

REVIEW OF THE IMPACT OF URBAN PARKS ON PUBLIC HEALTH DURING THE COVID-19 PANDEMIC

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ABSTRACT

The COVID-19 pandemic may have changed the effects that urban parks have on their users. The purpose of this study was to understand the mental health effects of the pandemic, explore the role of urban parks on human health, and propose future research directions. We conducted a literature review on the impact of the COVID-19 pandemic on the effects of urban parks on human health and well-being. Using five screening criteria, we selected 32 articles published in the Scopus, Mendeley, and Google Scholar databases for analysis. We chose a systematic literature review as the methodology because it allowed the identification of literature relevant to the research questions. We conducted a systematic study based on the characteristics of the selected articles and the operationalization of variables, reported the results, and made recommendations. The results indicated that people went to parks to relieve stress caused by the pandemic, although some were deterred because they perceived risk in visiting public parks and green spaces. Others focused more on the Internet while in green spaces than on taking advantage of park activities. Demands for safety, accessibility for all, and interesting environments will force urban parks to change. There were insufficient practical studies offering novel design ideas and examining the health impacts of small, regional urban parks during the pandemic.



Keywords: *Urban Park, Health, COVID-19, Change, Review*

INTRODUCTION

The COVID-19 outbreak was a vivid reminder that we must prepare for catastrophic events that affect human health. (WHO, 2021b). It also revealed that citizens lack the space and means to protect themselves from viral infections. The WHO calls for addressing urban health in a variety of ways, including urban planning, and the encouragement of healthier and smoke-free environments (WHO, 2021b). Human health problems have increased as a result of the pandemic. According to the WHO Regional Office for Europe, a global survey showed that 30% of 60,000 respondents in 40 countries or territories said they were experiencing intense stress and depressive symptoms during the outbreak (Xu, 2021). Governments promulgated limitations on outside behaviors to restrict the spread of COVID-19, but people became restless, lonely, anxious, and depressed from spending most of their time indoors (Brooks et al., 2020). According to the theory of psychological perception, unstable environments overload psychological perception and lead to psychological health problems (Grignoli et al., 2021; Javelle et al., 2021). Now, in the third year of the pandemic, there is an urgent need to review the pandemic’s influence on people’s health and well-being to guide future studies on public health.

Historically, environmental design has helped to address health crises in the Western world. Therefore, it is of interest to planners and policymakers. Designing “salutogenic” landscapes and perhaps more targeted interventions as well is necessary for the resolution of the health problems caused by the pandemic (Antonovsky, 1996; Van den Brink et al., 2017). In addition, public parks are considered high-quality landscapes (Thompson, 2011). They offer opportunities for socialization with others and contribute to subjective well-being (Mathew et al., 2022). Moreover, they also provide space for pleasurable experiences such as soundscapes, reduce noise pollution (Siaw Ling Lee et al., 2022), and alleviate stress and anxiety (Ribeiro et al., 2021). However, the fear of being infected with COVID-19 has led some people to perceive visits to urban parks as riskier than before the pandemic (Dinda & Ghosh, 2021; Vann et al., 2022). Visits to parks have risen in most countries since February 16, 2020 (Geng et al.,

2020) but decreased in some locations—for example, the number of park visitors at Krakow in Poland decreased by 13.1% (Noszczyk et al., 2022). These differences show potential changes in the relationship between urban parks and citizens. Summarizing these changes and identifying potential reasons for them could improve the utility of urban parks in public health.

Although the pandemic has had a negative impact on people and urban parks, the impact of urban parks on public health cannot be ignored. Moreover, the pandemic offers an opportunity to identify shortcomings in urban parks' influence on public health. Globally, COVID-19 has amplified pre-existing inequalities in health, well-being, and access to public facilities (WHO, 2021a). The inequalities in access to urban parks also appear to relate to other inequalities, such as urban parks are not designed for some groups have not visited the park frequently (Vatavali et al., 2020). Moreover, for those worried about exposure to COVID-19, a deserted space in a park now feels safer than the crowded spaces where people felt safer before the pandemic (Jasiński, 2020). Therefore, a review of studies on the health effects of urban parks during pandemics to identify park deficiencies in serving public health could provide a foundation for post-pandemic urban park development. Some studies have suggested design ideas for urban parks to counteract the negative effects of the pandemic. For example, some researchers proposed limiting the service radius of parks or minimizing interactions between park users by expanding trails to maximize users' activity distance (Freeman & Eykelbosh, 2020; W. Zhang et al., 2022). One study found a trend toward an increase in the preference for uncrowded park spaces by park users. Yet a comprehensive study of the impact of the pandemic on users' perceptions of park environments is needed (Curtis et al., 2022).

