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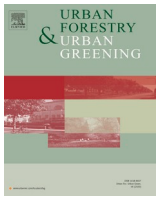

Review

# How the COVID-19 pandemic changed patterns of green infrastructure use: A scoping review

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ABSTRACT

The use of green infrastructure (GI) has been established as a way to alleviate stress and the COVID-19 pandemic has placed a new emphasis on the importance of GI as both a coping mechanism and a source of recreation. This scoping review seeks to address whether the COVID-19 pandemic affected the use of GI, specifically the ways in which the pandemic altered visitation patterns and the frequency of the use of GI. This review identifies studies that explore the relationship between the COVID-19 pandemic and GI use and assesses whether the pandemic has altered the use of GI, including whether GI use increased, decreased, or remained the same and examines potential changes in visitation structure as well as other effects studied. This review also discusses how future planning for GI can consider the lessons learned from the pandemic. Key findings suggest that GI use increased, as did visitors' appreciation for GI and its benefits. The use of local GI to one's home also increased in importance. Decreases in visitation were typically a result of COVID-19 lockdown restrictions and fear of viral transmission within GI.

## 1. Introduction

The emergence of the SARS-CoV-2 (COVID-19) pandemic has brought unprecedented changes to everyday life. COVID-19 emerged in China in late 2019 and rapidly spread to other countries. The World Health Organization declared it a pandemic on March 11th, 2020 (Dhama et al., 2020). Many countries enacted lockdown measures in order to slow the spread of the virus and while these lockdown measures varied by country, they generally consisted of stay-at-home orders, the closure of non-essential businesses, travel and movement restrictions, social distancing guidelines, and a shift to remote school and work (Koh, 2020). Along with such restrictions came the closure of fitness and recreational facilities, schools, and other places for recreation. This often left parks, green spaces, trails, and other forms of green infrastructure as the only places available for outdoor activity, yet many parks and public green spaces were also fully or partially closed due to lockdown restrictions, particularly in the first months of the pandemic (Slater et al., 2020). While outdoor transmission of COVID-19 has now been shown to be substantially lower than indoor transmission, making outdoor recreational spaces potentially popular for gatherings (Bulfone et al., 2021), at the beginning of the pandemic rates of transmission in outdoor areas were unknown given the novel nature of the virus, leading people to avoid public spaces out of caution (Khozaei et al., 2021). As such, the COVID-19 pandemic has likely had an effect on GI use, though the exact conditions and length of these changes is not fully understood, especially given the ongoing nature of the pandemic.

Parks and other forms of green infrastructure have long been seen as closely connected to physical health, particularly in cities. Early park advocates and designers like Frederick Law Olmstead, Ebenezer Howard, and others, advocated for parks and other green spaces to address unhealthy urban conditions, serving as "lungs" of the city and sites for physical activity by residents, responding to a range of factors including poor air and water quality and frequent cholera epidemics in the nineteenth century (Carr, 2021; Xing and Brimblecombe, 2020). Those park advocates have been proven correct, as researchers have proven that green infrastructure provides a variety of physical health benefits to people, including improved cardiovascular health, reduced incidences of respiratory illnesses and allergies, and improved pregnancy and birth outcomes (Suppakittpaisarn et al., 2017). Spending time in GI was also associated with a lower risk of poor health and a decrease in sedentary behavior (Andrusaityte et al., 2020). Access to parks may also be protective against obesity (Wolch et al., 2011). The opportunity

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to perform physical activity is also a major motivation for using GI (Burrows et al., 2018). Given the variety of physical benefits provided by GI and the closure of indoor facilities such as gyms, might GI use have increased during the pandemic?

In addition to providing physical health benefits, green infrastructure has also been shown to help alleviate stress. Higher levels of green space in neighborhoods have been associated with healthier cortisol levels (Roe et al., 2013). Visiting forests and parks was also shown to have a 87% recovery rate for stress (Hansmann et al., 2007), and people recovered from stress faster when exposed to nature versus an urban environment (Ulrich et al., 1991). The practice of "forest bathing", or walking in or viewing a forest, has also been shown to improve mood and promote feelings of restoration (Takayama et al., 2014), can possibly promote cardiovascular relaxation (Lee et al., 2014), and can be considered as a resource in which to mitigate the negative mental and emotional effects associated with the COVID-19 pandemic (Muro et al., 2022). Green space has even been shown to mitigate stressful life events, with one study finding that respondents living near a greater amount of green space were less affected by stressful life events than respondents living near lesser amounts of green space (van den Berg et al., 2010). Marselle et al. (2019) found that stressful life events were associated with an increase in perceived stress and depression, and a decrease in mental well-being, yet nature group walks were associated with a decrease in perceived stress and depression and an increase in mental well-being. With regards to the COVID-19 pandemic, the presence of green space nearby residences was associated with a buffering effect on stress levels during the pandemic, and while depression and anxiety levels were higher during the pandemic, spending time in green space was associated with lower anxiety and depression levels (Reid et al., 2022; Vos et al., 2022). A review of health outcomes during the COVID-19 pandemic found considerable evidence for mental health benefits from spending time in GI (Heckert and Bristowe, 2021). Thus, the COVID-19 pandemic presents an opportunity to both assess the role of GI as a nature-based mechanism for coping with a stressful life event and how the use of GI has changed as a result of such an unprecedented event.

Such benefits are important in light of equity concerns with GI during the pandemic. One study found that areas with a majority of people of color and lower incomes had fewer green areas and higher COVID-19 case rates, suggesting that those who are affected most by COVID-19 have less access to nature that may help them cope with the challenges of a pandemic and maintain their health (Spotswood et al., 2021). As well, changes due to the pandemic may exacerbate inequalities in GI access and use. If the use of public transportation is restricted or avoided, those who rely on it may no longer have access to GI, while those with access to a car may not be affected by such restrictions. Thus, it becomes important to provide quality GI that meets the needs of all residents, especially those who are vulnerable to the effects of the pandemic (Xie et al., 2020).

Researchers and park advocates have suggested that the pandemic and lockdown conditions would highlight the value and importance of GI. One author argued that not only are people utilizing nature now more than ever before but that they are also enjoying it more than before (Naomi, 2020). Nature can also help people, especially those particularly affected by the isolation of lockdown restrictions such as children and the elderly, cope with the stress of the pandemic by providing ecotherapy, or the healing and growth that accompanies interacting with nature, which includes green exercise, therapeutic horticulture, and other activities that involve interacting with nature (Chaudhury and Banerjee, 2020). Furthermore, GI can also promote physical and psychological well-being by providing people with areas to exercise and socialize, and can potentially promote resilience to both the COVID-19 pandemic and future pandemics as well (Kleinschroth and Kowarik, 2020).

