas for the demographic characteristics of the two state populations following census data on race, household income, education level, and age (U.S. Census Bureau, 2019a,b). The U.S. Census implements gender as a binary male/female variable. To allow for the inclusion of non-binary respondents, we adjusted the quota to allow up to 4% of respondents from each state to identify with a gender other than male or female. The survey ran from May 19 to June 16, at which point the quotas had been filled. The survey had a 60% response rate. Qualtrics compensated survey respondents for their time variably based on the context. Primary forms of compensation included gift cards, airline miles, and cash payments. The study design was approved by the University of the South Institutional Review Board.

Survey Design

Sampled California and New York residents were invited to participate in an online research study on nature access and mental health, and informed that the purpose of the study was partly to investigate how access to nature and greenspace had changed during the pandemic. Participants first responded to a set of mental health questions, then reported on the current status of the COVID-19 pandemic in their community and their access to nature, green space and natural areas. Participants were also asked about their relationship with nature and greenspace using the short-form version of the Nature Relatedness Scale (NR-6) (Nisbet and Zelenski, 2013). The survey finished with questions related to demographics and household characteristics.

Data

To explore disparities in nature access during the COVID-19 pandemic, we focused on how outcomes varied for three demographic groups: female (vs. male), low-income (vs. high-income), and non-white (vs. white). These groups were defined as binary categorical variables using responses to questions in the survey.

A participant's gender was defined as "female" if she selected "female" as that which best describes her gender identity. The comparison gender group was male because this contrast best captures the possible inequities in household dynamics we sought to examine through our analysis (United Nations, United Nations). Those who identified as transgender or non-binary, or preferred to self-describe or not to answer were excluded from our analyses that focused on gender.

A participant's income was defined as "low-income" if their household income range in 2019 before taxes was within the lowest quartile of survey participants. For our sample, this cutoff was $25,000, and it was the same value for both California and New York residents. This cutoff aligns with the U.S. Census Bureau 2019 Poverty Threshold for a family unit of four people, which is $26,172 (U.S. Census Bureau, 2021). The comparison group is participants in the highest quartile, whose household income was at least $100,000. Participants in this group were considered "high-income". Participants in the middle quartiles were excluded from the analyses that compared income groups.

A participant's race was defined as "non-white" if they had indicated the race with which they most identify as any other than White (i.e., American Indian or Alaskan Native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or other Pacific Islander, or Other). Although federal policy defines Hispanic as an ethnicity, "Hispanic or Latino" is included in the racial breakdown of census data by state. Many Hispanics consider their ethnic and cultural background to be part of their racial identity (Rodriguez, 2000; Gonzalez-Barrera and Lopez, 2015). However, this perspective is not universal and Latinos in the United States experience race differently (Rodriguez, 2000; Rothenberg, 2007). Participants in our survey were asked to select the "race with which you most identify," with "Hispanic or Latino" and "White" as two options. We use this self-identification process as justification for classifying those who selected "Hispanic or Latino" as "non-white". We focus on the white/non-white dichotomy because it is the racial divide for which evidence suggests there might be the greatest differences in access to urban greenspace (Wolch et al., 2014; Rigolon, 2016), barriers to spending time in nature (Kellert et al., 2017; Scott and Lee, 2018) and experience during the pandemic (Gross et al., 2020; Andrasfay and Goldman, 2021; Karaca-Mandic et al., 2021).

The nature access outcome measures were also defined according to survey responses (**Supplementary Table 1**). Participants indicated the frequency of time they spent in nature before and during the pandemic using a scale ranging from

never (0) to daily (4). These variables were coded as continuous. Participants also reported how the amount of time they spent in nature had changed since before the pandemic, choosing either less, same or more (coded as categorical). Type of nature access was coded categorically based on where participants indicated they spent time—in public parks or natural areas (*Park*), in a private yard or garden (*Home*), both or neither. Perceptions of nature-related COVID restrictions and risks include binary (true/not true) responses to statements about quarantine conditions (required to stay at home, closed public natural areas) and risk preferences (uncomfortable about COVID risks outdoors).

Additional individual characteristics were coded to include in the descriptive statistics and regression models described below. A participant's "nature relatedness" was determined by averaging responses to the NR-6 questions, which assess subjective connectedness with the natural environment (Nisbet and Zelenski, 2013). This is a continuous measure bounded by one (low) and five (high). We control for nature relatedness in order to account for differences in propensity toward nature, which has been shown to vary by gender (Wyles et al., 2019; Rosa et al., 2020). A participant had children at home if they indicated they lived with children under age 18. A participant was considered to have experienced a change in employment if they responded that the pandemic had increased or decreased the number of hours per week that they spend doing paid work (compared to those who responded "no change"). A participant was considered to live in an urban area if their zip code was classified as within a metropolitan area by the Office of Management and Budget as of October 2010 (USDA Economic Research Service ERS., 2013).

The initial data set used for the analysis was prepared by Watson et al. (see text footnote 1). In that study, 186 of 2,041 responses had missing values, which were replaced using an iterative regression imputation technique (Gelman and Hill, 2006).

The data used in this study will be made publicly available on Open Science Framework (doi: 10.17605/OSF.IO/7VEMJ).

Analysis

To test for differences in frequency of nature access before and during the pandemic (RQ1), we first checked the assumption of normally distributed differences for a paired *t*-test using the Shapiro-Wilk normality test. Because the differences were not normally distributed, we used the non-parametric Wilcoxon signed-rank test to compare change in frequency between time periods for the full sample. For differences within each demographic group (e.g., female vs. male, low-income vs. higher income, and non-white vs. white) at each time period, we used *t*-tests. Pandemic-related changes in nature access were analyzed by comparing time spent in nature during the pandemic to before the pandemic using mixed analysis of variance (ANOVA) within demographic groups and between time periods.

Changes in time spent in nature (RQ2) were tested using chi-squared tests overall and within each demographic group.

Differences in type of nature access (RQ3) were tested using McNemar's chi-squared test for the full sample between time periods, which is appropriate for paired nominal data (Agresti, 2002). Chi-squared tests evaluated differences within each demographic group at each time period.

Differences in perceptions of nature-related COVID restrictions and risks (RQ4) were tested using chi-squared tests for perceived requirement to stay home, perceived closure of public access points, and discomfort about COVID risks outdoors.

We also provide descriptive statistics for each outcome variable by racial subgroup in the **Supplementary Materials** to check whether the aggregation of non-white races is masking opposite trends between subgroups.

Finally, to explore how changes in time spent in nature are explained by demographic, pandemic, and individual characteristics, we estimated multinomial logistic regression models. The dependent variable was categorical, with three levels of time spent in nature since the pandemic: Less, Same, or More, where Same (or "no change") is the reference level. The main estimation included the demographic groups as predictors, possible pandemic-related effects on nature access (type of nature access, COVID restrictions, and discomfort about COVID risks outdoors), and individual-level covariates, including age, nature relatedness, kids at home, and change in employment. To compare how results changed when controlling for fewer factors, we estimated simpler models that include just subsets of those variables. We also estimated an additional full model that included an interaction for the effect of kids at home on women. All models included controls for state of residence and time period (week) in which the survey was taken.

All statistical tests included corrections for multiple comparisons using the Benjamini-Hochberg method with a false discovery rate of 5% (Benjamini and Hochberg, 1995). We pre-registered our analysis plan on Open Science Framework prior to conducting the analysis described herein. The scope of investigation and analytical methods have largely followed the plan, with a few variations. The research questions have been reorganized to better communicate the results. We initially planned to remove responses that failed a check for internal consistency using survey responses related to nature access, however, we subsequently decided that the questions were sufficiently different to negate the validity of that procedure. Additionally, we had intended to test for moderator effects of changes in employment and urban residence but lacked strong evidence regarding the direction of the effect of employment change and had too imbalanced a sample to test for urban vs. rural effects. For kids at home, we focused just on its effect on gender and changed this analysis to be more exploratory than confirmatory.

RESULTS

Overall, 2,036 people participated in the survey (**Table 1**). The most commonly represented race was White (46%), followed by Hispanic (30%), Black (11%), and then Asian (9%), with other races making up 4% of the sample. Household income in 2019 before taxes ranged from <$25,000 (24%) to $100,000

TABLE 1 | Descriptive statistics of sample.

