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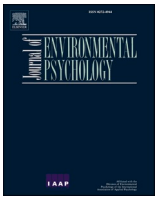

Natural environments, psychosocial health, and health behaviors in a crisis – A scoping review of the literature in the COVID-19 context

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ABSTRACT

The COVID-19 outbreak led to major restrictions globally, affecting people's psychosocial health and their health behaviors. Thus, the purpose of this scoping review was to summarize the available research regarding nature and health in the COVID-19 context. Keywords relating to natural environments and COVID-19 were combined to conduct a systematic online search in six major databases. Eligibility criteria were a) published since 2020 with data collected in the COVID-19 context b) peer-reviewed, c) original empirical data collected on human participants, d) investigated the association between natural environments and psychosocial health or health behaviors, and e) English, German, or Scandinavian languages. Out of 9126 articles being screened, we identified 188 relevant articles, representing 187 distinct studies. Most research focused on adults in the general population and was predominantly conducted in the USA, Europe, and China. Overall, the findings indicate that nature may mitigate the impact of COVID-19 on psychological health and physical activity. Through a systematic thematic analysis of the extracted data, three primary themes were identified: 1) type of nature assessed, 2) psychosocial health and health behaviors investigated, and 3) heterogeneity in the nature–health relationship. Research gaps in the COVID-19 context were identified regarding I) nature characteristics that promote psychosocial health and health behaviors, II) investigations of digital and virtual nature, III) psychological constructs relating to mental health promotion, IV) health-promoting behaviors other than physical activity, V) underlying mechanisms regarding heterogeneity in the nature–health relationship based on human, nature, and geographic characteristics, and VI) research focusing on vulnerable groups. Overall, natural environments demonstrate considerable potential in buffering the impact of stressful events on a population level on mental health. However, future research is warranted to fill the mentioned research gaps and to examine the long-term effects of nature exposure during COVID-19.

1. Introduction

The COVID-19 pandemic, declared on 11 March 2020, had a major impact on society globally. As of November 2022, the estimated death toll attributed to the virus is more than 6.5 million people (https://bit.ly/3Ud9KGx; Dong, Du, & Gardner, 2020). To mitigate the spread of the virus, many governments introduced containment measures such as physical distancing, suspension of social events, and restricted mobility, which resulted in significant social and economic consequences across different sectors (Nicola et al., 2020). Although almost 13 billion vaccine doses against COVID-19 have been administered as of November 2022 (https://bit.ly/3Ud9KGx; Dong et al., 2020), at the time of writing this, COVID-19 was still affecting daily life routines in some places, such as restricted access for visitors in hospitals (BBC, 2022) and travel restrictions to some countries (U.S. Embassy & Consulates in China, 2022). While some places have lifted all COVID-19 restrictions (e.g., Denmark,

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Switzerland), the short- and long-term effects of the pandemic are visible in several areas of human society, impacting individual's health, well-being, and health behaviors. For instance, across the world, psychological health and well-being have declined across the pediatric and adult population, while psychiatric symptoms and feelings of loneliness have increased due to physical distancing (Bonati, Campi, & Segre, 2022; Lee, Cadigan, & Rhew, 2020; Loades et al., 2020; Vindegaard & Benros, 2020; Wunsch et al., 2021; Xiong et al., 2020). It is expected that these mental health consequences are not only immediate, but will have long-lasting effects on individuals (Iqbal, Li, Onigu-Otito, Naqvi, & Shah, 2020). Furthermore, as health care systems directed their resources necessarily towards critical care for COVID-19 patients, preventive and chronic care resources were reduced (Tannous & Vahidy, 2022), leading to collateral damage due to missed diagnoses and delayed treatment of other (chronic) diseases (Malagón, Yong, Tope, Miller, & Franco, 2022; Nadarajah et al., 2022). For children born during the pandemic, first results indicate that the neurodevelopment of these children in the early years may be affected compared to children born prior to the pandemic. This is evidenced by lower scores on tests of language and motor skills (Wenner Moyer, 2022), while the consequences of school closures may lead to lifetime welfare losses of children (Fuchs-Schündeln, Krueger, Ludwig, & Popova, 2022). Additionally, the shift to remote working came with both opportunities, such as enhanced productivity and flexibility, and less commuting time (Oakman, Kinsman, Stuckey, Graham, & Weale, 2020), as well as challenges, such as intensified technical, psychological, and emotional work demands (Chan, Shang, Brough, Wilkinson, & Lu, 2022). It is expected that this shift to remote and hybrid working will continue in the future, challenging health behaviors such as movement and dietary behaviors (Peters, Dennerlein, Wagner, & Sorensen, 2022), which are typically embedded into structures related to work or school (Brazendale et al., 2017). Unfavorable changes in health behaviors were also reported during COVID-19, such as a decline in physical activity and an increase in sedentary behavior (Stockwell et al., 2021), adverse changes in eating behavior (Bhutani, Vandellen, & Cooper, 2021; Herle, Smith, Bu, Steptoe, & Fancourt, 2021; Robinson, Boyland, et al., 2021), as well as a substantial risk of problematic alcohol use and overuse of online gaming (Xu, Park, Kang, Choi, & Koo, 2021). First studies indicate that even after COVID-19 restrictions were lifted, health behaviors such as physical activity did not return to pre-pandemic levels (Koch et al., 2022; Salway et al., 2022). These developments provide an impetus to identify factors beyond a biomedical model that empower the general and especially vulnerable populations, defined as populations that are susceptible to psychological, physical, or social harm, health problems, or neglect (Phillips, 1992; Rogers, 1997) to maintain and promote their psychosocial health and health behaviors during the COVID-19 pandemic (Holmes et al., 2020; Kola et al., 2021) and beyond.

Prior to the COVID-19 outbreak, numerous studies, including reviews, have demonstrated that exposure and access to nature in its various forms, including (urban) green space, blue space such as rivers, private green space, such as gardens, or visual nature experiences are related to improved mental health and well-being and a reduced risk for psychiatric disorders (Bratman et al., 2019; De Bell et al., 2020; Engemann et al., 2019; Jarvis et al., 2021; Tost et al., 2019; White, Elliott, Gascon, Roberts, & Fleming, 2020; WHO, 2016). In addition, several studies support the concept that access and exposure to natural environments has the potential to promote physical activity (Remme et al., 2021), while interacting with nature, e.g. via gardening, can promote beneficial dietary behaviors (Beavers, Atkinson, & Alaimo, 2020; Davis, Ventura, Cook, Gyllenhammer, & Gatto, 2011).

The complex underlying mechanisms linking nature to health, well-being, and health behaviors are not entirely elucidated and require further investigation (Kuo, 2015). Potential mechanisms linking nature to health and well-being include reducing harm (e.g., air pollution), restoring capacities (e.g., stress recovery), and building capacities (e.g., physical activity and social cohesion) (Hartig, Mitchell, De Vries, & Frumkin, 2014; Markevych et al., 2017). These mediators have also been confirmed in a recent systematic review (Zhang, Zhang, & Rhodes, 2021). As a result, nature exposure, including access to biodiversity and recreational activities in nature, are recommended to strengthen psychological resilience (Aerts, Vanlessen, & Honnay, 2021). In this sense, natural environments can be part of a salutogenic approach (Antonovsky, 1987) to promote health through supportive environments (WHO, 1986), and through being a resource that empowers people to promote and protect their own health.

Beyond the impact of the COVID-19 pandemic on psychosocial health and health behaviors, it also influenced people's use of green space and natural environments. Depending on the containment measure in place, some people have interacted less with nature and others more (Burnett, Olsen, Nicholls, & Mitchell, 2021; Geng, Innes, Wu, & Wang, 2021; Ugolini, Massetti, Pearlmutter, & Sanesi, 2021). This global public health crisis can be considered a unique natural experiment with COVID-19 restrictions affecting people's daily lives around the world. We are not aware of any reviews that summarized research on a global scale, providing an overview of the role of natural environments for psychosocial health and health behaviors during a public health crisis such as the COVID-19 pandemic. Thus, this review aimed to identify the available evidence related to the role of natural environments regarding psychosocial health and health behaviors since the outbreak of the COVID-19 pandemic. The main question was: What do we know about the existing scientific literature regarding the relationship between natural environments and psychosocial health as well as health-related behaviors in the COVID-19 context? Specifically, we were investigating: a) Which types of nature were investigated in the context of the COVID-19 pandemic? and b) Which psychosocial health outcomes and health behaviors in relation to nature were investigated during the COVID-19 pandemic?

2. Materials and method

Since this study aimed to synthesize research regarding nature, health, and health-related behaviors in the COVID-19 context using an inclusive approach towards potential studies, we used a structured scoping review and systematic thematic analysis to explore our research question. Scoping reviews aim to map key concepts, evidence types, and research gaps in a research field based on a systematic search and knowledge synthesis (Colquhoun et al., 2014). A key strength that distinguishes a scoping review from a systematic review is that a scoping review question covers a "broader" scope (Munn et al., 2018), allowing researchers to be more inclusive regarding diverse methodological approaches within the academic literature. This was particularly relevant as the goal was to investigate the wide range of academic research regarding nature and health (behavior) in the COVID-19 context across diverse populations, outcomes, and nature types. In contrast, systematic reviews generally require imposing restrictions, such as study design restrictions (e.g., only experimental studies) (Sucharew, 2019). The reporting follows the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (Prisma-ScR; Tricco et al., 2018).

We specifically followed the established five-step process of Arksey and O'Malley (2005), including I) identification of the research question, II) identification of relevant studies, III) study selection, IV) data charting, and V) result summary and report. First, the research group met several times to discuss the research question (step I), which was guided by the PCC mnemonic (*Population*: Humans, *Concepts*: Natural environment and psychosocial health or health-related behaviors, and *Context*: COVID-19) (Peters et al., 2020). The team also agreed on definitions and the breadth of key terms in our research question (natural environment, psychosocial health, and health-related behaviors). We purposely applied a broad understanding and definition of the concepts to allow a comprehensive search and knowledge map. We defined natural environments as real-life and digital outdoor areas with physical

features and processes of non-human origin (Hartig et al., 2014). During the screening process, we identified multiple articles that included activities bound to take place in nature. Thus, we expanded our inclusion of articles that focused on nature-based activities. Following the example of Wolsko, Lindberg, and Reese (2019), we included nature-dependent activities (e.g. skiing, swimming, kayaking), nature consumption-related activities (e.g. fishing, hunting, gardening), and motorized activities in nature (e.g. quad bikes, motor boats) in our definition. Psychosocial outcomes were defined as any psychological or social aspects that are influenced by the environment and biological aspects and their interrelationship with human behavior (Vizzotto, de Oliveira, Elkis, Cordeiro, & Buchain, 2013), such as well-being, mood, quality of life, self-esteem, or cognition. Health behavior was defined as any behavior associated with health benefits or adverse health outcomes (e.g., physical activity, eating behavior, smoking).

Next, we identified relevant databases, and defined search terms as well as inclusion and exclusion criteria (step II). The latter was executed in an iterative process based on internal discussions and preliminary online searches to refine the research question and review execution. Search terms were defined based on the author's topic-related knowledge. Additional search terms were identified in the titles, abstracts, and keywords of relevant articles in a preliminary search. Following the preliminary search, a comprehensive online search was conducted in the databases Web of Science, Scopus, PubMed, Embase, CINAHL, and Greenfile on April 14, 2021, and updated on July 14, 2022, to include the latest literature in this scope. The search strategy was based on two strings, combining subject headings (MeSH terms) and keywords related to natural environments (e.g. green space, park, digital nature) and COVID-19 (e.g. Sars-Cov-2, pandemic, lockdown). The exhaustive search strategy for this study is provided in the *appendix A1*. Studies were included if they a) were published since 2020, b) included data collected since the outbreak of COVID-19, c) were accepted or published in a peer-reviewed journal, d) presented original empirical data collected on human participants, independent of the underpinning methodological approach (quantitative or qualitative), e) assessed the association between natural environments and psychosocial health or health behavior, and f) were written in English, German, or Scandinavian. A protocol presenting the project's objective and planned procedures was registered via the Open Science Framework platform (OSF) on June 6th, 2021 (available online: https://osf.io/ad2sx/).

For study selection (step III), all retrieved records were imported to and processed in Endnote Desktop reference management software (version X9.3.3). Following the removal of the duplicates, first, both the first and second author (C.N. and E.P.) screened independently from each other. Second, all titles that were deemed appropriate for abstract screening by one of the reviewers were included for abstract screening and again independently screened by both reviewers. Third, all abstracts that were deemed appropriate for full-text screening by one of the two reviewers were included for full-text screening and again independently screened by both reviewers (see Fig. 1). Disagreements were dissolved by discussion. If no consensus could be reached, the third author (T.M.) was consulted. After piloting the data extraction, we decided to systematically extract the following information from each study (step IV): Authors' names, year of publication, study location (country), sample characteristics (size, age, gender, ethnicity), data collection time frame, study design, methodological approach, data collection methodology, study objective, operationalization and measures of the used concepts nature and health/health behavior, and the main findings. The first and second authors extracted and inputted data from the final articles collection in a Microsoft Word table.

To prepare the extracted data for the report (step V), we adopted a systematic thematic analysis approach to summarize our findings and

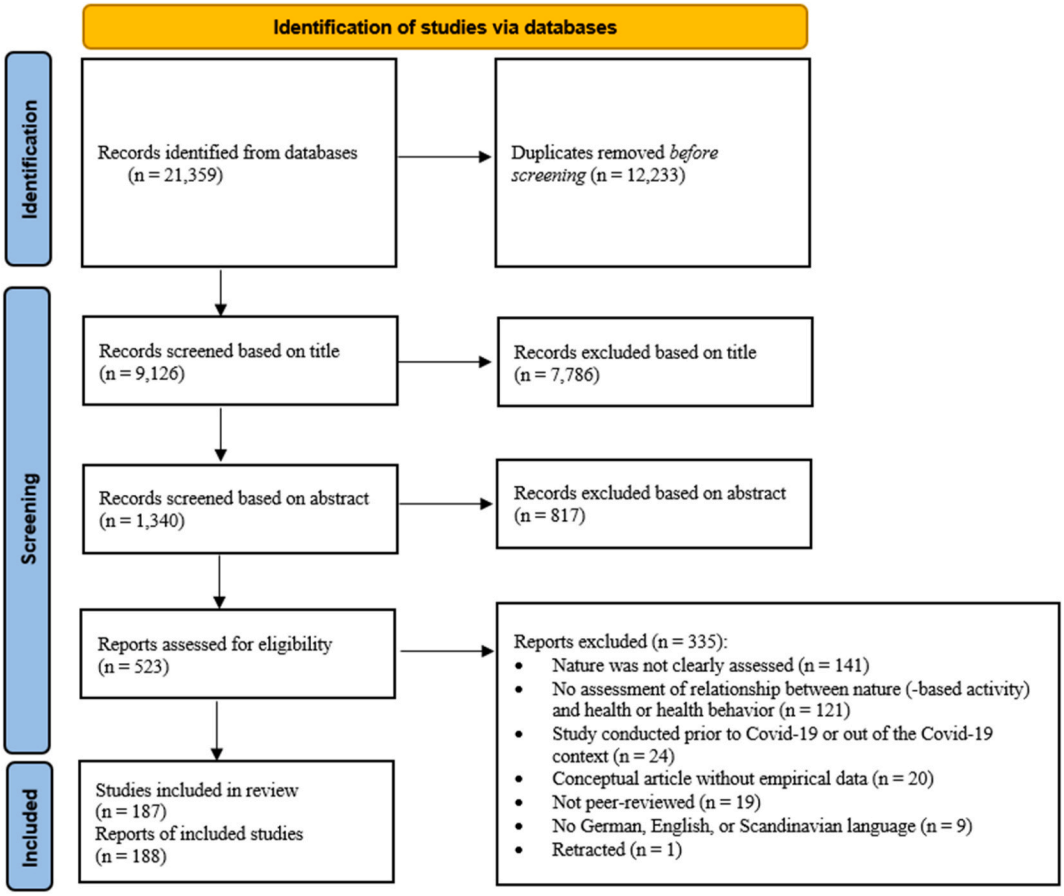

Fig. 1. Flow diagram of the screening process.

identify recurring themes. After we had extracted the data, one researcher (C.N.) imported the table into the program MAXQDA Analytics Pro (version 20.4.1). Following the guidelines proposed by Braun and Clarke (2006), we applied initial coding on each article charted in the table. Codes refer to a short phrase or word that summarizes or assign an attribute to a language-based content (Saldaña, 2016), from which we build the data extraction table. Especially relevant for coding were the columns: nature operationalization, measurement, and main findings. Before conducting the systematic thematic analysis, the first author (C.N.) piloted the coding and categorization process and discussed the applied procedures with the second author (E.P.). Then, the authors decided to follow a sequential deductive–inductive analysis process. First, based on our research question, two main categories were established deductively: 1) Nature type investigated during COVID-19, and 2) Health outcomes and health behaviors investigated during COVID-19. Codes that related to the type of nature investigated (e.g., forests, parks, water-based areas) were assigned to the first main category to answer the first research question regarding which type of nature was investigated during the COVID-19 pandemic. Codes relating to the type of health outcome (e.g., well-being, depression) or health behavior (e.g., physical activity, sleeping) were assigned to the second main category to answer the second research question regarding which health outcomes and health behavior were investigated in relation to nature during COVID-19. Codes that did not fit either of the main categories were revisited to develop a more representative code system, resulting in a third main category that was inductively developed during the coding process: 3) Heterogeneity in the nature–health association. This third main category contains codes relating to distinct associations in the nature–health relationship (e.g., varying relationships between nature and health for women and men), thus capturing characteristics which may play a key role in moderating the nature–health relationship. Within all three main categories, sub-categories were developed using a data-driven inductive approach. The initial coding for this procedure was conducted based on the column nature operationalization, measurement, and main findings. If required for context understanding, additional information was obtained from the article. For each article, the first author (C.N.) organized the initial codes first into the three main and then inductively into sub-categories in a systematic, repetitive procedure. As more articles were coded, they were mapped into previously identified sub-categories, and new or second-level sub-categories were established. To illustrate this on an example: First, any mental health and physical activity outcome that were associated with nature were put into the main category “Health outcomes and health behaviors during COVID-19”. With more and more codes emerging that related to mental health and physical activity, two first-level sub-categories “mental health” and “health behaviors” were established, with any mental health outcome (e.g., “less stress”, “less anxiety”, “better well--being”) being mapped into the “mental health” sub-category and any physical activity outcome (e.g., “walking”, “exercising”) being mapped into the sub-category “health behaviors”. With ongoing coding, it became clear that there were also distinct themes within the mental health sub-category, leading to second-level mental health sub-categories being established to obtain a more fine-grained picture, such as “Well-being”, “Stress”, “Coping” or “Depression and anxiety”.

Main- and sub-categories were not mutually exclusive, and codes could be mapped into multiple main- and sub-categories. The coding and categorization process was discussed with all authors, and codes and categories were re-arranged and adapted until all authors agreed. As we applied the coding process to synthesize the evidence, we report the number of codes obtained the categories in the result section. A coding protocol that accompanied the coding process as well as the MAXQDA-file containing the full data extraction table with all final codes and the categorization can be found in the data repository: https://osf.io/ad2sx/.

3. Results

3.1. Descriptive study characteristics

After removing duplicates, a total of 9126 search results were screened based on their titles, resulting in 188 articles representing 187 studies being included in our review. All studies were in English language. Most studies were excluded due to unclear assessment of the physical environment, which in most cases meant that there was only an assessment of whether people were outdoors or indoors, with this type of assessment possibly including any outdoor environment and not only natural environments. A flow diagram of the screening process is presented in Fig. 1. Most studies used quantitative methods (n = 132), while 30 studies applied qualitative methods and 25 studies mixed methods. Regarding the study design, most studies were of cross-sectional nature (n = 150), and 32 studies applied a longitudinal design. Most studies were observational (n = 171), while 16 studies used experimental methods. Online surveys were the most common form for data collection (n = 132), followed by qualitative interviews (n = 24), and other survey formats (n = 22), such as paper-pencil, and geospatial methods (n = 20). Data collection during COVID-19 took most frequently place during the months April (n = 60), May (n = 54), and June (n = 47) in the year 2020. Nature was most frequently assessed via self-report, such as by collecting the self-reported frequency of nature visits (n = 150), while 30 studies applied objective methods (n = 30), and the rest of the studies relating to nature visitation or exposure (n = 15) or exposure to digital nature (n = 8). Regarding the population studies, most studies targeted the general population (n = 84), followed by studies investigating specifically people living in urban areas (n = 42) and university students (n = 15). Vulnerable populations were less often included, and consisted of health care workers (n = 5), people with physical health problems (n = 6; e.g., people with tinnitus or cancer), people with mental health problems (n = 4), and people in nursing homes (n = 2). Most studies included the adult population (both adults [n = 158] and older adults [n = 128]), whereas children (n = 20) and adolescents (n = 24) were less studied. Most studies did not have information regarding ethnicity of the study population (n = 149), whereas 34 studies had information (n = 3 not applicable). Most studies were conducted in the USA (n = 36), UK (n = 18), China and Spain (n = 16, respectively), Italy (n = 15), Canada (n = 13), Germany (n = 11), and Australia (n = 10). The methodological characteristics of the articles included are summarized in Table 1, a map displaying all countries that studies were conducted in is displayed in Fig. 2, and the specific number of studies for each country can be found in the appendix Table A1. An overview regarding the year and months during which data of the included studies was collected can be found in the appendix Figure A1.

3.2. Identified main and sub-categories

As introduced in the methods section, we identified three main categories, with the first two main categories being deductively obtained based on the two research questions and the third main category being obtained through a data-driven inductive process in our analyses: 1) Nature type investigated during COVID-19, 2) Health outcomes and health behaviors investigated during COVID-19, and 3) Heterogeneity in the nature–health association during COVID-19. A summary of the main-as well as first- and second-level sub-categories is presented in Table 2, and a table with the extracted data for each study can be found in appendix Table A2.

3.2.1. First main category: nature type investigated during COVID-19

Within this main category, three first-level sub-categories were distinguished, including the geographic dimension, the characteristics of nature, and nature-based activities. From a geographical point of view, both public and private nature were investigated during COVID-19. Public nature was the domain that received the greatest interest

Table 1
Methodological characteristics of the included studies (N = 188 articles, N = 187 studies).

Characteristics	Categories	n
Methodological approach	Quantitative	132
	Qualitative	30
	Mixed-methods	25
Study design	Cross-sectional	150
	Longitudinal	32
	Intensive longitudinal	2
	Case-study	5
Study type	Observational	171
	Experimental	16
	Participatory action research	1
Data collection methodology	Online survey	132
	Other survey forms	22
	Qualitative interviews	24
	Geospatial methods	20
	Device-based health outcome assessment methods	7
	Analysis of audio-visual material	6
	Ethnographic approaches	4
	Social media analysis	4
	Fitness app analysis	3
	Participating writings	3
	Observation	2
	Other[b]	3
Nature assessment	Self-report	150
	Objective[c]	30
	Nature visitation or exposure in real-life[c]	15
	Digital nature exposure	8
Study population/sample	General population	84
	Urban residents	42
	University students	15
	Gardeners and farmers	8
	Families	8
	Park and forest visitors	7
	People with physical health problems	6
	Fitness app and social media post analysis	6
	People engaging in nature-based physical activity	5
	Health care workers	5
	People with mental health problems	4
	Greenspace experts	3
	Employees	2
	People in nursing homes	2
	Other[d]	9
Sample age [e]	Children	20
	Adolescents	24
	Adults	158
	Older adults	128
Sample size	≤10	6
	11–100	36
	101–500	47
	501–1000	34
	1001–5000	47
	5001–10,000	6
	>10,000	4

Please note: Some studies applied multiple study designs, data collection methodologies, and nature assessments and included multiple age groups. Thus, it is possible that the sum of the categories exceeds the number of studies and included articles. The sample size category does not include sample information about social media (i.e., number of posts). [a] Intensive longitudinal study design refers to study designs with repeated measurements within one unit (e.g., a person) to investigate changes within this unit (Bolger & Laurenceau, 2013). [b] "Other" refers to data collection methods that did not fit into any of those categories and were only applied once across the studies included, e.g., health impact assessment. [c] "Objective" refers to methods where nature is identified via geospatial approaches, such as creating buffers around residential addresses, while "nature visitation or exposure in real-life" refers to studies that investigated people in natural environments, e.g., park visitors or intervention studies exposing participants to nature. [d] "Other" refers population groups investigated that did not fit into any of those categories and were only investigated once across the included studies, e.g., prisoners or webcam travelers. [e] Children were defined as participants up to nine years, adolescents from ten 10–17 years (Sacks, 2003), adults 18–64 years, and older adults 65 years and older (Orimo et al., 2006).

(n = 111 codes), specifically parks (n = 33 codes), and urban natural areas (n = 28 codes). Private nature was less investigated (n = 32 codes) and concentrated on gardens and garden access (n = 25 codes). Regarding the characteristics of nature, most studies looked at greenspace and vegetation (n = 24 codes) and general nature (n = 21 codes), followed by views on nature from the window (n = 12 codes), and blue space, such as general blue space and beach areas (n = 11 codes). Less investigated were digital nature in forms of webcam travel, videos, and virtual nature experiences (n = 8 codes), nature quality (n = 6 codes), and nature sounds (n = 3 codes). Regarding nature-based activities (n = 38 codes), gardening was most frequently investigated (n = 17 codes, followed by nature-based physical activity, such as general physical activity in natural environments or adventure sports participation (n = 11 codes).

3.2.2. *Health outcomes and health behaviors in relation to nature during COVID-19*

Within this second main category, three first-level sub-categories were distinguished: psychological health, health behaviors, and social health. Within each of these sub-categories, outcomes were categorized into favorable associations and no or unfavorable associations. Across all sub-categories, the majority of health outcomes and health behaviors were favorable related to nature (n = 423 codes), with only a few studies reporting null results or a negative association between nature and psychosocial health or health behaviors (n = 72 codes). In the following, we report the number of codes including both favorable and no/unfavorable associations, for a stratified overview, please see Table 2.

Psychological health was most extensively investigated (n = 325 codes) in relation to nature during COVID-19. Within this first-level subcategory, the greatest interest was in well-being, including general well-being, happiness, and life satisfaction (n = 108 codes), followed by stress (n = 79 codes), mood and emotions (n = 51 codes), as well as depression and anxiety (n = 42 codes). Constructs relating to resources and restoration, including recovery (n = 13 codes) and coping (n = 12 codes), were less investigated. Two sub-categories specific to the COVID-19 context were the perceived mental break from the pandemic (n = 11 codes), with participants indicating that nature allowed them feelings of escape from the ubiquitous pandemic life situation, as well as feelings of food security (n = 4 codes), which was mainly investigated in the gardening context.

Health behaviors received the second most frequent interest in relation to nature during COVID-19 (n = 102 codes). Most of interest were behaviors of the 24-h movement cycle (n = 88 codes), especially physical activity, including walking, exercising, doing sports, general physical activity, and meeting the physical activity guidelines (n = 80 codes). Other behaviors of the 24-h movement cycle, including sleep (n = 4 codes) and sedentary behavior (n = 3 codes), were less investigated. Lastly, some interest was given to dietary behaviors (n = 8 codes) and children's play (n = 5 codes).