To better understand the changes in the effects of urban parks on public health due to the pandemic, this paper briefly reviews studies of urban parks and public health. Also, to identify the shortfalls of urban parks in responding to public health needs during the pandemic, we reviewed the connection between urban parks and their users from the standpoint of environmental psychology. Our main aim was to investigate the impact of urban parks on people's health and well-being during the pandemic and highlight lessons that could be learned for post-COVID urban planning and the design of urban parks.



METHOD

Literature Search

We conducted a systematic and extensive search in several electronic databases for articles published from the beginning of the pandemic in November 2020 through May 2022. We searched the databases, Scopus, Google Scholar, Web of Science, and ScienceDirect, using the keywords “COVID-19”, “health”, “environmental psychology”, “urban parks”, “park design”, and “health perception.”

Exclusion and Inclusion Criteria for Literature Selection

Before conducting the literature search, we defined inclusion criteria (Table 1). We did not restrict the literature search geographically.

Table 1. Criteria for Literature Selection

Items	Criteria
Year	2020–2022
Study area	Environmental psychology, the COVID-19 pandemic, urban parks, public health, and social well-being
Relevancy	Highest relevancy to the study objectives, published in journals related to the keywords or are highly relevant to the field of study and written in English or Chinese.
For analysis	Interconnection analysis of literature can help in achieving research objectives
Excluded	Medical, cancer-related, and socioeconomic outcomes

(Source: Author)

Figure 1 shows that we identified 46,451 records on Google Scholar, Scopus, and Mendeley using the different search keywords. After title screening, we retained 525 records in Endnote after title screening and 62 after screening the abstracts. After reading the complete texts, we selected 32 papers for detailed analysis.

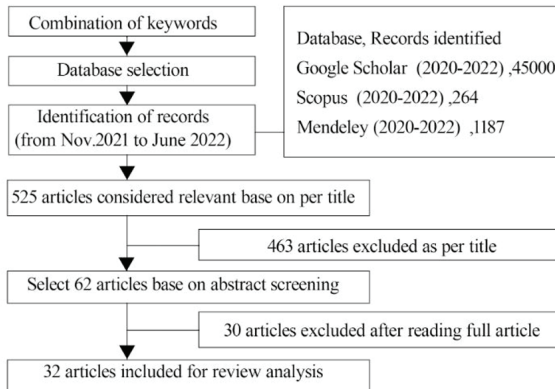


Figure 1. Research Search and Selection Process

(Source: Author)

RESULTS

After reading the 32 articles, we prepared an overview and summary of their characteristics, including general characteristics, the study design, and the geographical target. Then we distilled similar ideas from the 32 articles, using the literature analysis method to categorize and summarize the answers corresponding to the 4 study questions. See Appendix 1 for more details.

General Characteristics

Table 2 shows that the number of studies on health problems caused by pandemics has grown since 2020. In most cases, they examined adult (18–70) research populations (Tsao et al., 2022). However, review studies were less likely to mention the age of the study population and more likely to present research ideas aimed at the whole community (Clemente-Suárez et al., 2022; Geng et al., 2020; Gür & Kaprol, 2022).

Table 2. Year and Age Group of 32 Articles

Year of publication	No. of articles	Age group	No. of articles
2020	4	Adolescence	2
2021	16	Adults	16
2022	12	Older adults	2
--	--	Not mentioned	12

Table 3 shows that all continents except Antarctica were represented among the areas studied. Eleven countries were mentioned clearly, such as the US, the UK, China, and Canada. Three studies were multinational. The geographical settings of the other three studies were not mentioned because they were literature reviews. The countries included in the international studies were the Organization for Economic Co-operation and Development (OECD) countries (Krekel & MacKerron, 2020), 13 countries in Africa (Debes et al., 2021), and 48 other countries selected based on criteria such as the cumulative number of COVID-19 cases, infection and mortality rates, and the availability of data (Geng et al., 2020).