Race	Asian	Black	Hispanic	Other	White
	178 (8.7%)	219 (11%)	611 (30%)	84 (4.1%)	944 (46%)
Income	<$25,000		$25,000–99,999	$100,000 or more	
	496 (24%)		886 (44%)	654 (32%)	
Gender	Female		Male	Other	
	1,038 (51%)		960 (47%)	38 (1.9%)	
Age	18–29		30–49	50 or older	
	731 (36%)		643 (32%)	662 (33%)	
Political preferences	Liberal		Moderate	Conservative	
	642 (32%)		735 (36%)	659 (32%)	
State of residence		California		New York	
		1,029 (51%)		1,007 (49%)	
Lives in an urban area				1,845 (94%)	
Has kids at home				902 (44%)	
Experienced a change in employment in the pandemic				1,024 (50%)	
Had COVID-19				228 (11%)	
Know someone who had COVID-19				687 (34%)	
Total participants				$N = 2,036$	

Cells show number of observations (percent of sample).

or more (32%). Half of the sample self-identified as female (51%), 47% as male, and 1.9% as transgender, non-binary, or self-described. The age range was split between 18 and 30 years (36%), 31–49 years (32%), and 50 or older (33%). Political preferences of respondents are similarly equally divided, with 32% describing their views as liberal, 36% as moderate, and 32% as conservative. Due to sampling design, the sample is split evenly between California and New York residents and matches the demographic profiles of those states for race, household income, education level, and age (U.S. Census Bureau, 2019a,b). Almost all respondents (94%) live in urban areas; this proportion is similar to the urban-rural split of California (95% urban) and slightly higher than that of New York (86% urban) (U.S. Census Bureau, 2010). About half of respondents have kids under the age of 18 at home (44%) and have experienced a change in employment since the start of the pandemic (50%). At the time of the survey, only 11% of the sample reported having had COVID-19 symptoms or been diagnosed with the illness, while 34% knew someone who had symptoms of or been diagnosed with COVID-19.

Following the demographic groupings described in the Methods, the samples used in the analyses were split between 52% female (48% male), 43% low-income (57% high-income), and 54% non-white (46% white).

Changes in Frequency of Nature Access (RQ1)

Before the pandemic, respondents, on average, reported spending time in nature once or twice a week (mean = 2.07). Pre-pandemic reported time in nature was less for low-income and non-white groups compared to those who are high-income (diff = −0.35, $t = -4.82$, $p < 0.001$) and white (diff = −0.26, $t = -5.06$, $p < 0.001$).

During the pandemic, the average reported time spent in nature for all respondents decreased (mean = 1.75, $V = 442{,}912$, $p < 0.001$). All demographic groups reported a decline in time spent in nature during the pandemic (**Figure 1**; **Supplementary Table 3**). As with before the pandemic, reported time in nature during the pandemic was less for respondents who are low-income (vs. high-income; diff = −0.63, $t = -8.60$, $p < 0.001$) and non-white (vs. white; diff = −0.52, $t = -9.37$, $p < 0.001$). Pairwise comparisons and statistical results are shown in **Supplementary Table 2**.

Differences in reported frequency of nature access increased during the pandemic within all groups (**Figure 1**; **Supplementary Table 4**). Compared to before the pandemic, there was a greater decrease in the frequency of time spent in nature during the pandemic reported by women (difference from male respondents = 0.17, $F = 8.84$, $p < 0.01$), low-income respondents (difference from high-income = 0.28, $F = 13.06$, p

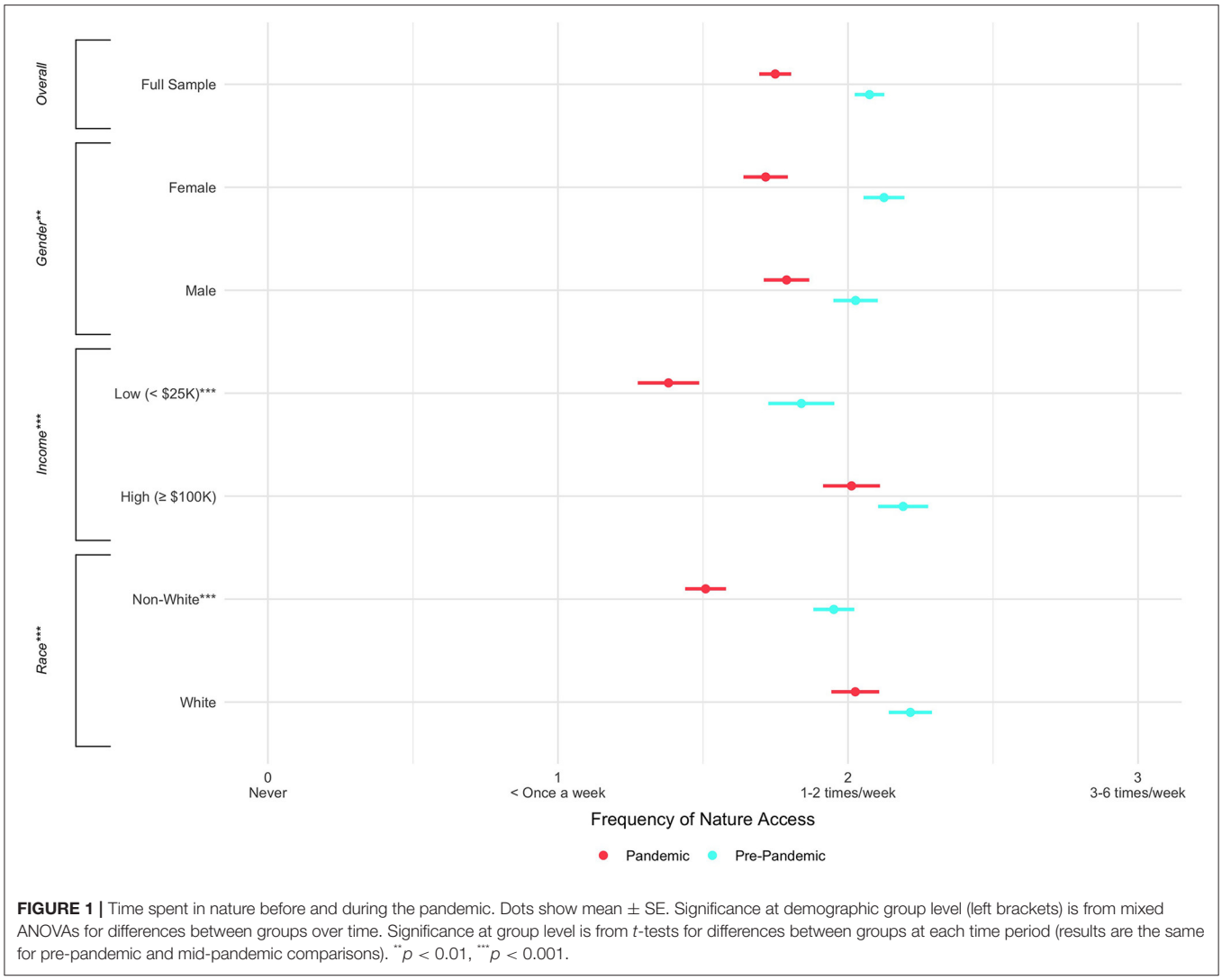

FIGURE 1 | Time spent in nature before and during the pandemic. Dots show mean ± SE. Significance at demographic group level (left brackets) is from mixed ANOVAs for differences between groups over time. Significance at group level is from *t*-tests for differences between groups at each time period (results are the same for pre-pandemic and mid-pandemic comparisons). $^{**}p < 0.01$, $^{***}p < 0.001$.

< 0.001), and non-white respondents (difference from white = 0.25, $F = 19.38$, $p < 0.001$; **Supplementary Table 3**).

Changes in Time Spent in Nature (RQ2)

Matching the results above, the most commonly reported experience for survey participants was spending less time in nature during the pandemic (52%), compared to 23% who reported spending more time in nature and 25% who reported they spent the same amount of time in nature. Loss of time in nature was the majority response for each group (**Figure 2**). Within demographic groups, women ($\chi^2 = 15.8$, $p < 0.001$), low-income ($\chi^2 = 11.06$, $p < 0.01$), and non-white participants ($\chi^2 = 43.9$, $p < 0.001$) reported different pandemic nature experiences than their counterparts (**Figure 2**; **Supplementary Table 5**).