Social health was least investigated in relation to nature in the COVID-19 context (n = 68 codes). Codes in this sub-category referred to general social health (n = 30 codes), social health regarding the family (n = 13 codes), and social health regarding neighbors and friends (n = 10 codes). Codes referring to loneliness (n = 7 codes) and community health (n = 5 codes) were less common.

3.2.3. *Heterogeneity in the nature–health association during the COVID-19 pandemic*

While the first two main categories synthesized codes referring to type of nature and the health outcomes/behaviors investigated during COVID-19, this third main category synthesized codes that refer to the nature–health relationship varying across populations and locations. Within this main-category, three first-level sub-categories were

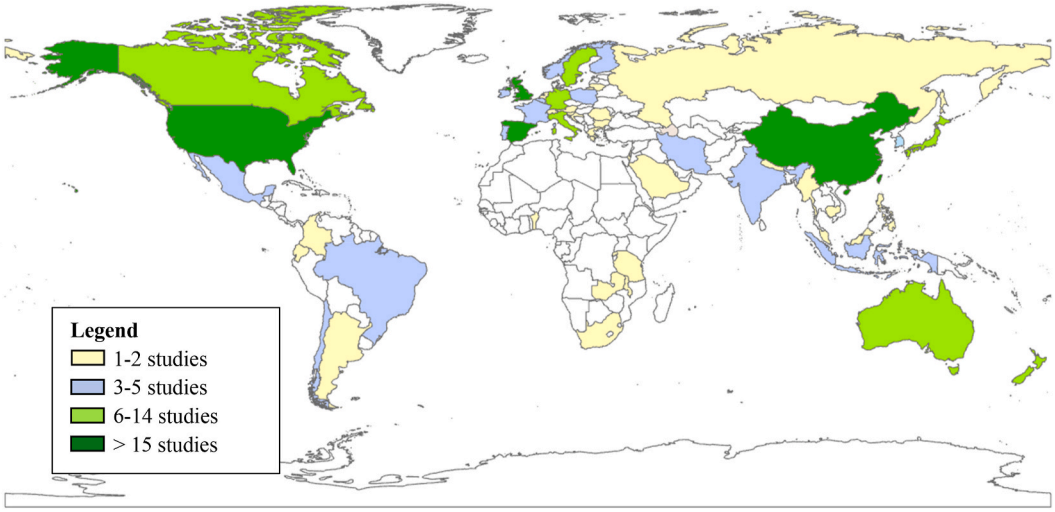

Fig. 2. The frequency of studies based on the geographical location of the sample.
Please note: In large-scale multi-country studies, we only included countries with 100 or more responses if country participant information was available (n = 4).

distinguished: Heterogeneity based on human characteristics, based on nature (activity) characteristics, and based on geographic regions.

Most articles targeted the variation between nature and health based on human characteristics (n = 56 codes), with most prominent variations occurring across sociodemographic characteristics (n = 34 codes), such as age, gender, and socio-economic status. In addition, some articles reported that the relationship between nature and health varied by access to nature (n = 9 codes), especially by garden access. Less investigated were other human characteristics, such as ethnicity (n = 2 codes) and characteristics more specific to the COVID-19 pandemic, e.g., being in a high-risk group (n = 1 code), working from home (n = 1 code), and social interactions during the pandemic (n = 1 code).

Heterogeneity was less frequently examined regarding nature characteristics (n = 19 codes). Most common variations were reported based on nature type (n = 13 codes), such as indoor compared to outdoor nature or park type. The sub-category crowdedness (n = 2 codes) was rarely investigated, but especially relevant in the pandemic context, describing variations based in the relationship if the natural area was crowded.

Regarding geographic heterogeneity, the association between nature and health varied depending on the country or city where the participants lived (n = 4 codes, respectively), as well as the specific COVID-19 situation at the participant's location, such as public space closures and case severity (n = 2 codes).

4. Discussion

This article presents the findings of a scoping review conducted to examine the research on natural environments, psychosocial health, and health behaviors in the COVID-19 context as a public health crisis. While research on natural environments and psychosocial health as well as health behaviors has strongly increased over the last decade (Zhang, Yu, Zhao, Sun, & Vejre, 2020), to this point, the role of nature in a public health crisis, such as the COVID-19 pandemic, has been unclear. The overall trend of the literature included in our scoping review suggests that nature holds the potential to mitigate the negative effects of COVID-19 on psychological health and physical activity during COVID-19 pandemic. However, this relationship is complex and varies regarding specific population characteristics, nature type, and geographic location.

We first extracted descriptive characteristics about the studies included in the review. Next, applying systematic thematic analysis, study content was coded into three main categories: a) the nature types investigated during the COVID-19 pandemic, b) health and health-related behaviors, and c) heterogeneity and variability regarding the association between nature and health. The descriptive characteristics revealed that most studies applied a cross-sectional study design, which is consistent with studies that have been conducted prior to COVID-19 (Collins et al., 2020; Zhang et al., 2021). Most studies were conducted in high-income countries, and the ethnic background of the participants was rarely reported. The most common samples comprised the general population, typically adults, while vulnerable populations were less commonly included in the sampling. This finding highlights a research gap since acute and long-term mental and social health consequences of this pandemic had and have the most severe impact on people already struggling with mental health challenges (Kola et al., 2021; O'Connor et al., 2021; Quittkat et al., 2020; Ting, Wong, Liu, Leung, & Ng, 2021). As previous research supports that people who are psychologically vulnerable benefit most from green space (Tost et al., 2019), more research on the role of nature to mitigate acute effects as well as to promote well-being amongst those most affected by the pandemic is warranted. Furthermore, people with vulnerability risk specific to the COVID-19 pandemic should be considered. For example, the imposed restrictions are expected to have exacerbated the "modern epidemic" of loneliness (Hwang, Rabheru, Peisah, Reichman, & Ikeda, 2020; Jeste, Lee, & Cacioppo, 2020), while a study conducted prior to COVID-19 showed that green space could decrease the risk for loneliness (Astell-Burt et al., 2022). Hence, more research among vulnerable groups regarding the relationship between nature and psychosocial health and health behaviors in crisis situations and their aftermath is required. In addition, a group that was barely included in our review were people suffering from long-term effects of a COVID-19 infection. Recent systematic reviews indicate that 43%–53% report long-term health effects of a COVID-19, including fatigue, general pain, or mental disorder symptoms (Chen et al., 2021; Domingo et al., 2021; Lopez-Leon et al., 2021), thus affecting a considerable number of people. For this population, exposure and interactions with natural environments may be a way to mitigate the negative long-term consequences (Kolbe, Jaywant, Gupta, Vanderlind, & Jabbour, 2021).

4.1. Type of nature investigated

We found that public nature was primarily investigated, with the greatest interest in parks, while private nature was mostly investigated in terms of gardens, with gardening activity being the most frequent form of nature-based activity. Green space and vegetation were the most common investigated nature characteristics. The thematic focus on general green space and vegetation cover is consistent with previous

Table 2
Overview about main- and sub-categories identified.

Main category	First-level sub-category	Second-level sub-category
Nature assessed (269)	Geographic dimension (143)	Public nature (111)
		Private nature (32)
	Characteristics of nature (88)	Green space and vegetation (24)
		Nature general (21)
		Window view on nature (12)
		Blue space (11)
		Digital nature (8)
		Nature quality (6)
		Nature sounds (3)
		Other (3)
	Nature-based activities (38)	Gardening (17)
		Nature-based physical activity (11)
		Unspecified nature-based activities (3)
		Active and passive nature-based activities (2)
		Nature-based tourism (2)
		Other (3)
Health outcomes and behaviors (495)	Psychological health (325) – favorable associations (282)	Well-being (97)
		Stress (67)
		Mood and emotions (49)
		Depression and anxiety (26)
		Recovery (13)
		Coping (12)
		Perceived break from pandemic (11)
		Food security (4)
		Other (3)
	Psychological health (325) – no and unfavorable associations (43)	Depression and anxiety (16)
		Stress (12)
		Well-being (11)
		Mood and emotions (2)
		Other (2)
	Health behaviors (102) – favorable associations (82)	24-h movement behaviors* (71)
		Diet (6)
		Play (5)
	Health behaviors (102) – no and unfavorable associations (20)	24-h movement behaviors* (17)
		Dietary behaviors (2)
		Other (1)
	Social health (68) - favorable associations (59)	Social health general (26)
		Social health regarding the family (13)
		Social health regarding friends and neighbors (10)
		Community health (5)
		Loneliness (4)
		Other (1)
	Social health (68) - no and unfavorable associations (9)	Social health general (4)
		Loneliness (3)
		Other (2)
Heterogeneity in the nature– health relationship (131)	Heterogeneity based on human characteristics (56)	Socio-demographic inequalities (34)
		Nature access (9)
		Time spent in nature (3)
		Time spent on the university campus (2)
		Other (8)
	Heterogeneity based on nature and nature-based activity characteristics (19)	Nature type (13)
		Vegetation (2)
		Crowdedness of the natural area (2)
		Other (2)
	Heterogeneity based on geographic region (11)	Country-based variability (4)
		City-based variability (4)
		COVID-19 related variability (2)
		Other (1)

Please note: The numbers in brackets represent the number of codes in the respective main-/sub-category. For the second-level sub-category, "other" refers to the number of codes that did not fit into any second-level sub-category. Some second-level sub-categories were further divided into third-level sub-categories. For a detailed overview regarding all the categories, we refer the reader to the coding file accessible on the Open Science Framework (https://osf.io/ad2sx/). * 24-h movement behaviors refer to physical activity, sedentary behavior, and sleep (Stevens et al., 2020).

reviews (Frumkin et al., 2017; Hartig et al., 2014). Other types of nature, including blue space, such as rivers or lakes (Britton, Kindermann, Domegan, & Carlin, 2020) or green infrastructure, referring to a network of open space or vegetation within a certain area that are specifically planned for ecosystem services (Matsler, Meerow, Mell, & Pavao-Zuckerman, 2021; Nieuwenhuijsen, 2021), have been neglected. Regarding gardens and gardening activity, the beneficial effects for mental health and well-being have been shown in studies prior to the pandemic (Howarth, Brettle, Hardman, & Maden, 2020), but the intensity of research and their importance seem to have increased during the pandemic: A systematic review conducted pre-dominantly prior to the pandemic regarding green space exposure and mental disorder prevention showed that out of 201 included studies, only four and two studies investigated specifically community and private gardens, respectively, whereas 81 studies investigated urban green space and nature exposure or contact (Reece, Bray, Sinnett, Hayward, & Martin, 2021). In contrast, in our review, 34 studies investigated the health benefits of gardens or gardening activity. The reason for the focus on gardens during COVID-19 is probably due to gardens facilitating contact with nature while adhering to stay-at-home orders (e.g., lockdowns). Also, a study in Brazil showed that having a home garden was most important to mitigate mental distress during COVID-19, while visiting urban parks was deemed less relevant (Marques, Silva, Quaresma, Manna, De Magalhães Neto et al., 2021). Thus, especially during a crisis like this pandemic, both practitioners and researchers should consider private and public nature as resources, if available.

An additional gap in the literature emerges regarding research in digital and virtual nature experiences, an area that has generated some interest prior to COVID-19, suggesting that virtual nature experiences can promote human–nature interactions and connections (Litleskare, E. Macintyre, & Calogiuri, 2020). This research area also seems to have experienced increasing interest during the pandemic: A systematic review regarding nature experience via virtual reality and psychological well-being prior to the COVID-19 pandemic included only 21 studies (Frost et al., 2022), compared to 153 studies included on a review on public urban green space and human well-being (Reyes-Riveros et al., 2021). In our review, elven studies investigated digital nature. Especially during COVID-19, the benefits of digital nature experiences became visible, specifically for places where leaving the house for recreational purposes was prohibited or if there was no nature access in the neighborhood. Beyond this pandemic, research on digital and virtual nature experiences should be expanded to facilitate people's contact with nature that may not have the opportunity to visit nature in real-life. For example, a study with incarcerated men showed that virtual nature

exposure led to decreased stress (Nadkarni et al., 2021). Hence, benefits of digital nature should also be investigated in other settings with limited nature access, such as elderly care homes, clinical care settings, or areas of urban degradation. This could also be a chance to investigate different nature types, which may illuminate our understanding of which natural features provide the strongest psychosocial health benefits for different public subgroups (Bratman et al., 2019).

Regarding nature operationalization, in self-reported measures, a common approach was to ask participants about the frequency of nature visits or the role of nature for health, without further specification of the nature type (e.g., Anderson, Salisbury, Uebelacker, Abrantes, & Battle, 2022; Beckmann-Wübbelt et al., 2021; Berdejo-Espinola et al., 2021; Kang et al., 2022; Soga, Evans, Tsuchiya, & Fukano, 2021; Ugolini et al., 2021). Regarding objective assessment, a common approach was the Normalized Difference Vegetation Index (NDVI) (Cheng, Zhang, Wei, & Zhao, 2021; Larson et al., 2022; Lõhmus, Stenfors, Lind, Lauber, & Georgelis, 2021; Reid, Rieves, & Carlson, 2022; Robinson, Brindley, Cameron, MacCarthy, & Jorgensen, 2021; Soga et al., 2021; Yang, Lu, Yang, Gou, & Liu, 2021), which has been commonly used in pre-COVID-19 studies (Ekkel & De Vries, 2017) to assess vegetation. However, none of those measures enables conclusions regarding which nature characteristics are relevant for a health in such a crisis. This is a major gap in the research, considering that some studies included in this review indicate that the nature–health relationship differs based on nature type characteristics (e.g., Cheng et al., 2021; Dzhambov et al., 2020; Khalilnezhad, Ugolini, & Massetti, 2021; Larson et al., 2022; Marques, Silva, Quaresma, Manna, Neto, et al., 2021; Maury-Mora, Gomez-Villarino, & Varela-Martinez, 2022; Trevino, Monsur, Lindquist, & Simpson, 2022; see also discussion about the third main category). In addition, previous studies proposed the use of nature quality indicators in explaining health outcomes and behaviors (Knobel et al., 2021; Van Dillen, De Vries, Groenewegen, & Spreeuwenberg, 2012), as well as nature characteristics, such as biodiversity (Knobel et al., 2021; Marselle et al., 2021; Sandifer, Sutton-Grier, & Ward, 2015). Beyond nature type and quality, characteristics of the human–nature interaction should be considered further. For example, in physical activity research, the FITT-principle is used for developing exercise prescriptions, referring to the description of physical activity frequency, intensity, time, and type (Reed & Pipe, 2016). Such a principle regarding human–nature interactions would be valuable to inform urban planners and practitioners, which may then refer to frequency, time (duration), type, and level (e.g., viewing a park vs. walking in a park) of human-nature interactions (Bratman et al., 2019; Masterton, Carver, Parkes, & Park, 2020).

4.2. Psychosocial health outcomes and health behaviors investigated

Psychological health received the most interest in relation to nature during COVID-19. This seems plausible as the COVID-19-related restrictions had a strong impact on mental health worldwide (Bu, Mak, & Fancourt, 2021; Kola et al., 2021; O'Connor et al., 2021; Xiong et al., 2020). More specifically, our analysis showed that the topics of most interest among researchers included well-being and general mental health, stress, mood and emotions, as well as depression and anxiety. In that sense, nature is considered a resource to prevent mental illness and disease. However, what has been less examined were psychological constructs in a salutogenic paradigm (Antonovsky, 1987), that is nature as a resource to empower people to promote their own health, reflected through few codes regarding coping and recovery and fewer investigations regarding associations between nature and social health in the COVID-19 pandemic context. Considering that nature exposure has been shown to have similar strong effects on well-being as social interactions (Killingsworth & Gilbert, 2010; Tost et al., 2019), we suggest that future research should go beyond a deficit-based approach and should focus instead on nature as a resource for mental health promotion both through real-life and digital nature experiences, termed a strength-based approach. Although social health was still the psychosocial health sub-category experiencing the least interest compared to psychological health and health behavior with 68 codes out of 495 codes (14%) in the main category health outcomes and behaviors, it seems that there was increasing interest in this health benefit: A systematic review prior to the pandemic about health benefits of urban green space showed that less than five out of 153 studies (3%) investigated social relations as a health benefit (Reyes-Riveros et al., 2021).

Regarding health behaviors, the role of nature regarding physical activity received the most interest from researchers in the field. This is not surprising, given the numerous health benefits of physical activity (Bull et al., 2020; Chaput et al., 2020) and its decline during COVID-19 (Paterson et al., 2021; Stockwell et al., 2021). Based on the studies included in our review, conclusions about whether specific features of the natural environment were relevant to the motivation of people to go to natural places in a crisis or whether physical activity in natural environments displaced other types of physical activity that were not possible due to the pandemic restrictions cannot be drawn. Both in the context of COVID-19 and beyond, it would be worthwhile to examine which features of the natural environment provide affordances for physical activity, given that nature-based physical activity may be a resource that promotes mental health to a greater extent than physical activity in other non-natural settings (Lahart, Darcy, Gidlow, & Calogiuri, 2019; Mnich, Weyland, Jekauc, & Schipperijn, 2019). Device-based assessment of physical activity combined with geolocation tracking technology could be valuable to obtain detailed insights on physical activity in natural environments (Jankowska, Schipperijn, & Kerr, 2015). Other health behaviors (e.g., sleep) were rarely investigated. However, from a conceptual point of view, investigations between specific types of nature or nature-based activity and health behaviors could be valuable in the context of COVID-19. For example, in two studies, most participants reported negatively changing their eating behaviors during the COVID-19 lockdown (Deschasaux-Tanguy et al., 2021; Robinson, Boyland, et al., 2021). In contrast, gardening activity was related to improved dietary intake (Beavers et al., 2020; Davis et al., 2011). Hence, as home gardening received increased interest during COVID-19 in some areas (Giraud, El-Sayed, & Opejin, 2021), there may be sustained effects on healthy eating behaviors, which warrants further study.

4.3. Heterogeneity in the nature–health relationship

The third main category indicated that the nature–health relationship may vary across different characteristics. Most common were variations based on gender and age differences, with no clear direction. For example, while one study reported that feelings of solace and respite and feelings of reconnection were more likely to be reported by men (Astell-Burt & Feng, 2021), another study reported that shorter distance to the nearest parks mitigated a step decline in older women, but not older men (Hino & Asami, 2021). The underlying mechanisms for these differences remain to be investigated and are essential for the planning of effective nature-based solutions and interventions that promote health and well-being across specific population groups. For instance, in a qualitative study, women indicated that fear of violence hinders positive well-being experiences when visiting an urban park in Mexico during COVID-19 (Huerta & Cafagna, 2021). A recent review summarized the evidence regarding mechanisms of green space interventions for mental health and investigated which mechanisms work for whom (Masterton et al., 2020). For example, they found that green space improves mental health via the mechanism "escape/getting away", works particularly well for people with an existing mental health diagnosis, while the mechanism "shared experiences" was important across study populations (Masterton et al., 2020). Hence, future endeavors should focus on identifying the underlying reasons for disparities in the nature–health association and provide interventions that facilitate an inclusive approach to ensure safe and positive nature experiences for all citizens.

Furthermore, heterogeneity has not only been investigated regarding population characteristics, but also with regards to nature types, indicating that different nature types may have differing importance for different health outcomes. For example, indoor green space, such as house plants, were weaker related to improved mental and social health outcomes than outside green space (Dzhambov et al., 2020; Maury-Mora et al., 2022; Trevino et al., 2022). Another study found that national and state parks, but not local parks or vegetation cover were related to less emotional distress (Larson et al., 2022), which was similar to other studies showing that restorativeness was highest in national parks compared to urban forests in South Korea (Lee et al., 2021). Two studies highlighted the importance of gardens for mental health compared to public green space (Khalilnezhad et al., 2021; Marques, Silva, Quaresma, Manna, Neto, et al., 2021). These results indicate that the relationship between nature and health may be difficult to generalize across nature types. For example, a recent article showed that associations between the natural environment and mental health, physical fitness, and physical activity varied across different concepts and configurations of the natural environment (Nigg, Niessner, Burchartz, Woll, & Schipperijn, 2022). Hence, to create effective nature-based solutions, it is important to understand which nature types are most effective in promoting health and health behaviors (Bratman et al., 2019).

Finally, heterogeneity was investigated regarding geographic regions, with most attention being paid to variability in the nature–health relationship between different countries, which may result from the diverse COVID-19 restrictions implemented across locations. We recommend that future reviews apply a comparison of WEIRD (Western, Educated, Industrialized, Rich, and Democratic) vs. non-WEIRD countries to explore the bias in sampling, favoring the former (Henrich, Heine, & Norenzayan, 2010) and to consider the human-environment interactions are embedded into cultural context, with WEIRD populations not necessarily representing the norm for human behavior (Milfont & Schultz, 2016; Tam & Milfont, 2020). Furthermore, future research is warranted regarding urban-rural differences in the nature–health relationship. For example, one study included in this review showed that an increasing number of parks was related to less depression in urban, but not in rural areas (Bustamante, Guzman, Kobayashi, & Finlay, 2022), mirroring some research results prior to the pandemic showing an urban-rural gradient in the nature–health relationship (Dennis & James, 2017). Since the effects of the pandemic also differed across the urban-rural gradient, such as differing effects on physical activity (Hino & Asami, 2021; Nigg et al., 2021), the role of nature along the urban-rural gradient in crisis situations requires more research.

4.4. Limitations

This scoping review provides a comprehensive overview about the research area in a time constituting a public health crisis. However, there are some limitations that should be considered. In the first step, due to the large number of studies and available resources, the study screening process was conducted based on title only, followed by abstract screening in a second step, before full texts were obtained in the third step. Thus, it cannot be ruled out that some eligible studies were overlooked in this process. However, in the title screening, both reviewers only excluded titles that were with a very high chance irrelevant for the review topic. Concurrently, or if the title was not informative enough to decide about its relevance, it was included for abstract screening. Also, both reviewers conducted the title screening independently from each other and if a title was deemed appropriate for abstract screening by only one reviewer, both reviewers screened the abstract. We only included articles published in German, English, or Scandinavian languages, thus, studies published in other languages were not included, which may have enhanced the bias regarding WEIRD countries. However, only nine studies were excluded in the stage of full-text screening based on language restrictions, with five studies from Europe, one from Brazil, one from Turkey, one from China, and one from Honduras. Except from Honduras and Turkey, all countries that were excluded are represented by other studies in this review. Regarding the systematic thematic analysis, it must be considered that the analysis was only conducted by one person, with the analytic angle may be being influenced by the person's prior knowledge. At the same time, it should be considered that there were regular meetings in the research team, where the person conducting the thematic analysis presented the codes and categorizations as well as the considerations behind the codes and categorizations, leading to re-structuring and re-categorizations.

Furthermore, we focused on psychosocial health and health behaviors based on the emerging literature that consistently demonstrated that psychosocial health and health behaviors deteriorated during COVID-19. We also focused on the benefits that humans gain from the natural environment but did not consider the impact of humans on the natural environment based on a planetary health understanding (Whitmee et al., 2015). Additionally, given the nature of a scoping review, we did not assess study quality and did not conduct an analysis to investigate publication bias (Devito & Goldacre, 2019). Together with the lack of reporting characteristics regarding human-nature interactions (e.g., nature exposure duration, frequency or type) that may impact health benefits on the study level, any conclusions about favorable and null or unfavorable results must be treated with caution.

Hence, for future reviews investigating associations between nature and health or health behaviors, it would be useful to also investigate associations between nature and physiological health and to assess the quality of the included articles. In addition, a comprehensive review that also considers the positive and negative impact of human–nature interactions on the natural environment, such as wildlife rebounding and increases in illegal nature activities such as hunting (Bates, Primack, & Duarte, 2021), as well as potential co-benefits (Inauen et al., 2021), would be valuable to obtain a holistic planetary health understanding (Whitmee et al., 2015).

5. Conclusion

The COVID-19 outbreak had a significant impact on people's psychosocial health and health behaviors. This study synthesized a wide range of available evidence regarding the types of nature and health outcomes and behaviors investigated during the COVID-19 pandemic. The available research suggests that nature may mitigate the negative impact of COVID-19 on well-being and mental health while facilitating physical activity during the pandemic, which replicates findings prior to the pandemic (Bratman et al., 2019; Remme et al., 2021; White et al., 2020). The replication of the results of non-pandemic times during pandemic times may indicate that natural environments are an important public health resource that not only promote well-being in normal circumstances, but particularly mitigate the negative effects of crisis on human's well-being. Comparing the type of conducted research included in this review to research on the nature–health relationship prior to the pandemic, we find that the focus on mental health and physical activity as research topics, the main origin of research being in high income countries, and the negligence of vulnerable groups are similar (Zhang et al., 2020). At the same time, it seems that the pandemic has intensified research on specific aspects of the nature–health relationship, including intensified research about the role of private green space in forms of gardens and digital nature, as well as the role of nature for social health (Zhang et al., 2020). Research gaps in the COVID-19 context were identified regarding I) nature types and characteristics that promote psychosocial health and health behavior, II) the impact of digital and virtual nature, III) psychological constructs relating to mental health promotion, such as resilience, IV) health-promoting behaviors other than physical activity, V) underlying mechanisms regarding heterogeneity in the nature–health relationship based on the study population, type of nature, and geographic characteristics, and VI) research focusing on vulnerable groups. Beyond the identified research gaps, future studies should ideally apply longitudinal designs and

follow-up on participants to investigate possible long-term associations between nature's impact on health and health-behavior outcomes in the COVID-19 context.

The COVID-19 pandemic serves as an example of a crisis on the societal level that are relevant for global public health. Gathering knowledge and learning from it is critical. Crisis on the societal level have occurred in the past, such as the global financial crisis 2008–2009, are currently happening, such as rising energy prices and inflation in Europe threatening welfare (European Commission, 2022; Eurostat, 2022), and have a high potential to occur again in the future, for example, caused by other zoonotic diseases (Quammen, 2012; Walsh, Sawleshwarkar, Hossain, & Mor, 2020) or extreme events, such as heatwaves as a consequence of climate change (Thiery et al., 2021). Therefore, natural environments may be a valuable resource to build resilience before, mitigate the negative impact during, and allow individuals to promote their health during a crisis impacting psychosocial health and health behaviors.

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CRediT authorship contribution statement

Carina Nigg: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Visualization. **Evi Petersen:** Conceptualization, Investigation, Writing – review & editing. **Tadhg MacIntyre:** Conceptualization, Supervision, Project administration, Funding acquisition, Writing – review & editing.

Declarations of interest

None.