This scoping review expands upon the scoping review previously conducted by the authors which found that GI use helped to protect non-COVID related physical and mental health benefits during the pandemic (Heckert and Bristowe, 2021). Unlike a systematic review designed to address more precise questions, our review seeks to understand the current breadth of literature, synthesize evidence, and identify gaps to inform future research concerning a particular topic (JBI, 2020). Similarly, this scoping review seeks to evaluate what evidence, if any, researchers have found of a relationship between the COVID-19 pandemic and GI use. This review sought to describe and evaluate research on (1) whether the frequency of GI visits was altered by the pandemic, or (2) whether the structure of visits changed as a result of the pandemic, in addition to (3) describing the general effects on GI use that have been studied so far. Given the novel nature of the COVID-19 pandemic and the rapid emergence of evidence at a time when daily life was altered due to pandemic restrictions, a scoping review provides an opportunity to explore how green infrastructure use has potentially been altered as a result of the COVID-19 pandemic.

The ultimate goal of this scoping review is to evaluate and synthesize the current body of research concerning the relationship between the COVID-19 pandemic and GI use. While other review protocols related to this topic have been proposed (Kleinschroth et al., 2022), to our knowledge our scoping review is the first and seeks to provide insight into how the global COVID-19 pandemic potentially affected GI use.

## 2. Methods

Green infrastructure has long been shown to provide benefits to people. One definition of green infrastructure is "an interconnected network of greenspace that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Benedict and McMahon, 2002) though green infrastructure can also include neighborhood and national parks, forests, community gardens, and various other forms of green spaces and natural lands (Coutts and Hahn, 2015) and in cities can also include green roofs and street trees (Nieuwenhuijsen, 2021). Rather than focus on one or several specific types of green infrastructure, this scoping review uses a broad definition of GI. In order to evaluate the studies comparatively and given the variability between lockdown conditions, we chose to focus on studies that specifically looked at GI use rather than simply the presence of or exposure to GI. As a result, this study focused on GI types that could be used or visited, including, but not limited to, parks, gardens, trails, and other green spaces, rather than measures of GI such as vegetation and "greenness."

This study was designed according to the JBI guidelines for conducting a scoping review and used the PRISMA-ScR checklist (JBI, 2020; Tricco et al., 2018) and followed the same process as Heckert and Bristowe (Heckert and Bristowe, 2021). Articles were identified using a five-step process. First, a systematic search of two academic databases, EBSCOhost's Academic Search Ultra and Scopus, was performed. A series of searches were performed between October 16th and 20th, 2021 to search for articles with titles, abstracts, or keywords including the term "COVID-19" in addition to at least one of a list of GI-related terms. These terms included: "parks," "greenspace," "green space," "green infrastructure," "gardens," "vegetation," "nature," and "natural lands." In addition, the search was restricted to only include full length peer-reviewed articles published in English. The articles were imported into Mendeley citation management software (Elsevier, Amsterdam, Netherlands) and duplicate articles were removed. Article titles and abstracts were read to assess suitability for the review based on whether they explored the potential relationship between the COVID-19 pandemic and GI use and articles that did not meet these criteria were excluded. In an effort to ensure that no relevant articles were missed, we supplemented the official database search by duplicating the search in Google Scholar and reviewing the first 10 pages of results, as well as reviewing relevant studies found in the works cited lists of included articles.

All remaining articles were then reviewed by reading the full text

based on the more explicit inclusion criteria of: (1) findings were empirical, (2) focus was on whether the COVID-19 pandemic affected the use of GI, and (3) specifically measured GI use, either in terms of visitation frequency or visitation structure. Articles that met these criteria were read closely and charted based on the following characteristics:

- the measure of GI use (number of visits, length of visits, etc.);
- data source or methods of measurement (i.e., mobility data, social media posts, or surveys);
- GI type studied;
- population studied (children, adults, seniors, or unspecified);
- results with regard to visitation frequency (whether GI use increased, decreased, or did not change, or any combination of these;)
- results with regard to visitation structure, and;
- a broad categorization of the effects studied.

We additionally noted the timeframes, locations, and lockdown conditions, as well as the major conclusions, including factors that were tested for association with changes in GI use. The results were also reviewed further to identify any additional research questions raised by the studies.

## 3. Results

Our initial search identified 5304 articles, of which 4484 remained after removing duplicates. After the initial title and abstract review to assess whether the articles were related to GI use and the COVID-19 pandemic, 127 articles remained. On initial readings of the full text, 76 were excluded, 40 were marked for inclusion, and 11 were flagged for discussion between the researchers. At this stage, 6 additional articles were added for review based on the Google Scholar search and review of references from included articles. After review and discussion of the 17 articles, 9 were included and 7 excluded, leaving 49 articles that were ultimately included in the review (Fig. 1).

The studies collected GI use data from a range of sources, including direct data collection from surveys, interviews, and observations, and analysis of third-party data such as tracking data from fitness apps, social media posts, or official visitor counts, with surveys being the most common data source. See Table 1 for a quantitative description of data sources.

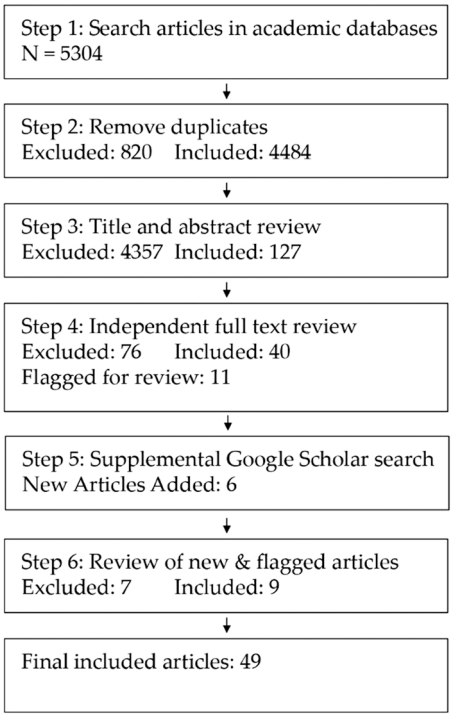


**Fig. 1.** Diagram of the article search process.

The types of GI being studied varied, with five studies specifying parks while most included various forms of GI. The forms of GI mentioned by studies included: parks, green spaces, natural areas, trails, gardens, green plazas, urban green space (UGS), agricultural areas, private GI such as yards and gardens, and outdoor recreation areas. It is important to note that Google's Community Mobility Reports, used in seven studies, used the term "parks" to cover national parks, marinas, public beaches, dog parks, plazas and public gardens, as well as other forms of GI.

With regard to the population studied, the articles were relatively evenly split between a specific focus on adults (21 studies) and no specified age group (24 studies). A small number of studies (5) focused on children, with parents providing data on children's activities.

Table 2 provides an overview of the studies' findings with regard to the effect on visitation frequency, the effect on visitation structure, and the other effects studied for all included articles.

### 3.1. Effect on frequency of GI use

Forty-five of the reviewed articles reported findings regarding changes in frequency of GI visits, with some reporting individual level results (percentages of respondents who increased or decreased visits) and others reporting aggregate information (changes in overall visitor numbers). The most common finding was evidence of increased GI visits (reported in 36 studies), followed by decreases in GI visits (reported in 30 studies), with 21 studies finding evidence of both increased and decreased GI use in subsets of the population or different locations. Fig. 2 shows the relative frequency with which articles reported increases, decreases, or no changes in frequency of GI use.