Type of Nature Access During the Pandemic (RQ3)

Prior to the pandemic, about 10% of the sample reported not typically spending time in nature or greenspaces at least once a week, while 14% spent time just in public parks or natural areas, 35% in both public natural areas and a private yards or garden, and 41% in just a private yard or garden (**Figure 3**). During the pandemic, the proportions of the sample in two groups grew: those who reported not being able to spend time in nature (14%) and those who reported using only private nature access (59%). Whereas, the proportions who reported spending time just in public (9%) or in both public and private (18%) natural areas declined. This shift in nature access before and during the pandemic for the full sample is statistically significant (McNemar's $\chi^2 = 327$, $p < 0.001$; **Supplementary Table 6**).

Type of nature access before the pandemic differed within each demographic group (**Supplementary Table 7**). During the pandemic, types of nature access differed for some demographic groups but not all (**Figure 4**; **Supplementary Table 8**). Women and men reported similar nature access ($\chi^2 = 4.56$, $p = 0.21$), which was similar to the full sample distribution described above. Type of nature access during the pandemic was different, however, for low-income (vs. high-income; $\chi^2 = 72.2$, $p < 0.001$) and non-white (vs. white; $\chi^2 = 58.5$, $p < 0.001$) respondents. These groups were more likely to report not being able to

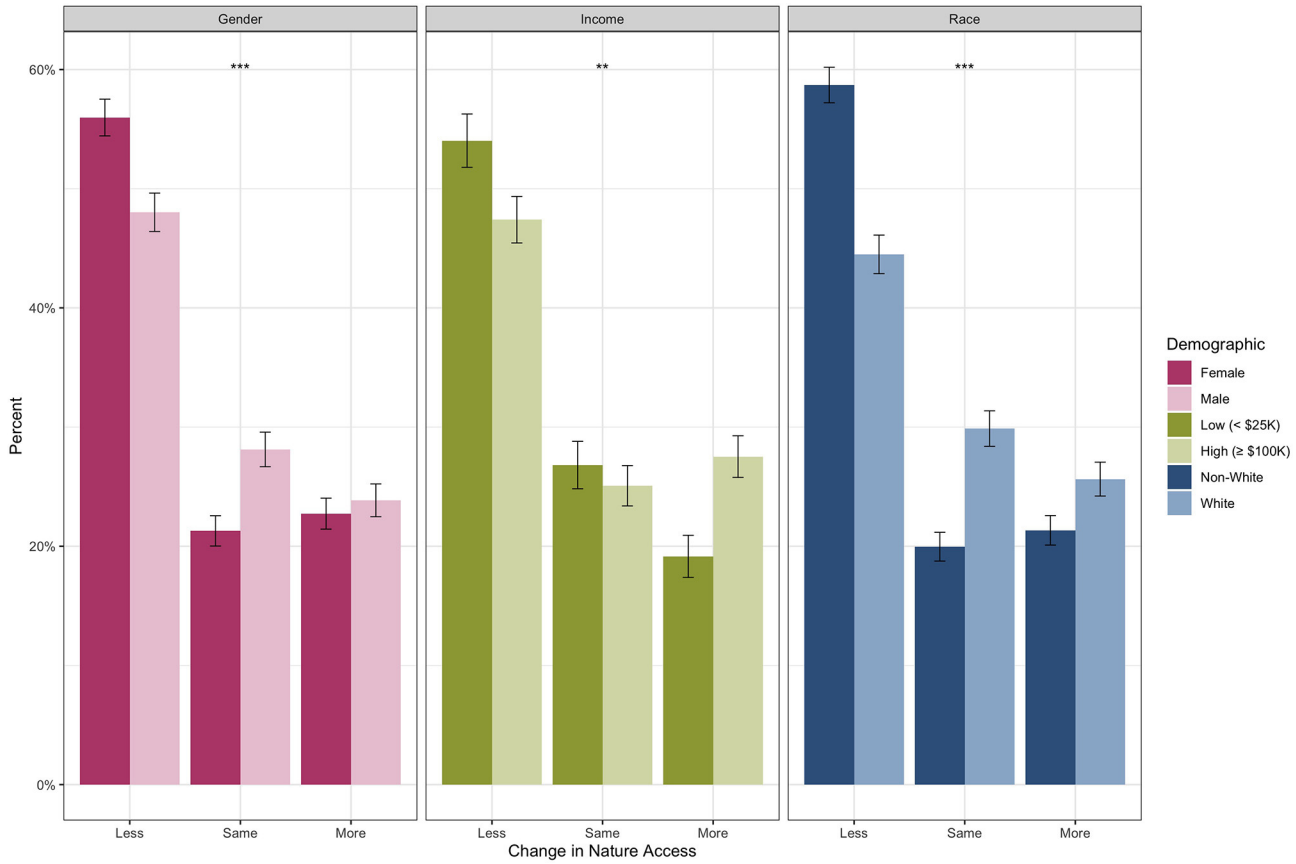

FIGURE 2 | Changes in time spent in nature during the pandemic by demographic group. Error bars represent SE of mean. Significance is from chi-squared tests within demographic groups. $^{**}p < 0.01$, $^{***}p < 0.001$.

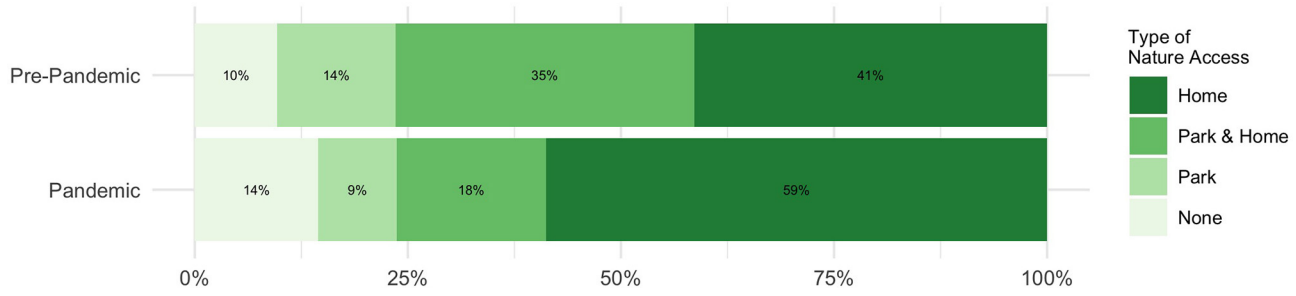

FIGURE 3 | Type of nature access for the full sample before (pre-) and during (mid-) the pandemic. None indicates not spending time in nature; Park indicates just time in public parks or natural areas; Park and Home indicates time in both public and private natural areas; and Home indicates just time in a private yard or garden.

spend time in nature ($\text{Income}_{\text{diff}} = 15.0$ percentage points; $\text{Race}_{\text{diff}} = 7.7$ percentage points) or to have spent time just in public nature areas ($\text{Income}_{\text{diff}} = 5.2$ percentage points; $\text{Race}_{\text{diff}} = 6.5$ percentage points). They were also less likely to report having spent time in a private yard ($\text{Income}_{\text{diff}} = -8.5$ percentage points; $\text{Race}_{\text{diff}} = -8.7$ percentage points) or both a private yard and public nature areas ($\text{Income}_{\text{diff}} = -11.6$ percentage points; $\text{Race}_{\text{diff}} = -5.4$ percentage points; **Supplementary Table 5**).