Appendix

Natural Environments, Psychosocial Health, and Health Behaviors during COVID-19 – A Scoping Review.
Carina Nigg, Evi Petersen, Tadgh MacIntyre

A1. Detailed search strategy implemented

Web of Science

TS=("Covid 19" OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND TS=(outdoor* OR "green space" OR "green area*" OR vegetation OR "blue space" OR "blue area*" OR river OR lake OR ocean OR sea OR "nature-based" OR "natur* space" OR "natur* environment" OR "open space" OR "green infrastructure" OR park OR woodland* OR forest* OR mountain* OR beach OR wetland* OR horticulture OR "therapeutic landscape*" OR "ecosystem service*" OR friluftsliv OR wilderness OR garden* OR "digital nature" OR "planetary health")

Scopus

TITLE-ABS-KEY("Covid 19" OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND TITLE-ABS-KEY (outdoor* OR "green space" OR "green area*" OR vegetation OR "blue space" OR "blue area*" OR river OR lake OR ocean OR sea OR "nature-based" OR "natur* space" OR "natur* environment" OR "open space" OR "green infrastructure" OR park OR woodland* OR forest* OR mountain* OR beach OR wetland* OR horticulture OR "therapeutic landscape*" OR "ecosystem service*" OR friluftsliv OR wilderness OR garden* OR "digital nature" OR "planetary health")

Pubmed

(COVID-19[mh] OR Covid19[tiab] OR SARS-CoV-2[mh] OR Corona [tiab] OR lockdown[tiab] OR pandemic[tiab]) AND (outdoor[tiab] OR "green space"[tiab] OR "green area*"[tiab] OR vegetation[tiab] OR "blue space"[tiab] OR "blue area*"[tiab] OR river[tiab] OR lake[tiab] OR ocean[tiab] OR sea[tiab] OR "nature based"[tiab] OR "natural environment"[tiab] OR "natural space"[tiab] OR "therapeutic landscape"[tiab] OR "park"[tiab] OR woodland[tiab] OR forest[tiab] OR mountain[tiab] OR beach[tiab] OR wetland[tiab] OR horticulture[tiab] OR "ecosystem service*"[tiab] OR friluftsliv[tiab] OR wilderness[tiab] OR garden*[tiab] OR "digital nature" [tiab] OR "planetary health" [tiab])

Embase (via Ovid)

1 Covid: Title OR Abstract OR keyword
2 Green: Title OR Abstract OR keyword
3 Year of Publication: 2020 Or 2021

1 and 2 and 3
(Covid 19 OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND
(outdoor OR green space OR green area OR vegetation OR blue space OR blue area OR river OR lake OR ocean OR sea OR nature-based OR natural space OR natural environment OR open space OR green infrastructure OR park OR woodland OR forest OR mountain OR beach OR wetland OR horticulture OR therapeutic landscape OR ecosystem service OR friluftsliv OR wilderness OR garden OR digital nature OR planetary health).

CINAHL

Select a field (optional) and restriction to 2020 and 2021 (Year of Publication).

(Covid 19 OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND
(outdoor OR green space OR green area OR vegetation OR blue space OR blue area OR river OR lake OR ocean OR sea OR nature-based OR natural space OR natural environment OR open space OR green infrastructure OR park OR woodland OR forest OR mountain OR beach OR wetland OR horticulture OR therapeutic landscape OR ecosystem service OR friluftsliv OR wilderness OR garden OR digital nature OR planetary health).

Greenfile

Select a field (optional).
(Covid 19 OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND
(outdoor OR green space OR green area OR vegetation OR blue space OR blue area OR river OR lake OR ocean OR sea OR nature-based OR natural space OR natural environment OR open space OR green infrastructure OR park OR woodland OR forest OR mountain OR beach OR wetland OR horticulture OR therapeutic landscape OR ecosystem service OR friluftsliv OR wildernesss OR garden OR digital nature OR planetary health).

APA PsychINFO

1 Covid: Title OR Abstract OR keyword
2 Green: Title OR Abstract OR keyword
3 Year of Publication: 2020 Or 2021

1 and 2 and 3
(Covid 19 OR COVID-19 OR Corona OR Covid19 OR pandemic OR Sars-Cov-2 OR lockdown) AND
(outdoor OR green space OR green area OR vegetation OR blue space OR blue area OR river OR lake OR ocean OR sea OR nature-based OR natural space OR natural environment OR open space OR green infrastructure OR park OR woodland OR forest OR mountain OR beach OR wetland OR horticulture OR therapeutic landscape OR ecosystem service OR friluftsliv OR wilderness OR garden OR digital nature OR planetary health).

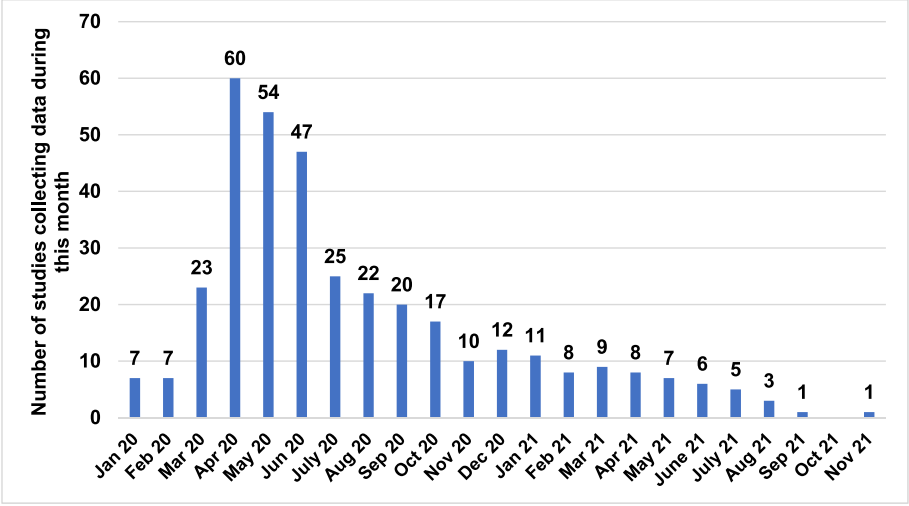

Fig. A1. Months during which data collection of the studies included in the review took place.

Please note: We recorded each month during COVID-19 when a study collected data. For example, if a study reported data collection from April 2020 to July 2020, this study would be included in the figure for the months April, May, June, and July 2020. There were n = 20 studies that are not included in this figure as the time frame was not specifically given (e.g., spring 2020). Data collection conducted prior to the pandemic for longitudinal studies is not included.

Table A1
Countries in which studies were conducted

Country	Number of studies conducted in this country
Argentina	2
Australia	10
Austria	1
Belgium	4
Benin	1
Brazil	4
Bulgaria	1
Cambodia	1
Canada	13
Chile	4
China	16
Colombia	1
Croatia	1

(*continued on next page*)

Table A1 (*continued*)

Country	Number of studies conducted in this country
Ecuador	1
Finland	3
France	5
Germany	11
Greece	1
India	3
Indonesia	5
Iran	3
Ireland	3
Israel	2
Italy	15
Japan	6
Lithuania	1
Malawi	1
Malaysia	2
Malta	1
Mexico	4
Myanmar	1
Nepal	1
Netherlands	1
New Zealand	9
Norway	3
Philippines	1
Poland	5
Portugal	3
Romania	1
Russia	2
Rwanda	1
Saudi Arabia	2
Singapore	3
Slovenia	1
South Africa	2
South Korea	5
Spain	16
Sweden	6
Switzerland	1
Taiwan	1
Tanzania	1
UK	18
USA	36
Zambia	1

Multi-country studies

Study	*Countries included*
Beukes, Onozuka, Brazell, and Manchaiah (2021)	Canada, USA
Boudreau, Mackenzie, and Hodge (2022)	Canada, New Zealand, France, Australia, UK, USA, Romania, Belgium
Dushkova et al. (2021)	Russia, Australia
Egerer et al. (2022)	Australia, Germany
Garrido-Cumbrera et al. (2021)	Ireland, Spain
Herman and Drozda (2021)	New Zealand, Poland
Koch et al. (2022)	Spain, Austria, Sweden
Lee, Cheng, et al. (2022)	Cambodia, Indonesia, Japan, South Korea, Myanmar
Lee, Mkandawire, et al. (2022)	Malawi, Rwanda, South Africa, Tanzania, Zambia
Passavanti et al. (2021)	Australia, Chile, Ecuador, Iran, Italy, Norway, USA
Perez-Urrestarazu et al. (2021)	Brazil, Greece, Spain, Italy, Colombia, Chile, UK
Pouso et al. (2021)	Spain, UK, Germany, France, USA, Portugal, Italy, New Zealand, Mexico
Ribeiro et al. (2021)	Portugal, Spain
Robinson, Brindley, et al. (2021)	USA, Canada, Australia, India, China, Brazil, Argentina, Portugal, Germany, Nepal, New Zealand, South Africa
Samus, Freeman, Dickinson, and Van Heezik (2022)	Germany, New Zealand
Ugolini et al. (2020)	Spain, Croatia, Israel, Italy, Lithuania, Slovenia

Table A2
Detailed study characteristics of the studies included in the scoping review.

Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
Addas and Maghrabi (2022), Saudi-Arabia	Adults urban park visitors (215, largest age group 30–40 years (35.5%), 40%, 96.5% Saudi-Arabian)	June–August 2021	Observational, cross-sectional, quantitative, online and -on-site-survey	Investigate reasons for visiting urban parks during pandemic and non-pandemic periods and related socio-demographic factors	Urban parks	Questions about reasons for urban park use	Affective attachment Social attachment Reasons for visiting urban parks	Eight items to assess affective and emotional attachment rated on a 5-point Likert scale Ten questions asking about perceptions of urban parks	During the pandemic, park visits were mostly for mental refreshment (47%), escaping loneliness (22%), and physical activity (14%). 79% agreed that parks assist in eliminating psychological stress, 86% agreed that they are important for enhancing mental health and, 81% agreed that they are sufficient to meet participants' needs during the crisis period. Also, participants largely agreed or strongly agreed that they felt affectively attached to urban parks and that the urban parks are important social places regarding friends, family, and neighbors.
Akbari, Yazdanfar, Hosseini, and Norouzian-Maleki (2021), Iran	Adults (421, 32.73 ± 9.01 years, 70.3%, n. a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Evaluate mental health of residents during COVID-19 quarantine considering housing type and environmental factors	Green space	Question about satisfaction with green space	Mental health	General health questionnaire (GHQ-12)	Higher satisfaction with green space was associated with better mental health ($\beta = -0.23$). Those with the highest satisfaction level hat the lowest mental health problems (mean = 9.98), those with the lowest satisfaction the greatest mental health problems (mean = 14.85).
Amerio et al. (2020), Italy	University students (8177, 22.02 ± 2.88 years, 49.9%, n. a.)	April–May 2020	Observational, cross-sectional, quantitative, online-survey	Investigate associations between apartment architectural parameters and mental health	Green view	Question about window view on greenery or buildings	Depressive symptoms	Patient Health Questionnaire (PHQ-9)	A higher proportion of students with moderate-to-severe depressive symptoms lived in apartments with building view (34.9%) than in apartments with green view (41.2%). Logistic regression revealed no association between green view and moderate-to-severe depression (OR = 0.94, 95%CI = 0.82-1.09).

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
Anderson et al. (2022), USA	Perinatal women with antenatal depression (60, 32 ± 3.8 years, 100%, 28.3% minorities)	April 2020–April 2021	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate clinical symptoms, stressors, and coping strategies in a sample of perinatal women with elevated depression prior to the pandemic	General nature	Question about spending time in nature as a coping strategy	Mental health	Question about spending time in nature as a coping strategy Edinburgh Postnatal Depression Scale (EPDS), including the anxiety subscale	Spending time in nature was the third most frequently endorsed coping strategy (51.7%) during the COVID-19 pandemic (out of 23 potential strategies). However, women with elevated depression symptoms during COVID-19 were less likely to report spending time in nature as a coping strategy compared to women with elevated depression levels (OR = 0.30, CI = 0.09–0.94). Being in nature was also reported as one of the most helpful coping behaviors in the qualitative part of the questionnaire.
Arafat, Silvalia, and Sari (2021), Indonesia	Doctors and nurses that worked in a COVID-19 ward Questionnaire: (65, n.a., n.a., n. a.) Semi-structured interviews (11, n.a, n.a., n. a.)	NR	Observational, cross-sectional, quantitative/ qualitative, online survey	Explore preferences and patterns towards open space during COVID-19	Open spaces	Questions about use and preferences of open space	Activities	Questions about use and preferences of open space	Beaches were important places for playing with the family, whereas mountain areas and sports grounds were more important for active recreation, such as biking and doing sports. Those activities were not different during compared to before the pandemic.
Astell-Burt and Feng (2021), Australia	Adults and older adults (2697, largest age group 55–64 years (20.3%), 45%, n.a.)	October 2020	Observational, cross-sectional, quantitative, online-survey	Investigate associations between health-related green and blue space benefits and sociodemographic characteristics	Green space and blue space	Three items to indicate how far green/blue space helped to stay connected with neighbors, how they brough solace and respite, and how walking/ exercise frequency in green/blue space changed	Health-related benefits of nature visits	Three items to indicate how far green/blue space helped to stay connected with neighbors, how they brough solace and respite, and how walking/exercise frequency in green/blue space changed	25.7% (95%CI = 23.7-27.9) of the participants reported that they were able to reconnect with neighbors due to visiting nature during COVID-19. Social reconnection feelings were more likely for males (OR = 1.47, 95%CI 1.21-1.76), adults between 35 and 44 years and adults ≥65 years (OR = 2.25-3.10, 95%CI 1.08-6.32), having a university degree (OR = 1.53-1.54, 95%CI = 1.04-2.16), and for people with higher nature relatedness scores (OR = 1.65-2.27, 95%CI

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									= 1.32-2.81). 53.7% (95%CI = 51.3-56.1) reported feelings of solace and respite due to visits in nature. Feelings of solace and respite were more likely for males (OR = 1.74, 95%CI 1.45-2.06), those working always or often from home and those being retired (OR = 1.47-1.57, 95%CI 1.05-2.20), having a university degree (OR = 1.77-1.84, 95%CI = 1.31-2.54), and for people with higher nature relatedness scores (OR = 2.94-3.73, 95%CI = 2.40-4.59). 28.2% (95%CI = 26.0–30.5%) reported walking or exercising more often in green or blue space since before the COVID-19 pandemic, which was less likely for people between 45 and 74 years (OR = 0.39-0.56, 95%CI = 0.22–0.95), more likely for people mostly working from home (OR = 1.61-1.66, 95%CI = 1.10-2.27), and more likely for people with higher nature relatedness scores (OR = 1.33-1.40, 95%CI = 1.05-1.73).
Baroqah, Sudjata, and Irawan (2021), Indonesia	Adults (10, n.a, n.a., n.a.)	April–May 2021	Experimental, longitudinal, quantitative, oxygen, blood pressure, and heart rate measurement	Investigate effects of healing forest program on stress relieve	Forest	Healing forest program, including emotional freedom technique, art therapy, mindfulness yoga, and wrapping emotion	Stress relief	Oxygen levels Blood pressure Heart rate	Stress levels decreased after the healing program, shown by a 6.1% decrease in blood pressure, a 13.2% increase in heart rate, and a 3.1% increase in oxygen levels.
Barron and Emmett (2020), Ireland	Children and adolescents (1467, 4–18 years, n.a., n.a.)	May 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Identify the impact of COVID-19 on children's and adolescent's play and friendship groups	Garden	Self-reported back-garden access	Play	Two items asking for the best idea for playing outside and the most difficult thing about playing outside as children used to	Back gardens were turned into multifunctional spaces serving, amongst others, as playground, socializing space, as well as sports pitch and exercise space. Children

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Table A2 (*continued*)

Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
								(predominantly proxy-reported via the parents)	without a back garden were seriously distracted to play and socialize outdoors, which especially affected children living in appartements.
Basu, DasGupta, Kumar, and Dhyani (2021), India	Urban adult and older adult residents (408, largest age group 25–34 years (35.5%), 53.7%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online-survey	Investigate if home gardens moderate effects on mental distress from home confinement	Home gardens	Time spent working the home garden Diversity composition of home garden	Mental health	Depression, Anxiety, and Stress scale (DASS-21)	Compared to non-garden owners, having a garden buffered the effects of number of days spent at home due to home confinement on stress and depression (both $\beta = -0.19$, $p < 0.001$) as well as total mental distress ($\beta = -0.43$, $p < 0.001$), but not on anxiety ($\beta = -0.06$, $p = 0.23$). Spending more time in the garden was related to a decrease in stress ($\beta = -0.05$, $p = 0.02$), anxiety ($\beta = -0.04$, $p = 0.02$), and total mental distress ($\beta = -0.10$, $p = 0.01$), but not in depression. There was no significant effect of the composition of the home garden mental distress. However, higher home garden composition decreased total mental distress for those spending low time in their garden, but not for those spending a lot of time in their garden.
Baumann et al. (2021), France	University students (4018, 21.7 ± 4.0 years, 70.7%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online-survey	Investigate associated factors with mental health during the lockdown	Private garden	Access to private garden	Mental health	Medical outcome study short form questionnaire (SF-12) – mental component summary	Compared to having a domestic garden, having no outside access was related to an increased risk of mental impairment (OR = 1.8, 95%CI 1.4-2.2), but there was no benefit compared to a courtyard/garden for collective use or a private balcony, courtyard, or terrace.
Beckmann-Wübbelt et al. (2021), Germany	Adults and older adults in Karlsruhe and	August–September 2020	Observational, cross-sectional, quantitative, online-survey	Investigate perceptions of cultural ecosystem	Urban and peri-urban forests	Questions about perceptions/values of ecosystem	Well-being	Questions about perceptions/values of	About 90% of the respondents indicated a high importance of urban

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
	Rheinstetten (501, 43 years, 55.5%, n.a.)			services or urban and peri-urban forests		services of forests and trees		ecosystem services of forests and trees	forests for well-being. This was especially important for those without garden access (OR = 2.2). Compared to retired people, the odds of agreeing that urban forests are important for well-being were higher for those working in part time (OR = 10) and for university students (OR = 6). Walking and relaxing were the most often indicated types of use of the forests. More specifically, exercising and meeting friends were frequent reasons to use forests. Socio-demographic differences were observed, with increasing age being associated with higher values of cultural ecosystem services; however, social relation values of forests were perceived more important by younger participants.
Behe, Staples, Huddleston, and Malone (2022), USA	Adults and older adults (1211, 38.6 ± 17.95 years, 61.4%, n.a.)	July–August 2020	Observational, cross-sectional, quantitative, online-survey	Investigate motivations for plant purchases	Plants	Questions about perceived benefits of plants	Well-being Social benefits Food security	Questions about perceived benefits of plants	Well-being benefits of plant buyers differed by generation, with millennials deriving the greatest social benefits, followed by physiological (e.g., physical activity) and psychological benefits. Compared to non-plant-buyers, people buying edible plants or a mixture of edible and flower plants perceived greater food security.
Berdejo-Espinola et al. (2021), Australia	Adults and older adults in Brisbane (1002, largest age group 26–35 years (23.4%), 50.2%, n.a.)	June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between changes people's perception of green space benefits and frequency in time	Urban green and blue space	Frequency of urban green and blue space visit Rating of reasons for using urban green and blue space on a 5-point Likert scale	Reasons for visiting urban green and blue space Psychological well-being benefits	Rating of reasons for using urban green and blue space on a 5-point Likert scale Sum of three perceptions of benefits: stress, anxiety, and depression reduction	77.4% of the participants rated psychological well-being benefits as the top reasons for visiting urban green and blue space; 59%, 55%, and 48% reported more or much more importance of the

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
				spent in urban green space					benefits stress, anxiety, and depression reduction through visiting urban green and blue space, while 51% and 37% reported more or much more importance of the benefits family togetherness and sense of community during the restriction period. The psychological well-being benefits were especially important for people who used green spaces prior to COVID-19, whereas former non-green space rated physical benefits as the main reason for visiting green space.
Berdejo-Espinola, Zahnow, Suarez-Castro, Rhodes, and Fuller (2022), Australia	Adults and older adults in Brisbane (372, 43 ± 17.7 years, 48.3%, n. a.)	June 2020	Observational, cross-sectional, quantitative, online survey	Investigate changes in perceived benefits of urban green space during the lockdown and associations with socio-demographic characteristics	Urban green space	Change in self-perceived benefits of urban green space	Psychological benefits Physical activity Family and social interactions	Change in self-perceived benefits of urban green space	Being male ($b = -0.001$, $p < 0.01$) and being older than 43 years ($b = 0.001$, $p < 0.001$) were associated with reporting an increase in the importance of urban green space for psychological benefits during the lockdown. Also, younger people were more likely than older people to report increases in the importance of green space for physical activity (RRR = 0.98, $p < 0.01$). The odds of reporting an increase in the importance of green spaces for social interactions pandemic was significantly higher for younger individuals (RRR = 0.98, $p < 0.01$), and higher income earners (RRR = 1.07, $p < 0.01$). The odds of reporting an increase in the importance of green spaces for family interactions was significantly higher for

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									younger individuals (RRR = 0.98, $p < 0.01$), and higher income earners (RRR = 1.06, $p < 0.05$), and those using green spaces with more complex shapes compared to those who visited more compact green spaces (RRR = 1.27, $p < 0.05$).
Beukes et al. (2021), Canada and USA	Adults and older adults with tinnitus (1522,ø = 64.1 ± 11.6 years, age range 18–95 years, 43%, n.a.)	May 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate which resources individuals utilized to cope during the pandemic	Nature	Any nature type or nature-based activity mentioned by the participants	Coping resources	Item asking about coping resources and open-ended questions	Gardening was reported as support activity for coping.
Bhalla, Chowdhary, and Ranjan (2021), India	Employees (9, 24–36 years, n.a., n.a.)	NR	Observational, cross-sectional, qualitative, telephone interviews	Investigate if spiritual tourism provides psychotherapeutic healing during COVID-19	Nature-based tourism	Any nature reported by the participants	Mental health	Open-ended questions in interviews	Participants were looking forward to visiting nature-based places, including places such as mountains, beaches, greenery, and sun rays. Themes that emerged in relation to visiting nature-based places were recovery from the miseries and setbacks of COVID-19, facilitate transformation from a negative to a positive state of life, healing, calmness, and peace, thus allowing people to center their locus and improve mental health and well-being.
Blair et al. (2021), USA	Cancer survivors (30, 50–83 years, 70%, 27% Hispanic White or Other)	February–November 2020	Experimental, longitudinal, quantitative, telephone/ paper or online surveys	Investigate preliminary efficacy of a gardening program	Gardening program	Gardening program with participant/Master Gardener dyads	Fruit and vegetable consumption Physical activity, Quality of life	EATs screener Accelerometer (activPAL3) Godin's Leisure Time Physical Activity Questionnaire PROMIS questionnaire	There was a median change of 1.2 additional vegetable servings per day ($p = 0.03$). No statistically significant changes in quality of life or physical activity were observed.
Boudreau et al. (2022), Canada, New Zealand, France, Australia, UK, USA, Romania, Belgium	Adventure sports participants (20, 35.7 ± 10.7 years, 20%, n.a.)	April–May 2020	Observational, cross-sectional, qualitative, semi-structured interview	Investigate lived experiences and psychological well-being of adventure recreations participants	Nature-based physical activity	Nature experienced during adventure sports such as mountaineering, rock-climbing, white water rafting etc.	Psychological well-being	Interview	Due to restricted access to their nature-based physical activity, participants reported a lack of physical and mental challenge, and emotion regulation. At the same time, they received the chance to recover from their adventure activities, while the

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									mindset and the resilience that they developed during their usual activities helped them to cope with pandemic-related challenges and government restrictions.
Bourion-Bedes et al. (2021a), France	University students (3936, ø = 21.7 ± 4.0 years, 71%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online survey	Investigate factors associated with anxiety during COVID-19	Garden	Self-reported access to private domestic garden	Anxiety	7-item Generalized Anxiety Disorder Scale (GAD-7)	Compared to students with a private garden, students without access to outside space had a higher probability of moderate to severe anxiety (OR = 1.6, 95%-CI = 1.3-2.0). No differences compared to a private balcony, courtyard or terrace or a courtyard or garden for collective use was observed (OR = 1.2-1.3, 95%CI = 0.9–1.8).
Bourion-Bedes et al. (2021b), France	University students (3764, 21.7 ± 4.0 years, 71%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online survey	Investigate perceived stress levels of students and associated factors during COVID-19	Garden	Self-reported access to private domestic garden	Perceived stress	Perceived stress scale (PSS)	Compared to students with a private garden, students with a private balcony, courtyard or terrace and students without access to outside space had a higher probability of high perceived stress levels (OR = 1.4, 95%-CI = 1.1-1.8; OR = 1.6, 95%CI = 1.3-2.1). No difference compared to students with a courtyard or garden for collective use was observed (OR = 1.1, 95%CI = 0.8–1.7).
Briguglio, Caruana, and Debono (2021), Malta	Adults and older adults (1821, n.a., n.a., n.a.)	March 2020	Observational, cross-sectional, quantitative, online survey	Investigate factors related to subjective well-being during COVID-19	Nature	Frequency of going by the sea or nature	Happinness Life satisfaction	One item question, respectively	Frequency of nature visits was related to happiness prior (B = 0.23, p < 0.001), but not during the COVID-19 pandemic. The same pattern was observed for life satisfaction (prior COVID-19: B = 0.15, p = 0.016).
Browning et al. (2021), USA	University students (2534, largest age group 18–24 years (76.8%), age range 18–74	March–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate psychological impact of COVID-19 and associated factors	The outdoors	Self-reported time spent outdoors at a park, greenway/ trail, neighborhood/ yard etc.	Psychological impact	9 items assessing negative emotion states, preoccupation with COVID-19, feeling stressed, worry, and time demands	Students spending two or more hours in the outdoors were less likely to be at risk or higher than average levels of emotional distress and

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
	years, 61%, 79% non-Hispanic White, 12.8% non-Hispanic Asian, 8.5% Other)								worry time (RES = −3.17, p = 0.014).
Bu, Steptoe, Mak, and Fancourt (2021), UK	Adults and older adults (55204, largest age group ≥60 years (29.9%), 50%, 12.5% Black, Asian & Minority Ethnic)	March–May 2020	Observational, intensive longitudinal, quantitative, online survey	Investigate associations between specific activities or time use and mental health and well-being during COVID-19	Garden	Weekly self-report about time spent in gardening activity	Depression Anxiety Life satisfaction	Patient Health Questionnaire (PHQ-9) Generalized Anxiety Disorder Assessment (GAD-7) One item asking about life satisfaction in the last week	Compared to no gardening activity, <30 min and ≥30 min gardening activity were associated with less depressive symptoms (B = −0.15 and B = −0.30), less anxiety symptoms (B = −0.15 and B = −0.24), and more life satisfaction (B = 0.06 and B = 0.16; all p's < 0.001).
Burnett et al. (2021), UK	Adults and older adults (2252, weighted to represent adult UK population)	April–May 2020	Observational, cross-sectional, quantitative, online survey	Investigated changed experience of green space and associations with socio-demographic characteristics.	Green space	Statements regarding increased mental health benefits of green space, increased physical activity in green space, and missing social interactions during the COVID-19 lockdown	Mental health Physical activity Social interactions	Statements regarding increased mental health benefits of green space, increased physical activity in green space, and missing social interactions during the COVID-19 lockdown	65% of the respondents agreed that green spaces benefited their mental health more after movement restrictions were introduced, Agreement for mental health benefits was more likely reported by females compared to males (predicted probability (PP) = 0.70 vs. 0.59, p = 0.004), respondents from higher compared to lower social grade (PP = 0.68 vs. 0.59, p = 0.048), and people between 25 and 64 years compared to older and younger ones (PP = 0.68 vs. 0.55, p < 0.001). 29% of the respondents agreed that they had increased physical activity in green space since movement restrictions were imposed. Agreement for more physical activity in green space was more likely for younger people between 18 and 24 years (PP = 0.44 vs. 0.18-0.29, p = 0.002), and more likely for people who did not own a dog (PP = 0.31 vs.