Table 3. Areas Studied in the 32 Articles

Continents	Country	No. of articles
Asia	China	6
	South Korea	2
	Japan	1
	Iran	1
Europe	United Kingdom	5 (UK, 2; Scotland, 1; England, 2)
	Belgium	1
	Poland	1
	Spain	1
North America	Canada	2
North America	USA	5
Oceania	Australia	1
All continents except Antarctica	Multinational	3
Not mentioned	-	3

(Source: Author)

Study Design

Table 4 shows that the main data collection and research methods used in the 32 articles were questionnaires, mixed methods, and cross-sectional approaches. For example, Bustamante et al. (2022) used a quantitative method to evaluate the associations between several neighborhood parks and psychological health problems. Hubbard et al. (2021) employed a cross-sectional method to examine associations between psychological health and green space during Scotland's pandemic. All but six of the studies had

sample sizes of more than 1000 people. Two studies included fewer than 100 people: a study in Chengdu, China, that included 47 people (Luo et al., 2021) and a study conducted in Taiwan that enrolled 25 adult volunteers (Tsao et al., 2022). Most of the studies were at the national level; few focused on smaller regions.

Table 4. Study Design Characteristics of the 32 Articles

Characteristics	No. of articles	Characteristics	No. of articles
Method		Method	
Questionnaire	8	Mixed method	6
Questionnaire and observation	1	Not mentioned	1
Questionnaire and existing data	1	Sample size	
Questionnaire and case study	1	n < 100	2
Questionnaire and cross-sectional study	1	100 ≤ n < 1000	4
Observational pilot	1	1000 < n < 5000	6
Existing data	2	n > 5000	9
Existing data and observation	1	Not mentioned	11
Interview	1	Geographical target	
Literature review	2	Nationwide	17
Literature analysis and quantitative analysis	1	Selected regions	8
Cross-sectional study	3	International	5
Models	3	Not mentioned	2

(Source: Author)

FINDINGS


Depression and Unhealthy Habits are Increasing

A 43-question survey of 13 countries in Africa showed that the impact of the Newcastle pneumonia pandemic reduced the proportion of people who never felt depressed from 61% to 31% and increased the number of people who were depressed daily from 2% to 20% (Debes et al., 2021). A study conducted on Japanese workers found that telecommuting might foster unhealthy dietary habits because it reduces commuting time and leads to



more snacking at home, which can increase stress and depression (Kubo et al., 2021). Also, when people work long hours and have constraints on their leisure time they may rely on alcohol and smoking to relieve stress (Lee et al., 2021). Another phenomenon is that people play with electronic products to alleviate stress and fill their free time, even when they are relaxing in a park with their friends or relatives (Table 5). According to the 2021 China Leisure Development Index, the two favorite leisure activities in China are traveling and playing with mobile phones. But the effects of the latter are not ideal: 60.5% of the respondents feel “bored and empty” after completing a game on a mobile device (Liu, 2021). Overall, studies show that lifestyle impacts health—a reminder that we should guide people toward healthier activities through environmental design.

Table 5. People Are Playing with Cell Phones in the Park

Activities	Picture
Playing with a phone alone	
Friends gather but each plays on the phone	
Parent speaking on a phone while a child plays	

Source: Photographs taken by the first author in 2022 at Peninsula Park, Baise City, China