Perceptions of Nature-Related COVID Restrictions and Risks (RQ4)

Regarding nature-related COVID restrictions, 18% of the sample reported that they were required to stay at home in the previous 2 weeks. This experience was different for all three demographic groups (**Figure 5**; **Supplementary Table 9**). Women reported stay-at-home requirements 4.5 percentage points more than men ($\chi^2 = 6.74$, $p < 0.01$), low-income respondents 8.7 percentage points more than high-income respondents ($\chi^2 = 13.2$, $p <$

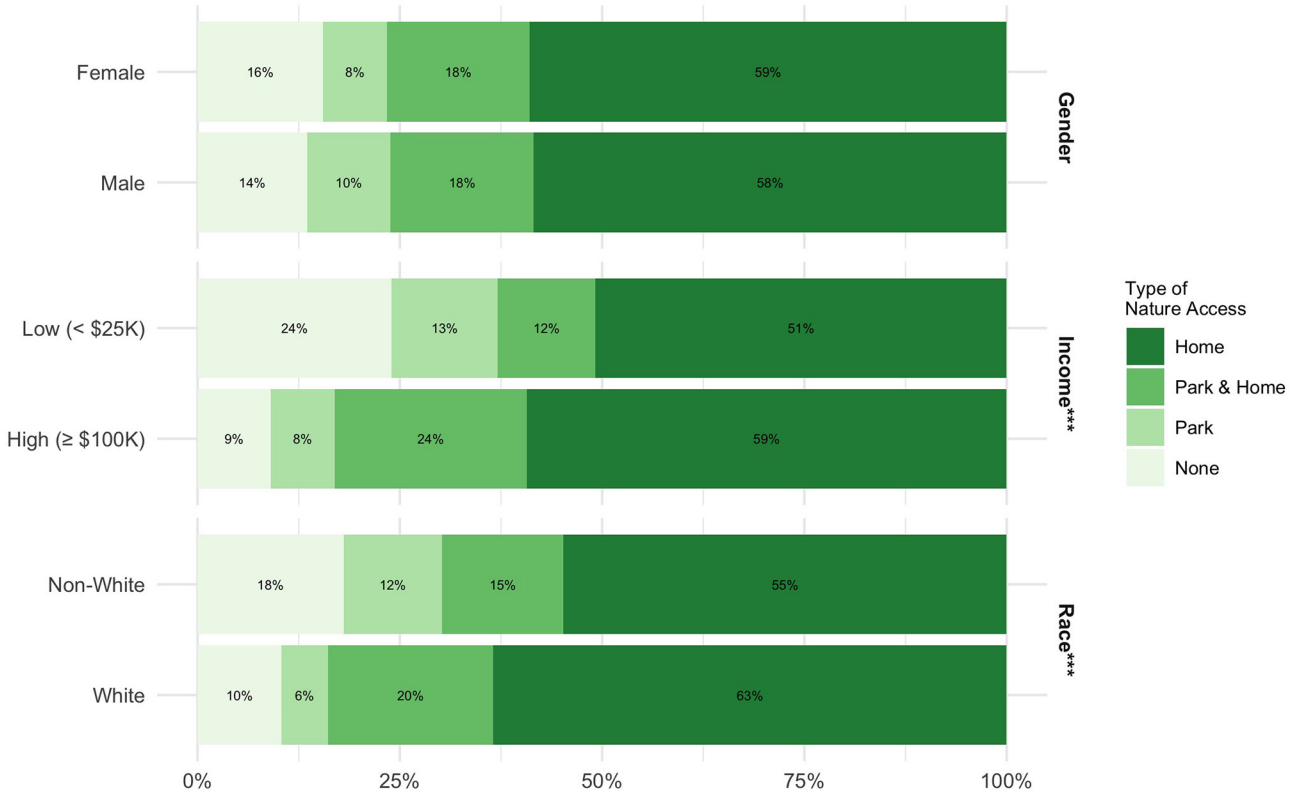

FIGURE 4 | Type of nature access during the pandemic by demographic group. None indicates not spending time in nature; Park indicates just time in public parks or natural areas; Park and Home indicates time in both public and private natural areas; and Home indicates just time in a private yard or garden. Significance is from chi-squared tests within demographic groups. ***$p < 0.001$.

0.001), and non-white respondents 9 percentage points more than white respondents ($\chi^2 = 27.6$, $p < 0.001$).

About a quarter (23%) of the full sample indicated they were permitted to leave their homes to access public parks or natural areas but the public access points they typically use were closed. Gender ($\chi^2 = 0.18$, $p = 0.67$) and income ($\chi^2 = 0.0$, $p = 1$) groups experienced this COVID restriction similarly (**Supplementary Table 10**). However, non-white respondents reported closed access points more than white respondents (5.9 percentage points, $\chi^2 = 9.48$, $p < 0.01$).

A fifth (20%) of the sample said they were permitted to spend time outside but felt uncomfortable about the risk of exposure to or spreading COVID-19. While there was no difference in risk preferences by income ($\chi^2 = 1.14$, $p = 0.28$), discomfort was expressed by 23% of women (compared to 16% of men; $\chi^2 = 16.9$, $p < 0.001$) and 22% of non-white respondents (compared to 17% of white respondents; $\chi^2 = 6.28$, $p < 0.05$; **Supplementary Table 11**).

Non-white trends for each outcome measure described above (frequency of nature access, change in time spent in nature, type of nature access, and perceptions of nature-related COVID restrictions and risks) appear consistent across Hispanic, Black, and Asian respondents (**Supplementary Table 12**). As with the aggregate "non-white" grouping, each these races averaged greater losses in the frequency of nature access and spending less time in nature than white respondents.

Predicting Changes in Time Spent in Nature

Results from the main multinomial regression model (**Table 2**) support those described above. When controlling for all three demographic characteristics and additional pandemic and household factors, women and non-whites were more likely to report spending less time in nature during the pandemic than men and whites [female = 5%, 95% CI (1, 9%); non-white = 9%, 95% CI (4, 14%)]. Non-whites were also less likely to report spending more time in nature than white respondents [−5%, 95% CI (−9%, 0%)].

As one would expect, having access to public parks, a private yard, or both were all associated with spending more time in nature compared to having no access to nature during the pandemic [public = 16%, 95% CI (9, 23%); private = 13%, 95% CI (8, 17); both public and private = 29%, 95% CI (23, 35%)]. The relationships between type of nature access and less nature are less clear—only those who had access to both public and private nature were less likely to report spending less time in nature compared to those who had no access [−17%, 95% CI (−25, −9%)].