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									0.17, $p < 0.001$). 54% of the respondents agreed that they missed social interactions in green space more during the movement restrictions. Agreement for missing social interactions in green space was more likely for females (PP = 0.58 vs. 0.45, $p < 0.001$).
Bustamante et al. (2022), USA	Adults >55 years Quantitative (6661, largest age group 55–64 years (41.4%), 63.8%, 15.5%) Qualitative (767, largest age group 65–74 years (47.5%), 78.5%, 6.6% Non-Hispanic Black, Hispanic, or Other)	April–May 2020	Observational, cross-sectional, quantitative/ qualitative, online survey + geospatial analysis	Investigate the role of parks during the COVID-19 pandemic	Park	Number of neighborhood parks within zip-code area	Depression Anxiety Loneliness	8-item Center for Epidemiological Studies-Depression (CES-D) scale 5- item Beck Anxiety Inventory (BAI) 3-item UCLA loneliness scale Open-end responses about outdoor experience	Overall, there was no association between the number of neighborhood parks and depression, anxiety, or loneliness. However, when stratified by urban/rural status, more parks were related to less depression among urban residents: Urban residents who had 1-5 parks in their neighborhood were 26% less likely to report depressive symptoms (6-10 parks: 29% less likely, >10 parks: 32% less likely). Qualitative results revealed the importance of parks for physical activity, mental well-being such as alleviating stress and anxiety, as well as promoting positive emotions and feelings of restoration, and social well-being through bonding with others.
Butler, Szili, Hay, and Cutler (2022), Australia	Adults and older adults (32, 34.5% 18–29 years, 34.5% 30–54 years, 66%, n.a.)	October 2020–February 2021	Observational, cross-sectional, qualitative, focus group interviews	Explore regional nature-based tourism experiences during COVID-19	Nature	Any nature mentioned by participants	Mental health Physical activity	Coding from transcripts	Nature-based tourism supported participants' mental health and wellbeing during the pandemic via escaping from home, coming to terms with disruptions and insecurities, and managing anxieties. In addition, natural places were important

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									destinations for physical activity.
Camerini, Albanese, Marciano, and Corona Immunitas Research (2022), Switzerland	Children and adolescents (844, 5–19 years, 12.78 ± 4.00 years, 47.6%, n.a.)	Autumn 2020 – spring 2021	Observational, longitudinal, quantitative, online survey	Investigate within- and between-person associations between green time and mental health during COVID-19	Green time	Time spent in nature on weekdays and weekend days Self-reported availability of nearby green space	Mental health Screen time	Seven DSM-5 cross-cutting symptom measures for children and adolescents 4 items asking about time spent in screen-based activities	On a between-person level, green time was related to less mental health problems (B = −0.42, p = 0.033), but not on the within-person level. Green time and screen time were unrelated over time.
Cerda, Guenat, Egerer, and Fischer (2022), Chile	Adults and older adults (305, largest age group 26–35 years (30.2%), 79.2%, n.a.)	March–April 2021	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate perceived benefits of home food gardening for health and well-being	Gardening	Rating of agreement of 5 potentially perceived benefits of home food gardening Open-ended questions	Health and well-being	Rating of agreement of 5 potentially perceived benefits of home food gardening Open-ended questions	The most significant perceived benefits were feeling less stressed through practicing home food gardening (84.9% agreement), having therapeutic potential and bringing happiness. Furthermore, 68.5% agree that it improved their diet in quality or quantity, in this way contributing to food security. Also, 65.9% agreed that gardening fostered socializing and to feel part of a community.
Chen and Liu (2021), China	Adults and older adults (937, large age group 25–34 years (40.7%), 35%, n.a.)	January–February 2020	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate the importance of risk factors with regards to psychological distress during COVID-19	Park	Objectively measured direct distance from participant's residence to nearest park	Psychological distress	Kessler Psychological Distress Scale (K6)	Out of 18 sociodemographic, environmental, health, and individual's perception predictors, distance to the nearest park was ranked as the fourth most important predictor (relative importance: 9.38%) and the most important predictor from objective environmental measures.
Cheng et al. (2021), China	Social media users (through geotagged posts on Sina Weibo [Chinese Twitter]; 560,000 posts)	July 2019–June 2020	Observational, longitudinal, qualitative/ quantitative, social media analysis and geospatial analysis	Investigate association between urban parks, their characteristics, and happiness before and during COVID-19	Urban parks	Objectively assessed radial service buffer zones of 300–2000 m around the parks and Normalized Difference Vegetation Index (NDVI)	Happiness	Emotional classification of posts via automated sentiment analysis	Residents living within the service buffer zone of the park showed higher happiness (0.713) than residents outside the service buffer zone (0.706). Pre-pandemic, there was no association between NDVI-values and happiness (B = −0.08, p > 0.1), whereas an association was observed during the pandemic (B =

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									0.37, $p < 0.01$). Compared to very low NDVI values, higher NDVI-values, representing higher green quality, were associated with higher happiness (low NDVI: $B = 0.04$, $p = 0.01$; medium NDVI: $B = 0.05$, $p < 0.001$; high NDVI: $B = 0.06$, $p = 0.001$, very high NDVI: $B = 0.09$, $p < 0.001$). The strength of the association varied by the type of urban park (community-scale park: $B = 0.32$, $p < 0.01$; subdistrict-scale park: $B = 0.37$, $p < 0.01$; regional-scale urban park: $B = 0.35$, $p < 0.01$, city-scale park: $B = 0.33$, $p < 0.01$).
Collins, Haase, Heiland, and Kabisch (2022), Germany	International university students (10, n.a., n.a., n. a.)	October–December 2020	Observational, cross-sectional, qualitative, semi-structured interviews	Explore mental health and well-being with reference to urban green space exposure	Urban green space	Semi-structured interviews	Mental health Well-being	Semi-structured interviews	Urban green space was a resource to support wellbeing during a stressful and isolating time in various ways: It provided a safe arena to maintain social contact with friends outdoors and to disconnect and to be alone, to escape the home environment, It also facilitated positive emotions and mitigated negative emotions and thoughts, and allowed to experience respite and relaxation.
Constant, Conserve, Gallopel-Morvan, and Raude (2020), Scotland	Adults and older adults (4005, largest age group 18–59 years (74.3%), 55%, n.a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigate factors associated with healthy and unhealthy lifestyle changes during COVID-19	Garden	Self-reported garden at home	Changes in health behaviors	Frequency of screen watching, snacking, eating fruits and vegetables, exercising, and walking during the lockdown compared to prior to the lockdown	Having a garden was related to a higher number of changes in unhealthy changes (RR = 1.16, 95%-CI = 1.07-1.36) and unrelated to changes in healthy behaviors (RR = 1.01, 95%CI = 0.90-1.14).
Corley et al. (2021), Scotland	Older adults (171, ø = 84 ± 0.5 years, 48%, n.a.)	May–June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between home garden usage and	Garden	Self-reported access to a home garden, garden	Emotional and mental health Anxiety about	One-item question for each outcome of interest, respectively	More garden usage during compared to prior to the lockdown was associated with better emotional and

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				mental health during COVID-19		usage and activities	COVID-19 Sleep quality		mental health (B = 0.58, 95%CI = 0.02-1.13), sleep quality (B = 0.58, 95%CI = 0.70-1.09), and composite health (B = 0.79, 95%CI = 0.32-1.25), while it was unrelated to anxiety about COVID-19 (B = 0.19, 95%CI = −0.37 to 0.75). Gardening and relaxing in the garden were unrelated to all health outcomes (p = 0.13-0.93).
Cuerdo-Vilches, Navas-Martin, and Oteiza (2020), Spain	Adults and older adults (242, largest age group 45–54 years (31.8%), n. a.)	April–June 2020	Observational, cross-sectional, qualitative, photos with open questions	Investigate aspects of space of personal home that participants like least and that are most comfortable	Nature	Any nature places and spaces mentioned, or a picture taken by the participants	Comfort	Photos and written narratives about spaces at home during the lockdown that provide comfort	Spaces open to the outside, including gardens, were, amongst others, most valued during the lockdown for comfort, and provided a meeting place at the social level.
Czyz and Starosciak (2022), Poland	Adults and older adults (320, 18–76 years, 60.4%, n. a.)	March–April 2020	Observational, cross-sectional, quantitative, online survey	Investigate how the COVID-19 pandemic affected physical activity and sedentary behavior	Garden	Accessibility to own garden	Physical activity Sedentary behavior	International Physical Activity Questionnaire (IPAQ)	There were no differences between garden and non-garden-owners regarding moderate or vigorous physical activity, walking, and sitting time.
Daiz, Rosales, Diago, and De los Santos (2022), Philippines	Adults and older adults (400, largest age group 21–40 years (63%), 56%, n.a.)	NR	Observational, cross-sectional, quantitative, online survey	Assess health and well-being in gardener and non-gardeners during COVID-19	Garden	Owning a garden for more than 6 months (control group: not owning a garden)	Health Fear of COVID-19 Perceived stress Resilience Bereavement and loss coping	Fear of COVID-19 scale Health orientation scale Perceived stress scale Brief resilience scale Coping assessment for bereavement and loss	Gardener reported better health (M = 3.40, SD = 0.48), higher resilience (M = 3.82, SD = 0.51), and better coping (M = 3.82, SD = 0.56) than non-gardeners. Non-gardeners were more fearful of COVID-19 than gardeners (M = 3.26, SD = 0.63). No differences were observed for perceived stress.
Dobson, Gore, Graham, and Swade (2021), UK	Interviews: Adults and green space professionals (42, n.a., n.a., n. a.) Survey: Members of voluntary community organization concerned with	May–July 2020	Observational, cross-sectional, qualitative, semi-structured interviews + survey	Explore the five pathways to nature in the context of the COVID-19 pandemic	Green and public space	Semi-structured interviews	Emotions	Semi-structured interviews	Experiencing the beauty of nature was closely related to positive emotions, such as enhanced mood through seeing animals, feeling relief through being outside, de-stress through having nice aesthetics while going for a walk, and being invigorated.

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	green space (29, n.a., n.a., n. a.)								
Doughty, Hu, and Smit (2022), Netherlands	Long-term residents and international university students (30, 23–67 years, 53%, n.a.)	May–June 2020 October–November 2020	Observational, cross-sectional, qualitative, semi-structured interviews + annotated photographs and videos	Investigate the role of nature in the maintenance of well-being through everyday interactions during the pandemic	Any nature mentioned by participants, including indoors and outdoors	Semi-structured interviews	Well-being	Semi-structured interviews	Natural environments served as therapeutic landscapes for well-being, enabling social interactions in person and via sharing nature experiences in social media, while also being places for solace. Green spaces were a place to deal with difficult experiences, allowing to disconnect from everyday life, making it easier to deal with stress, and bringing ease, relaxation, and rejuvenation. They allowed for multi-sensory experiences, including auditive and tactical experiences as well as embodiment experiences via physical activity in nature.
Dushkova et al. (2021), Russia and Australia	Adults and older adults in Moscow and Perth (326, largest age group 40–65 years (Perth), largest age group 20–40 years (Moscow), 67%, n.a.)	May–July 2020	Observational, cross-sectional, quantitative, online survey	Investigate perceptions, values, and use of urban green and blue space during COVID-19	Urban blue and green infrastructure	One item asking participant to rate the importance of accessing nature for personal well-being Multiple choice question with predefined answer options of nature benefits	Personal well-being and perceived benefits of urban nature	One item asking participant to rate the importance of accessing nature for personal well-being Multiple choice question with predefined answer options of nature benefits	In Moscow and Perth, 76% and >97% rated contact with nature important or very important for mental health. Among perceived personal benefits, mental health benefits (Perth: 83.8%; Moscow: 71.2%) and having a place to relax and unwind (Perth: 81.9; Moscow: 68.4%) were amongst the most frequently selected benefits as well as meeting other people (Perth: ~35%; Moscow: ~25%) and spending time with family (Perth: ~60%; Moscow: ~20%).
Dushkova et al. (2022), Russia	Adults and older adults in Moscow (216, largest age group 21–30	May–July 2020	Observational, cross-sectional, quantitative, online survey	Investigate use and value of urban green space during the COVID-19 pandemic	Urban green space	Rating of the importance of urban green space for mental well-being	Mental well-being	Rating of the importance of urban green space for mental well-being	Urban green space was highly valued for mental well-being (70% agreement). The importance of contact with nature was not

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	years (31.9%), 73%, n.a.)								dependent on age group, but there was a tendency for more appreciation by older adults, while answers in the younger age group were more varied. The most frequent rated benefits were mental health benefits (12.2–12.8%) and "a place to relax and unwind" (11.1–14.4%). The value of green space for social interactions was more pronounced in younger people (<20 years: 9.6% agreement) compared to older adults (>60 years: 2% agreement), while spending time with family and visiting playgrounds was mostly valued by people with children in the age group 41–50 years (7.2% agreement).
Dzhambov et al. (2020), Bulgaria	University students (323, ø 21.99 ± 3.10, age range 18–35 years, 69%, 87% Bulgarian)	May–June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between greenery and mental health	Greenery indoors and outdoors	Self-reported number of houseplants, exterior greenery visible from inside, presence of a domestic garden, and neighborhood greenery	Depression Anxiety	Patient-Health-Questionnaire (PHQ-9) Generalized Anxiety Disorder scale (GAD-7)	Houseplants were associated with less depressive symptoms (B = −0.02, 95%CI = −0.04 to −0.01) and a lower risk for clinically meaningful levels of depression (OR = 0.97, 95%CI = 0.94-0.99), but not with anxiety. Exterior green view was related to lower levels of depressive and anxiety symptoms (B = −0.05 to −0.06, 95%CI = −0.11 to −0.003) and a lower risk for clinically meaningful levels of depression and anxiety (OR = 0.83-0.88, 95%CI = 0.74-0.98). Having a garden was unrelated to all outcomes except for anxiety symptoms (B = −0.47, 95%CI = −0.89 to −0.06). Neighborhood greenery was related to less depressive and

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									anxiety symptoms (B = −0.10 to −0.11, 95%CI = −0.16 to −0.05) and a lower risk for clinically meaningful depression and anxiety levels (OR = 0.79-0.80, 95%CI = 0.70-0.91).
Egerer et al. (2022), USA, Australia, Germany	Adult and older adult gardeners (3743, largest age group 51–70 years (46.7%), 83%, n.a.)	May–August 2020	Observational, cross-sectional, quantitative, online survey	Explore the perceived benefits of gardening during the COVID-19 pandemic	Gardening	Self-reported perceived benefits of gardening based on default options	Perceived benefits	Self-reported perceived benefits of gardening based on default options	Relaxation and stress release was the second most important benefit of gardening (87% agreement), followed by outdoor physical activity (78% agreement) and food production or quality (54% agreement). The number of reported COVID-19-related difficulties was associated with the importance of gardening for food provision.
Fagerholm, Eilola, and Arki (2021), Finland	Adolescents, adults, older adults in Turku (730, largest age group 15–64 years (90%), 71%, n.a.)	May–June 2020	Observational, cross-sectional, quantitative, online survey	Explore how nature contributed to subjective well-being during the early phases of the COVID-19	Perceived benefits of nature	Nine statements about nature benefits for well-being with default answer options	Well-being	Nine statements about nature benefits for well-being with default answer options	Looking at or recreating in nature positively affected mood and social interactions (49.2–96.6% agreement with the statements). Agreement with the statements was lower for those who spent less time in nature.
Ferguson et al. (2021), Canada	Adolescents (851, 15.6 ± 1.7 years, 71%, n.a.)	June–September 2020	Observational, cross-sectional, qualitative, online survey	Explore coping strategies for feeling and emotions during the COVID-19 pandemic	Any nature mentioned by participants	One open-ended question asking about coping strategies	Coping	One open-ended question asking about coping strategies	Leisure and health-promoting activities were one way to cope with the pandemic, including spending time outside in natural environments, such as forests, beaches, and gardens, which helped to relax. Also, being outdoors in the garden allowed social connections with the neighbors.
Fithriyah, Nasrullah, and Sulistyantara (2021), Indonesia	Adults and older adults in Bogor city (192, largest age group 20–29 years (49.5%), 55%, n.a.)	June–July 2020	Observational, cross-sectional, qualitative, online survey	Explore perceptions of urban park during the pandemic	Urban park	Default answer options for reasons for park visitation	Reasons for park use	Default answer options for reasons for park visitation	During the pandemic, the park was mostly visited for physical exercise (M = 3.69 SD = 1.04), which was also the main reason prior to the pandemic (M = 4.12 SD = 0.82).

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Folk et al. (2021), USA	Young adults (720, 24.7 ± 2 years, 62%, 18.2% Black/ African-American, 16.5% Hispanic/ Latino, 23.9% Asian American, 3.5% Native Hawaiian/ American or Pacific Islander, 8.3% Other)	April–October 2020	Observational, cross-sectional, qualitative, online survey	Explore changes in physical activity during COVID-19	Any nature mentioned by participants	Open-ended questions how COVID-19 has influenced physical activity	Physical activity	Open-ended questions how COVID-19 has influenced physical activity	A dichotomy emerged in whether participants used outdoor areas, such as parks, trails, beaches, and lakes for physical activity: While some indicated that those areas were important for physical activity, others reported less use of these areas due to closures or feeling unsafe.
Garrido-Cumbrera et al. (2021), UK, Ireland, Spain	Adults and older adults (3109, 39.7 ± 14.1 years, 73%, n.a.)	April–July 2020	Observational, cross-sectional, quantitative, online survey	Explore associations between perceptions of improvement in the natural environment and self-perceived health and well-being during COVID-19	Nature improvements due to the lockdown	Agreement with improvements in number of birds, animal life, and nature sounds	Well-being	WHO-5 Well-Being Index Rating of self-perceived health status	People with a better self-perceived health were more likely to appreciate the improvement in animal life (83.7%), and nature sounds (92.3%) compared to those with very poor self-perceived health (45.5% and 81.8%, respectively). Respondents with higher well-being appreciated the improvement in nature sounds to a higher extent.
Giraud et al. (2021), USA	Study 1: Farmers and gardeners (13, n.a., n.a., 23% Non-White) Study 2: Gardeners (96, largest age group >45 years (79%), n.a., 9% Afro-American, 3% Hispanic, 4%)	Study 1: 2020–2021 Study 2: NR	Observational, cross-sectional, qualitative/ quantitative, semi-structured interviews + online survey	Explore associations between gardening and food well-being	Sustainable gardening	Semi-structured interview about motivation and enjoyable experiences with gardening	Eudemonic well-being Food well-being	Questionnaire	In Study 1, eleven interviewees highlighted gardening for eudemonic well-being derived from a sense of purpose and pleasure that food growing brought. Most frequently raised were physical (e.g., physical activity), social (e.g., sense of community), and emotional benefits (e.g., empathy and caring) of food growing. In Study 2, sustainable gardening was associated with better eudemonic well-being ($\beta = 0.32$, $p < 0.001$).
Gola, Botta, D'Aniello, and Capolongo (2021), Italy	Health care workers (77, n.a., 61%, n. a.)	April–May 2020	Experimental, longitudinal, quantitative, online survey	Investigate well-being benefits of nature for hospital staff based on one	Nature	Participants reported the space they used for their nature experience, which was then	Well-being	Profile of Mood States (34 items)	Hospital staff working both Covid- and non-Covid-areas decreased anxiety, depression, anger, fatigue, and

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				self-selected nature experience		categorized into garden of a health care facility, public nature space, and private nature space			confusion after the nature experience, and increased strength. Percentage change of the subscales from prior to after the nature experience ranged from 25% to 67%. The greatest benefits were obtained if the nature experience took place during or after the work shift. For strength, the hospital garden yielded the most benefits, while there were no remarkable differences for the other subscales between the different nature typologies.
Greenwood-Hickman et al. (2021), USA	Older adults with obesity (25, ø = 68 years, age range 60–77 years, 64%, 88% White, 12% Black and Indigenous people of color)	June–August 2020	Observational, cross-sectional, qualitative, telephone interviews	Investigate the impact of COVID-19 on older adult's well-being and identify coping strategies	Nature	Any nature mentioned by participants	Coping strategies	Semi-structured interviews	Many participants reported more gardening, tending to plants, or doing major yard improvement projects as coping strategies. Simultaneously, yard work had the additional benefit of physical activity and allowing contact with neighbors.
Grima et al. (2020), USA	Visitors of parks and natural areas (346, n.a., n.a., n.a.)	March–June 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate how natural areas provide basic non-material basic needs of urban communities	Urban and peri-urban natural areas consisting of various green and blue space types	Question asking respondents to indicate what motivates them to visit natural areas with pre-defined and open answer options	Motives for visiting natural areas	Question asking respondents to indicate what motivates them to visit natural areas with pre-defined and open answer options	18.6% reported exercise, 13.8% finding peace and quiet, and 2.7% socializing as key reasons for visiting nature.
Halliday et al. (2022), UK	Public advisors of a research collaboration (15, 30–70 years, 67%, 40% Non-White)	April–June 2020	Observational, cross-sectional, qualitative, semi-structured online diaries	Explore how mental health was affected during the first COVID-19 lockdown	Nature	Any nature mentioned by participants	Coping	Semi-structured online diaries	Spending time in gardens, parks or other green spaces improved well-being and facilitated unwinding from daily pressures.
Hansen, Beery, Fredman, and Wolf-Watz (2022), Sweden	Survey 1 + interviews: Adults (530–22 being interviewed, n. a., n.a., n.a.) Survey 2: Adults (1506, n.a., n.a., n.a.)	Survey 1: April–June 2020 August–October 2020 Survey 2: July–October 2020 Survey 3: September 2020	Observational, cross-sectional, quantitative/ qualitative, online survey + semi-structured + Public Participation Geographic Information System	Explore changes in the use of outdoor areas during COVID-19	Nature	Any nature mentioned or mapped by participants	Motives for visiting green space	Open-ended questions and mapping	About half of all survey respondents (49%) of Survey 2 reported having experienced changes in recreational habits, which was motivated due to perceiving the outdoors as a calm and safe place, as a place to escape the city,

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	Survey 3: Adults (1023, n.a., n.a., n.a.)								and as a place to socialize. In all three studies, nature was a place to experience relief from stress and anxiety, as well as to recover, and re-energize. Managing mental and physical health were frequent reasons for spending time in the outdoors.
Harding et al. (2022), Indonesia	Urban gardeners (67, largest age group 51–60 years (58%), n. a., n.a.)	NR	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate well-being of urban gardeners during COVID-19	Gardening	Gardens	Subjective well-being	Satisfaction with life scale (SWLS) Scale of positive and negative experiences (SPANE) Reasons for gardening	52% reported high and 40% reported medium life satisfaction, while 16% reported never experiencing negative emotions, while 83% reported mixed positive and negative emotions. Most frequently reported motives for gardening where hobby (34%), relating to stress relief and reduction of boredom, and happiness (18%). Health, exercise, and people were the least mentioned reasons.
Hazlehurst et al. (2022), USA	Child-parent and adolescent-parent dyads (Child and adolescents characteristics: 1000, 10.8 ± 3.5 years, 47%, 11% African-American/Black, 16% Other, 5% Asian-(American), American-Indian, or Alaska Native) Parent characteristics: 1000, n.a., 55%, 11% African-American/Black, 13% Other, 5% Asian-(American), American-Indian, or Alaska Native)	October–November 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between parks access and child and parent physical activity and mental health	Park access	Self-reported park access within 10 min walking distance from home	Mental health problems Physical activity	Patient Health Questionnaire (PHQ-4) Strength and Difficulties questionnaire (SDQ) International Physical Activity Questionnaire (IPAQ)	Park access was associated with a lower SDQ total score among children (β: 1.26, 95% CI: 2.25, −0.27) and a lower PHQ-4 total score among parents (β: 0.89, 95% CI: 1.39, −0.40). In models stratified by child age, these associations were observed for SDQ scores among adolescents ages 11–17 and for PHQ-4 scores among parents of children ages 6–10 years. Park access was also associated with higher levels of parent physical activity (β: 1009 MET-min/week, 95% CI: 301, 1717), but not child physical activity (β: 0.31 days/week, 95% CI: 0.03, 0.66).