Perceptions and Participation of People in Urban Parks

A study conducted in Belgium found that the pandemic strongly affected citizens' behavioural intentions as well as their attitudes and civic engagement. In response to the question, "Will your attitude towards green space change?" 30% of respondents said they intended to take part in a movement advocating for the construction of more urban green space, 23% said that they would ask the local government to provide more urban green space, and 8% said they plan to move to a greener location or a greener community (da Schio et al., 2021). Thus, urban parks have helped to ensure public welfare during the pandemic, and the population of park users has increased. Between February 16, 2020, and May 26, 2020, park visitation increased in most countries, according to an analysis of data from Google's Community Mobility Reports and the Oxford Coronavirus Government Response Tracker (Geng et al., 2020). Similarly, Day (2020) found a 34% increase in people who walk to green spaces in a study that used Google Mobility data and the predictive powers of the ORVal model. However, the pandemic has prompted some visitors to consider visiting public green spaces risky, leading to a decrease in the number of park visits in certain areas. The more people know about COVID-19 and its effects, the more they will avoid activities or exercise outside. This tendency was observed in Iran, the US, and Poland. Trips per participant in the US to public outdoor recreation sites decreased by approximately 26% after the onset of the COVID-19 pandemic (Landry et al., 2020). In Kraków, Poland, over 75% of the participants considered visiting green spaces essential for their health, but the number of park visitors was 13.1% lower between March to November 2020 compared to before the pandemic (Noszczyk et al., 2022). Smaller, more accessible parks were preferred to large, distant parks. In residential areas, the use of small neighborhood parks increased by 3% to 6%, whereas big urban parks received fewer visitors (Park et al., 2021). Women, compared to men, were more likely to agree that green space benefited their mental health during the pandemic, although the time they spent visiting green spaces decreased (Burnett et al., 2021). In short, the pandemic has not reduced people's positive psychological perceptions of the role of urban parks in public health, but there are between-group differences and the pandemic affected the activities people engaged in parks.

The Influence of Urban Parks on Human Health

The positive impact of urban parks on mental health has been more pronounced during the pandemic. US college students became more aware of parks' contributions to public health (Larson et al., 2022). Those who engaged in activities in urban parks reported that their negative emotions decreased. Almost 80% of participants in a study conducted in Brisbane claimed that connecting with nature or spending time in urban green spaces was their favored method for reducing self-reported stress, anxiety, and depression (Berdejo-Espinola et al., 2021). A study in China also found that public recreational green space helped reduce depressive symptoms (Zhou et al., 2022). Historically, marginalized groups, compared with people in groups that are better accepted, tend to face more mental health issues and negative emotions; if they visit parks less frequently as well, their psychological distress may be worse (Pipitone & Jović, 2021). A study from Scotland found that younger people, women, and people who visit green spaces less often showed higher levels of psychological distress than older people, men, and people who spend more time in green spaces (Hubbard et al., 2021). The study suggests that urban parks show deficiencies in serving different groups. People with restricted access to outdoor public spaces have a higher risk of developing symptoms of mental health disorders than those with partial or full access to outdoor spaces (Pouso et al., 2021). Subsequent park research should continue to examine the shortcomings of urban parks in ensuring public well-being and accessibility for all groups and identify corresponding solutions.

In evaluating the risk of contracting COVID-19, some researchers have considered urban parks safe outdoor spaces. Compared to crowded public places, public green spaces offer higher air quality, which is considered key to reducing the risk of infection. Some people surveyed in Chengdu, China, claimed that they feel safe in such outdoor green spaces (Luo et al., 2021). Public green spaces became protective spaces during the pandemic for those without private gardens (Poortinga et al., 2021). The lack of crowds is a key point in considering the risk of infection in urban parks. A study in England found that the link between park use and decreased residual case rates was stronger for parks that were uncongested and contiguous rather than sporadic. The authors of the study also suggested that outdoor park use may be safer than other forms of mobility (e.g., shopping or office-

based work) if mobility is necessary (Johnson et al., 2021). Although well-used spaces were considered safe pre-pandemic in the theory of crime prevention through environmental design, now uncrowded spaces seem safer because they appear to present less risk of exposure to the virus that causes COVID-19 disease (Jasiński, 2020). In summary, it seems that the pandemic has changed park users' psychological perceptions of parks and urban parks should act to cope with these changes.