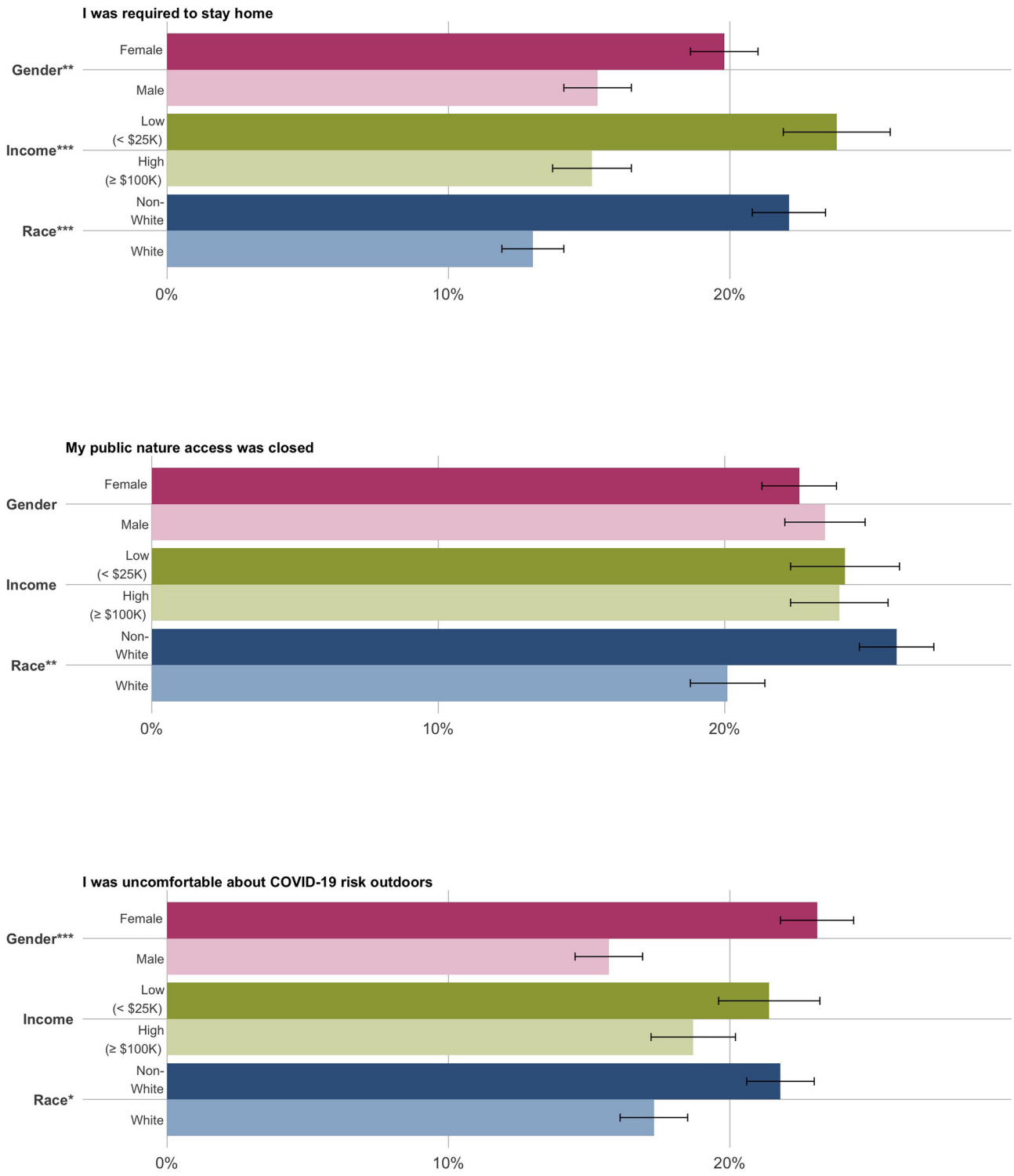

FIGURE 5 | Perceptions of nature-related COVID restrictions and risks by demographic group. Error bars represent SE of the mean. Significance is from chi-squared tests within demographic group for each statement. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Perceptions of nature-related COVID restrictions and risks were associated with reported changes in time spent in nature. Less nature was associated with requirements to stay at home [16%, 95% CI (10, 21%)], closed public parks [9%, 95% CI (4, 14%)], and discomfort with the risks of catching or spreading COVID-19 outdoors [23%, 95% CI

TABLE 2 | Average marginal effects of demographic, pandemic, and household characteristics on reported change in time spent in nature since the pandemic.

	Less nature	More nature
Female	0.050	−0.008
	(0.006, 0.094)	(−0.046, 0.029)
	(0.025)	(0.663)
Low-income	−0.033	−0.023
	(−0.084, 0.018)	(−0.067, 0.021)
	(0.208)	(0.298)
Non-White	0.088	−0.045
	(0.039, 0.137)	(−0.087, −0.004)
	(0.000)	(0.032)
Access: public parks	−0.031	0.155
	(−0.121, 0.059)	(0.085, 0.225)
	(0.495)	(0.000)
Access: private yard	0.009	0.127
	(−0.055, 0.074)	(0.084, 0.170)
	(0.778)	(0.000)
Access: both public and private	−0.167	0.290
	(−0.245, −0.089)	(0.227, 0.352)
	(0.000)	(0.000)
COVID: stay at home	0.157	−0.080
	(0.101, 0.213)	(−0.126, −0.034)
	(0.000)	(0.001)
COVID: parks closed	0.092	−0.019
	(0.041, 0.142)	(−0.060, 0.022)
	(0.000)	(0.362)
COVID: risks outdoors	0.226	−0.102
	(0.175, 0.277)	(−0.144, −0.061)
	(0.000)	(0.000)
Change in employment	0.068	0.077
	(0.024, 0.111)	(0.040, 0.115)
	(0.002)	(0.000)
Kids at home	0.020	0.030
	(−0.026, 0.066)	(−0.009, 0.069)
	(0.386)	(0.129)
Nature relatedness (NR-6)	0.027	0.019
	(0.003, 0.050)	(−0.001, 0.040)
	(0.026)	(0.069)
30–49 years old	−0.018	0.002
	(−0.072, 0.035)	(−0.045, 0.049)
	(0.498)	(0.925)
Over 50 years old	−0.005	−0.058
	(−0.067, 0.056)	(−0.110, −0.007)
	(0.865)	(0.027)
Number of observations	1,998	1,998

Estimates are from multinomial regression on change in time spent in nature since the pandemic comparing against a baseline of "no change." Model coefficients can be found in ***Supplementary Table 12****, under Model (3). Low-Income indicates participants whose household income (hhi) is <$25,000; the comparison group in the model is all participants whose hhi ≥ $25,000.* ***Supplementary Table 12*** *shows results where the comparison group is high-income participants (hhi ≥ $100,000), which excludes nearly half of the observations, as described in Methods. Variables beginning with "Access" or "COVID" are based on responses to the survey questions in* ***Supplementary Table 1****. The model includes controls for state of residence and week in which the survey was completed. Coefficients (first row within each variable) show average marginal effects; confidence intervals in brackets; p-values in parentheses.*

(18, 28%)]. Conversely, more time in nature was negatively associated with stay-at-home requirements [−8%, 95% CI (−12, −3%)] and COVID risks outdoors [−10%, 95% CI (−14, −6%)].

Regarding individual characteristics, changes in employment and nature relatedness were associated with both less and more time in nature.

Simpler models that do not include all covariates show similar but stronger relationships between demographic characteristics and reported changes in nature (**Supplementary Table 12**). Adding an interaction term to the full model indicates that women with children at home were more likely to report spending less or more time in nature, compared to the same nature, and this moderation effect seems to drive the relationship between women and changes in nature (which becomes insignificant when including the interaction).

DISCUSSION

In Spring 2020, when the COVID-19 pandemic and associated lockdowns were at their height, the majority of respondents in our representative samples of California and New York residents reported losing nature exposure. This was true both for the frequency of nature access and for time spent in nature, regardless of gender, income or race. Most reported accessing nature less often and spending less time in nature than before the pandemic. This overall loss of nature was associated with perceptions of risks and restrictions from the pandemic, as well as reporting fewer options for nature access.

Importantly, this reported loss of nature was greater for women, low-income and non-white people than for their male, high-income, white counterparts. These findings parallel those from other studies using different methodologies: lower-income, communities of color reported losing time in and access to nature during the pandemic (Larson et al., 2021; Pearson et al., 2021). We also find that the pandemic seems to have exacerbated prior inequalities in nature access: low-income and non-white people reported spending even less time in nature and having fewer nature access options than they did before the pandemic. Such disparities have critical implications given the potential benefits to wellbeing of time in nature (Russell et al., 2013; Samuelsson et al., 2021; Stieger et al., 2021).

These results provide a new lens with which to view studies highlighting increases in nature use during the pandemic (e.g., Derks et al., 2020; Grima et al., 2020; Venter et al., 2020; Geng et al., 2021). While those aggregate numbers suggest people may have increased their nature exposure during the pandemic, we find the opposite to be true overall and especially among more vulnerable groups. Instead, others' results showing increases in nature usage during the pandemic may have been driven by a select population (male, higher-income, or white people) who had sufficient resources (time, money, access) and comfort to spend time outdoors.

Responses to our survey suggest how access and comfort may have influenced nature access for some groups. We found evidence for inequalities in the ways that different demographic

groups reported accessing nature. While reports of public nature access shrank overall, greater proportions of high-income and white respondents reported being able to spend time in a private yard or garden compared to low-income and non-white respondents—more of whom reported having just public nature access or no nature access at all.

Non-whites were also more likely than whites to report that they were required to stay home, their public nature access was closed, and they were uncomfortable about the risks of catching or transmitting COVID-19 outdoors. Regarding restrictions, it is unclear whether those are differences related to location (i.e., true differences in stay-at-home orders and park closures) or differences in perceptions of the personal relevance of those restrictions. Perhaps people of color expressed a heightened awareness of public orders because they were more sensitive to possible consequences of violating those orders or because they were more likely to hold an "essential" job that required leaving home. High-income respondents were also less likely to report that they were required to stay at home—a distinction that could be similarly related to privilege in employment options, perceptions of restrictions or actual differences in policy by location.

Women reported they were required to stay at home and uncomfortable about COVID risks outdoors more often than men. Different perceptions of restrictions could be related to rule-following: evidence has shown that women show a greater preference for acting according to moral norms (i.e., what's right) rather than possible consequences, compared to men (Friesdorf et al., 2015). Women also tend to be more risk averse than men (Eckel and Grossman, 2008). For gender differences, which often operate within a household, it is also possible that responses to the statement "I was required to stay in my home" were the result of household obligations rather than policy restrictions. Women have carried the burden of childcare during the pandemic and given up employment to do so (Heggeness and Fields, 2020; Heggeness et al., 2021); perhaps staying at home was seen as a function of those factors.