All of the reviewed studies were explicit in that they were looking at how COVID-19 influenced behaviors, with many attributing their findings to lockdowns and lockdown characteristics. Several studies with more severe lockdown restrictions reported decreases in GI use and attributed them to lockdowns, especially in Italy, where public parks were closed during their period of movement restrictions (Larcher et al., 2021; Ugolini et al., 2020). Countries with less severe restrictions, such as Sweden, not only reported increases in GI use, but the respondents of one survey reported that they visited GI more often during the spring of 2020 than they would have if the pandemic had not occurred (Lõhmus et al., 2021). Similarly, countries with lower COVID-19 case counts, such as Australia, also saw increases in GI use (Nathan et al., 2021). Dushkova et al. (2021) compared GI use in Moscow, Russia which closed 55 public parks and effectively banned GI use, and Perth, Australia, where parks were not closed. As a result, Moscow reported that the majority of residents decreased their GI use, while the majority of residents in Perth maintained their frequency of use. In addition, the included articles differed as to the effect of lockdown restrictions on visitation, with ten reporting both increases and decreases (Curtis et al., 2021; Day, 2020; Gür, 2021; Herman and Drozda, 2021; Hockenhull et al., 2021; Kupfer

**Table 1**
Summary of data sources.

| Data source | # of articles |
|---|---|
| Online survey | 27 |
| Telephone survey or interview | 2 |
| Face-to-face survey or interview | 4 |
| Google Community Mobility Reports | 7 |
| Geotagged social media posts | 4 |
| Online fitness tracking app data | 3 |
| National Park Service visitation data | 3 |
| Direct observation or sensor-based tracking | 4 |

* 4 articles used mixed data sources and are counted more than once

**Table 2**
Summary chart of included articles.

| Author (Year) | Effect on Visitation Frequency | | | Effect on Visitation Structure | | | | | | Other Effects Studied | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Use increased | Use decreased | Use remained the same (no change) | Change in type of GI | Time of visit changed | Distanced traveled changed | Access mode changed | Activity conducted changed | Social distancing/ concerns over transmission | Change in visitation conditions (general observations of GI, time, weather, holidays) | Explanation for changes in visitation | Reasons for visiting/ benefits obtained | Non-users started to use GI |
| Astell-Burt and Feng (2021) | X | | | | | | | | | | | X | |
| Berdejo-Espinola et al. (2021) | X | X | X | | | | | | | | | X | X |
| Borkenhagen et al. (2021) | | X | | | | | | | | | | X | |
| Burnett et al. (2021) | X | X | X | | | | | | | | | X | |
| Chenarides et al. (2021) | | X | | | | | | | | | | | |
| Curtis et al. (2021) | X | X | | | | | | | | | | | |
| da Schio et al. (2021) | X | | | | | | | | | | | | |
| Day (2020) | X | X | | | X | | X | | | | | | |
| Derks et al. (2020) | X | | | | X | X | | | | | | | X |
| Dushkova et al. (2021) | X | X | X | | | | | | | | | X | |
| Erdönmez and Atmiş (2021) | X | X | X | | | | | X | | | | | |
| Fagerholm et al. (2021) | X | X | X | X | | | | | | | X | X | X |
| Geng et al. (2021) | X | X | X | | | | | | | | X | | |
| Grima et al. (2020) | X | X | X | | | | | | | | | X | X |
| Grzyb et al. (2021) | X | | | X | X | | | X | | | | X | |
| Gür (2021) | X | X | | X | | X | | | | | | | |
| Hamidi and Zandiatashbar (2021) | | X | | | | | | | | | X | | |
| Heo et al. (2021) | X | X | X | | | | | | X | | X | X | |
| Herman and Drozda (2021) | X | X | | | X | | | X | X | X | X | X | X |
| Hockenhull et al. (2021) | X | X | | X | | X | | | X | | | X | |
| Jenkins et al. (2021) | | X | | | | | X | X | X | X | | X | |
| Jiang et al. (2021) | | X | | | | | | | | | | | |
| Khozaei et al. (2021) | | | | | | | | | X | | X | | |
| Kupfer et al. (2021) | X | X | | | | X | | | | | | | |
| Lanza et al. (2021) | | X | | | | | | | X | | | | |
| Larcher et al. (2021) | | X | | | | | | | | | X | X | |
| Legeby and Koch (2021) | X | | | | | | | | | | | X | |
| Lenaerts et al. (2021) | X | | | | | | | | X | | X | X | |
| Logan et al. (2021) | X | X | X | | | | | X | X | | X | X | |
| | X | | | X | | | | | | | | X | |

(*continued on next page*)

**Table 2** (*continued*)

| Author (Year) | Effect on Visitation Frequency | | | Effect on Visitation Structure | | | | | | Other Effects Studied | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Use increased | Use decreased | Use remained the same (no change) | Change in type of GI | Time of visit changed | Distanced traveled changed | Access mode changed | Activity conducted changed | Social distancing/ concerns over transmission | Change in visitation conditions (general observations of GI, time, weather, holidays) | Explanation for changes in visitation | Reasons for visiting/ benefits obtained | Non-users started to use GI |
| Lõhmus et al. (2021) | | | | | | | | | | | | | |
| Lopez et al. (2021) | X | X | | | | | | | X | | X | X | |
| Lu et al. (2021) | X | | | X | | | | | | X | | | |
| McCormack et al. (2020) | X | X | | | | | | | | | | | |
| Morse et al. (2020) | X | X | X | | | | | X | | | | X | |
| Nathan et al. (2021) | X | | | | | | | | | | | | |
| Pipitone and Jović (2021) | X | | | X | | | | X | X | | | X | |
| Rice and Pan (2021) | X | | | | | | | | | | X | | |
| Schneider et al. (2021) | | | | | | | | | X | | | | |
| Schweizer et al. (2021) | X | | X | | | | | | | | | | |
| Uchiyama and Kohsaka (2020) | X | | | | | | | | | | X | | |
| Ugolini et al. (2020) | | X | X | X | | X | X | | | | X | X | |
| Ugolini et al. (2021) | | X | X | X | | X | X | | | | | X | |
| Venter et al. (2020) | X | | | X | X | | | | X | | | | |
| Venter et al. (2021) | X | | | X | | | | | | | | | |
| Volenec et al. (2021) | X | X | | | | | | | | | | | |
| Weinbrenner et al. (2021) | X | X | | | | | | | X | X | | X | X |
| Wynveen et al. (2021) | | | | | | | | | X | | | | |
| Yamazaki et al. (2021) | | | | X | | | | | | | | X | X |
| Zwierzchowska and Lupa (2021) | X | X | X | | | X | | | | | | | |