Three characteristics of urban parks influence public health: their physical characteristics (e.g., the number of parks, plant landscapes, and the proportion of parkland), user activities, and user characteristics. The proportion of parkland (calculated as the area of parkland to the total area of a city) moderates the connection between well-being, lockdown, and the number of COVID-19 infections (Yao et al., 2022). In the COVID-19 Coping Study in the US, Bustamante et al. (2022), using a mixed-methods approach, found that residents aged ≥ 55 years living around more parks were linked to less depression and anxiety. Furthermore, urban park landscapes offer the opportunity to “escape” from the city, providing a sense of solitude that helps people to feel relaxed (Luo et al., 2021). Landscapes that contain plants play the greatest role in improving health. A Canadian study found that parks could provide therapeutic plant landscapes not only for enjoyment but also to improve physical and mental health through the stimulation of the five senses—olfactory, gustatory, tactile, visual, and auditory (He et al., 2022). Plants in parks can enhance human immune function by generating biogenic volatile organic compounds (BVOCs) to improve natural killer cell activity levels (Tsao et al., 2022). Thus landscape design has a significant effect on the influence of parks on health.

Having relatively safe places for people to exercise was critical if parks were to help people achieve well-being during the first wave of the pandemic (McCormack et al., 2022). Diverse activities in greenspaces can enhance social well-being (Bustamante et al., 2022). Walking or hiking in public green spaces can increase happiness by 2%; observing nature, and taking sports activities can increase happiness by 4 to 7 percentage points, and people are a little more than 1.5% happier outdoors than indoors (Krekel & MacKerron, 2020). Adolescents who participated in outdoor activities during the pandemic experienced less of a decline in subjective well-being than those who did not (Jackson et al., 2021). But there is some evidence that



people need to have a better understanding of the rules for Social Diversion under Relaxed Residential Restrictions when they exercise in parks (Geng et al., 2020). Thus, identifying ways to encourage people to follow social rules while engaging in activities in urban parks is worthy of further study.

There is sufficient evidence that green space provides benefits in terms of happiness and life satisfaction, but the effects on different aspects of well-being may vary depending on individual differences—for example, individuals with a greater need and/or preference for spending time in nature may experience greater benefits in terms of well-being (Poortinga et al., 2021). Many studies have confirmed this hypothesis. For example, a recent study showed that increases in the green coverage ratios of city-built districts were associated with decreases in depression in the elderly, but the effect was weaker in the middle-aged, whose work and family responsibilities and, sometimes, socioeconomic status, gave them fewer opportunities to enjoy urban parks (Zhou et al., 2022). In contrast, another study reported that park use increased during the pandemic in almost all demographic groups except individuals older than 45 years. Because the elderly are at risk of experiencing severe complications from COVID-19, fear of infection may make them less likely to spend time in green spaces (Berdejo-Espinola et al., 2021). The studies described above confirm that factors that affect the influence of urban parks on human health are not fixed because people’s perceptions are affected by the general environment. Continuing to study the relationships between urban parks and human health will be valuable. For example, an increase in total green space was not observed to reduce depressive symptoms in middle-aged people, but this subject deserves further investigation and should include the consideration of green spaces in both residential and work areas (Zhou et al., 2022).

Design Ideas to Enhance Urban Parks' Influences

Some researchers think that equipment and walking areas and urban parks should be arranged according to social distancing rules to decrease the risk of transmitting illness among users. Moreover, the pandemic highlighted the need to be close to nature in the city. In addition, park managers should improve circulation systems in urban parks to increase the rate of physical activity (BAYRAMOĞLU1 et al., 2021).

As fewer park visitors are taking public transit due to the pandemic risks, urban parks' service radii should be rethought. One study suggested that the typical urban parks service radius should decrease from 4230 m to about 3000 m to prevent increased inequality in access to urban parks during pandemic conditions (W. Zhang et al., 2022). To foster diversity and democracy in urban parks and improve citizens' attachment to parks, we should improve the perception of safety in parks for all racial groups (Powers et al., 2022). Biophilic designs that use nature, daylight, and air to improve the quality of spaces have been proposed to enable users to enjoy leisure experiences in parks multidimensionally and multisensorially, as well as both individually and socially (Gür & Kaprol, 2022).