Finally, reported differences in nature loss for women and for nature loss and lack of gains among non-whites are robust when controlling for overlap between demographic characteristics and other factors, including job loss, children at home, and nature relatedness. This adds further support to the interpretation that systemic inequities in society and within the household were exacerbated during the pandemic in terms of access to nature. Our regression results also suggest that women were more likely to lose nature in part because they were shouldering the burden of kids at home more so than men.

Our results identify disparities in reported access to nature during the COVID-19 pandemic for certain demographic groups that have been disproportionately burdened by the pandemic's disruption and costs. Although we provide evidence from representative samples of two densely populated and pandemic-stricken regions of the United States, we cannot say whether our results generalize to people in other parts of the country or world. Populations in rural areas and regions with lower pandemic risks and restrictions likely experienced different or lesser changes in nature exposure. It is also likely that the pandemic had different effects on certain subgroups within our demographic groupings (e.g., low-income vs. high-income women or Asian Americans vs. Hispanics). Interviews conducted around the time of our survey identify anti-Asian racism as a barrier for Asian Americans to spending time outdoors in public spaces (Maurer et al., 2021). Thus, while Black, Hispanic, and Asian survey participants reported a loss, on average, of time in nature during the pandemic (**Supplementary Table 12**), the reasons for this change could be distinct and related to racial identity. Possible differences between Asian and Hispanic respondents in nature access and risk perceptions, in particular, may point to the unique experiences of these two non-white groups. While these subgroup effects are beyond the scope of our investigation, we encourage future research to explore these important differences and move beyond the binary categorizations used in this study.

It is worth noting that the measures used in this study are self-reported and comparisons to pre-pandemic baselines are sensitive to the reliability of respondents' recall. The pandemic's disruption to people's schedules and wellbeing may have influenced how well people were able to remember their prior nature experiences. Surveying participants before and again during the pandemic would have provided more reliable responses. Still, asking participants to report how their time in nature has changed provides insight into their perceptions of how the pandemic has affected their ability to spend time in nature. These results also complement recent work using objective measures of greenspace to identify dual disparities in nature access and COVID-19 case rates (Spotswood et al., 2021). While prior evidence shows time spent in nature can improve wellbeing, we recognize that the COVID-19 pandemic generated unprecedented stress in daily life. Although we do not offer evidence on the possible benefits of the nature-related outcomes measured, subsequent analysis will test for associations between these outcomes and participants' self-reported mental health (see text footnote 1).

We also note that preferences for time in nature are not universal, and some people may choose to spend less time outdoors. While these preferences may vary by gender—women often score higher than men on scales measuring connectedness to nature (Cervinka et al., 2012; Wyles et al., 2019; Rosa et al., 2020)—it is not clear that nature preferences vary consistently by race or income. Literature that claims blacks and other non-white groups are disconnected from nature has been challenged by more recent and nuanced work, which finds little or no difference in nature affinity between races and calls for greater cultural sensitivity in how preferences are measured (Kellert et al., 2017; Taylor, 2018, 2021). In our study, women and non-whites were more likely to report losing time in nature even when controlling for nature relatedness, a scale that is similar to others used to measure nature affinity (Howell et al., 2011; Tam, 2013). Future qualitative research could help illuminate the complexities between racial identity and preferences for and barriers to accessing nature (e.g., Maurer et al., 2021). Although our results do not allow us to say *why* we observe demographic differences in frequency of nature use before and during the pandemic, the observed racial and socioeconomic disparities echo results from other studies: non-white and

low-income groups have fewer urban green spaces (Rigolon, 2016; Landau et al., 2020; Spotswood et al., 2021) and greater barriers to spending time in nature (Kellert et al., 2017; Scott and Lee, 2018). Regardless of preferences, these inequities mean that such groups are deprived the opportunity to capture nature's benefits to health and wellbeing. Populations living in the greenest environments have the lowest income-related health inequality (Mitchell and Popham, 2008).

The results from our study can also be viewed as contribution toward understanding the unequal effects of disturbances on vulnerable populations. Our results show that the COVID-19 pandemic affected groups differently in how they reported accessing nature and exacerbated existing inequalities. This is consistent with the literature showing the unequal impacts of the pandemic on other outcomes, including morbidity (Bui, 2020; Gross et al., 2020; Karaca-Mandic et al., 2021), employment (Montenovo et al., 2020; Weill et al., 2020), and childcare (Heggeness and Fields, 2020; Heggeness et al., 2021). Together, these trends are in line with broader research showing that economic downturns, natural disasters, and climate change tend to widen inequalities (Diffenbaugh and Burke, 2019; Hong et al., 2021; van Bavel and Scheffer, 2021). On the other hand, the COVID-19 pandemic may be unique in its effect on nature exposure and access. By simultaneously limiting peoples' movement and limiting social engagement to outdoor settings, the pandemic and associated lockdown measures acted to prohibit and facilitate nature access *via* mechanisms that are unlikely to exist in other disruptive events.

In addition to strict pandemic lockdowns during our survey period, the United States saw heightened racial tensions. The death of George Floyd and subsequent Black Lives Matter protests occurred nationwide while our survey was in the field. While it is unlikely that these events affected the nature access outcomes measured in our survey, they do highlight the relevance of this investigation. Racial inequities in the United States persist in the criminal justice system, public health, education, and other public services. Although access to nature is a minor concern in comparison, environmental injustices are impactful and widespread. Many of these injustices are related to where people live—in green neighborhoods with park access, or in under-resourced neighborhoods with poor infrastructure or near polluting industries. Moreover, projections of population and land use changes find that non-white and lower income populations are more likely to lose out on a range of benefits from nature in the future (Gourevitch et al., 2021). Nature access may be part of a suite of policy interventions to address public health inequalities. We hope that these results are useful to organizations working to advance environmental justice, policymakers who determine the location of and investment in greenspace in urban areas, and decision makers who can foster resilience against future disturbances.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

This study was reviewed and approved by Sewanee: University of the South IRB. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HBF, CHW, and KW: conceptualization, investigation, methodology, and writing—review and editing. HBF: formal analysis, visualization, and writing—original draft. KW: funding acquisition. All authors contributed to the article and approved the submitted version.

FUNDING

Funding for this project was provided by Sewanee, the University of the South through the McKrickard Earth and Environmental Systems Grant.

ACKNOWLEDGMENTS

We would like to thank Dr. Deborah McGrath for her input and feedback on our survey design and questions.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2022.709982/full#supplementary-material

REFERENCES

Agresti, A. (2002). *Categorical Data Analysis. 2nd Edn*. New York, NY: Wiley-Interscience.

Andrasfay, T., and Goldman, N. (2021). Reductions in 2020 US life expectancy due to COVID-19 and the disproportionate impact on the Black and Latino populations. *PNAS* 118. doi: 10.1073/pnas.2014746118

Astell-Burt, T., Feng, X., Mavoa, S., Badland, H. M., and Giles-Corti, B. (2014). Do low-income neighbourhoods have the least green space? A cross-sectional study of Australiazs most populous cities. *BMC Public Health* 14, 292. doi: 10.1186/1471-2458-14-292

Benjamini, Y., and Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J. R. Stat. Soc. B (Methodol.)* 57, 289–300. doi: 10.1111/j.2517-6161.1995.tb02031.x

Blackall, M. (2020). *Lockdown UK: "There Are Now Two Classes, People With Gardens and the Rest of Us."* The Guardian. Available online at: http://www.theguardian.com/world/2020/apr/23/trapped-in-coronavirus-lockdown-uk-no-garden-outside-space (accessed May 11, 2021).