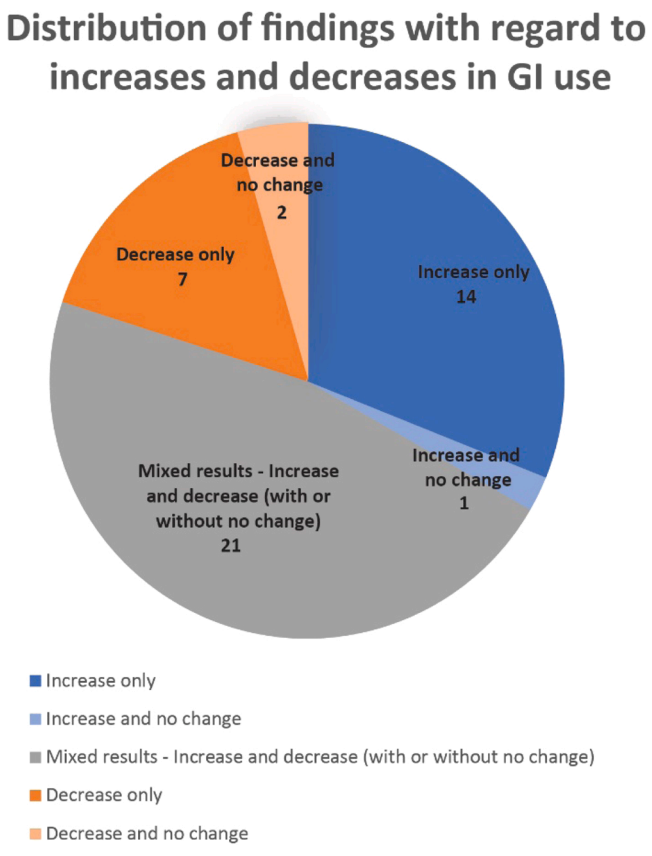


**Fig. 2.** Distribution of article findings relative to changes in GI use patterns.

et al., 2021; Lopez et al., 2021; McCormack et al., 2020; Volenec et al., 2021; Weinbrenner et al., 2021). Seven studies reported that GI use decreased during lockdown (Borkenhagen et al., 2021; Chenarides et al., 2021; Hamidi and Zandiatashbar, 2021; Jenkins et al., 2021; Jiang et al., 2021; Lanza et al., 2021; Larcher et al., 2021) while three studies reported that use increased during lockdown but decreased as restrictions were eased (Chenarides et al., 2021; Derks et al., 2020; Grzyb et al., 2021), or that GI use increased during school, gym, and entertainment venue closures (Curtis et al., 2021), suggesting that GI was used as a stopgap to replace other activities that resumed as lockdowns eased.

To further explore the relationship between lockdowns and behavior changes, we coded findings as strict versus loose restrictions and compared the percentages of studies finding increases, decreases, or mixed results in GI use. Strict lockdowns included those where residents were barred from leaving home other than for food or emergencies or where parks were explicitly closed. Loose lockdowns were those where GI use – usually for physical activity – was an explicitly allowed reason for leaving home. Thirty-two studies provided enough lockdown details to code them in this fashion – 9 with strict lockdowns and 23 with loose restrictions. While strict lockdown studies did have a higher proportion of findings of only decreased GI use and loose lockdowns had a higher proportion of findings of only increased GI use, a chi-squared test indicates that these differences are not statistically significant (see Table 3).

**Table 3**
Results distribution for strict versus loose lockdowns. Percentages are row percentages. Differences are not statistically significant (p = .3).

| Lockdown | Decrease only | Mixed results | Increase only | Row total |
|---|---|---|---|---|
| Strict | 3 (33%) | 5 (56%) | 1 (11%) | 9 |
| Loose | 3 (13%) | 13 (57%) | 7 (30%) | 23 |
| Total | 6 | 18 | 8 | 32 |

In addition to studies that sought to contextualize their findings based on local lockdown conditions, 30 studies used direct comparisons and statistical analysis to identify factors that correlated with increases or decreases in GI use. By comparing use patterns over time and across locations as well as between different groups of study participants, these studies suggested potential contributing or limiting factors leading to changes in behavior, including pandemic factors such as COVID-19 case rates and government restrictions, built environment factors such as types and availability of GI, and social and demographic factors such as age, gender, and employment status. Table 4 indicates the factors identified as positively associated with GI use, based on either increased use or relatively lower decreases in use, and the number of articles with each finding. A small number of factors were associated with decreases in GI use and are indicated with a (-). Interestingly, several factors were identified in differing articles as having opposite associations with GI use. For example, the severity of the pandemic – typically based on case counts – was associated with lower GI use in two studies but higher GI use in another, and female respondents were more likely to increase GI use in six studies, while male respondents were more likely to increase GI use in two.

Questions remain as to whether the COVID-19 pandemic will lead to

**Table 4**
Factors identified as associated with increases in GI use by number of articles. Factors followed by (-) were associated with decreases in GI use, while factors followed by (+) were associated with increases in GI use.

| Factor | # of articles |
|---|---|
| **COVID-Related Factors** | |
| COVID concerns (-) | 3 |
| No strict lockdown | 2 |
| Pandemic severity (-) | 2 |
| School closures | 1 |
| Entertainment venue closures | 1 |
| Easing restrictions | 1 |
| No social distancing measures in park | 1 |
| Pandemic severity (+) | 1 |
| Parks closed (-) | 1 |
| **Physical Environment Factors** | |
| More natural/wilder/greener areas | 5 |
| GI urban areas | 2 |
| Park availability | 1 |
| Park space per person | 1 |
| Close to home | 1 |
| Sites outside city center | 1 |
| Immediate vicinity to home | 1 |
| Compact counties | 1 |
| Private GI | 1 |
| Closer to city center | 1 |
| Larger GI | 1 |
| GI in middle/upper income community | 1 |
| Urban periphery | 1 |
| **Social and Demographic Factors** | |
| Female | 6 |
| Younger | 5 |
| Higher income | 3 |
| Work from home | 3 |
| Children in household | 3 |
| Not sick or disabled | 2 |
| Have private GI (yard or garden) | 2 |
| Male | 2 |
| Dog owners | 2 |
| Not suffering from major depression | 2 |
| White | 2 |
| Lost job/unemployed | 2 |
| Older | 1 |
| High nature-relatedness score | 1 |
| Use park for physical activity | 1 |
| Education | 1 |
| Asian | 1 |
| Household of 3 or more people | 1 |

an increase in GI use given the important role GI played in reducing stress and anxiety and maintaining physical health for users (Heckert and Bristowe, 2021). Seven studies have reported that GI use was higher post-lockdown than during lockdown and before the pandemic (Day, 2020; Herman and Drozda, 2021; Hockenhull et al., 2021; Kupfer et al., 2021; Pipitone and Jović, 2021; Schweizer et al., 2021; Volenec et al., 2021). Grima et al. (2020) specifically noted that those who used GI frequently before the pandemic continued to use it frequently. It is worth noting that park use may have increased in the spring and summer of 2020 as the weather got warmer regardless of the influence of the pandemic. Rice and Pan (2021) found that GI use did increase, though the authors argued that it was a result of warmer weather rather than due to the COVID-19 pandemic and its associated effects. It is worth noting, however, that the visitation data in their study was from the period of April 1st through June 30th, 2020, compared to their baseline of January 3rd to February 6th, 2020, and that increases or decreases in GI usage may not have been fully captured within this timeframe.