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Heidarzadeh, Rezaei, Haghi, Shabanian, and Lee (2021), Iran	Adult and older adult walking path users (100, 40.4 ± 16.5 years, 45%, n.a.)	January 2021	Experimental, longitudinal, quantitative, paper-pencil survey	Investigate impact of walking on mood	Green walking path	Walk along a 3 km green walking path	Mood	Mood and Feelings Questionnaire Self-Repot Profile of Mood States (POMS)	Walking enhanced mood during the pandemic; with more frequent walks resulting in better mod enhancement. The change in mood was also influenced by baseline mood and age.
Heo, Desai, Lowe, and Bell (2021), South Korea	Adults and older adults (322, largest age group 30–49 years (35.7%), 76%, n.a.)	September–December 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between patterns of greenspace use and psychological symptoms	Green space Vegetation	Self-reported type, frequency, duration, and social aspects of green space visits One item asking about changes in frequency of green space visits during compared to pre-pandemic One item about health-related reasons for visiting green space with predefined response options Objectively measured enhanced Vegetation Index (EVI) for each ZIP code	Depression Anxiety Motives for visiting green space	Patient Health Questionnaire (PHQ-9) Generalized Anxiety Disorder (GAD-2) One item about health-related reasons for visiting green space with predefined response options	There was no statistically significant association between decreased visits to green space and major depressive disorder (OR = 2.06, 95%CI = 0.91-4.67) and generalized anxiety disorder (OR = 1.45, 95%CI = 0.63-3.34). In addition, neither were association observed for the frequency of visits pre-pandemic and risk for major depression (OR = 1.08-3.08, 95%CI = 0.22-12.72) and anxiety disorder (OR = 0.56-1.29, 95%CI = 0.23-7.97), nor between the EVI and major depression and anxiety disorder (OR = 0.62-0.63, 95%CI = 0.28-1.41). Regarding reasons for visiting green space, during the pandemic, respondents were more likely to visit green space for stress relief compared to pre-pandemic (52.2% vs. 50.3%), whereas less people reported visiting green space for relaxation, social reasons, or exercise compared to pre-pandemic.
Herbec et al. (2022), UK	Adults and older adults (2657, 50 ± 16 years, 53%, 9.5% Non-White ethnicity)	April–June 2020	Observational, cross-sectional, quantitative, online survey	Explore changes in COVID-19 related physical activity changes	Access to park/ green space	Self-reported access to public park or green space that is open during COVID-19	Physical activity	Questions on engagement in moderate-to-vigorous and muscle-strengthening activity prior and during COVID-19	The odds for meeting the WHO recommendations for moderate-to-vigorous physical activity were higher for those with access to green space within walking distance (aOR = 1.31, 95%CI 1.03-1.66), but was unrelated to meeting the guidelines

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									for muscle-strengthening-activity. Access to green space was unrelated to increases or decreases in moderate-to-vigorous physical activity and muscle-strengthening activity for both active and non-active participants.
Herman and Drozda (2021), New Zealand and Poland	Parks users (12, 11–70 years, 50%, n.a.) For social media: 144 posts of 113 users	May, August, and December 2020	Observational, case study qualitative, pandemic urban ethnography	Investigate the functioning of green infrastructure during COVID-19	Two parks in Wellington and Warsaw	Parks and social media posts related to the parks	General health and well-being, including health behaviors	Autoethnography, interviews, non-participant observations, digital ethnography based on social media (Instagram)	Green space played a crucial role for health and well-being, physical activity, sports, and play, and social life during the pandemic.
Hino and Asami (2021), Japan	Adults and older adults in Yokohama (18817, largest age group ≥65 years, 52%, n.a.)	First half of 2019 First half of 2020	Observational, longitudinal, quantitative, step counter and geospatial analysis	Investigate associations between changes in step counts and the neighborhood environment	Park	Average distance to the nearest park calculated via geographic information systems	Step counts	Pedometer (Omron HJ-326F)	In 2019, the distance to the park was not associated with step counts. During the COVID-19 state of emergency, shorter distance to the nearest park mitigated the decline in step counts in older women (year-on-year ratio short distance = 0.70, year-on-year ratio long distance: 0.67). The associations remained after the state of emergency was lifted. In some weeks, the association between distance to the park and step count change was also present for younger women, while there were no associations for younger or older males.
Houessou, Cassee, and Sonneveld (2021), Benin	Adults and older adults (240, 38.9 ± 11.5, 45%, n.a.)	September–October 2020	Observational, cross-sectional, quantitative, online survey	Investigate the role of allotment gardens in food security	Gardens	Access to a garden	Food security	Rapid Food Security Appraisal (RFSA)	Access to allotment gardens effectively supported households in mitigating the effects of the COVID-19 pandemic on the food crisis.
Howarth et al. (2021), Canada	Recreational fishers (789, 51 years, age range 12–81 years, 8.5%, 90% Canadians)	August 2020	Observational, cross-sectional, quantitative, online survey	Investigate how the pandemic impacted recreational fishers	Fisheries	Self-reported recreational fishing	Motivation for fishing during the pandemic	Opinion statements about fishing motivation during the pandemic	Recreational fishing may enhance well-being: 86% of participants agreed or strongly agreed that fishing improves their mental or physical well-being, while 62% agreed

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									or strongly agreed to go fishing to spend time with family/kids.
Hsieh et al. (2022), Taiwan	Older adults with mild-to-moderate cognitive impairment in nursing homes (14, n.a., n.a. n.a.)	NR	Experimental, longitudinal, quantitative, biofeedback instruments	Investigate impact of immersive garden experience during COVID-19	Virtual gardens	Six-minute exposure to virtual vegetable garden	Heartrate Heartrate variability Standard deviation of NN interval (SNN) Low and high frequency	Electrocardiography (ECG)	Within 6 min of completing the experiment, heart rates of participants dropped slightly, while SDNN and HF values continued to rise. SDNN values before and after the experiment demonstrated a statistically significant improvement, indicating less anxiety. Also, participants reported that this program allowed them to feel as if they were actually experiencing nature and brought up past social memories.
Hu et al. (2022), China	Medical doctors, nurses, and police officers (71, 36.15 ± 8.66 years, 35%, n.a.)	March–April 2020	Experimental, longitudinal, quantitative, online survey	Investigate impact of nature-based intervention on well-being during COVID-19	Virtual nature	Two-minute video clips of natural scences for five days (control group: urban scenes)	Subjective well-being	Satisfaction with Life Scale (SWLS) Positive and Negative Affect Schedule (PANAS)	Interaction analysis revealed a significant condition x time on positive affect, $F(1, 61) = 6.14$, $p = 0.016$, $n_p^2 = 0.091$, revealing that the nature group maintained positive affect, whereas the control group decreased. Similar patterns were observed for negative affect, $F(1, 61) = 2.82$, $p = 0.098$, $n_p^2 = 0.091$, indicating that negative affect increased among the city group at a marginal-significant level, $p = 0.058$, while a reduction of negative affects was found among nature group, $p < 0.001$. Also, life satisfaction showed greater improvement in the intervention group, but decreased in the control group, $F(1, 64) = 12.92$, $p = 0.001$, $n_p^2 = 0.17$. Looking at instant effects on a daily basis, compared to the urban stimuli, the

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									natural stimuli had significantly higher restorative effects of positive affects (B = 0.41, t = 3.41, CI95%, 0.19–0.66, p = 0.001) and lower restorative effects of negative affect (B = −0.30, t = −4.82, CI95%, −0.41 to −0.18, p < 0.001).
Hubbard et al. (2021), Scotland	Older adolescents and adults (502, median age = 53 years, interquartile range = 38–65 years, 59%, n.a.)	June–July 2020	Observational, cross-sectional, quantitative, telephone interviews	Investigate if frequency and duration of green space visits are related to mental health during COVID-19 and moderate relationships between individual demographics, illness beliefs, and mental health	Public green and open space	Self-reported frequency and duration spent in public green and open space	Psychological distress	Patient Health Questionnaire (PHQ-4)	More frequent visits of green/open space were associated with more psychological distress (B = 0.18, p < 0.001), whereas duration was not (B = 0.11, p < 0.06). Frequency and duration of green space visits moderated the association between being in a high-risk group for COVID-19 and psychological distress, with more frequent visits and shorter visits in green space relating to higher psychological distress (both p's < 0.01). For less frequent visits and longer visits in green space, people in the high-risk group for COVID-19 did not differ from those who were not at risk for COVID-19 with regards to psychological distress.
Huerta and Cafagna (2021), Mexico	Adults in Mexico City (16, 22–58 years, 69%, n.a.)	September–October 2020	Observational, cross-sectional, qualitative, solicited audio, photo diary, interviews	Investigate the association between participants' urban green space use and well-being	Urban green space	Perception of the neighborhood quality, quality-related interview questions including size and amenities	Well-being	Semi-structured interviews based on photo-diaries	Urban green space use appears to serve as a coping mechanism to decrease the effects of stress and isolation caused by the pandemic and increase overall well-being, however, disparities of well-being benefits emerged with regards accessibility barriers for urban green space and women fearing violence. Almost all participants

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									expressed that nature contact brought them positive emotions that increased their mental well-being. The seven participants who used urban green space regularly reported experiencing positive feelings such as comfort, happiness, and tranquility during their use. Individuals in the group who did not use urban green space described as consequence of the deficiency more frequent sensations of anxiety and stress as well as reduced physical activity. Disparities were revealed, including barriers to accessing green space for people with a low socio-economic status and violence fears of women across all socio-economic levels, thus hindering positive effects of urban green space. In addition, most participants reported that green space quality, characterized by greenery and vegetation, were important for satisfaction.
Huerta and Utomo (2021), Mexico	Adults and older adults in Mexico City (1945, largest age group 18–24 years (27%), 59%, n.a.)	June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between the frequency of urban green space use and subjective well-being pre- and during COVID-19	Urban green space	Frequency of urban green space use Time to closest urban green space Urban green space quality based on infrastructure, maintenance, size, and events (all self-reported)	Subjective well-being	Warwick-Edinburgh mental well-being scale	Using green space frequently was related to higher subjective well-being, with the relationship being stronger during COVID-19 ($B = 1.65$, $p < 0.01$) compared to pre-COVID-19 ($B = 0.87$, $p < 0.01$). Urban green space quality was associated with better subjective well-being both prior and during COVID-19 with a similar strength ($B = 2.22$-5.81, all p's < 0.01). Longer time to the closest urban green space

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									(21+ minutes) was related to lower subjective well-being prior to COVID-19 (B = −1.32, p < 0.01), but not during COVID-19 (B = −0.33, p > 0.10). Compared to those who stopped using urban green space during COVID-19, those who kept or started using urban green space had higher odds for maintained or increased well-being (OR = 1.46, 95%CI = 1.21-1.76), while there was no association or urban green space quality or time to the closest urban green space observed (all p's > 0.10).
Humberstone (2021), New Zealand	Older adults (1, n.a., 100%, n.a.)	March–June 2020	Observational, case study, qualitative, autoethnography	Investigate nature-based recreation and its contribution to health and well-being	Green and blue space	Any green and blue space experienced by the autoethnographic researcher	Health and well-being	Realist tales of first kayaking and hiking experiences after the lockdown	Being in the outdoors affords enormous emotional and spiritual benefits for older people.
Idoiaga Mondragon et al. (2021), Spain	Children and adolescents (250, ø = 7.24 ± 2.57 years, age range 3–12 years, 52%, n.a.)	March–April 2020	Observational, cross-sectional, qualitative, online survey	Investigate the impact of the COVID-19 lockdown on children's emotional response	Nature	Any self-reported nature places and spaces mentioned by the children (e.g., parks, mountains; transcribed by the parents)	Emotional response	Open question "How are you feeling these days"?	Children missed the outdoors and contact with natural elements during the lockdown, which was reflected in a negative emotional response.
Jackson, Stevenson, Larson, Peterson, and Seekamp (2021), USA	Adolescents (624, 10–18 years, 50%, 59.8% White, 11.4% Black, 12.5% Hispanic, 14.9% Other)	April–June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between different types of outdoor activities and subjective well-being during COVID-19	Nature	Self-reported nature-based activities (e.g., hiking) Single item asking if time spent in nature helped to deal with the stress caused by physical distancing	Subjective well-being Mental health	Modified 5-item Subjective Health and Well-being scale One-item question to report mental health prior and during COVID-19 Single item asking if time spent in nature helped to deal with the stress caused by physical distancing	Continued participation in nature-based activities during COVID-19 was related to a weaker decline in subjective well-being (B = 0.21, β = 0.14, p = 0.016). Children who increased participation in nature-based activities displayed levels of subjective well-being similar to the ones prior COVID-19. Engagement in nature-based activities prior to COVID-19 were unrelated to changes in subjective well-being scores (B =

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									−0.08, β = −0.01, p = 0.271). 76.4% of children and adolescents reported that spending time outside in nature helped them to deal with stress caused by physical distancing, which translated to mitigated declines in subjective well-being (M = −0.39, SD = 0.73) and self-reported mental health (M = −0.35, SD = 0.89), compared to the ones not reporting those benefits (M = −0.70, SD = 0.87; M = −0.54, SD = 0.90).
Janus, Szewczyk-Taranek, and Smrokowska-Reichmann (2022), Poland	Allotment garden owners (203, largest age group 41–50 years (28.6%), 49%)	NR	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate value and reasons for purchasing allotment gardens during COVID-19	Gardens	Questions about perceived value and reasons for gardening	Perceived value	Questions about perceived value and reasons for gardening	Relaxation was the most frequently reported benefit of a home garden across age groups (33–70% agreement) except in the <20 year-olds and 61-70 year-olds. For <20 year-olds and 61-70 year-olds, growing fruit and vegetables was most frequently reported (38% and 35% agreement, respectively). Spending time with family was most frequently reported by 31–40 year-olds (21%). Physical activity was barely mentioned. Reasons for purchasing an allotment garden also varied across age groups, with a place to meet family and friends being the most important for <20 year-olds (38% agreement), while physical activity was the most important reasons for 41-50 year-olds (21% agreement). For most of the <20 year-olds and 41-50-year-olds, the gardens were a place to escape

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									from everyday problems (83% and 50% strong agreement, respectively).
Jarratt (2021), mostly UK	Webcam travelers (227, n.a., 69%, n.a.)	NR	Observational, cross-sectional, quantitative, online survey	Investigate connections to places and nature via webcam travels	Digital nature	Self-reported webcam travel	Well-being	Scale items asking participants to indicate how viewing webcams made them feel, including scales on feeling more positive, more connected, and relaxed Description in one word chosen by the participant how viewing webcams made them feel.	68% of webcam viewers looked at nature, with most of them viewing wildlife cams. Overall, the results suggests that webcam viewers experienced an uplift in mood: 83% felt more positive, 90% more relaxed, and 90% more connected after webcam traveling. Of those who had visited the place in real-life before, 83% indicated that this brought back happy memories. The most commonly words used to describe the experience were terms around happy, relaxed, fascinated, and connected.
Jato-Espino, Moscardo, Rodriguez, and Lazaro (2022), Spain	Adults and older adults (9883, >50% 16–49 years, >53% women, n.a.)	April–May 2020 March 2020–June 2021	Observational, cross-sectional, quantitative, online survey	Investigate associations between living close to green infrastructure and mental health during the COVID-19 lockdown	Green infrastructure	Geospatial analysis of green space 150, 300m, and 500m circular buffers	Stress Anger Enjoyment Alcohol Consumption Medication use Doctor visits	Secondary data obtained from another study	Stress ($r = -0.66$ to $r = -0.72$), anger ($r = -0.40$ to $r = -0.57$), medication use ($r = -0.53$ to $r = -0.67$), alcohol consumption ($r = -0.82$ to $r = -0.84$), or visits to the doctor ($r = -0.79$ to $r = -0.84$) significantly decreased if citizens lived close by green infrastructure. Results for enjoyment were less consistent.
Jenkins et al. (2021), New Zealand	Adults and older adults (759, ø = 43.04 ± 13.71 years, age range = 18–81 years, 79%, 82.9% New Zealand European, 15.4% Other)	April 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate if physical activity context (nature-based vs. non-nature based) moderates the association between physical activity and psychological well-being during the COVID-19 lockdown	Nature during physical activity	Two items asking participants if they have the option to be active in or around natural environments and if they participated in nature-based physical activity	Psychological well-being Motivational quality	WHO-5 Well-Being Index Behavioral Regulation in Exercise questionnaire	Both nature- and non-nature based physical activity were positively related to psychological well-being, with no moderation of the context.
Jo, Sato, Minamoto, and Ushimaru (2022), Japan	Adults and older adults in megacities	November 2020	Observational, cross-sectional, quantitative, online survey	Investigate the role of blue space for well-being during	Blue space	Questions about purpose and motivation of	Well-being	Questions about purpose and motivation of visitation of blue space	People primarily visited sea and river areas to feel at ease (sea: 53.2%

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	(5756, largest age group >70s (22%), 51.3%, n. a.)			the COVID-19 pandemic		visitation of blue space			agreement; river: 33.5% agreement) and for walking (sea: 56.4% agreement; river: 63.0% agreement).
Johnson and Sachdeva (2022), USA	Social media users (through Twitter posts in metropolitan US regions; 971,968 tweets)	March–July 2019 March–July 2020	Observational, longitudinal, quantitative, social media analysis (Twitter)	Investigate associations between nature and well-being during COVID-19	Nature	Tweets with nature- and green space-based keywords	Well-being	PERMA lexicon	Socializing outdoors was associated with increased well-being during the pandemic ($\beta = 1.06$, $p < 0.001$), as well as gardening ($\beta = 0.50$, $p < 0.001$), with the associations of the latter one with well-being being stronger during the prior to during the pandemic. Hiking/camping/beach was unrelated to well-being.
Joshi and Wende (2022), Canada	Gardeners and garden coordinators in Edmonton (215, n.a., n.a., n.a.)	May–October 2020	Observational, longitudinal, qualitative, ethnographic + interviews + survey	Investigate opportunities and challenges of community gardening	Community gardens	Gardening	Opportunities and challenges of com	Ethnographic observations and open-ended questions	A majority of the community gardeners experienced positive social association with community gardening activities during the pandemic, including getting a break from the lockdown, having a space for safe outdoor gathering, meeting other gardeners, as well as stress relief and happiness through gardening. Negative experiences were also mentioned by some participants, such as feeling isolated and lonely in the garden.
Kang et al. (2022), China	Adult and older adult urban residents (1364, largest age group 18–30 years (42%), 65%, n.a.)	January–April 2020	Observational, cross-sectional, quantitative, online survey	Investigate if community parks helped to reduce stress levels during the lockdown	Community park	Frequency and duration of community park use during lockdown Reasons for park use	Stress	Visual analogue scale Reasons for park use	There was no significant relationship between stress level and community park use. Participants agreed to use the park to relax (21.74%), ease stress (14.12%), and to exercise (10.61%), whereas only 1.24% reported to use the park for social needs.
Karpinski and Skrzypczak (2022), n.a.	Recreational anglers (564, largest age group 25–65	July–August 2021	Observational, cross-sectional, quantitative, online survey	Investigate perceptions and behavior of recreational anglers	Angling	Reasons for angling	Stress	Reasons for angling	Perceptions of pandemic stress reduction were confirmed by 63.8% of anglers. Feelings of stress

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	years (79.3%), n. a., n.a.)			during the COVID-19 pandemic					reduction were most strongly related to a preference for fishing with friends and family. Escaping the pandemic media hype was a reason for more angling during the pandemic.
Khalilnezhad et al. (2021), Iran	Adults and older adults (394, largest age group 30–39 years (33%), 61%, n.a.)	January–February 2021	Observational, cross-sectional, quantitative, online survey	Investigate use and motivation to visit green space during COVID-19 and the effect on user's feelings	Public and private green space	Frequency and type of green space visitation; motivation to visit green space	Feelings Reasons to visit green space	Feelings in green space during and prior to the pandemic	Walking was the most reported reason to visit public green space (27%), whereas private green space was more important for relaxing (15% agreement). Being in a green space resulted in enhanced positive feelings, such as happiness, pleasure and physical energy, without difference between public or private green spaces. The majority of respondents indicated that green spaces contribute to reducing a series of negative feelings, including anxiety, tension, sadness, depression. Private green spaces contributed more to the reduction of anxiety and fear than the public green spaces.
Kim, Choi, and Kim (2022), Korea	Medical workers (13, 42.23 ± 10.99 years, 85%, n.a.)	November 2021	Experimental, longitudinal, quantitative, survey + physiological parameter assessment	Investigate effects of a forest healing program on health during COVID-19	Forest healing therapy	Two-day forest treatment program with various components, e.g., a walk in the forest, woodworking, and relaxation program	Stress Sleep quality	Perceived stress scale (PSS) Epworth sleepiness scale (ESS) Stanford sleepiness scale (SSS) Pittsburgh Sleep Questionnaire Index (PSQI) Hospital Anxiety and Depression scale (HADS) Somatization symptoms (KSCL95) Salivary cortisol Dehydroepiandrosterone sulfate (DHEA-S) Melatonin	There was an improvement in sleep duration from prior to post-treatment (+41.54 ± 46.70 min, $p < 0.05$) as well as in perceived stress (−2.69 ± 3.73, $p < 0.05$) and in dehydroepiandrosterone sulfate (−1.42 ± 2.07, $p < 0.05$), indicating that some sleep and stress parameters improved.

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King and Dickinson (2022), UK	Urban adults and older adults (12, late 20s–70s, n.a., n. a.)	March 2020	Observational, longitudinal, qualitative, mobile instant messaging diaries	Investigate value of urban green space during COVID-19	Urban green space	Any green space presented by the participants	Value of urban green space	Any benefits brought up by the participants	Contact with nature contributed to the participant's physical, psychological, and social well-being. Green space became a meaningful place that allowed activities to alleviate boredom from the lockdown. At the same time, the large number of people using green space seemed to be perceived in a negative way, with the green spaces being very busy.
Koch et al. (2022), Spain, Austria, Sweden	Adult population of three cities	March–April 2020 (acute period) May–June 2020 (deconfinement period)	Observational, longitudinal, quantitative, health impact assessment	Investigate impact of changes in green space visits on depression and anxiety during COVID-19 acute lockdown period and deconfinement period	Green space	Secondary data on green space visits from other surveys (Baseline) Variable "Parks" from the COVID-19 Community Mobility Reports (Google)	Mental health and vitality	Secondary data from other surveys	If the decrease in green space visits lastet for a longer duration, the risk of worse mental health and vitality would increase by 82% in adult residents in Barcelona during the lockdown, while there was no significant association between green space visit changes and mental health in Vienna and Stockholm. No associations in the post-confinement period were observed. These observations were impacted by seasonal variability.
Kolbe et al. (2021), USA	Patients and hospital staff in the COVID-19 recovery unit (13 patients, 11 staff, n.a., n.a., n.a.)	Spring 2020	Experimental, cross-sectional, qualitative/ quantitative, survey	Investigate satisfaction and perceived benefit of a virtual reality tool during COVID-19	Digital nature	Virtual reality sessions with three different categories, max 30 min, free choice of the participants what to do: 1) guided meditation in highly realistic immersive nature scenes, 2) guided active or passive nature experience, 3) cognitive stimulation games. In appearance, all modules three-	Satisfaction Perceived benefits	Four-item survey after the first virtual reality session	On a scale of 1–10, patients reported a mean of satisfaction of 8.42 of the virtual experience with regards to helping to manage their pain and anxiety. Hospital staff reported a mean satisfaction of 9.45 of the virtual reality experience with regards to helping to manage stress. Open-ended responses revealed several benefits such as feelings of escape from problems, relaxation, enhanced alertness, and

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						dimensional soothing natural settings.			feeling connected to others on the patient side, as well as feelings of escape, relaxation, coping, and self-care on the hospital staff side.
Kondo et al. (2022), USA	Adults and older adults in New Orleans (244, 52 years, age range 22–94 years, 70%, 82% Black)	January 2019–March 2020 (pre-pandemic) March 2020–April 2021 (during pandemic)	Observational, longitudinal, quantitative, online survey + census tract data	Investigate associations between neighborhood characteristics and psychological distress during the COVID-19 pandemic	Parks	Objectively assessed park score with different parameters, such as park quality, accessibility, facilities, and investment	Psychological distress	Kessler 6 Psychological Distress Scale (K6)	A higher park score, representing park systems with higher quality, was associated with reduced distress related to the pandemic ($\beta = -0.03$; 95% CI: −0.05, −0.01).
Kontsevaya, Mukaneeva, Myrzamatova, Okely, and Drapkina (2021), Russia	Adults and older adults (2432, ø = 37.6 ± 13.4 years, 83%, n.a.)	April–June 2020	Observational, cross-sectional, quantitative, online survey	Investigate factors associated with physical activity and sleep changes during COVID-19	Green space	Self-reported access to private or public green zone	Physical activity Sleep habits and quality	Self-reported physical activity frequency, intensity, time, and type Self-reported sleep items about getting enough sleep, trouble falling asleep, and waking up earlier than wanting to	Having access to green space compared to no access was associated with an increased chance to meet the physical activity (OR = 1.17, 95% CI = 1.09-1.24) and muscle-strengthening (OR = 1.14, 95%CI = 1.06-1.23) recommendations. Having access to green space was unrelated to changes in moderate ($\beta = -0.38$, 95%CI = −1.10 to 0.34) and vigorous ($\beta = -0.33$, 95%CI = −1.17 to 0.50) physical activity, walking ($\beta = -0.60$, 95% CI = −1.74 to 0.54), muscle-strengthening activity ($\beta = 0.00$, 95%CI = −0.01 to 0.02), and not getting enough sleep ($\beta = -0.10$, 95%CI = −0.29 to 0.09).
Korpilo et al. (2021), Finland	Adults and older adults in Helsinki (418, n.a., 57%, n.a.)	May 2020	Observational, cross-sectional, qualitative, public participation survey + open-ended questions	Investigate changes in urban green infrastructure use during COVID-19	Urban green infrastructure	Frequently visited places mapped by participants Open questions about outdoor recreation and perception of green space	Green space perceptions	Open questions about outdoor recreation and perceptions of green space	Urban green infrastructure, especially nearby forests, played a critical role for well-being during the pandemic. While it allowed to meet people, crowded places in nature seemed to be perceived in a negative way.
Kou, Zhang, Li, and Liu (2021), China	Shanghai community gardeners,	August 2020	Participatory action research, cross-sectional, quantitative/qualitative,	Investigate the impact of community	Gardens	„Seeding Plan", a contactless	Mental health Social	Items to indicate negative, no, and positive changes in mental health, family	Results revealed that participants of the community garden

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	citizens and people outside the community (1154, largest age group 26–40 years (50.25%), 55%, n.a.)		questionnaire surveys and interviews	gardening on resident's daily life during COVID-19		community gardening program	interactions Perceived benefits	harmony, neighborhood interaction, and relative/ friend interaction, and optimism Semi-structured interviews to identify perceived benefits	project reported the most positive changes in mental health (M = 2.29, SD = 1.78), as well as family harmony and social interactions (M = 2.28-2.45, SD = 1.67-1.80), while they reported stable optimism pre- and during the pandemic (pre-pandemic: M = 2.60, SD = 1.65, during the pandemic: M = 2.63, SD = 1.58). Those changes were significantly more positive than reported by people who live in the same community, but did not participate in the program and people living outside the community (all p's < 0.01). However, people living in the community, but not participating in the program, reported more positive changes than people not living in the community (all p's < 0.01). Semi-structured interviews revealed that the seeding activities did not only promote mental health, but also allowed reconnecting with family members, neighbors, and other seeding participants both in-person and digitally, while the seeding program also promoted participation in other online and offline community activities.
Lades, Laffan, Daly, and Delaney (2020), Ireland	Adults and older adults (604, ø = 47.2 ± 12.1 years, 68%, n.a.)	March 2020	Observational, cross-sectional, quantitative, day reconstruction method via an online survey	Investigate associations between daily activities and affective experiences	Garden	Participants described 5 'sequential' episodes of their day and what they did, with gardening being one of the reported activities	Emotional well-being	3 items asking about positive and 6 items asking about negative feelings	Gardening activity was related to higher positive affect (B = 0.29, p < 0.01), but not negative affect (B = −0.09, p > 0.05).