Blundell, R., Dias, M. C., Joyce, R., and Xu, X. (2020). COVID-19 and inequalities. *Fiscal Stud.* 41, 291–319. doi: 10.1111/1475-5890.12232

Boden, M., Zimmerman, L., Azevedo, K. J., Ruzek, J. I., Gala, S., Abdel Magid, H. S., et al. (2021). Addressing the mental health impact of

COVID-19 through population health. *Clin. Psychol. Rev.* 85, 102006. doi: 10.1016/j.cpr.2021.102006

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., Vries, S., de Flanders, J., et al. (2019). Nature and mental health: an ecosystem service perspective. *Sci. Adv.* 5, eaax0903. doi: 10.1126/sciadv.aax0903

Bui, D. P. (2020). Racial and ethnic disparities among COVID-19 cases in workplace outbreaks by industry sector — Utah, March 6–June 5, 2020. *MMWR Morb. Mortal. Wkly. Rep.* 69, 1133–1138. doi: 10.15585/mmwr.mm6933e3

Cervinka, R., Röderer, K., and Hefler, E. (2012). Are nature lovers happy? On various indicators of well-being and connectedness with nature. *J. Health Psychol.* 17, 379–388. doi: 10.1177/1359105311416873

Cooke, J. E., Eirich, R., Racine, N., and Madigan, S. (2020). Prevalence of posttraumatic and general psychological stress during COVID-19: a rapid review and meta-analysis. *Psychiatry Res.* 292, 113347. doi: 10.1016/j.psychres.2020.113347

Day, B. H. (2020). The value of greenspace under pandemic lockdown. *Environ. Resour. Econ.* 76, 1161–1185. doi: 10.1007/s10640-020-00489-y

Derks, J., Giessen, L., and Winkel, G. (2020). COVID-19-induced visitor boom reveals the importance of forests as critical infrastructure. *Forest Policy Econ.* 118, 102253. doi: 10.1016/j.forpol.2020.102253

Diffenbaugh, N. S., and Burke, M. (2019). Global warming has increased global economic inequality. *PNAS* 116, 9808–9813. doi: 10.1073/pnas.1816020116

Eckel, C. C., and Grossman, P. J. (2008). "Chapter 113 men, women and risk aversion: experimental evidence," in *Handbook of Experimental Economics Results*, eds. C. R. Plott and V. L. Smith (Amstredam: Elsevier), 1061–1073.

Fan, Y., Das, K. V., and Chen, Q. (2011). Neighborhood green, social support, physical activity, and stress: assessing the cumulative impact. *Health Place* 17, 1202–1211. doi: 10.1016/j.healthplace.2011.08.008

Francis, J., Giles-Corti, B., Wood, L., and Knuiman, M. (2012). Creating sense of community: the role of public space. *J. Environ. Psychol.* 32, 401–409. doi: 10.1016/j.jenvp.2012.07.002

Friesdorf, R., Conway, P., and Gawronski, B. (2015). Gender differences in responses to moral dilemmas: a process dissociation analysis. *Pers. Soc. Psychol. Bull.* 41, 696–713. doi: 10.1177/0146167215575731

Gelman, A., and Hill, J. (2006). *Data Analysis Using Regression and Multilevel/Hierarchical Models*. Cambridge: Cambridge University Press.

Geng, D., Innes, J., Wu, W., and Wang, G. (2021). Impacts of COVID-19 pandemic on urban park visitation: a global analysis. *J. For. Res.* 32, 553–567. doi: 10.1007/s11676-020-01249-w

Gonzalez-Barrera, A., and Lopez, M. H. (2015). *Is Being Hispanic a Matter of Race, Ethnicity or Both?* Pew Research Center. Available online at: https://www.pewresearch.org/fact-tank/2015/06/15/is-being-hispanic-a-matter-of-race-ethnicity-or-both/ (accessed November 9, 2021).

Gourevitch, J. D., Alonso-Rodríguez, A. M., Aristizábal, N., de Wit, L. A., Kinnebrew, E., Littlefield, C. E., et al. (2021). Projected losses of ecosystem services in the US disproportionately affect non-white and lower-income populations. *Nat. Commun.* 12, 3511. doi: 10.1038/s41467-021-23905-3

Grima, N., Corcoran, W., Hill-James, C., Langton, B., Sommer, H., and Fisher, B. (2020). The importance of urban natural areas and urban ecosystem services during the COVID-19 pandemic. *PLoS ONE* 15, e0243344. doi: 10.1371/journal.pone.0243344

Gross, C. P., Essien, U. R., Pasha, S., Gross, J. R., Wang, S., and Nunez-Smith, M. (2020). Racial and ethnic disparities in population-level covid-19 mortality. *J. Gen. Intern. Med.* 35, 3097–3099. doi: 10.1007/s11606-020-06081-w

Hartig, T., Mitchell, R., de Vries, S., and Frumkin, H. (2014). Nature and health. *Annu. Rev. Public Health* 35, 207–228. doi: 10.1146/annurev-publhealth-032013-182443

Heggeness, M. L., and Fields, J. (2020). *Working Moms Bear Brunt of Home Schooling While Working During COVID-19*. U.S. Census Bureau. Available online at: https://www.census.gov/library/stories/2020/08/parents-juggle-work-and-child-care-during-pandemic.html (accessed May 4, 2021).

Heggeness, M. L., Fields, J., García Trejo, Y. A., and Schulzetenberg, A. (2021). *Tracking Job Losses for Mothers of School-Age Children During a Health Crisis*. U.S. Census Bureau. Available online at: https://www.census.gov/library/stories/2021/03/moms-work-and-the-pandemic.html (accessed May 4, 2021).

Hong, B., Bonczak, B. J., Gupta, A., and Kontokosta, C. E. (2021). Measuring inequality in community resilience to natural disasters using large-scale mobility data. *Nat. Commun.* 12, 1870. doi: 10.1038/s41467-021-22160-w

Howell, A. J., Dopko, R. L., Passmore, H.-A., and Buro, K. (2011). Nature connectedness: associations with well-being and mindfulness. *Person. Indiv. Diff.* 51, 166–171. doi: 10.1016/j.paid.2011.03.037

Jalali, A. M., Peterson, B. M., and Galbadage, T. (2020). Early COVID-19 interventions failed to replicate 1918 St. Louis vs. Philadelphia outcomes in the United States. *Front. Public Health* 8, 522. doi: 10.3389/fpubh.2020.579559

Karaca-Mandic, P., Georgiou, A., and Sen, S. (2021). Assessment of COVID-19 hospitalizations by race/ethnicity in 12 states. *JAMA Intern. Med.* 181, 131–134. doi: 10.1001/jamainternmed.2020.3857

Kellert, S. R., Case, D. J., Escher, D., Witter, D. J., Mikels-Carrasco, J., and Seng, P. T. (2017). *The Nature of Americans: Disconnection and Recommendations for Reconnection*.

Kleinschroth, F., and Kowarik, I. (2020). COVID-19 crisis demonstrates the urgent need for urban greenspaces. *Front. Ecol. Environ.* 18, 318–319. doi: 10.1002/fee.2230

Landau, V. A., McClure, M. L., and Dickson, B. G. (2020). *Analysis of the Disparities in Nature Loss and Access to Nature*. Truckee, CA: Conservation Science Partners.

Larson, L. R., Zhang, Z., Oh, J. I., Beam, W., Ogletree, S. S., Bocarro, J. N., et al. (2021). Urban park use during the COVID-19 pandemic: are socially vulnerable communities disproportionately impacted? *Front. Sustain. Cities* 3, 103. doi: 10.3389/frsc.2021.710243

Maurer, M., Cook, E. M., Yoon, L., Visnic, O., Orlove, B., Culligan, P. J., et al. (2021). Understanding multiple dimensions of perceived greenspace accessibility and their effect on subjective well-being during a global pandemic. *Front. Sustain. Cities* 3, 124. doi: 10.3389/frsc.2021.709997

McKinsey and Company (2021). *Seven Charts That Show COVID-19's Impact on Women's Employment | McKinsey*. Available online at: https://www.mckinsey.com/featured-insights/diversity-and-inclusion/seven-charts-that-show-covid-19s-impact-on-womens-employment (accessed April 14, 2021).