### 3.2. Effect on visitation structure

Several studies explored potential changes in the nature of GI use in addition to or instead of changes in frequency of visits. Table 5 indicates the types of changes in behavior that were found and the number of articles discussing them.

Twelve studies reported shifts in the type or location of GI used during the pandemic. These shifts were either towards more rural or less crowded GI, or away from urban GI (Fagerholm et al., 2021; Grzyb et al., 2021; Gür, 2021; Hockenhull et al., 2021; Lõhmus et al., 2021; Lu et al., 2021; Venter et al., 2021), or a shift towards more local GI, meaning GI in closer proximity to the home (Gür, 2021; Hockenhull et al., 2021; Ugolini et al., 2020; Ugolini et al., 2021; Zwierzchowska and Lupa, 2021). Four studies also reported exploring new GI locations (Astell-Burt and Feng, 2021; Fagerholm et al., 2021; Hockenhull et al., 2021; Pipitone and Jović, 2021). Rural and remote GI became refuges from crowded city conditions and provided a sense of solitude for users, as did familiar and local GI. These studies also suggest that local GI became increasingly important during the pandemic as travel restrictions meant that in some areas residents could only travel within a certain distance of their homes, or that people continued to maintain their use of local and familiar GI. The shift towards new GI was surprising, but may indicate that people had more opportunities to explore new forms of GI that they would have otherwise not had the ability to as a result of the pandemic.

Changes to the timing of GI visits varied. Day (2020) found that there was an increase in the number of trips to GI on weekdays compared to weekends. However, Grzyb et al. (2021) reported that during lockdown the increase in visitation was steady regardless of the day of the week, but when restrictions were eased, visits became concentrated on the weekends again. Derks et al. (2020) noted that visits peaked in late afternoon rather than before or after working hours as they had pre-pandemic and that there was no longer a noticeable difference between weekday and weekend visits, with Saturdays becoming a popular day for GI use. Venter et al. (2020) reported an increase in visits on weekends, but activities within GI became more spread out throughout the day instead of being concentrated during mornings and evenings. Similarly, a respondent in Herman and Drozda (2021) observed that more people were using a park at different times of the day and the authors also noted that while weekend and weekday use was the same, more people tended to visit in the afternoons or after working hours. This suggests that lockdowns led to more opportunities for people to use GI, as evidenced by increases in weekday and afternoon use rather than weekend, morning, and evening use.

Six of the seven studies that measured a change in distance traveled to GI found that generally there was a shift towards GI in close proximity to the home and away from visits to GI that was farther away. Kupfer et al. (2021) found that the number of visitors to national parks from many states decreased, particularly those farthest away from the park, suggesting visitors came from states closer to the park, though as time went on visitors did come from more states. Respondents reported walking closer to home (Hockenhull et al., 2021), and residents in Italy, Spain, and Israel shifted to more local GI (<200 m from home) (Ugolini et al., 2020). Residents in Italy decreased visitation to urban green spaces that were more than 500 m from their residence by 9%, and most visited urban green spaces that were less than 200 m from home, as lockdown restrictions in Italy mandated that outdoor activity be kept to within 200 m of home (Ugolini et al., 2021). Some users also preferred using local or home GI rather than crowded urban GI (Gür, 2021). Schools also shifted towards more local GI with schools in Poland shifting to more local green spaces for children to use rather than traveling to farther green spaces (Zwierzchowska and Lupa, 2021). Two studies reported that users were exploring new GI locations, though it was not clear that this was a sustained shift towards GI that is farther away (Derks et al., 2020; Hockenhull et al., 2021). Similar to the results found in the change of GI type, these results again show a shift towards more local GI during the pandemic.

In line with a shift towards more local GI during the pandemic, accessing GI on foot also increased as driving generally decreased (Day, 2020; Ugolini et al., 2020; Ugolini et al., 2021). Jenkins et al. (2021) assessed how Yosemite National Park implemented restrictions on visitors during the pandemic and reported that park managers implemented a day-use and online permit system and suspended "walk-up" reservations. This change in access was used to limit the park's capacity to roughly 50%.

Changes in activities varied. Activities that increased included visiting GI with children or grandchildren, dog walking, being with family or friends, exercising, undertaking a new activity (Erdönmez and Atmiş, 2021; Logan et al., 2021; Pipitone and Jović, 2021), vigorous exercise (Grzyb et al., 2021), foraging, gardening, hiking, photography, relaxing alone, walking, and wildlife watching (Morse et al., 2020). Activities that decreased included traveling (Grzyb et al., 2021), group activities (Jenkins et al., 2021), and camping and relaxing with others (Morse et al., 2020). Erdönmez and Atmiş (2021) found that picnics did not increase, but a respondent in Herman and Drozda (2021) observed more people having picnics. In line with people undertaking new activities during the pandemic, Herman and Drozda (2021) also found that people used recreational spaces differently than before and that these activities were rare or did not occur before the pandemic. This included using cricket turfs for picnics, bringing recreational equipment from home, and flying kites and drones. Respondents in their survey also noted that park users did activities in areas that were not designed for that activity (Herman and Drozda, 2021). During the pandemic people sought new forms of activity or increased certain activities. Group activities or activities that involved interacting with others generally decreased as a likely result of social distancing protocols. People also used GI in new ways during the pandemic, not only demonstrating creative uses during a time of stress but also highlighting the importance of a variety of GI in order to meet the needs of people, especially during a pandemic.

Of the articles that reported on social distancing while using GI, four articles specifically addressed whether people adhered to social distancing protocols. One study found that most people did not follow social distancing protocols (Lanza et al., 2021), and another found that

**Table 5**
Summary of findings related to changes in behaviors in GI use.

| Behavior change | # of articles |
|---|---|
| Type of GI visited | 12 |
| Timing of GI visits | 5 |
| Distance traveled to GI | 7 |
| Mode of travel to GI | 4 |
| Activities conducted | 7 |
| Altering behavior related to social distancing | 13 |

53.5% of encounters among trail users were within 6 feet, though 53.4% of groups did attempt to increase the distance between groups (Wynveen et al., 2021). Adherence also varied due to trail width, as more users were able to social distance on wider trails than narrower trails (Schneider et al., 2021) and more isolated trails (Venter et al., 2020). However, two studies found that conditions in the parks they studied did allow for social distancing either due to less crowding, which made it easier for groups to social distance (Jenkins et al., 2021) or that a large open space allowed people to form "bubbles" in order to social distance from other users (Herman and Drozda, 2021). Concerns over whether other users would be following social distancing protocols were cited in four studies (Herman and Drozda, 2021; Khozaei et al., 2021; Lopez et al., 2021; Pipitone and Jović, 2021) and in some cases these concerns led others to either actively avoid others while using GI or modify the type of GI they used in order to avoid others, including not using GI because of these concerns (Heo et al., 2021; Herman and Drozda, 2021; Hockenhull et al., 2021; Lenaerts et al., 2021; Logan et al., 2021; Weinbrenner et al., 2021). While concerns over social distancing and crowding were clear reasons for not using GI during the pandemic, certain forms of GI, such as wider trails and larger open spaces, made it easier for people to comply with social distancing protocols. A focus on creating GI that allows for people to maintain distance from each other is critical in promoting urban resilience, especially against future pandemics.