DISCUSSION

As shown in Appendix 1, 32 articles provided data relevant to this study's two objectives. According to the theory of environmental psychology, life felt unstable to many people during the pandemic, causing sensory overload. Worries over financial losses, fear of infection, and behavioral restrictions increased stress (da Schio et al., 2021). In response, many people developed unhealthy habits such as addictions to electronic products (Liu, 2021). For urban parks, the pandemic brought opportunities and challenges. The pandemic increased people's need for urban parks and reduced the negative psychological health effects of the pandemic by providing a comparatively safe space where people could exercise (McCormack et al., 2022; Tsao et al., 2022). These benefits highlight the importance of urban parks in promoting public health. However, people's perceptions of urban parks are affected by their experiences and cognition (Poortinga et al., 2021). Fear of COVID-19 deterred some people from visiting urban parks (Berdejo-Espinola et al., 2021; Landry et al., 2020), although there is limited research on how those perceptions changed (Geng et al., 2020). In addition, the pandemic revealed that inequality in urban parks is expanding; urban parks had almost no beneficial impact on middle-aged people (Zhou et al., 2022). The articles reviewed in this paper offer some solutions to these problems, but further study is needed.

Compare with pre-pandemic studies, studies of the impact of urban parks on people show both similarities and differences. They are similar in



that the positive impact of urban parks on public health guided the studies on the relationship between urban parks and public health during the pandemic, indicating that the role of urban parks in public health became more obvious (Schwatka et al., 2021; C. Zhang et al., 2022). However, the need to be close to natural environments increased during the pandemic because of social distancing restrictions and decreased accessibility. All these factors have affected people's perceptions of urban parks and raised challenges for urban park development (Luo et al., 2021). In addition, studies conducted during the pandemic revealed that people's preferences for activities in urban parks changed with the onset of the pandemic. They began to consider uncrowded settings safer than crowded environments. People engaging in activities and parks should follow social distancing rules to avoid contracting viral infections. Some people have experienced sensory overload during the pandemic. Others cannot easily access urban parks because of social distancing restrictions or physical distance. These discoveries are different from those reported in previous studies.

Additionally, the relationships among environments, people, and health and well-being are dynamic (Gibson, 1979; Hu & Lin, 2018). People's psychological perceptions vary, depending on their personalities, and the pandemic is an environmental variable that can affect perceptions (Rahimi-Ardabili et al., 2021). Our knowledge of changes in perception is incomplete and lacks detail. Also, this review suggests that strategies for urban parks to ensure human health during pandemics are insufficient. Most of the studies that have examined solutions are at the macro level. They consider states or large cities, whereas few studies have been conducted in small districts. Ideas such as decreasing the service radii of parks, improving people's perceptions of safety in parks, and using biophilic design to improve the quality of urban parks are scattered; we lack a practical framework that can guide park design enhancements (Burnett et al., 2021).

CONCLUSIONS, LIMITATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

Taken as a whole, the positive impact of urban parks on public health has not changed significantly during the pandemic. However, the frequency of park visits has been affected, increasing or decreasing in different areas

based on local psychological perceptions of the pandemic and urban parks.

Despite its significant findings, this review has some limitations. The first limitation relates to the contexts of the reviewed studies. Different countries have applied different regulations to their citizens' activities during the pandemic. Urban parks were closed at times in some countries. Such restrictions may have had a large effect on the impact of urban parks on users. Therefore, future research should take consider the context to obtain a better understanding of the impact of urban parks on users' health and well-being. This work is also limited by the scale of the studies. Most were macroscopic, rather than microscopic. This is very important because each region has its distinctive characteristics. Therefore, subsequent studies on the relationship between urban parks and public health should examine regions and be conducted with an awareness of regional characteristics.

The increase in mental health problems and the adverse risk of the pandemic have both deterred people from enjoying the health benefits of parks. While addressing the adverse effects of the pandemic in various areas, current design concepts are not sufficient to address the challenges facing urban parks and public health during the pandemic. Given the increase in harmful habits such as over-dependence on electronic products, further studies could explore interventions to alleviate such habits in urban park users. Furthermore, the changes in people's park-related perceptions (e.g., perceptions of safety in urban parks), should be studied more clearly to guide quality improvement. Given that the pandemic has revealed that people who are low-income or lack access to urban parks have had limited or no ability to enjoy the benefits of urban parks during the pandemic, scholars should continue to study how to decrease inequalities in the availability of urban green space to different groups. In summary, the changes caused by the pandemic in different regions and populations and different types of parks need to be studied more deeply. The relationship between demographic characteristics and the environment is not fixed. The pandemic has alerted us that we have not done enough to ensure public health through environmental design.