Mitchell, R., and Popham, F. (2008). Effect of exposure to natural environment on health inequalities: an observational population study. *Lancet* 372, 1655–1660. doi: 10.1016/S0140-6736(08)61689-X

Montenovo, L., Jiang, X., Lozano Rojas, F., Schmutte, I. M., Simon, K. I., Weinberg, B. A., et al. (2020). Determinants of disparities in covid-19 job losses. *Natl. Bureau Econ. Res.* doi: 10.3386/w27132

Nesbitt, L., Meitner, M. J., Girling, C., Sheppard, S. R. J., and Lu, Y. (2019). Who has access to urban vegetation? A spatial analysis of distributional green equity in 10 US cities. *Landscape Urban Plan.* 181, 51–79. doi: 10.1016/j.landurbplan.2018.08.007

Nisbet, E., and Zelenski, J. (2013). The NR-6: a new brief measure of nature relatedness. *Front. Psychol.* 4, 813. doi: 10.3389/fpsyg.2013.00813

Pearson, A. L., Horton, T., Pfeiffer, K. A., Buxton, R., Gardiner, J., Liu, W., et al. (2021). Contact with nature as a mental health buffer for lower income communities during the COVID-19 pandemic. *Front. Sustain. Cities* 3, 86. doi: 10.3389/frsc.2021.688473

Poulson, M., Geary, A., Annesi, C., Allee, L., Kenzik, K., Sanchez, S., et al. (2021). National disparities in COVID-19 outcomes between black and white Americans. *J. Natl. Med. Assoc.* 113, 125–132. doi: 10.1016/j.jnma.2020.07.009

Pouso, S., Borja, Á., Fleming, L. E., Gómez-Baggethun, E., White, M. P., and Uyarra, M. C. (2021). Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Sci. Total Environ.* 756, 143984. doi: 10.1016/j.scitotenv.2020.143984

Rho, H. J., Fremstad, S., and Brown, H. (2020). *A Basic Demographic Profile of Workers in Frontline Industries*. Washington, DC: Center for Economic and Policy Research.

Rigolon, A. (2016). A complex landscape of inequity in access to urban parks: a literature review. *Landscape Urban Plan.* 153, 160–169. doi: 10.1016/j.landurbplan.2016.05.017

Rodriguez, C. E. (2000). *Changing Race: Latinos, the Census, and the History of Ethnicity in the United States*. New York, NY: New York University Press.

Rosa, C. D., Larson, L. R., Silvia, C., Cloutier, S., and Profice, C. C. (2020). Gender differences in connection to nature, outdoor preferences, and nature-based

recreation among college students in Brazil and the United States. *Leisure Sci.* 1–21. doi: 10.1080/01490400.2020.1800538

Rothenberg, P. S., ed. (2007). *Race, Class, and Gender in the United States: An Integrated Study. 7th Edn*. New York, NY: Worth Publishers.

Russell, R., Guerry, A. D., Balvanera, P., Gould, R. K., Basurto, X., Chan, K. M. A., et al. (2013). Humans and nature: how knowing and experiencing nature affect well-being. *Ann. Rev. Environ. Resour.* 38, 473–502. doi: 10.1146/annurev-environ-012312-110838

Samuelsson, K., Barthel, S., Giusti, M., and Hartig, T. (2021). Visiting nearby natural settings supported wellbeing during Sweden's "soft-touch" pandemic restrictions. *Landscape Urban Plan.* 214, 104176. doi: 10.1016/j.landurbplan.2021.104176

Schelhas, J. (2002). Race, ethnicity, and natural resources in the United States: a review. *Natl. Resour. J.* 42, 723–763. Available online at: https://www.jstor.org/stable/24888656

Schwarz, K., Fragkias, M., Boone, C. G., Zhou, W., McHale, M., Grove, J. M., et al. (2015). Trees grow on money: urban tree canopy cover and environmental justice. *PLoS ONE* 10, e0122051. doi: 10.1371/journal.pone.0122051

Scott, D., and Lee, K. J. (2018). People of color and their constraints to national parks visitation. *George Wright Forum* 35, 73–82. Available online at: http://www.georgewright.org/351scott.pdf

Soga, M., Evans, M. J., Cox, D. T. C., and Gaston, K. J. (2021a). Impacts of the COVID-19 pandemic on human–nature interactions: pathways, evidence and implications. *People Nat.* 3, 518–527. doi: 10.1002/pan3.10201

Soga, M., Evans, M. J., Tsuchiya, K., and Fukano, Y. (2021b). A room with a green view: the importance of nearby nature for mental health during the COVID-19 pandemic. *Ecol. Appl.* 31, e2248. doi: 10.1002/eap.2248

Spotswood, E. N., Benjamin, M., Stoneburner, L., Wheeler, M. M., Beller, E. E., Balk, D., et al. (2021). Nature inequity and higher COVID-19 case rates in less-green neighbourhoods in the United States. *Nat. Sustain.* 4, 1092–1098. doi: 10.1038/s41893-021-00781-9

Stieger, S., Lewetz, D., and Swami, V. (2021). Emotional well-being under conditions of lockdown: an experience sampling study in austria during the COVID-19 pandemic. *J. Happiness Stud.* 22, 2703–2720. doi: 10.1007/s10902-020-00337-2

Tam, K.-P. (2013). Concepts and measures related to connection to nature: similarities and differences. *J. Environ. Psychol.* 34, 64–78. doi: 10.1016/j.jenvp.2013.01.004

Taylor, D. (2018). Racial and ethnic differences in connectedness to nature and landscape preferences among college students. *Environ. Just.* 11, 118–136. doi: 10.1089/env.2017.0040

Taylor, D. E. (2021). Understanding black, asian, latinx, and white college students' views of nature: frequent thoughts about wild, remote, rural, and urban landscapes. *Am. Behav. Sci.* doi: 10.1177/00027642211013403

U.S. Census Bureau (2010). *2010 Census Urban and Rural Classification and Urban Area Criteria*. Census.gov. Available online at: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html (accessed November 22, 2021).

U.S. Census Bureau (2019a). *American Community Survey 1-year Estimates*. Retrieved from Census Reporter Profile page for California. Available online at: http://censusreporter.org/profiles/04000US06-california/ (accessed November 30, 2021).

U.S. Census Bureau (2019b). *American Community Survey 1-Year Estimates*. Retrieved from Census Reporter Profile page for New York. Available online at: http://censusreporter.org/profiles/04000US36-new-york/ (accessed November 30, 2021).

U.S. Census Bureau (2021). *Poverty Thresholds*. Census.gov. Available online at: https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html (accessed December 8, 2021).

United Nations. *How COVID-19 Impacts Women and Girls*. Available online at: https://interactive.unwomen.org/multimedia/explainer/covid19/en/index.html (accessed April 14, 2021).

USDA Economic Research Service ERS. (2013). *Rural-Urban Continuum Codes Documentation*. Available online at: https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/documentation/ (Accessed April 26, 2021).

van Bavel, B., and Scheffer, M. (2021). Historical effects of shocks on inequality: the great leveler revisited. *Humanit Soc. Sci. Commun.* 8, 1–9. doi: 10.1057/s41599-021-00763-4

van den Berg, M., Wendel-Vos, W., van Poppel, M., Kemper, H., van Mechelen, W., and Maas, J. (2015). Health benefits of green spaces in the living environment: A systematic review of epidemiological studies. *Urban Forest. Urban Green.* 14, 806–816. doi: 10.1016/j.ufug.2015.07.008

Venter, Z. S., Barton, D. N., Gundersen, V., Figari, H., and Nowell, M. (2020). Urban nature in a time of crisis: recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environ. Res. Lett.* 15, 104075. doi: 10.1088/1748-9326/abb396

Weill, J. A., Stigler, M., Deschenes, O., and Springborn, M. R. (2020). Social distancing responses to COVID-19 emergency declarations strongly differentiated by income. *PNAS* 117, 19658–19660. doi: 10.1073/pnas.2009412117

Wolch, J. R., Byrne, J., and Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' *Landscape Urban Plan.* 125, 234–244. doi: 10.1016/j.landurbplan.2014.01.017

Wyles, K. J., White, M. P., Hattam, C., Pahl, S., King, H., and Austen, M. (2019). Are some natural environments more psychologically beneficial than others? The importance of type and quality on connectedness to nature and psychological restoration. *Environ. Behav.* 51, 111–143. doi: 10.1177/0013916517738312

Ziesler, P. S., and Spalding, C. M. (2021). *National Park Service Statistical Abstract 2020*. Fort Collins, CO: National Park Service. Available online at: https://irma.nps.gov/DataStore/DownloadFile/659696 (accessed May 12, 2021).

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.