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Lanza et al. (2021), USA	Children and adolescents (361, 1–12 years, 45%, n.a.)	Autumn 2019 Autumn 2020	Observational, longitudinal, quantitative, observation	Investigate the impact of the pandemic on park use outside school hours during COVID-19	School parks	Observation of children in parks	Physical activity	System for Observing Play and Recreation in Communities (SOPARC)	Compared to prior the COVID-19 pandemic, a 42% [95% CI: 16–59%] and 60% [95% CI: 36–75%] decrease in the number of girls and boys engaging in physical activity was observed in the parks, respectively ($p < 0.01$).
Larcher, Pomatto, Battisti, Gullino, and Devecchi (2021), Italy	Adults and older adults (3286, largest age group 46–60 years (33.8%), 64.5%, n.a.)	April–May 2020	Observational and case study, cross-sectional, quantitative, online survey	Investigate public green area perception during the physical distancing period	Public green-area	One item asking about thoughts related to participant's physical/ psychological need to enjoy a public green area?	Psychological and physical need for green space	One item asking about thoughts related to participant's physical/ psychological need to enjoy a public green area?	23.3% of the participants reported a pressing physical or psychological need for green areas, 47.5% reported a recurrent need, 21.7% an occasional need, and 7.5% no need. The need was especially relevant for people who used to frequent public green areas prior to the physical distancing period and who had no outside (green/non-green) access options, whereas it was absent for those who did not visit public green space and those who had a private garden.
Larson et al. (2022), USA	University students (1280, 80% < 25 years, 61%, 11% Asian, 4% Hispanic/Latinx and Black, respectively)	March–May 2020	Observational, cross-sectional, quantitative/ qualitative, survey + geospatial analysis	Investigate associations between outdoor recreation and psychological health during COVID-19	Parks	Self-reported changes in park use due to COVID-19 Geospatial assessment of park area/10,000 residents and NDVI at zip code level Open ended questions about reasons for changes in park use	Emotional distress	Visual analogue scale based on PANAS items Open ended questions about reasons for changes in park use	General health was unrelated to park use during COVID-19 (OR = 0.97, 95%CI = 0.86-1.08). Area of national/state parks was associated with less emotional distress (B = −1.70, 95%CI = −2.9, −0.6), whereas reducing park use during the pandemic was related to greater emotional distress (B = 3.40, 95%CI = 1.6, 5.2). Area of local parks and NDVI were unrelated to emotional distress. Qualitative data analysis revealed that for people who increased park use, improving mental health and reducing boredom were important reasons as well as parks being a

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									replacement for former indoor exercise. Among those who reduced park use, negative emotions were mentioned as one barrier that hindered them to go out in the park.
Lee and Jeong (2021), UK	Social media users (through Twitter posts in London; 427 tweets during the lockdown, 367 tweets in 2019)	March–May 2019 March–May 2020	Observational, longitudinal, quantitative, social media analysis (Twitter)	Investigate changes in noise sources of annoyance during COVID-19	Nature sounds	Outdoor noise in the category nature and animal	Noise complaints	Analysis of Twitter posts regarding noise complaints and annoyances of nature and animal soundscapes	Prior to the lockdown in 2019, there were 2 posts reporting annoyances through nature and animal soundscape, which increased to 15 posts during the same time of the year in 2020 during the lockdown period. Most complaints were about bird noise (N = 12).
Lee et al. (2021), South Korea	Park visitors (1196, largest age group 50–59 years (31.8%), 48.7%, n.a.)	May–July 2020	Observational, cross-sectional, quantitative, survey	Investigate associations between forest types and well-being during COVID-19	Forests in different parks: national park, natural recreational forest, urban forest	Frequency and duration of forest visits Multiple choice questions with predefined answer options with visiting reasons	Perceived restorativeness Social-psychological stress Reasons for visiting forests during COVID-19	Perceived Restorativeness Scale (PRS) Psychological Well-Being Index Short Form (PWB-SF) Multiple choice questions with predefined answer options with visiting reasons	Perceived restorativeness of forests was negatively related to social-psychological distress ($r = -0.40$, $p < 0.001$). Perceived restorativeness was higher in the national park ($M = 5.36$, $SD = 0.79$) and natural recreation forest ($M = 5.57$, $SD = 0.91$) compared to urban forests ($M = 5.17$, $SD = 0.77$; $p < 0.001$), while there was no difference in social-psychological stress observed ($p = 0.060$). There were significant differences in the time spent in the forest depending on health status, with healthy people tending to spend more time in the forest (>5 h: 12.6%) compared to the potential stress group (5.2%) and the high-risk stress group (4.4%). The most common reason (67%) for visiting forests during COVID-19 was for physical activity (exercise, walking, mountain climbing).

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Lee, Bae, and Jang (2022), Korea	University students (175, ~20–23 years, 0%, n.a.)	March 2021	Experimental, longitudinal, quantitative, survey + cognitive test	Investigate effects of nature-based physical activity during COVID-19	Nature-based physical activity	Exposure to real natural environment during outdoor exercise and exposure to virtual natural environment during indoor exercise (control group: indoor exercise without real-world/virtual exposure to natural environment); 30 min exercise session with 5 min breaks after every 10 min	Concentration Psychological capital	Cognitive function test (Trail Making Test Part 2) Positive psychological capital test	The scores for positive psychological capital sub-factors (self-efficacy, optimism, and hope) in the groups with the natural environmental exposure with outdoor exercise and visual stimulation with indoor exercise conditions experienced more positive change than the indoor exercise group ($p < 0.05$). Concentration improved through the trial, with no differences between the groups.
Lee, Cheng, et al. (2022), Cambodia, Indonesia, Japan, South Korea, Myanmar	Adults and older adults (542, largest age group <29 years, 57.4%, n. a.)	June–July 2020	Observational, cross-sectional, quantitative, survey	Investigate perceived benefits of nature during COVID-19	Nature	Question about benefits of nature for psychological health	Psychological health	Question about benefits of nature for psychological health	Respondents across all countries showed high agreement for strengthened awareness regarding the benefits of nature for their psychological health.
Lee, Healy, and Haegele (2022), USA	Children and adolescents with autism spectrum disorder (92, 13.26 ± 2.21, 23.9%, n. a.)	October 2020–January 2021	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate correlates of leisure-time physical activity during COVID-19	Parks	Walking distance to nearest park based on zip code entered in Google Maps	Leisure-time physical activity	Godin Leisure Time Questionnaire (filled in by the parents)	Local park proximity was positively associated with leisure time physical activity ($r = -0.33$, $p = 0.006$) and number of days with at least 60 min of physical activity ($r = 0.51$, $p < 0.001$).
Lee, Lee, Xu, Li, and Ory (2022), USA	Adults in El Paso (720, 44.56 ± 0.52 years, 67.7%, 14.4% Non-Hispanic White)	July–August 2020	Observational, cross-sectional, quantitative, survey	Investigate correlates of physical activity during COVID-19	Park and green space	Self-reported presence of parks/ natural green space in the neighborhood	Moderate-to-vigorous physical activity Recreational walking	Questions adapted from the International Physical Activity Questionnaire (IPAQ)	Presence of neighborhood parks and green space was unrelated to moderate-to-vigorous physical activity and walking.
Lee, Mkandawire, et al. (2022), Malawi, Rwanda, South Africa, Tanzania, Zambia	Adults and older adults in the capitals of the respective country (430, largest age group <29 years, 45.2%, n. a.)	April–June 2020	Observational, cross-sectional, quantitative, survey	Investigate changes in health recovery perceptions and forest outdoor activity during COVID-19	Urban forests	Question about perception of health recovery in urban forest	Mental health	Question about perception of health recovery in urban forest	Most of the respondents answered that it was newly recognized that nature experience in urban forests helped people to recover their psychological health during the pandemic.
Lehberger, Kleih, and Sparke (2021), Germany	Adults and older adults (495, largest age group 50–59	May 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate associations between use of green	Garden Public green space	Garden owners: Time spent in the garden; non-garden owners:	Mental well-being Life satisfaction Meaning of	Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) One item asking	Garden owners showed higher life satisfaction and mental well-being (M = 7.40, SD = 1.80; M =

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	years (24.8%), age range 18–65 years, 49%, n.a.)			space and well-being during COVID-19		Time spent in public green space Changes in time spent in the garden/public green space Open-ended question asking participants to describe the meaning of green space	green space during COVID-19	participants to rate their current life satisfaction Open-ended question asking participants to describe the meaning of green space	50.71, SD = 8.69) compared to non-garden owners (M = 6.31, SD = 2.26; M = 46.55, SD = 9.01; $p < 0.001$). However, garden ownership was neither associated with mental well-being (B = 0.26, 95% CI = −1.51 to 2.03) nor life satisfaction (B = 0.20, 95%CI = −0.22 to 0.61). Rather, variables related to garden ownership, including time spent in green space, less fear of job loss, higher income, and lower neuroticism scores were related to better mental well-being and life satisfaction. For life satisfaction, lower neuroticism scores and higher income were Time spent in green space was related to mental well-being (B = 2.32-2.73, 95%CI = 0.13-4.52), but not life satisfaction (B = 0.18-0.22, 95%CI = −0.35 to 0.70). The vast majority of participants associated positive meanings (e.g., joy) and family time with private gardens and public green spaces during the pandemic.
Lenaerts et al. (2021), Belgium	Adolescents, adults, and older adults (11352, largest age group 41–65 years (51–65 years), age range 12–65+ years, 68%, n.a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigate factors that influence nature visits during COVID-19	Nature	Frequency of nature visits	Mental health Well-being	One item asking about how healthy that participants is feeling in the head 11 items asking about feelings after visiting nature	Those who were mentally healthy were more likely to visit nature more frequently than the ones that were mentally unhealthy (OR = 1.31, 95%CI = 1.18-1.46). 51.6% of the people who went into nature during COVID-19 experienced it more positive than before.
Lenzi, Sádaba, and Lindborg (2021), Basque Country	50 audio-recordings in Getxo evaluated by experts (14,	March–May 2020	Observational, case study, qualitative, observations, field audio	Investigate feelings about natural soundscapes	Nature sounds	Any nature sound within the audio recording	Feelings about the soundscape (soundscape	Adapted version of the Swedish Soundscape Quality Protocol	Pleasantness was correlated with perceived natural sounds ($\rho = 0.44$, $p < 0.001$).

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	median age 40 years, age range 24–53 years, 50%, n.a.)		recordings, photography, diary notes				quality) rated by experts		
Lesser and Nienhuis (2020), Canada	Adults and older adults (1098, ø = 42 ± 15 years, 79.3%, n.a.)	April–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate changes in COVID-19 related physical activity	Nature	Natural/non-natural physical activity context	Physical activity	Godin Leisure Questionnaire and classification in active (≥150 min moderate-vigorous physical activity/week) and inactive participants (<150 min moderate-to-vigorous physical activity/week)	There were no statistically significant differences between the proportion of active and inactive participants conducting physical activity in natural environments (82.6% vs. 75.6%, $p = 0.053$).
Li, Luo, et al. (2021), China	Adults and older adults in megacities (628, largest age group 18–35 years (71.3%), 64.5%, n.a.)	December 2020–March 2021	Observational, cross-sectional, quantitative, survey	Investigate components of urban green space that relate to health benefits	Urban green space	Self-reported green space access, size, maintenance, and soundscape	Mental health benefits Social health benefits	Question asking about agreement of urban green space contributing to mental/social health	Green space access was associated with improved mental and social health (both $\beta = 0.15$, $p < 0.01$), as was green space maintenance (mental health: $\beta = 0.18$, $p < 0.01$, social health: $\beta = 0.15$, $p < 0.01$). Green space size and type were unrelated to mental and social health.
Lee and Jeong (2021), China	Prisoners (269, 34.45 ± 8.09 years, 0%, n.a.)	March 2020	Observational, cross-sectional, quantitative, survey	Investigate effects of nature view outside the window on psychological well-being during COVID-19	Nature window view	Self-reported nature visibility through the window Frequency and duration of viewing	Depression Anxiety Loneliness Well-being	Patient Health Questionnaire (PHQ-9) Generalized Anxiety Disorder Scale (GAD-7) UCLA Loneliness Scale short form (ULS-6) Distress Tolerance Scale (DTS) Satisfaction with Life Scale (SWLS) WHO Well-Being Index (WHO-5)	Frequency of looking at nature outside the window was associated with increased well-being ($\beta = 0.10$, $p < 0.05$), while nature visibility was associated with higher distress tolerance ($\beta = 0.15$, $p < 0.05$) and greater life satisfaction ($\beta = 0.14$, $p < 0.05$). Duration was not associated with any of the outcomes. No direct relationships emerged with any of the other variables.
Lin, Chen, Tseng, Lee, and Lin (2022), China	Questionnaire: Adults and older adults (743, largest age group (41.5%), 47%, n.a.) Interviews: River improvement participants and	June–September 2021	Observational, cross-sectional, quantitative/ qualitative, online survey + interviews	Investigate the impact of river improvement and greening on the urban well-being index during COVID-19	River and greenspace	Urban river improvement and greening project	Well-being	Urban happiness index	The project has the potential to help people to relieve stress and improve their mental health. However, due to poor management, visiting this area posed an infection risk, resulting in limited leisure benefits and thus not being helpful for

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
	experts (12, n.a., n.a., n.a.)								improving mental health or having fun. Additionally, survey responses by people from different backgrounds varied.
Liu, Liu, Zhang, An, and Zhao (2021), China	Urban older adults (248, largest age group 70–80 years (52.4%), n.a.)	February–April 2020	Observational, cross-sectional, qualitative, interviews	Influences on elderly mobility during COVID-19	Nature	Any nature mentioned by participants	Physical activity	Interviews	Walking and other physical exercises remained enjoyable for those who lived in communities with accessible and attractive green spaces (71 out of 248).
Logan, Metzger, and Hollingdale (2021), Scotland	Adults and older adults living in woodlands Questionnaires (765, n.a., n.a., n.a.) Interviews (31, n.a., n.a., n.a.)	January–March 2020 September–October 2020	Observational, longitudinal, quantitative/qualitative, online survey + semi-structured interviews	Investigate the contribution of community woodlands to well-being during COVID-19	Woodlands	Questions about physical and mental health benefits provided by woodlands	Well-being	Questions about physical and mental health benefits provided by woodlands Semi-structured interviews	Physical well-being benefits, including physical activity, were the most frequently mentioned benefits from woodlands, followed by mental well-being. Social benefits were least mentioned. The majority of respondents did not feel that their appreciation and use of woodlands had changed during COVID-19.
Lõhmus et al. (2021), Sweden	Adults (2060, largest age group <70 years (82%), 55%, 89% from Scandinavian countries or Baltic States)	June–August 2020	Observational, cross-sectional, quantitative, online survey	Investigate if people's mental health and well-being differed depending on greenness exposure during COVID-19	Greenness Nature	Objectively measured Normalized Difference Vegetation Index (NDVI) with buffers between 50 and 500 m around participant's home address Self-reported visits to natural areas Reasons for visiting nature areas pre- and during COVID-19	Alcohol consumption Sitting score Mental health Vitality Anxiety Depression Perceived stress Cognitive stress	Self-reported frequency and amount of alcohol consumption International Physical Activity Questionnaire Short Form Mental health and vitality subscales of RAND-36 Depression and anxiety subscales from the Hopkins Symptom Checklist 90 6-item perceived stress scale Cognitive stress scale from the Stress Profile Reasons for visiting nature areas pre- and during COVID-19	Problematic alcohol consumption was more likely for participants with low NDVI values compared to high NDVI values (57% vs. 43%, p = 0.019). High sitting scores were also more likely for participants with low NDVI values (54% vs. 46%, p = 0.017). Increases in sitting behavior were observed independent of the NDVI-value. Higher NDVI values within 50 m were related to mental health (B = 5.95, 95%CI = 0.69-11.21), anxiety (B = −0.62, 95%CI = −1.10 to −0.14), and cognitive stress (B = −6.31, 95%CI = −12.60 to −0.01). Vitality, depression, and

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									perceived stress were unrelated for the 50 m buffer, but showed some associations for the other buffer sizes. For those visiting nature often or very often, the reasons for visiting nature changed from prior to during COVID-19: Decreases were observed for stress recovery (36%–33.8%, $p = 0.028$) and relaxation reasons (62.4%–52.5%, $p = 0.001$), and increases for physical activity (69.7%–72.1%) and health reasons (68.8%–72.5%, $p = 0.001$).
Lopez, Kennedy, Field, and McPhearson (2021), USA	Adults and older adults in New York (1145, largest age group 20–39 years (45%), 70%, 8% Black, 7% Asian, 1% Native American, 10% Latinx)	Spring 2020	Observational, cross-sectional, quantitative, online survey	Investigate who benefits of urban green space during COVID-19	Urban green space	Questions about changes in perceptions of urban green space benefits Frequency of urban green space visitation, changes in visitation, and important features	Mental health	Question about green space exposure impacting mental health	Over 80% reported that urban green space was either extremely or very important for mental health, with increased importance since the onset of the pandemic. Men assessed green space less important than women, people with Black ethnicity assessed green space less important than other ethnicities, and people from Queens assessed green space less important compared to people from Manhattan.
Luo, Xie, and Furuya (2021), China	Urban adult and older adult residents (47, 35.4 ± 15.4 years, age range 21–84 years, 64%, n.a.)	March–May 2020	Observational, cross-sectional, qualitative, telephone interviews	Investigate motives of urban residents to visit green space during COVID-19	Urban green space	Interview questions about reasons for visiting green space as well as experiences and activities	Reasons for visiting green space	Interview questions about reasons for visiting green space as well as experiences and activities	Urban green space served as therapeutical place during COVID-19 via providing relaxation, a place to escape from pandemic-related stressors and a break from negative emotions, and mental health promotion via engagement in outdoor activities and physical exercise. Also, urban green space served as meeting place through simple social interactions,

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									hence providing social support.
Mackinnon, Mackinnon, Zari, Glensor, and Park (2022), New Zealand	Wellington residents (118, n.a., n.a., n.a.)	April–May 2020	Observational, cross-sectional, quantitative, survey	Investigate reasons for visiting green space during COVID-19	Urban green space	Questions about reasons for visiting green space	Reasons for visiting green space	Questions about reasons for visiting green space	The most frequently reported reason for visiting green spaces during lockdown was mental wellbeing. Park visits helped participants alleviating negative emotions and stress, while it helped to combat loneliness and allowed safe social interactions. Most respondents indicated that the benefits of nature remained constant during COVID-19 compared to prior to the pandemic.
Marconi, Perelman, and Salgado (2022), Argentina	Residents of Buenos Aires (298, n.a., n.a., n.a.)	December 2020–January 2021	Observational, cross-sectional, quantitative, online survey	Investigate perceptions of urban green space during COVID-19	Urban green space	Questions about reasons for visiting green space and services provided by green space	Reasons for visiting green space	Questions about reasons for visiting green space and services provided by green space	Green spaces were visited due to providing a space for social gatherings as well as a place for sports.
Marques, Silva, Quaresma, Manna, Neto, et al. (2021), Brazil	Adult and older adult residents of Rio de Janeiro (173, n.a., 78%, n.a.)	November 2020–January 2021	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate associations between different types of urban green infrastructure and mental distress during COVID-19	Urban parks Green views Gardens	Distance to parks based on zip code Questions about frequency of visiting green space, seeing trees from home, garden at home, and taking care of plants	Mental distress	Depression, Anxiety, and Stress scale 21 (DASS-21)	Although urban parks and green views were important, home gardens were most efficient in mitigating mental distress. Home gardens were most efficient in mitigating mental distress. (LMM model coefficient = −5.2), while visits to parks, green view, and taking care of plants had a smaller relative importance in reducing mental distress (LMM model coefficients: 1.9, −0.7 and −0.5, respectively). The increased distance from parks and leaving home for non-essential activities had a minor relative importance in enhancing mental distress (LMM model coefficients: 1.1 and 0.4, respectively).

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Marques, McIntosh, Muthuveerappan, and Herman (2022), New Zealand	Adults and older adults (212, largest age group 18–25 years (33.8%), 76.6%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online survey	Investigate links between nature exposure and well-being	Outdoors	Any natural environments brought up by participants	Physical activity	Questions about sports and physical activity	Different natural environment, such as urban parks, forest, mountains, and marine blue spaces, such as seafront, beach, or harbor were important places for physical activity during the pandemic.
Mastorci et al. (2021), Italy	Children and adolescents (1289, 12.5 ± 1.3 years, 51.7%, n.a.)	September 2019 April 2020	Observational, longitudinal, quantitative, online survey	Investigate health-related quality of life during COVID-19	Garden	Question about garden at home	Health-related quality of life	KIDSCREEN-52	The perception of physical well-being was lower for those who did not have green space (−4.4 ± 7.5 vs. −2.8 ± 7.2, F = 11.1, p = 0.001) during the COVID-19 phase compared to prior COVID-19.
Maurer et al. (2021), USA	University students (1200, n.a., 67.1%, 26.5% people of color)	Spring 2020	Observational, cross-sectional, quantitative, online survey	Investigate between going outdoors and subjective well-being during COVID-19	Public and private greenspace	Self-reported frequency and distance to green space	Subjective well-being	Rating of overall life satisfaction, momentary life satisfaction, and outdoor life satisfaction with one item, respectively	Time spent in greenspace correlated with higher levels of subjective wellbeing, while type of greenspace (public vs. private) did not have a significant effect on subjective well-being.
Maury-Mora et al. (2022), Spain	Adult and older adult residents of Madrid (132, largest age group 41–55 years (40%), 64%, n.a.)	May–June 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between urban green space and stress during COVID-19	Urban green space	Self-reported typology and use of urban green space	Stress	Questions about physical and behavioral stress symptoms and mood	Main findings showed that indoor plant interaction is not a substitute for different outdoor green experiences to manage stress. Those who interacted with green spaces in a daily manner managed stress levels better than people who didn't (but their effects might lose strength over time); and turning to green spaces for comfort during stressful times even if not done so usually helps overcoming difficult situations.
McCormack, Doyle-Baker, Petersen, and Ghoneim (2020), Canada	Children and adolescents in Calgary (328, Children: 5–17 years; 10.8 ± 4.0 years; 55%, parental ethnicity: 56.4%	April–June 2020	Observational, cross-sectional, quantitative, online survey	Examine associations between parent's COVID-19 anxiety and physical activity and sedentary behaviors among school-aged children	Park	Frequency in play behavior at a park proxy-reported via the parents	Child play	Frequency in play behavior at a park proxy-reported via the parents	Approximately half of parents perceived decreases in their child's play at the park (52.7%), while only 15.5% reported increases.

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	Caucasian, 11.3% Chinese, 13.7% Asian other, 18.6% Non-Asian or multiple ethnicities)								
Millán-Jiménez, Herrera-Limones, López-Escamilla, López-Rubio, and Torres-García (2021), Spain	Undergraduate students (188, 20–32 years, 68%, n.a.)	June–July 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate associations between home characteristics and health during COVID-19	Park/garden and river/sea	Self-reported window view from home, including park/garden or river/sea	Feelings when looking through the window	Questions about sensations when looking out of the window	Feelings of imprisonment were linked to window views of other buildings ($p = 0.005$, IC 0.06–0.34), while those feelings were not experienced for park/ gardens and river/sea window views. Feelings of peace were related to park/garden and river/ sea window views ($p = 0.003$, IC 0.33–0.08), but not to window views including buildings.
Mitra et al. (2020), Canada	Children and adolescents (1472, largest age group 5–11 years (53%), age range 5–17 years, parental ethnicity: 79.2% European, 13.2% Asian, 7.6% Other)	April 2020	Observational, cross-sectional, quantitative, online survey and geospatial analysis	Investigates associations between changes in patterns of physical activity, sedentary and sleep behavior patterns and the built environment during COVID-19	Objective assessment of access to parks within 1 km	Total number of parks, playgrounds, and open recreational areas based on parental-reported zip code within a 1 km radial buffer distance	Movement behavior clusters	Parental proxy-reported changes and time spent in 11 movement behaviors via parents on a 5-point-Likert scale for each behavior	For children (5–11 years), park access was unrelated to chances of increased outdoor activities cluster membership (OR = 0.83, $p = 0.067$), whereas access to parks increased the chances of increased outdoor activities cluster membership for adolescents (12–17 years) living in high-density neighborhoods (OR = 1.35, $p < 0.001$)
Mouratidis (2022), Norway	Adults and older adult residents in Oslo and Viken (1796, 49.7 ± 16.5 years, 50%, n.a.)	June–August 2020	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate changes in health and well-being during COVID-19 and related city characteristics	Green space	Objectively assessed green space % within 1 km radius around participant's residential address	Health and well-being	Questions based on the European Social Survey and OECD	Green space was unrelated to life satisfaction, satisfaction with personal relationships, general health, happiness and during COVID-19 as well as to perceived health-related changes.
Mouratidis and Yiannakou (2022), Greece	Adults and older adults in Greek cities (1201, 41.6 years, 57.7%, n. a.)	April–May 2020	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate built environment characteristics in relation to changes in health and well-being during COVID-19	Green space and parks	Objective assessment of park area (m^2 within 1 km radius) and tree cover (% within 1 km radius)	Health and well-being	Questions based on the European Social Survey and OECD	Park proximity and tree cover were mostly unrelated to life satisfaction, satisfaction with personal relationships, and overall health during COVID-19.