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CONFLICT OF INTEREST

The authors declare no conflict of interest.

Appendix 1

This table classifies the 32 studies included in this review by their relationship to the study questions (see Table 1) and details their characteristics and conclusions.

Study objective- Main conclusion	Author	Location, method, sample, age in years	Recommendations
O1-Increase in depression	Debes et al. (2021)	13 countries in Africa. Questionnaire. N=489. The average age of the respondents was 30.	Healthcare workers face double stress due to lockdowns' social effects. Work challenges along with subsequent psychological health stress. How to alleviate these problems need more study.
O1-Bad behaviors adopted to deal with stress	Kubo et al. (2021)	Japan. Questionnaire and cross-sectional studies. N=33,302. Workers are aged 20–65.	Telecommuters may develop unhealthy dietary habits due to the pandemic; intervention strategies are needed to help them.
	Lee et al. (2021)	South Korea. Questionnaire. Data from the Korea Health Panel Study from 2011 to 2014. N= 6937. Paid employees aged 20–59.	How to tightly regulated people's leisure time and reduce their unhealthy habits need further study.
	Liu (2021)	China. Mixed method.	Playing with cell phones reached a record high in the past three years in China. Then, improving the quality of leisure products and guiding people to acquire leisure skills through leisure product design is the core of further studies.

O2-People poured into the parks	Burnett et al. (2021)	The UK. Cross-sectional survey. N=2252. Aged≥18.	Inequities in urban park use persist and increased during periods when movement was restricted due to rising COVID-19 case levels. Which should be studied more.
	da Schio et al. (2021)	Belgium. Questionnaire	Unequal access to urban green space during the pandemic needs ongoing research.
	Day (2020)	England. The ORVal model.	Behavioral responses to the lockdown varied across the country. Ongoing changes in outdoor recreation during the pandemic should be studied, taking into account regional differences in exposure to COVID-19 risk, occupational profiles, sociodemographics, and the availability and quality of local green spaces.
	Park et al. (2021)	Seoul, Korea. Existing data and observation.	Urban parks are a significant refuge and recreational space for urban residents during the pandemic. Therefore, they need to be adequately supplied and maintained to ensure that parks can adapt to changing needs.
	Geng et al. (2020)	48 countries. Existing data from each country.	Park use during the pandemic helps increase individuals' health and social well-being.
O2-Fear of infection and fewer visits to parks	Khozai et al. (2021)	Iran. Mixed-method approach. N=404.	The more people know about the negative effects of COVID-19, the more they will avoid outdoor activities. How to decrease the negative influence of the pandemic through urban parks is not studied enough.
	Landry et al. (2020)	The US Questionnaire. N=1,020 adults.	Urban park managers should develop innovative approaches to reduce the negative effects of COVID-19 on the welfare and well-being associated with outdoor recreation.
	Noszczyk et al. (2022)	Kraków, Poland. A mixed model with spatial data and GIS software. N=1251. All ages.	The pandemic has changed public perceptions of the importance of green space. Such change needs to be studied further to improve human well-being.

O3-Positive impact on mental health	Berdejo-Espinola et al. (2021)	Brisbane, Australia. Questionnaire. N=1,002, Aged 18–70+.	The COVID-19 pandemic demonstrates the need to clearly understand the characteristics of people receiving public services in challenging circumstances. Accordingly, how to maximize green infrastructure benefits need to be studied deeply.
	Bustamante et al. (2022)	US. Mixed method. Adults aged ≥55.	Access to greenspaces and other natural environments helps the elderly to cope with the pandemic. But these benefits from the park are considerable disparities for older people in the US based on race, income, and health status, it should seek further interventions to enable equal access to nature for individuals with different backgrounds.
	Poortinga et al. (2021)	The UK. COVID-19 Public Experiences (COPE) mixed-methods. N = 5,566.	More quantitative and qualitative research is needed to show how the pandemic has changed the use and perception of public and private green spaces and how these green spaces provide benefits to their users.
	Yao et al. (2022)	296 cities in China. Used big data from Baidu.	It advises policymakers and planners to increase urban park usage with proper precautions, such as keeping social distancing by the park environment, to achieve the goal of promoting mental well-being during the pandemic.
O3-Parks are safe places compared with other indoor public spaces	Johnson et al. (2021)	England. Two core models: baseline transmission and green transmission. N=299.	In high-density areas, park use is associated with a reduction in residual case rates. However, further evidence is needed to demonstrate the possible additional utility of these green spaces.
	Luo et al. (2021)	Chengdu, China. Semi-structured telephone interviews. N=47. Aged 21–84.	It requires ongoing studies to help urban residents obtain enough urban green space benefits.