### 3.3. Other effects studied

Several studies explored other types of changes in GI use during the pandemic in addition to or instead of changes in frequency or structure of visits. Table 6 indicates the other effects studied and the number of articles discussing them.

Four articles examined changes in visitation conditions, which included general observations of GI, time spent in GI, the influence of weather on GI use, and visits on holidays. Thirteen articles reported explanations for changes to GI visitation. Factors that encouraged use generally included having more leisure time to visit GI, an increased appreciation for GI and nature, and hoping to obtain physical and mental health benefits associated with GI. Factors that discouraged use generally included government restrictions, fear of transmission of COVID-19, and potential crowding. Twenty-four articles looked at reasons for visiting GI and the benefits people hoped to obtain from them. These reasons and benefits varied, but included physical exercise, mental health benefits including a reduction of stress and anxiety, escaping crowded urban conditions, connecting to nature, and the ability to see other people and socialize with friends. Seven articles found that those who did not use GI before the pandemic started to do so during the pandemic.

Changes in visitation conditions included spending more time in GI (Herman and Drozda, 2021; Weinbrenner et al., 2021), using GI more in weeks with holidays or when temperatures were higher (Lu et al., 2021), and that respondents observed how empty or less crowded GI felt (Jenkins et al., 2021). The length of visit generally increased, indicating that people had more time to spend in GI as a result of the pandemic, though Lu et al. (2021) found that GI use increased when the weather was warmer and during weeks with holidays which would likely have led to an increase in GI use without a pandemic. Jenkins et al. (2021) also found that users felt that Yosemite National Park was empty, though it is important to note that visitor capacity was generally capped at 50% and that perceptions of crowding vary according to the individual. It is also worth noting that a large national park will likely feel much less crowded than a smaller urban park.

**Table 6**
Summary of findings related to additional effects on GI use.

| Effects Studied | # of articles |
|---|---|
| Change in visitation conditions | 4 |
| Explanations for changes in visitation | 13 |
| Reasons for visiting/benefits obtained | 24 |
| New users started to use GI | 7 |

Explanations for changes in visitation varied, along with whether they were associated with an increase or decrease in visitation. Reasons for increases included changes in everyday routines that allowed for more time to be spent outdoors (Fagerholm et al., 2021), wanting to obtain health benefits (Lopez et al., 2021; Ugolini et al., 2020), and wanting to socialize with friends in an outdoor environment (Fagerholm et al., 2021). Reasons for decreases included fear of COVID-19 transmission (Fagerholm et al., 2021; Herman and Drozda, 2021; Khozaei et al., 2021; Lenaerts et al., 2021; Lopez et al., 2021), wanting to avoid crowded recreation areas (Fagerholm et al., 2021; Heo et al., 2021; Lenaerts et al., 2021; Logan et al., 2021; Lopez et al., 2021; Ugolini et al., 2020), and changes in habits, such as no longer biking to work (Fagerholm et al., 2021), and no longer meeting with people or observing nature (Ugolini et al., 2020). Social gathering restrictions, workplace closures, public event cancellations, and internal movement restrictions were associated with an increase in park visitation, though daily increases in COVID-19 cases, stay-at-home orders, and government stringency as related to lockdown conditions were negatively associated with park visitation, suggesting they were associated with a decrease in visitation (Geng et al., 2021). Other reasons were simply that parks were closed and people were therefore unable to visit parks, as was the case with Italy in the early weeks of the pandemic (Larcher et al., 2021; Ugolini et al., 2020). Hamidi and Zandiatashbar (2021) found that as the length of the duration since the shelter-in-place orders were implemented increased, it led to a significantly higher reduction in people's trips to parks, and Rice and Pan (2021) also found that the duration of safer-at-home orders was negatively related to changes in park visitation. However, at a certain point Hamidi and Zandiatashbar (2021) suggest that as the shelter-in-place orders went on and were extended, people were less likely to comply with them. Uchiyama and Kohsaka (2020) found that households with children were more likely to visit GI than those without children, and that households with higher incomes visited GI more than those with lower incomes. They also found interactions between the type of GI available (parks, agricultural lands, and gardens) and the number of children, gender, location of residence, age, and socioeconomic status when it came to influences on GI use. Rice and Pan (2021) also found that older populations were more likely to decrease park use and they also suggest that climate was also a factor as to whether people used GI during the pandemic.

Reasons for visiting GI and the benefits obtained varied widely. Nine studies cited mental health benefits, such as a reduction in stress and anxiety (Berdejo-Espinola et al., 2021; Burnett et al., 2021; Dushkova et al., 2021; Heo et al., 2021; Hockenhull et al., 2021; Lopez et al., 2021; Morse et al., 2020; Weinbrenner et al., 2021; Yamazaki et al., 2021), physical health benefits, including walking and running (Dushkova et al., 2021; Grzyb et al., 2021; Lenaerts et al., 2021), and social benefits, such as reconnecting with neighbors and socializing with friends (Astell-Burt and Feng, 2021; Fagerholm et al., 2021; Lõhmus et al., 2021), a connection to or appreciation of nature (Berdejo-Espinola et al., 2021; Grima et al., 2020; Herman and Drozda, 2021; Legeby and Koch, 2021) and the ability to spend time alone or feel a sense of escapism (Hockenhull et al., 2021; Jenkins et al., 2021; Larcher et al., 2021). The number and variety of benefits people obtained from visiting GI specifically during the pandemic highlights the protective role GI plays on both physical and mental health (Egorov et al., 2016) and demonstrates the importance of GI use during times of stress (van den Berg et al., 2010). GI clearly played an important role in many users' lives during the COVID-19 pandemic.

Seven studies also found that people began to use GI during the pandemic that had not used GI before. Berdejo-Espinola et al. (2021) found that of 85 non-users, 44.7% started to use GI during the pandemic, citing physical benefits as a major reason for visiting. Similarly, Grima

et al. (2020) found that of 41 respondents who had not previously visited the study area, 21 now visited frequently and 26% of respondents were rare-to-first-time visitors. Yamazaki et al. (2021) found that 10% of respondents reported using urban green space for the first time during lockdown, and that telecommuters and women were more likely to be new users. Other studies reported that GI attracted new users as well (Derks et al., 2020; Fagerholm et al., 2021; Herman and Drozda, 2021; Weinbrenner et al., 2021).