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Mullins, Charlebois, Finch, and Music (2021), Canada	Adults and older adults (1023, largest age group 24–38 years (39%), 52.5%, n.a.)	September 2020	Observational, cross-sectional, quantitative, online survey	Investigates associations between home food gardening and attitudes, beliefs and motivations during COVID-19	Garden	Home food gardening	Well-being related attitudes, beliefs and motivations concerning home food production	14 questions related to attitudes, beliefs, and motivations	All home food gardeners agreed that gardening is important for mental and physical well-being; 70.6% of long-term gardeners and 61.6% of gardeners agreed that they garden for relaxation; 57.6% of long-term and 61.6% of new gardeners considered their gardening as physical exercise.
Muro, Feliu-Soler, Canals, Parrado, and Sanz (2022)	Adults (16, 47.5 ± 8.3 years, 87.5%, n. a.)	May 2020	Experimental, longitudinal, quantitative, survey	Investigate psychological benefits of forest bathing during COVID-19	Forests	Three-hour session of forest bathing	Psychological well-being and overall health	State-Trait Anxiety Inventory (STAI) Positive and Negative Affect Schedule (PANAS) Profile of Mood States (POMS) State Mindfulness Scale	Results showed pre-post improvements across all measurements, specifically in positive affect, vigor, friendship and mindfulness, and decreases in negative affect, anxiety, anger, fatigue, tension, and depressive mood. Effect sizes observed for all the outcomes were significant and large, ranging from d = 1.02 to d = 2.61.
Narea et al. (2022), Chile	Mothers with children between 12 and 15 months (985, 29.5 years, 100%, n.a.)	2019 September–November 2020	Observational, longitudinal, quantitative, online survey + geospatial analysis	Investigate impact of COVID-19 lockdowns on maternal mental health parental practices and their relationship with urban green space	Green space	Objectively assessed green space within a 300-m radius around mother's residential address	Mental health Parental practices	Parent Stress Index Scale (PSI-SF) Center for Epidemiological Study's Depression Scale (CES-D) Parental Cognitions and Conduct toward the Infant Scale (PACOTIS)	Lockdown duration increased dysfunctional interactions with children for mothers with little access to green space, while this was not seen for mothers living close to green space.
Niles, Wirkkala, Belarmino, and Bertmann (2021), USA	Adults and older adults (600, largest age group 55+ years (43.8%), 67.3%, 93.2% White, 6.7% Other)	August–September 2020	Observational, cross-sectional, quantitative, online survey	Investigate the association between home food procurement activity and dietary quality during COVID-19	Home food procurement activities	Self-reported engagement and changes in gardening, fishing, foraging, hunting, backyard livestock	Dietary quality	Fruit, vegetable, red meat, processed meat intake and changes in fruit/vegetable and red meat intake	Gardening since the beginning of COVID-19 was related to increased fruit (B = 0.39, 95%CI = 0.16-0.63) and vegetable intake (B = 0.55, 95%CI = 0.31-0.79), whereas foraging was unrelated to fruit and vegetable intake. More gardening/foraging was unrelated to current fruit and vegetable intake and changes in fruit and vegetable intake. Results showed that the increase in fruit and vegetable was only observed for food secure households (B =

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									0.31, 95%CI = 0.39-0.95; B = 0.67, 95%CI = 0.39-0.95), but not for food insecure households. Livestock since COVID-19 was related to increased red meat intake (B = 1.02, 95%CI = 0.40-1.64), whereas fishing and hunting were not. Fishing and hunting since COVID-19 and more livestock, fishing, and hunting since COVID-19 were unrelated to red meat and processed meat intake.
Noel and Dardenne (2022), Belgium	Adults and older adults (675, 28.63 ± 12.75, age range = 17–77 years, 76.2%, n.a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigate relationship between green space and prosocial behavior	Public green space	Self-reported frequency of green space visit since start of the lockdown	Prosocial behavior	Social Value Orientation (SVO) slider	There was no association between green space attendance and prosocial behavior (Spearman rank r = −0.001, p = 0.971), however, interaction analysis showed that green space attendance was related to more prosocial behavior at places that were perceived as little crowded (β = 0.13, p = 0.030).
Noszczyk, Gorzelany, Kukulska-Kozie, and Hernik (2022), Poland	Adults and older adults in Krakow (1251, largest age group 25–40 years (42%), n. a., n.a.)	December 2020–February 2021	Observational, cross-sectional, quantitative, online survey	Investigate the importance of urban green space to the public during COVID-19	Urban green space	Reasons for visiting urban green space and impact on mental health	Mental health	Reasons for visiting urban green space and impact on mental health	Over 50% of the respondents indicated visits to green spaces during the pandemic as the most important factor for the improvement of their general well-being (54.2%) and for having a walk (50.6%). Over 75% of the participants considered visits to green spaces as having a very big (42.2%) or big (34.5%) impact on stress level reduction. Simultaneously, exercise at an outdoor gym did not matter for 35.5% of the respondents and had a very small importance to 16.5% or them. At the same time, almost half of the respondents that

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									visiting urban green space was an opportunity to spend time with friends and family. According to the study, residents believed green spaces to be important for their mental and physical health. Over 75% of the participants considered visits to green spaces as having a very big or big impact on stress level reduction.
Olszewska-Guizzo, Fogel, Escoffier, and Ho (2021), Singapore	Urban adults and older adults (25, 40.4 ± 17.9, age range 21–74 years, 56%, n.a.)	January 2020 April 2020	Experimental, longitudinal, quantitative, electroencephalography (EEG) and paper-pencil survey	Investigate whether contact with nature and perception of natural environments during home confinement can mitigate the impact of the stay-at-home order on mental health and well-being.	Digital nature Nature areas	Three 20-s video scenes from lush gardens and residential green, respectively (control condition: busy downtown without green) prior (T1) and right after the stay-at-home order (T2) Self-reported frequency and duration of visits to parks, gardens, or nature reserves (self-reported)	Frontal alpha symmetry (FAA) brain activity as a proxy for positive emotions Depressive symptoms Valence Energetic arousal Mood disturbances	Electroencephalography (EEG; antiCAP) Becks Depression Inventory-II (BD-II) Self-Assessment Manikin (SAM) Profile of Mood Scale (POMS)	Positive emotions assessed via brain activity decreased among those participants with high nature exposure during the stay-at-home order, while it remained stable in those with low nature exposure ($p = 0.005$). Valence response to the videos remained stable over time and was not moderated by nature exposure, whereas the intensity of positive emotions towards busy downtowns decreased among those with high nature exposure ($p = 0.002$). Changes in total mood disturbances and depressive symptoms based on Beck's Depression Inventory were not moderated by nature exposure.
Olszewska-Guizzo, Mukoyama, et al. (2021), Singapore	Urban adults and older adults (12, males: ø = 47.8 ± 17.8 years, females: ø = 17.8 ± 18.2 years, age range 21–75 years, 58%, n.a.)	Second quarter 2019- first quarter 2020 June 2020	Experimental, longitudinal, quantitative, fNIRS scans	Investigate changes in hemodynamic activation patterns of the prefrontal and occipital cortices from pre- to during COVID-19	Digital nature	Three 20-s video scenes from lush gardens and residential green, respectively (control condition: busy downtown without green) prior (T1) and right after the stay-at-home order (T2)	Cortical hemodynamic brain activation	Portable fNIRS cap set	Significant decreases were observed in average oxyhemoglobin over time for the urban park ($p < 0.05$, Cohen's $d = -1.01$), while the decreases for residential green and the city center were not significant, but yet of large effect size (Cohen's $d = -0.91$ to -1.00). There were no statistically

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									significant interactions observed.
Oswald, Rumbold, Kedzior, Kohler, and Moore (2021), Australia	Young adults in metropolitan areas (1004, 21.23 ± 1.93 years, age range 18–24 years, 55%, n.a.)	November 2020–January 2021	Observational, cross-sectional, quantitative, online survey	Investigate associations between potential risk and protective factors and mental illness and well-being during COVID-19	Nature	Incidental nature contact (3 items; outdoor access, living within 300-m walking distance to a green space or blue space, perceived neighborhood greenness or nature) Purposive nature contact (4 items; changes in nature contact, going out in the neighborhood, spending time at the local park, planning activities in nature)	Complete mental health state	Four categories based on scores of the Kessler Psychological Distress Scale (K-10) and the Mental Health Continuum Short Form (MHC-SF): Flourishing, Languishing, Struggling, Floundering	High perceived neighborhood nature or greenness was associated with a decreased risk for the mental health states languishing (RRR = 0.35, 95%CI = 0.14-0.85) and floundering (RRR = 0.25, 95%CI = 0.07-0.91). More than 300 m walking distance to the closest by green or blue space was associated with an increased risk for languishing (RRR = 1.77, 95%CI = 1.02-3.06). Those who decreased nature contact during COVID-19 were more likely to be floundering (RRR = 1.98, 95%CI = 1-09-3.58), whereas those who increased nature contact were less likely to be floundering (RRR = 0.49, 95%CI = 0.26-0.95). More detailed, those who decreased being out in the neighborhood were more likely (RRR = 1.85, 95% CI = 1.00-3.41) and those increasing time at the local park (RRR = 0.41, 95%CI = 0.20-0.81) and planned activities in nature (RRR = 0.40, 95% CI = 0.20-0.82) were less likely to be floundering. Those who increased planned activities in nature were less likely to be languishing (RRR = 0.54, 95%CI = 0.32-0.91). Those who disagreed that nature felt like getting away were more likely to be languishing, struggling, or floundering (RRR = 3.22-5.92, 95%CI = 1.18-17.03). Those who were neutral or agreed

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									that nature felt uncomfortable were more likely to be struggling (RRR = 2.61-5.51, 95%CI = 1.46-9.94).
Ottoni, Winters, and Sims-Gould (2022), Canada	Older adults (31, 55% < 75 years, 87% women, 10% Jewish, 3% Chinese, 3% South Asian, 84% White)	May–June 2020	Observational, cross-sectional, quantitative, semi-structured interviews	Investigate how neighborhood factors shape social experiences during COVID-19	Nature	Any nature mentioned by participants	Social connectedness	Any social connectedness mentioned by participants	The outdoors provided a place to meet with others while socially distance to go for walks, however, while some participants perceived those spaces to promote social connectedness for one-on-one interactions, others intentionally chose walking routes and times to avoid people, and almost always walked alone.
Pasek and Szark-Eckardt (2021), Poland	Women engaging in water-based outdoor and indoor physical activity (60, ice-swimming: N = 30, 39.9 ± 11.2, 100%, n.a.; aqua fitness: N = 30, 50.6 ± 10.9 years, 100%, n. a.)	NR	Observational, cross-sectional, quantitative, online survey	Investigate differences between indoor and outdoor water-based physical activity regarding mental health outcomes during COVID-19	Ice water	Engagement in ice-water swimming	Anxiety Body esteem	State-Trait-Anxiety Inventory (STAI) Body Esteem Scale (BES)	Women engaging in ice-swimming felt, compared to women engaged in aqua fitness, more relaxed and less tense, resentful, depressed and worried. Regarding body esteem, out of 35 indicators, women engaging in ice swimming reported higher body esteem on eight indicators.
Passavanti et al. (2021), Australia, China, Ecuador, Iran, Italy, Norway, USA	Adults and older adults (1612, 28 ± 9.36, 60%, n.a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigate the impact of COVID-19 on mental health and associated factors	Private garden	Garden as open space in one's home	Mindfulness Post-traumatic stress disorder Depression Anxiety Stress	Event Scale-Revised (IES-R) Depression, Anxiety and Stress Scale (DASS-21) Patient Health Questionnaire (PHQ-9) Perceived stress scale (PSS10)	In the PSS10 Scale, those without access to open air space had significantly higher stress scores (M = 19.52, SE = 1.79) than those with a private garden (MD = 1.25, p = 0.014, 95% CI: 0.31 to 2.16). No other differences were observed.
Pearson, Breeze, Reuben, and Wyatt (2021), USA	Breast cancer patients (56, 63.1 ± 10.7, 98%, 7.1% Black, 3.6% Native American, a.8% Hispanic/Latino, 88% White)	July 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between changes in nature use and perceived stress	Nature	Self-reported frequency and engagement in nature-based active and passive activities prior and during COVID-19	Stress	Perceived stress scale (PSS10)	Decreased usage of parks/ trails was significantly associated with higher stress (B = −2.30, p = 0.030)

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Pearson, Horton, et al. (2021), USA	Low-income adults and older adults (86, 56.8 ± 14.6, 57%, 83% African-American)	August–October 2019 June–July 2020	Observational, longitudinal/cross-sectional, quantitative, online survey + geospatial analysis	Investigate associations between quality of nature views from home and mental health issues	Nature	Objectively assessed park view from home Self-reported access and use of nature	Stress Anxiety Depression	Perceived stress scale (PSS10) Patient-Reported Outcomes Measurement Information System (PROMIS)	Higher visibility of greenspace was associated with higher anxiety ($\beta = 3.97$, $p = 0.025$), but not depression or stress. Use and accessibility were unrelated to all constructs.
Perez-Urrestarazu et al. (2021), mostly Brazil, Greece, Spain, Italy	Adults and older adults (4205, largest age group 26–65 years (~20%), 56%, n.a.)	April–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate the impact of indoor and outdoor vegetation on emotional well-being during COVID-19.	Indoor and outdoor vegetation Green space	Self-reported number of indoor and outdoor plants at home Two items with statements that general green space and indoor vegetation are beneficial for participant's well-being	Emotional well-being	Frequency of positive and negative emotions Two items with statements that general green space and indoor vegetation are beneficial for participant's well-being	89.5% indicated that green space was necessary for their psychological well-being, while 76.0% indicated that indoor vegetation was beneficial for their psychological well-being. People frequently visiting green areas prior to COVID-19 displayed better emotional well-being (weekly visits: mean = 12.25, SD = 2.7; less than once a month: mean = 12.62, SD = 2.8; $p < 0.001$) as did people with a higher number of indoor plants (1-3 plants: mean = 12.35, SD = 2.6, >10 plants: mean = 11.92, SD = 2.7), while there was no difference in emotional states for outdoor plants. For some countries, emotional states were no different for the frequency of nature visits and the number of indoor plants.
Poortinga, Bird, Hallingberg, Phillips, and Williams (2021), UK	Adults and older adults (5566, largest age group 61–70 years (32.5%), 68.9%, n.a.)	March–April 2020 June–July 2020	Observational, cross-sectional, quantitative, online survey	Explore potential benefits of public and private green space during and after the first peak in COVID-19 infections.	Public green space Private green space	Self-reported walking time to nearest public green space areas Self-reported access to own or communal garden	Subjective wellbeing Self-rated health	SF36 scale One item for self-rated health	During the first COVID-19 peak (lockdown) and post-peak (restrictions loosened), compared to public green space within <5 min walking distance, public green space within 5–10 min and >10 min walking distance was associated with lower subjective wellbeing (B = −0.12 to −0.34, 95%CI = −0.05 to −0.43) and lower self-rated health (B

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									= −0.20 to −0.48, 95%CI = −0.13 to −0.56). During the first peak, having garden access could compensate for walking distance >10 min to public green space for subjective well-being (B = 0.31, 95%CI = 0.03-0.59) and self-rated health (B = 0.36, 95%CI = 0.09-0.63), while this was not the case post-peak. Interaction revealed that with one exception (private green space having a bigger impact on male's subjective well-being during the first peak, B = 0.23, 95%CI = 0.03-0.44), private and public green space had a similar impact independent of gender, age, working status, and marital status.
Pouso et al. (2021), Spain, UK, Germany, France, United States, Portugal, Italy, New Zealand, Mexico	Adults and older adults (5218, largest age group 36–45 years (25.6%), 65%, n.a.)	April–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate whether maintained contact with outdoor nature spaces was associated with better mental health and mood during lockdown restrictions	Direct and indirect outdoor nature	General nature accessibility based on self-reported lockdown level Individual nature accessibility: self-reported window views of natural features (indirect contact) and public and private outdoor space availability One-item asking participants if indirect and direct outdoor nature helped them to deal with the lockdown	Mental health Mood	4-item Patient Health Questionnaire (PHQ-4) Choice of 1–3 emotions based on Plutchik's wheel of emotions One-item asking participants if indirect and direct outdoor nature helped them to deal with the lockdown	Moderate or severe poor mental health was more prevalent for people with severe lockdown restrictions (level 1; 23.9%) compared to less strict lockdown restrictions (level 2: 18.4%, level 3: 19.2%; $p < 0.001$). People with nature views were less likely to exhibit depressive symptoms (OR = 0.77, 95%CI = 0.67-0.89) and anxiety symptoms (OR = 0.82, 95%CI = 0.72-0.93), as were people with access to outdoor nature space (depressive symptoms: OR = 0.72, 95%CI = 0.61-0.84; anxiety symptoms: OR = 0.75, 95%CI = 0.64-0.87). For people in the strictest lockdown situation in Spain, moderate or severe poor

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									mental health prevalence was lower for views of natural area elements (17.8%) compared to limited or urban views (27.2%, $p < 0.001$). During the lockdown, individuals with natural elements in their views mentioned more positive emotions than individuals with limited or urban views.
Pringle, Kime, Zwolinsky, Rutherford, and Roscoe (2022), UK	People living with and beyond cancer (PLWBC) (9, 78%, 78%, n. a.)	May–July 2021	Observational, cross-sectional, qualitative, semi-structured interviews	Investigate indoor and green space-outdoor physical activity experiences during COVID-19	Green space	Structured exercise sessions in green space	Physical activity	Physical activity experience in green space	Participants expressed different experiences regarding the exercise session in green space: While some expressed that the sessions in green space facilitated continuing with the structured exercise sessions and reported wonderful feelings, others reported the exercise sessions in green space to be a barrier due to temperatures, the lack of infrastructure, and the barrier of using public transport to get there.
Puhakka (2021), Finland	University students (47, 19–33 years, 80.8%, n. a.)	March–April 2020	Observational, cross-sectional, qualitative, thematic writings	Investigate the role of nature for university students well-being during COVID-19	Nature	Thematic writings of students how nature impacts their well-being	Well-being	Open question about effects of nature on psychological, physical, and social well-being	Nature can have an important role in students' well-being during COVID-19, providing opportunities for physical activity, emotional and cognitive renewal, strengthening social relationships and sharing experiences, reducing loneliness, and relieving the negative physiological effects of various stressors, and supporting retreating behaviors by enabling 'being away' and providing freedom from the pressures of student life.
Qiu, Sha, and Utomo (2021), Australia	National forest park visitors	October 2019 October 2020	Observational, longitudinal,	Investigate the perceived	Natural soundscapes	Continuous equivalent sound	Perceived restorativeness	Perceived Restorativeness Soundscape Scale (PRSS)	Perceived restorative characteristics of natural

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	(pre-pandemic: 526, ø = 38.4 ± 8.5 years, age range 20–70 years, 55%, n.a.; during the pandemic: 371 adults, ø = 36.2 ± 6.5 years, 56%, n.a.)		quantitative, paper-pencil survey	restorative characteristics of natural soundscapes before and after COVID-19 outbreak		pressure level in Burleigh Heads National Park, Australia Perceived Restorativeness Soundscape Scale (PRSS) adapted to natural sound environments		adapted to natural sound environments	soundscapes were mostly higher for the during-pandemic group compared to the pre-pandemic group.
Quarta et al. (2022), Italy	University students and academic staff (University students: N = 939, largest age group 18–24 years (62.4%), 75%, n.a.; Staff: N = 238, largest age group 45–54 years (40.3%), 54.2%, n.a.)	April–May 2021	Observational, cross-sectional, quantitative, online survey	Investigate associations between time spent in nature and mental health	Nature	Self-reported frequency of spending time in nature	Anxiety Depression Quality of life Subjective well-being Energy levels	Depression Anxiety Stress Scales Short Version (DASS-21) WHOQoL-Brief questionnaire 9-item subjective well-being (SWB) questionnaire Fatigue scale	Students with low depression, anxiety, and stress spent more time in nature than students with moderate/high depression, anxiety, and stress. Simultaneously, students with low subjective well-being spent less time in nature than students with moderate/high subjective well-being (effect size: r = 0.14-0.19). These associations were not observed for staff members. Time spent in nature was positively associated with quality of life and energy levels both in students and staff members.
Rajoo, Karam, Abdu, Rosli, and Gerusu (2021), Malaysia	Adults with depression, anxiety, or stress symptoms (30, 26.2 ± 4.14 years, 33%, n.a.)	April–May 2020	Experimental, longitudinal, quantitative, survey	Investigate the potential nature-based exercise and nature therapy in improving mental wellbeing during COVID-19	Urban greenery	One week of unsupervised exercise (circuit training without equipment) or nature therapy activities (sensory enjoyment, stretching, mediation) conducted by each participant on their own in urban greenery (Rooftop and neighborhood parks, home gardens	Stress Anxiety Depression	Depression Anxiety Stress Scales Short Version (DASS-21)	Both the nature-based exercise and the nature therapy program resulted in stress, anxiety and depression symptom reductions. When evaluating the effectiveness of exercise and nature therapy on a case-by-case basis, nature therapy was more effective in treating mental health issues.
Reid et al. (2022), USA	Adults and older adult in Denver (911, largest age group 30–49	November 2019-January 2021	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate if green space exposure buffers against stress	Green space	Objectively measured Normalized Difference	Stress Depression Anxiety	Perceived Stress Scale (PSS-4) Center for Epidemiological Studies	Spending a lot of time in green space (usage) was significantly associated with lower anxiety and

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	years (43%), 58%, 3.8% Black, 1.8% Asian/Pacific Islander, 2.1% Native American, 3.3% Multiracial, 89% White)			and distress during COVID-19		Vegetation Index (NDVI) within 300m and 500m circular buffers around participant's home Self-reported abundance, visibility, access, usage, and quality of green space		Depression Scale (CES-D-10) Minnesota Multiphasic Personality Inventory-2 Anxiety Scale (MMPI-2 Anxiety)	depression. In both buffers, NDVI (objective abundance) was significantly associated with lower depression scores, while perceived green space abundance was associated with lower anxiety scores. Results for green space quality and lower anxiety scores were inconsistent. No associations between green space and stress were observed.
Rhodes, Liu, Lithopoulos, Zhang, and Garcia-Barrera (2020), Canada	Adults and older adults (1055, ø = 48.8 ± 16.7 years, 51%; 82.8% Caucasian, 17.1% Other)	May 2020	Observational, cross-sectional, quantitative, online survey	Investigate socio-ecological correlates of current moderate to vigorous physical activity and COVID-19 related moderate-to-vigorous physical activity shifts	Nature Parks and trails	Neighborhood Environment Walkability Scale (NEWS) for self-report about attractive natural sights and proximity to parks and trails	Moderate to vigorous physical activity COVID-19 related transitions in meeting the physical activity guidelines	Modified version of Godin Leisure-Time Questionnaire Modified stage questionnaire to assess transitions	Proximity to parks and trails ($\beta = 0.03$) and nature aesthetics ($\beta = 0.07$) were unrelated to moderate-to-vigorous during lockdown (both p's > 0.01) and changes in moderate-to-vigorous physical activity (proximity to parks and trails: $\beta = -0.01$, nature aesthetics: $\beta = 0.02$, both p's > 0.01). No difference in nature aesthetics and park proximity was observed between transition groups.
Ribeiro et al. (2021), Portugal and Spain	Adults (3157, largest age group 40–64 years (46.7%), 74.6%, n.a.)	March–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between changes in nature contact and mental health during COVID-19	Greenery, including private indoor and outdoor green space and public green space	7 items covering nature visit frequency, views, and care of different types of natural elements	Psychological distress Somatization Perceived stress	General Health Questionnaire (GHQ-12) Adapted 4-dimensional symptom questionnaire One question asking about stress during the lockdown	In Portugal, maintaining/ increasing views of nature were associated with less psychological distress (B = −0.27, 95%CI = −0.51 to −0.03), less somatization (B = −0.79, 95%CI = −1.39 to −0.20), and lower stress levels (B = −0.48, 95%CI = −0.73 to −0.23). Public natural spaces were associated with lower stress levels (B = −0.29, 95%CI = −0.49 to −0.08). None of these observations was made in Spain. In Spain, indoor plants were associated with less stress (B = −0.52, 95%CI = −0.96 to

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									−0.07), while community private green space (B = −0.82, 95%CI = −1.61 to −0.03) and other natural spaces or elements (B = −1.06, 95%CI = −1.79 to −0.32) were associated with less somatization. None of these findings were observed in Portugal.
Robinson, Brindley, et al. (2021), mostly UK	Adults and older adults (1184, largest age group ≥55 years (53%), 72%; n.a.)	April–July 2020	Observational, cross-sectional, quantitative, geospatial analysis and online survey	Investigate nature's potential health and well-being benefits during COVID-19	Green space	Objectively measured Normalized Difference Vegetation Index (NDVI), green space presence, and green space abundance around participant's postcode with 50–500-m buffers Self-reported duration and frequency of green space visits Items asking about perceived health benefits of nature	Mental well-being Perceived Stress	Warwick–Edinburgh Mental Wellbeing Scale (WEMWBS) Perceived Stress Scale Items asking about perceived health benefits of nature	48% of respondents agreed that spending time in nature helped them to cope with COVID-19, with the response strength being stronger for females and those not working or being unemployed due to COVID-19. The most popular reasons for visiting nature were exercise, stress and anxiety reduction, and relaxation. There were no statistically significant associations between green space abundance or presence, the NDVI index, and mental well-being or perceived stress for any buffer distance. Further analysis of green space typology revealed that the mean number of food-growing allotments was higher for those with higher mental well-being scores within a 100-m ($p < 0.01$) and 250-m buffer ($p = 0.03$).
Roche, Fisher, Fancourt, and Burton (2022), UK	Adults and older adults (116, 49.5 ± 20, 61.2%, 70.7% White British)	May 2020–January 2021	Observational, cross-sectional, qualitative, topic guided interviews	Investigate physical activity facilitators and barriers during COVID-19	Nature	Any nature mentioned by participants	Physical activity	Any physical activity mentioned by participants	Green space in rural areas that allowed physical distancing as well as observing seasonal changes in nature were reported as facilitators of physical activity. Also, garden access was reported as an opportunity for physical activity engagement via gardening.

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Rogers et al. (2020), UK	COVID-19 risk group adults and older adults (9190, largest age group 55–69 years (46.1%), 78%; 95% Caucasian, 3.7 black and minority background)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigate the impact of the COVID-19 lockdown on physical activity	Garden	Self-reported garden access	Physical activity intensity	Self-reported changes in PA intensity from pre-COVID-19 lockdown to the time of survey participation during COVID-19 lockdown	Lack of garden access was associated with increased odds of starting to do less intense physical activity during the lockdown (OR 1.74, 95%CI = 1.56–1.91, p = 0.001), while garden access was unrelated to starting more intense physical activity (OR = 1.21, 95%CI = 0.96-1.47).
Samuelsson, Barthel, Giusti, and Hartig (2021), Sweden	Adults and older adults (684, largest age group 35–49 years (37.6%), 67.0%, n.a.)	April–June 2020	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate associations between changes in visiting natural areas and well-being changes during COVID-19	Nature	Landcover data on fields, forests, and water	Well-being	Question about how well-being changed in relation to visiting natural places	Abstaining from visiting places with natural features located in high densely populated areas was related to a negative influence on wellbeing. Yet, fields, forests and water were strongly associated with places people claimed wellbeing benefits from during pandemic restrictions. The further a visited place was from the respondent's home, the more likely it was to have a positive wellbeing influence.
Samus et al. (2022), Germany, New Zealand	Urban adults and older adults (Germany: 101, largest age group 35-44 (31.7%), 76.2%, n.a) New Zealand: 160, largest age group 25–34 years (28.1%), 89.4%, n.a.)	May 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between biodiversity of private gardens, and mental wellbeing during COVID-19	Private garden Nature	Habitat heterogeneity scale Ten questions about plant growth forms Self-reported time spent in nature Self-reported garden size	Mental well-being	Positive and negative affect schedule (PANAS) Center for Epidemiological Studies Depression Scale (CES-D)	Time spent in nature was positively associated with positive affect (B = 0.32, p = 0.002). Garden size was positively associated with positive affect (B = 0.26, p = 0.034) and negatively related to negative affect (B = −0.24, p = 0.044) and depression (B = −0.38, p = 0.002). These associations were only observed in Germany, but not New Zealand. Garden feature richness was related to less depressive symptoms only in New Zealand (B = −0.25, p = 0.042). No other associations emerged.
Sanusi et al. (2021), Malaysia	Adults and older adults (30, largest age group 41–50	NR	Observational, cross-sectional, quantitative, online survey	Investigate the role of home pocket gardens for quality	Home pocket garden	Self-reported ownership of home pocket garden	Food security Quality of life	Agreement with statements regarding the contribution of home	A large part of the respondents (strongly) agreed that home pocket gardens contributed to