O3-Parks are places for exercise that helps enhance people's health	Clemente-Suárez et al. (2022)	Literature review.	Physical activity in parks during the pandemic is valuable for the prevention of COVID-19. Further study should study more on how physical activity could modulate the pandemic impact on mental health in the population.
	Jackson et al. (2021)	The US. Questionnaire; principal component factor analysis. N= 624. Aged 10–18.	Physical activity, social interaction, and exposure to nature can be crucial in promoting adolescents' resiliency during pandemics. Future studies should highlight pandemic impacts on youth in other regions, and aim for large, representative samples outside of the United States, to illustrate trends of parks' impact on youth may hold or change across cultural contexts.
	Krekel and MacKerron (2020)	Worldwide. Literature analysis and quantitative analysis. Data from the Gallup World Poll.	Natural environments encourage physical activity and social interaction, which are vital determinants of happiness. Better models are needed to understand this effect.
	He et al. (2022)	Canada. Investigation of plant species and semi-structured interviews. N=100. Aged > 18 years.	Plant design in further for parks should consider plants' specific sensory influences to enhance the visitors' overall experiences and benefits.
	McCormack et al. (2022)	North-central Calgary, Canada. Online questionnaire and observing. N= 1124. Aged >18.	Park and green space scale and space should be adequate to prevent overcrowding and allow physical distancing during infectious disease pandemics. Exactly how this will be done, however, is unclear.

O3-Healing mental health problems	Larson et al. (2022)	Four large public universities across the US Questionnaire. N=1280, college students.	Further research should consider the potentially valuable role of other types of public spaces (e.g., sidewalks, greenways) and walkable urban environments for health during a pandemic. On the other hand, the quality of parks and the intensity of natural doses should also be considered when assessing the potential impact of park use on mental health.
	Tsao et al. (2022)	Taiwan, China. Observational pilot. N=25.	City managers should develop parks and increase canopy coverage to satisfy the citizens' health requirements. A larger study is needed to investigate other mechanisms for assisting residents to make use of the natural environment.
	Zhou et al. (2022)	China. Questionnaire and existing data. N=7397. Aged ≥45.	It is advised to explore the new pathways that link green space and mental health and the different influences on people of various green space
O3-If there is no access to urban parks	Hubbard et al. (2021)	Scotland. A cross-sectional study (CHARIS-E). N=2969. Aged ≥16.	Future studies should consider the objective measurement utility of green space accessibility.
	Pouso et al. (2021)	Spain. Questionnaire. N = 3403.	In Spain's strict lockdown, people perceived that the natural environment helped them be resilient through the benefits of ecosystem services to cope with lockdown harm.
O4-Need to improve urban circulation systems	O4-Biophilic design	Literature analysis.	Social distancing created the need to redesign open green spaces.
O4-Service radii of urban parks should be reduced	W. Zhang et al. (2022)	Wuhan, China. Case study and questionnaire survey. N=3387. All ages.	It is vital for sensible urban planning to be aware of changes in the accessibility of urban parks; we should also examine whether access is equitable.
O4-Increased sense of welcome, belonging, and safety	Powers et al. (2022)	US. Cross-sectional quantitative. N=1,213.	Urban parks have the potential to foster frequent and positive interracial contact to increase belonging. Future studies should continue to explore the various impacts of green space on human life.
O4-Biophilic design	Gür and Kaprol (2022)	Not mentioned. A book.	The use of biophilic design in urban parks will support the city's sustainable and resilient development. But how to fulfill it in different districts needs in-depth study.

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