## 4. Discussion

To our knowledge, this scoping review is the first to synthesize the emerging evidence concerning how the COVID-19 pandemic affected GI use. While other review protocols related to this topic have been proposed (Kleinschroth et al., 2022), our study was conducted in October 2021 and at the time was filling a gap in knowledge of how the pandemic, particularly in its early stages, affected GI use. Though limited in scope and timing, the results of this scoping review are consistent with more recent studies, such as the work of Ciesielski et al. (2022) who found that forest use differed when compared to use in the year before the pandemic. The authors found that changes in visitor numbers were particularly affected by the various periods of the pandemic, lockdown restrictions, and seasonality, and stressed the importance of green spaces to public welfare, given that more people visited the forests included in the study as the pandemic went on (Ciesielski et al., 2022).

### 4.1. Effect on frequency of GI use

With regard to patterns of GI use, it is clear that for most people and in most parts of the world, GI use changed considerably as a result of the pandemic and associated lifestyle changes, including not only various lockdown conditions and government restrictions, but also adjustments to work locations and schedules, and concerns over social distancing and COVID-19 case rates. In some studies, GI use during the COVID-19 pandemic was found to be influenced by various socio-economic factors such as age, gender, income, education, and access to GI. While increases in GI use were the most common finding, decreases were also experienced for many people and in many locations. This, coupled with the wide range of factors associated with changes in GI use suggest that both geographic and personal context played a significant role in determining the nature of these changes. This is especially highlighted by the fact that several factors were identified as both positively and negatively associated with GI use across different studies. Several of the factors associated with GI use differences – especially lockdown restrictions and, to a more limited extent, work-from-home conditions – have largely ended, leaving open room for research into whether or not changes during the pandemic are sustained over time. It now remains to be seen whether and in what ways these behavior changes continue. To the extent that GI became a destination as a replacement for other activities that were curtailed, it would seem reasonable to expect that GI use will decrease as the world moves further from lockdown restrictions. But will use return to pre-pandemic levels, or will new or increased users find a new value in GI that leads long-term changes in behavior?

It is also worth noting that the socioeconomic factors most associated with increased GI use included working from home and higher incomes, suggesting that GI use during the pandemic was classed. This is consistent with a more recent in-depth survey of pandemic GI use in Japan, which found that household income was a predictor of increased GI use (Uchiyama and Kohsaka, 2022). This is potentially of significant concern, especially when combined with the known mental and physical health benefits associated with GI use during the pandemic (Heckert and Bristowe, 2021).

Higher rates of use by women, parents of young children, and members of larger households (presumably larger due to the presence of children) suggests that green spaces became important destinations for caregivers looking to occupy children while schools and other childcare opportunities were unavailable. These findings, too, are consistent with Uchiyama and Kohsaka's (2022) more recent study in Japan.

### 4.2. Effect on visitation structure

The observed changes in visitation structure – especially the shift to local GI and adjustment of the timing of visits seem to be clearly connected to lockdown conditions. Travel was heavily restricted during the early days of the pandemic and fear of transmission also kept residents closer to home. Both work-from-home conditions and job losses meant that residents had more flexibility in timing for GI visits, flexibility that is likely to disappear as businesses reopen and more workplaces return to in-person work.

### 4.3. Other effects studied

A look at factors beyond changes in visitation amount and structure reveals some of the values and importance that GI played for users during the pandemic. da Schio et al. (2021) found that 79% of respondents during lockdown felt that the government should give urban green space high priority during lockdown and keep it open, 30% indicated they would join a movement to advocate for more urban green space and 23% would ask the local government for more urban green space, and the majority of the respondents in Larcher et al. (2021) reported having a pressing need for parks while they were closed during lockdown and wanting to use GI more after the pandemic. Even infrequent or new users of GI recognized the importance of access to GI during lockdown restrictions with 69.2% of the first time or infrequent visitors in Grima et al. (2020) reporting that having access to GI was 'very important' during the pandemic. While government-imposed lockdown conditions were associated with a decrease in GI use, these corresponded to the outset of the pandemic when the risk of outdoor transmission was not yet fully understood, hospitals were overwhelmed, and the world was still adjusting to the impact of the pandemic.

### 4.4. Implications

The various benefits of GI, including its protective effect on mental health in a time of increased stress, as well as providing people with the ability to exercise, appreciate nature, and engage in new or favorite recreational activities, among others, suggest that GI should be kept open during future pandemics if at all possible in order to help people cope. Urban green spaces in particular have been shown to encourage physical activity, promote mental health and well-being, reduce stress, and provide spaces for social interaction (Lee et al., 2015). During the pandemic, the respondents of one study stressed the importance of urban green spaces to both physical and mental health, and urban green spaces have become particularly important spaces for social interaction and relieving stress due to isolation (Lopez et al., 2021). However, future pandemics may vary from one another and may require the closure of GI in order to lower the rate of transmission. While we were unable to find data on the actual use of GI during past pandemics such as the 1918 influenza pandemic, it is worth noting again that the movement to create urban GI in general and parks in particular was influenced by health concerns, including the cholera and yellow fever outbreaks of the 19th century (Carr, 2021).

While we may not be able to prevent future pandemics, what we can do is design GI with pandemics in mind in order to promote resilience and encourage its use. Samuelsson et al. (2020) found that spending time in urban GI during a pandemic can promote urban resilience and maintain well-being. In order to achieve resilience, a variety of GI is needed as well as ensuring that GI is able to accommodate multiple uses, from seeking out seclusion to socializing with others (Legeby and Koch, 2021). Along these lines, Herman and Drozda (2021) found that a large lawn in a park allowed people to form social distancing "bubbles", and

users utilized existing GI in new ways during the pandemic. Placing an increased importance on GI requires investment from decision-makers to protect existing green spaces and create new green spaces that are designed to meet the needs of local communities (Geary et al., 2021). GI offers clear public health benefits and is an opportunity to protect ourselves from the effects of future pandemics.

Given the increased importance of local GI in light of the COVID-19 pandemic, concerns over whether everyone has access to GI in close proximity to their homes must be addressed. Having access to local GI can promote physical and mental health and help residents cope with the stress caused by the pandemic, and thus, ensuring access to local GI is crucial in ensuring resilience against future pandemics if similar lockdown restrictions are enacted. While larger destination parks can provide more opportunities for such activities as sports, exercise, and cycling, and can better facilitate social distancing, having more smaller, local parks or GI is equally as important given that studies have shown that people are more likely to utilize local GI than larger destination parks, and local GI can help address various socioeconomic needs and improve accessibility and functionality (Alves et al., 2008; Kaźmierczak, 2013; Mell and Whitten, 2021). As well, lockdown restrictions during the COVID-19 pandemic strongly encouraged people to utilize local GI, though those without local GI may have been forced to stop visiting, especially if they lacked the ability to travel to GI given the restrictions on public transportation. The pandemic has highlighted the unequal distribution of GI across social groups, and addressing this issue requires a rethinking of how GI is both distributed and functions (Reinwald et al., 2021).

Finally, concerns over equity and GI use and access have also been of special focus during the pandemic. Concerns over equity in access to GI predate the pandemic, with numerous studies showing disparities in access to GI based on race and class, particularly in the United States (Boone et al., 2009; Comber et al., 2008; Heckert, 2013; Sister et al., 2010). Of particular importance for the pandemic is the fact that these disparities are not always related to the existence of GI, but often relate to the size and level of congestion within GI, both factors that were of concern during the pandemic. These pre-existing differences in access may account for some of the variations in use patterns reported and provide important context for the findings reported in the studies reviewed here. One study conducted during the pandemic found that while people did increase their use of GI during the pandemic and felt a stronger sense of belonging to their local green space, the increase was highest among White respondents and those living in upper-middle- to upper-income areas of New York City while the respondents in the lowest income neighborhoods were the least likely to report an increase of use and belonging (Pipitone and Jović, 2021). In addition, the changes to many peoples' lives as a result of the pandemic may have exacerbated existing inequalities as to who can use and access GI. For example, those who were able to work from home often reported using GI more than those who were not able to work from home (Astell-Burt and Feng, 2021; Fagerholm et al., 2021). Those who were older also tended to decrease their use of GI as well, likely due to transmission concerns and a heightened risk of COVID-19 (Rice and Pan, 2021), suggesting that GI may not be perceived as a safe place to go during a pandemic. Those who already used GI before the pandemic tended to still use or increase their use (Grima et al., 2020), as did those who were younger and higher educated (Lõhmus et al., 2021). Concerns over park safety and a lack of access to GI, whether due to access issues that existed before the pandemic or developed as a result of it, such as park closures, and a lack of desired features within GI were also found to be barriers to GI use (Lopez et al., 2021). During the pandemic, Black, Indigenous, and people of color (BIPOC) or lower-income communities were more likely to report decreases in park use which is of particular concern given that these communities also had lower levels of park use pre-pandemic (Larson et al., 2021), while park visits in predominately White neighborhoods increased by 43% more than park visits in communities of color once restrictions were eased (Jay et al., 2022). This demonstrates a need to better improve access to quality GI so that everyone has access to the benefits of GI. In addition, given the benefits of GI on mental health, reduced GI use as a result of the pandemic may have a negative effect on mental health. One study found that those who used GI for social interactions before the pandemic had a higher risk of probable major depression than those who used GI for other reasons, and that those who decreased their GI use had two times greater odds of probable major depression (Heo et al., 2021). GI is known to have a protective effect on mental health and a decrease in GI use due to COVID-19 restrictions may have negative repercussions for mental health, especially for those who do not or cannot use GI, whether through lack of time or lack of GI availability.

### 4.5. Limitations and future research

This study provided a scoping review of the literature concerning GI use and thus sought to assess the evidence published so far and offer a preliminary assessment of the emerging literature on the COVID-19 pandemic and GI use. Evidence is still emerging on this topic, and more research is needed to better understand the impact the pandemic has had on GI use, especially since this review assesses the body of literature published prior to October 2021. While this review does reveal interesting patterns in GI use during lockdown, it also raises many questions for future study. Given that the vast majority of the studies included in this review were conducted in early or mid-2020, and considering that the pandemic is on-going, though lockdown restrictions have generally ended, more research is needed to evaluate whether the COVID-19 pandemic will lead to a sustained increase in GI use. Future research should also explicitly explore the relationship between lockdown conditions and GI use, and longitudinal studies could better explore how GI use varied according to waves of transmission during the pandemic. Additionally, as COVID-19 shifts toward becoming endemic, research as to whether people returned to pre-pandemic levels of GI use, increased their use, or decreased their use would also help to illuminate the full impact of the pandemic on GI use.

Future research could also assess whether the COVID-19 pandemic will lead to changes in GI use, design, and management going forward. While previous pandemics such as the 19th century cholera pandemics and the 1918 influenza pandemic contributed to the urban parks movement, it remains to be seen what the impact of the COVID-19 pandemic will be on GI distribution and design (Carr, 2021). Examining historical visitation records, if recorded, for parks during previous pandemics could also be compared with visitation data from the COVID-19 pandemic to assess whether visitation trends differed. Future studies could also consider the differences in use between different forms of GI, and could also further evaluate the interactions between factors that promote an increase or decrease in GI use.

It will also be important to continue to explore questions of equity in access to GI. It is unclear to what extent GI use disparities during the COVID-19 pandemic represent a continuation or exacerbation of previous patterns of GI use and access or whether the pandemic created new patterns of inequality. While the studies shed some light on the groups that were and were not able to increase their use of GI, they do not directly address the questions of why these patterns emerged. Though some findings strongly suggest variations in use based on ability to access GI – particularly findings that those working from home or unemployed were more likely to visit GI than those working outside of the home or that those with access to private GI such as yards or gardens were more likely to use it than those who had to go farther afield, other findings hint at personal preferences or concerns, such as less use by those more concerned about COVID-19 transmission or more use by families with children. Thus another important area for further exploration is whether differences in use represented differences in ability to access GI (whether based on restrictions, proximity, time availability, etc.), differences in interest in GI use, or some combination of ability and interest.

The studies reviewed here span the world, and thus represent wide variations in local conditions, not only due to the pandemic but also to geographic differences. Most studies did not go into sufficient detail of the specific forms of GI studied (beyond "parks" or "natural areas") to enable comparison of results based on types of GI. Given the wide variations in climate and landscape, it would be interesting to further explore potential spatial patterns in the findings. Rice and Pan (2021) questioned whether increases in park visitation in the US were more attributable to increasing temperatures as spring progressed during lockdown compared to baseline pre-pandemic data that represented winter patterns of park visits. A global study that compares not only differences in GI forms but also accounts for differences in seasonality might be able to shed additional light on this question.

## 5. Conclusions

The results of this scoping review indicate that parks and other forms of GI have been important for many during the COVID-19 pandemic. The majority of the studies reported increases in use to some extent, indicating that GI use did increase as a result of the pandemic. Reasons for increases included having more time for GI as a result of remote work and the desire to obtain the benefits offered by GI, especially mental and physical health benefits and the desire to appreciate nature more. The fact that new users started to use GI during the pandemic also highlights the benefits of GI in such times of stress. The most frequent reasons cited for decreases in use were almost always concerns over social distancing, crowding, and fear of transmission, indicating that use also decreased as a result of the pandemic either due to individual fears or widespread restrictions on movement and GI closures. Local GI became particularly important given that lockdown restrictions often meant that residents had to use GI closer to their homes. Given the myriad benefits that GI use can provide, these findings highlight longstanding concerns about equity in the distribution and quality of GI.

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## CRediT authorship contribution statement

**Amanda Bristowe:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project Administration. **Megan Heckert:** Conceptualization, Methodology, Writing – review & editing, Visualization, Supervision, Project administration.

## 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.

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