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	years (40%), 83.3%, n.a.)			of life during COVID-19				pocket garden to food security and quality of life	food security during the pandemic, enhanced interactions amongst family members and among neighbors, and contributes to enhanced quality of life for oneself and the community.
Schmidt et al. (2021), Germany	Children and adolescents (1394, 46.5% 6–10 years, 53.5% 11–17 years, 50.5%, n. a.)	August 2018–March 2020 April–May 2020	Observational, longitudinal, quantitative, online survey	Investigate the role of the housing situation in physical activity changes during COVID-19	Garden	Access to garden owned by the family	Physical activity	One item asking about the number of days with at least 60 min physical activity	Daily life physical activity (playing outside, walking/cycling, gardening, housework) increased for children and adolescents with garden access, but not for those without garden access.
Schweizer et al. (2021), Germany	Strava segments (30 segments in urban areas, 14 segments in rural areas)	March–June 2020	Observational, cross-sectional, quantitative, fitness app data analysis (Strava)	Investigate cycling behavior in urban and rural public green spaces during COVID-19	Nature parks (rural areas) and urban green space	Strava segments in green space	Cycling	User frequency of Strava cycling segments	During the lockdown, there was a 55% cycling increase in urban green space (95%CI = 45%–75%), but not in rural green space. After lockdown restrictions were loosened, no increased cycling frequency was observed anymore.
Sia et al. (2022), Singapore	Urban adults and older adults (Gardening group: 8786, largest age group 35–44 years (27.4%), n. a., n.a.) Community group: 1849, largest age group 25–34 years (35.1%), n. a., n.a.)	Community group: May–June 2020 Gardening group: May–July 2021	Observational, cross-sectional, quantitative, online survey	Investigate the impact of gardening on mental resilience during COVID-19	Garden	Self-reported time spent in gardening activity	Mental resilience	Singapore Youth Resilience Scale	Gardeners had higher mental resilience than people from the non-gardening community group. Within the gardening group, those with less than 1 h of weekly gardening time had significantly lower scores in their mental resilience compared to those with more weekly gardening time.
Soga et al. (2021), Japan	Adults and older adults (3000, n = 500 for each age group, 50%, n. a.)	June 2020	Observational, cross-sectional, quantitative, geospatial analysis and online survey	Investigate nature's role in mitigating adverse mental health outcomes due to the pandemic.	Green space Neighborhood greenness	Self-reported frequency and duration of green space use, green view from window Objectively measured Normalized Difference Vegetation Index (NDVI) within a 250m buffer	Self-esteem Life satisfaction Subjective happiness Loneliness Depression & anxiety	Rosenberg Self-Esteem Scale Liang's (1984) version of the Life Satisfaction Index A Subjective Happiness Scale UCLA Loneliness Scale (Version 3) 12-item General Health Questionnaire	Green window view was associated with increased self-esteem (B = 0.13, 95%CI = 0.04-0.21), live satisfaction (B = 0.21, 95%CI = 0.14-0.32), and happiness (B = 0.16, 95% CI = 0.07-0.25), decreased loneliness (B = −0.11, 95%CI = −0.20 to −0.02) and decreased depression and anxiety (B

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
						around the centroid of respondent's postcode.			= −0.10, 95%CI = −0.19 to −0.01). The frequency of green space use was associated with increased self-esteem (B = 0.06, 95%CI = 0.03-0.10), live satisfaction (B = 0.07, 95%CI = 0.04-0.11), and happiness (B = 0.09, 95% CI = 0.06-0.13), and decreased loneliness (B = −0.08, 95%CI = −0.20 to −0.02) and depression and anxiety (B = −0.05, 95%CI = −0.09 to −0.02). Neighborhood greenness assessed via the NDVI index was unrelated to any of the five health metrics (all p's > 0.05).
Spano et al. (2021), Italy	Adolescents, adults, and older adults (3886, 41.9 ± 15.2 years; age range: 14–93 years, 62%, n.a.)	March–April 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between home greenness and psychological health during lockdown	Greenery at home	Self-reported indoor and outdoor green features, including green view, presence of plant pots, accessibility to private green space, type of road the house was located as proxy for the natural environment	Psychological state	Self-reported changes in anxiety, anger, fear, confusion, moodiness, boredom, irritability, recurrent thoughts and/or dreams, poor concentration, and sleep disturbance	Plant pots were associated with less worse changes in anger, fear, irritability, and sleep disturbance (β = −0.08 to −0.10, all p's < 0.05). Green view (β = −0.04 to −0.08, all p's < 0.05) and private green space (β = −0.04 to −0.09, all p's < 0.05) were associated with less negative changes in all psychological states. General natural environment was related to less negative changes in anxiety, fear, boredom, irritability, recurrent thoughts/dreams, and sleep disturbance (β = −0.04 to −0.06, p < 0.05).
Sun et al. (2021), China	University students (819, n.a., 57.3%, n.a.)	May–August 2020	Observational, cross-sectional, quantitative, paper-pencil questionnaire	Investigate psychological recovery effect of campus environment during COVID-19	Blue and green space	Questions about preferences for blue and green space	Restoration	Perceived Restorativeness Scale	Compared to grey space and sports grounds, perceived restorativeness was highest for blue and green space, with varying results across campus time or stay duration.
Szpunar et al. (2021), Canada	Parents and children (Parents: 12, 40.7 ± 7.5,	December 2020–January 2021	Observational, cross-sectional, qualitative, guided interview	Investigate physical activity barriers and facilitators during COVID-19	Nature	Any nature mentioned by participants	Physical activity	Any physical activity mentioned by participants	Closure of nature-based physical activity locations, such as parks and outdoor trails, as well

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	91.7%, n.a.; Children: 9, 7.3 ± 2.9, 66.7%)								as lacking access to a garden, constituted barriers to physical activity during lockdown. At the same time, engagement in nature-based outdoor activities, such as hiking and exploring trails, as well as having a garden were physical activity facilitators.
Talal and Gruntman (2022), Israel	Adults and older adults in Tel-Aviv (458, 42, 56%, n.a)	March–May 2021	Observational, cross-sectional, quantitative, online survey	Investigate how urban nature site shifts relate to mental health during COVID-19	Urban nature	Changes in urban nature visitation based on self-reported distance to and time spent in urban nature sites	Mental health	WHO Well-Being Index Statement about mental health contribution of visiting urban nature site	A relative increase in urban nature visitation was positively associated with higher ratings of mental health ($B = 0.15$, $p < 0.05$).
Tarsitano, Sinibaldi, and Colao (2021), Italy	Children, adolescents, adults, and older adults participating in guided tours at an urban park (401, largest age group 40–55 years (23%), age range 5–74 years, n.a., n.a.)	September–October 2020	Experimental, case-study, qualitative, interview	Investigate the social and sensorial-perceptive impact of the guided tour experience on social relationships and well-being after the COVID-19 lockdown	Urban park, dinosaur museum, nature-based laboratory activities	4 h guided tours at the urban park of Lama Balice, dinosaur museum, and nature-based laboratory with an interactive experiential approach of Landsense Ecology	Social relationships Well-being	Questionnaire interview about experiences at the workshop with one question asking if the experience encouraged the emergence of friendships or other social relationships and one question asking if the experience influenced well-being after the pandemic restrictions	87% rated the workshop experience as good or excellent regarding the encouragement of friendships or other social relationships. In addition, 95% rated the workshop experience as good or excellent regarding the influence on overall well-being after the pandemic restrictions.
Tavares and Marinho (2021), Brazil	Older adults (23, 68.4 ± 6.2, 69.7%, n.a.)	July–October 2020	Observational, cross-sectional, qualitative, semi-structured interviews	Investigate the influence of the COVID-19 pandemic on frequent urban nature park visitors	Urban nature	Urban nature park visitors	Physical activity	Any physical activity mentioned by participant	Park closures impacted physical activity opportunities for adults, which were the designated location for physical activity prior to the pandemic.
Theodorou et al. (2021), Italy	Adults and older adults (303, ø = 39.9 ± 13.4 years, age range 18–74 years, 68.3%, n. a.)	March–May 2020	Observational, cross-sectional, quantitative, online survey	Investigates the relation between gardening and psychopathological distress during the lockdown of the first wave of COVID-19	Garden	Self-reported engagement in gardening activities during COVID-19	COVID-19 related distress Psycho-pathological distress	22-item Impact of Event Scale-Revised (IES-R) 9-item Symptom-Checklist-K-9 (SCL-K-9)	Gardening was related to lower COVID-19 related distress ($r = -0.18$, $p < 0.01$) and psychopathological distress ($r = -0.23$, $p < 0.01$). COVID-19 related distress mediated the association between gardening and psychopathological distress.
Tomasso et al. (2021), USA	Adults and older adults in metropolitan	April–May 2020	Observational, cross-sectional, quantitative, online survey	Investigates how nature exposure and perceived nature	Any type of nature	One-item statement asking	Flourishing	Harvard Flourishing Index	Strong agreement with nature deprivation was associated with a

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	areas (529, largest age group 25–34 years (29%), 75%, 82% white non-Hispanic)			deprivation relate to well-being during COVID-19		for feelings of nature deprivation			flourishing decline (B = −4.04, 95%CI = −7.33 to −0.74, p = 0.03) relative to those who strongly disagreed with feeling nature deprived. Feelings of nature deprivation and ethnicity interacted, with Caucasians decreasing flourishing with feelings of nature deprivation (B = −6.03 to −4.08, 95%CI = −9.60 to −0.93), while non-whites increased flourishing with feelings of nature deprivation (B = 4.70-7.15, 95%CI = 2.25-19.83).
Tomikawa, Niwa, Lim, and Kida (2021), Japan	Parents of primary school children (310, largest age group 40–45 years (35%), 56%, n.a.)	April 2020	Observational, cross-sectional, qualitative, online survey	Investigate associations between current life satisfaction and spatial characteristics during COVID-19	Parks	Total amount of park space	Life satisfaction	One open-ended question to describe aspects what participants are currently satisfied in their life	Based on text mining analysis, for people living in the Western area, satisfaction with the circumstances surroundings parks was observed, however, for the Eastern and Central City area, there was a weak or no relationship observed.
Toselli et al. (2022), Italy	Adults and older adults (328, largest age group 18–44 years (46.7%), 77.1%, n.a.)	May–September 2021	Experimental, longitudinal, quantitative, online survey	Investigate the impact of a structured park-based physical activity intervention on well-being during COVID-19	Urban parks	Three-month park-based exercise intervention	Well-being	Psychological General Well Being Index short form (PGWB-S)	For women, psychological well-being improved across all six domains (feeling nervous, full of energy, downhearted, emotionally stable, cheerful, tired), whereas for men, improvements were only observed for two domains (feeling full of energy, feeling tired).
Trevino et al. (2022), USA	University students (353, largest age group 18–24 years (77.5%), 75.3%, n.a.)	Spring-fall 2020	Observational, cross-sectional, quantitative, online survey	Investigate how nature interactions impact mental health during COVID-19	Nature	12 questions about active and passive interactions with nature	Depression Anxiety Stress Academic stress	Depression Anxiety Stress (DASS) Depression Anxiety Stress and Academic Stress (DAAS)	Outdoor plant exposure was related to better mental health, however, indoor plant exposure and plant access were mostly unrelated to mental health.
Ugolini et al. (2020), Spain, Croatia, Italy, Lithuania, Slovenia, Israel	Adults (2540, majority 30–69 years, 74–84%; n.a.)	March–May 2020	Observational, cross-sectional, quantitative/ qualitative, online survey	Investigate human behaviors, perceptions, and attitudes towards urban green space in relation to COVID-	Urban green space	Self-reported type and visit frequency of urban green space, distance to urban green space Multiple choice	Motives related to visiting urban green space use Nature deprivation	Multiple choice and open-ended questions asking about motivation visit a green area and factors most missed during	During the COVID-19 isolation, urban green space was important for providing places of solace and respite, and for exercise and relaxation.

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				19 related restrictions		and open-ended questions asking about motivation visit a green area and factors most missed during isolation in relation to green areas		isolation in relation to green areas	The main motivation to visit urban green space similar for frequent and infrequent urban green space visitors, namely exercise (2%–47%), followed by relaxation (2%–50%), with large variations across countries. In all except for one country, more than 50% indicated that they missed urban green space "rather" or "a lot", with missed aspects, amongst others, exercising outdoors (9%–44%) and meeting others (6%–40%). Agreement for missing nature was dependent on frequency of visiting urban green space during COVID-19 and window views of natural elements.
Ugolini et al. (2021), Italy	Adults (2081, largest age group 40–50 years (24.5%), 57%, n.a.)	March–May 2020	Observational, cross-sectional, qualitative, online survey	Investigate perceptions and behavioral patterns related to urban green space	Urban green space	Self-reported visit frequency of and distance to urban green; green view from the window Multiple choice questions with mostly predefined answer options regarding reasons for urban green space use	Motivation to visit green space Feelings of deprivation	Multiple choice questions with mostly predefined answer options regarding reasons for urban green space use	During the lockdown, 20% in red zones (areas severely affected by COVID-19) and 32% in non-red zones ($p < 0.001$) reported the main reason for visiting urban green space was exercise, while 24% in red zones and 19% in non-red zones ($p < 0.05$) reported relaxing as a main reason. Meeting people was mentioned by 1%. Physical exercise was a motivation that increased by 8% during the lockdown in the non-red zones, whereas all other motivation reasons decreased during lockdown. Engagement in physical exercise during the lockdown was related to frequency of urban green space visitation prior to the lockdown ($B = 0.02$, $p < 0.05$). In areas where people

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									could not access urban green space, feelings of deprivation were reported by 86% of the respondents. Feelings of urban green space deprivation were more likely for frequent pre-pandemic urban green space visitors (B = 0.27, p < 0.005) and for people that had no green view from the window (B = 0.05, p < 0.05).
van Houwelingen-Snippe, van Rompay, and Ben Allouch (2020), Northern Europe and North America	Adults and older adults (1203, largest age group 40–49 years (41%), 35%, n.a.)	April 2020	Experimental and observational, longitudinal and cross-sectional, quantitative/ qualitative, online survey	Investigate the influence of digital nature on social and mental well-being, and the association between real nature access and loneliness	Digital nature General nature	Participants watched one of four nature landscape videos (~5 min): dense-tended, dense-wild, spacious-tended, spacious-wild nature scene Self-reported walking time towards nearby nature, number of nature interactions, and garden access	Connectedness to community Loneliness	Inclusion of in the Community Self-scale UCLA loneliness scale	Connectedness to the community scores were higher post-exposure to digital nature (M = 3.94, SD = 1.27) than pre-exposure (M = 3.72, SD = 1.24; p < 0.001). Peoples' comments on the video revealed that they allowed to relax and were ideal for people in a lockdown situation to stop worrying. Longer walking time towards nature was associated with higher loneliness scores (B = 0.24, β = 0.30, p < 0.001), whereas garden access (B = 0.44, β = 0.03, p > 0.05) and the number of nature interactions (B = 0.02, β = 0.00, p > 0.05) were unrelated to loneliness.
Vega-Perona, Bernabe-Villodre, Garcia-Ochoa, and Martinez-Bello (2022), Spain	Teachers and parents in the early childhood education and care setting with 2–3 year old toddlers (34, 38, 67.6%, n.a.)	October 2020–March 2021	Observational, cross-sectional, qualitative, semi-structured interviews	Investigate physical activity barriers and facilitators during COVID-19	Nature	Any nature mentioned by participants	Physical activity	Any physical activity mentioned by participants	Parents reported the poor availability, difficult accessibility, and closure of parks as a physical activity barrier for toddlers.
Veitch, Biggs, Deforche, and Timperio (2022), Australia	Adult park users (9, n.a., n.a., n.a.)	Up to July 2020	Observational, cross-sectional, qualitative, semi-structured walk-along interviews	Investigate perceptions of parks and park use during COVID-19	Parks	Park users	Perceptions of park use	Any health outcome or behavior mentioned by participant	Parks were important locations during the pandemic to leave the house and go for a walk, provide a safe place for

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									physical distancing, and to relax.
Venter, Barton, Gundersen, Figari, and Nowell (2021), Norway	Strava users in Oslo (~53000, 13 years and older)	January 2019–August 2020	Observational, longitudinal, quantitative, fitness tracker app analysis (Strava)	Investigate the longevity of increases in recreational urban green space use during the lockdown	Green and blue space	Coastal zone, forest, agriculture, city park, protected areas (based on land use zone data)	Walking and cycling	Mobile tracking data in Oslo	During the lockdown, increases of +228% for walking activities (running, walking, hiking) and +252% for cycling were observed. The strongest increase was observed in forest areas (pre-pandemic: 9%, during the pandemic: 23%) and protected areas (pre-pandemic: 0.6%, during the pandemic: 1.5%). The increase was especially strong in adolescents (13–19 years), while a drop was observed for people between 35 and 64 years. While the increase was not maintained during Norway's summer holidays, while another +89% increase above baseline was observed after the summer holidays.
Vogel et al. (2021), USA	Adults and older adults (990, 50.5 ± 16.7 years, 77%; 69.4% White/ Caucasian, 21.2% Asian, 9.4% Other)	March–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate associations between physical activity, stress, and coping strategies in the during early and mid-COVID-19 lockdown	Gardens	One item asking participants what they do to manage their stress with predefined answer options including gardening during mid-COVID-19 lockdown	Physical activity	Stanford Leisure-Time Activity Categorical Item (L-Cat)	During mid-COVID-19 lockdown, participants meeting the physical activity guidelines were more likely to report gardening as a coping strategy (adjusted odds ratio = 1.68, 95%CI = 1.22-2.29).
Vos et al. (2022), Belgium	Mothers of young children (766, 36.6 ± 4.9, 100%, n.a.)	December 2020–May 2021	Observational, cross-sectional, quantitative, online survey + geospatial analysis	Investigate how residential proximity to green space was related to stress response buffering during COVID-19	Green space	Objectively assessed green space within 50, 100, 300, 500, and 1000m circular buffer around participant's home based on land cover data	Stress Physical activity	Two items asking about feeling more stressed compared to prior the pandemic One item asking about physical activity participation	For an inter-quartile range contrast in residential green space 300 m and 500 m around the residence, participants were respectively 24% (OR = 1.24, 95%CI: 1.03 to 1.51) and 29% (OR = 1.29, 95%CI: 1.04 to 1.60) more likely to be more resistant against stress. Associations were not observed for the 50, 100, and 1000m buffer. No associations were

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Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
									observed with physical activity.
Weinbrenner et al. (2021), Germany	Urban forest visitors (Questionnaire: 714, 41 years, age range 16 and 82 years, 59%, n. a., Ethnographic observation: 18 participants Instagram analysis: 5172 posts)	April–May 2020	Observational, case study, qualitative and quantitative, online survey, ethnographic observations, Instagram post analysis	Investigate the relevance of forests for city residents during the COVID-19 pandemic.	Forests around a German city	Questions regarding free time activities in the forest pre- and during the pandemic Reasons for visiting forests Behavioral participant observations (with protocol) in forests Instagram picture analysis	Coping and social contacts	Reasons for visiting forests Behavioral participant observations (with protocol) in forests Instagram picture analysis	Respondents visited the forest for different purposes, including staying healthy and doing sports (98% full/partial agreement), reduced psychological stress (91% full/partial agreement), and keeping in touch with friends and family (58% full/partial agreement). Of those respondents who agreed that there is a connection between their forest visits and COVID-19 (67.2%), reasons for this were that forest visits were retreats from the pandemic and helped to cope with changed everyday life, with the latter one being the most important one. In addition, the forest became a replacement to fulfill different needs without breaking the rules, including a functioning as social meeting point, gym, and playground.
Wendtlandt and Wicker (2021), Germany	Adults and older adults (412, 27 years, age range 18–64 years age, 66.8% female, n.a.)	June–August 2020	Observational, cross-sectional, quantitative, online survey	Investigate the effects of nature-based, natural resource-using, and nature-neutral sport activities before and during the COVID-19 lockdown on subjective well-being	Nature-based physical activity	Time spent in nature-based (e.g., canoeing, skiing, hiking)	Subjective well-being	WHO-5 scale	Nature-based activities were related to individuals' subjective well-being pre- ($B = 0.22$, $p < 0.05$) and even stronger during the COVID-19 lockdown ($B = 0.52$, $p < 0.01$) period. This was also the case for nature-neutral sports, but not for resource-using sports. An increase in nature-based sports was positively associated with a change in subjective well-being ($B = 0.36$, $p < 0.01$), as was nature-neutral sports, but not resource-using sports.

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Whitehead and Torossian (2021), USA	Older adults (825, largest age group 60–69 years (63.8%), 79.3%, 96.6% non-Hispanic White, 3.4% Other)	March 2020	Observational, cross-sectional, qualitative/ quantitative, online survey	Investigate the impact of COVID-19 on psychological well-being assessed through stressor and coping mechanisms	General nature	Any nature elements and places mentioned by the participants	Perceived stress Negative affect Positive affect	Perceived stress scale (PSS) Positive and Negative Affect Schedule (PANAS) Two open-ended questions asked about stressors and joys/comfort (coping)	11% of the participants mentioned nature as a source of joy during the pandemic. Those who mentioned nature as a source of joy (N = 82) demonstrated enhanced positive affect compared to those who did not mention it (M = 43.0 vs. 41.8), but no differences regarding perceived stress and negative affect were observed.
Xie, Luo, Furuya, and Sun (2020), China	Adults and older adults in Chengdu (386, largest age group 18–35 (67.9%), 58.3%, n.a.)	April 2020	Observational, cross-sectional, quantitative, online survey	Investigates the role of urban parks during the pandemic period for perceived health and social interaction needs	Urban parks	Self-reported weekly visit frequency, duration, preferred time of urban park visit and activities Items asking if participants believe that urban park visits improve mental health and allow fulfilling social interaction needs	Mental health Social interactions Perceived health benefits of park visit	Self-assessed mental health and social interaction level Items asking if participants believe that urban park visits improve mental health and allow fulfilling social interaction needs	Most residents agreed that urban park visits allowed them to meet their social interaction needs (M = 4.1, SD = 0.99) and to improve their mental health (M = 3.46, SD = 1.11). Park visit duration was positively related to improved mental health (B = 0.22, $p < 0.001$) and fulfilling social interaction needs (B = 0.17, $p < 0.001$), whereas frequency of visits was unrelated (all p's > 0.05). The lower the resident's perception of their social interaction level, the more beneficial the urban park use was for them. Regarding activities, the number one reason to visit an urban park was for a walk (N = 268).
Yamazaki et al. (2021), Japan	Adults and older adults in Tokyo (3085, n.a., 47%, n.a.)	June 2020	Observational, cross-sectional, quantitative, online survey	Investigate urban green space perceptions during COVID-19	Urban green space	Self-reported use of different urban green space locations	Reasons for visiting urban green space	Agreement with statements regarding urban green space	More than half of the participants agreed that urban green space helps to relieve stress, whereas only about a quarter agreed that it helps to connect with others and to reduce loneliness. The perceptions regarding usefulness varied across user type (e.g., telecommuters, older adults, family with children).

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Yang et al. (2021), China	Children, adolescents, and adults in Hong Kong (661, largest age group 18–44 years (43.9%), 47.7%, n.a.)	January 2020 May 2020	Observational, longitudinal, quantitative, survey via face-to-face interviews	Investigates if urban greenery mitigates COVID-19 related decreases in leisure-time physical activity	Urban greenery	Objectively measured Normalized Difference Vegetation Index (NDVI) based on the tertiary planning unit	Physical activity	Three items adopted from the International Physical Activity Questionnaire (IPAQ) and asked prior (T1) and during (T2) COVID-19	People who lived in a high greenery neighborhood did not decrease their leisure time physical activity ($\triangle = -0.23$ min/week), while people in less green neighborhoods decreased their total physical activity ($\triangle =$ 78.84 min/week, $p =$ 0.003). Decreases for leisure-time physical activity conducted in the neighborhood ($\triangle =$ −15.85) and for leisure physical activity at home ($\triangle = -0.74$ min/week) were less pronounced for people living with high greenery compared to those living in areas with low greenery (neighborhood physical activity: $\triangle = -53.77$ min/week, $p = 0.025$; home physical activity: $\triangle = -21.78$ min/week, $p = 0.016$). Additionally, people who lived in greener neighborhoods experienced increased levels of physical activity related to visits to country parks during the pandemic ($\triangle = +16.36$ min/week), whereas people living in neighborhoods with low greenery did not ($\triangle =$ −3.29 min/week), however, this was not statistically significant ($p = 0.101$).
Yi et al. (2022), USA	Young adults (168, 23 ± 2.9, 47%, 30.4% Hispanic)	May 2020–June 2021	Observational, intensive longitudinal, quantitative, e-diary	Investigate effects of physical activity location choices on physical activity maintenance during COVID-19	Parks	Self-reported physical activity location	Physical activity	One question asking about physical activity engagement the previous week compared to prior the pandemic	Participants performing physical activity at parks/ open spaces were twice as likely to maintain physical activity levels.
Yuan, Tao, and Li (2022), China	Older adults at an elderly care institution	March 2021	Experimental, longitudinal, quantitative, online survey	Investigate effects of a virtual forest experience on psychological well-	Virtual forest	One short break (immediate) and three short breaks over three days	Positive affect Negative affect Stress recovery	Positive and negative affect schedule (PANAS) ROS scale	Compared to the control group, results showed immediate improvements in negative affect (F (2,

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	(63, 82.0 ± 7.1, 33%, n.a.)			being during COVID-19		(sustained) in a virtual forest			60) = 20.42, $p < 0.001$, $\eta^2 = 0.25$) and stress recovery (F (2, 60) = 33.44, $p < 0.001$, $\eta^2 = 0.35$), whereas no significant effects for positive affect were observed. Looking at effects across the three days, improvements were observed for negative affect (F (3, 187) = 14.40, $p < 0.001$), stress recovery (F (5, 247) = 11.94, $p < 0.001$), and positive affect (F (3, 169) = 10.09, $p < 0.001$).
Zabini et al. (2020), Italy	Adults and older adults (75, 47.3 ± 13.1 years, 59%, n.a.)	April–May 2020	Experimental, longitudinal, quantitative, online survey	Investigates the restorative effects of forest vs. urban videos during COVID-19	Digital nature	Participants watched the same forest-based audio-video (intervention condition) or same urban space video (control condition) on five consecutive days (video length: 5 min)	Anxiety	State-Trait Anxiety Inventory (STAI) Sheehan Patient Rated Anxiety Scale (SPRAS)	For each day of the five study days, results of the interaction analysis revealed that the group watching the forest video exhibited lower anxiety scores after watching the video compared to the pre-value (Pre: M = 3.61-5.20, SD = 3.63-5.22; Post: M = 2.37-3.17, SD = 2.73-3.76), whereas the group watching the urban videos maintained or increased their anxiety score compared to the pre-value (Pre: M = 2.82-4.47, SD = 2.96-4.32; Post: M = 3.12-4.41, SD = 3.09-4.20; p = <0.001–0.006). No one-week pre-post differences were observed for either condition (p = 0.241–0.915).
Zagalaz-Sánchez, Cachón-Zagalaz, Arufe-Giráldez, Sanmiguel-Rodríguez, and González-Valero (2021), Spain	Children (837, 6.22 ± 3.36 years, age range 0–12 years, 49.8%, n. a.)	March–May 2020	Observational, cross-sectional, quantitative, online survey	Investigate whether children's living conditions during the COVID-19 related confinement period influenced their daily activities	Garden	Self-reported house with garden access	Screen time Physical activity Free play Psychosocial aspects	Parental proxy-report: Daily time spent in screen time (game consoles, televisions, computers, tablets, and mobile phones), physical activity, and free play Items (scale 1-10) asking about parental perceptions of the child's state of fatigue, happiness,	Children with a garden had the lowest television time (M = 68.64; SD = 44.94, p = 0.015), and the highest physical activity (M = 45.89; SD = 42.01, $p < 0.001$) and free play levels (M = 118.11; SD = 85.41, p = 0.045). No differences for in any of the other screen time

(*continued on next page*)

Table A2 (*continued*)

Author (year), country	Study population (N, age, % female, ethnicity)	Data collection time	Study design, methodological approach, data collection methodology	Objective	Nature operationalization	Nature measurement	Health outcome/ behavior	Health outcome/behavior measurement	Main finding
								energy level, self-esteem, and creativity	variables were observed ($p > 0.05$). Parent of children with a garden perceived them happier ($M = 8.32$; $SD = 1.63$, $p = 0.028$) and less tired ($M = 3.37$, $SD = 2.29$, $p = 0.016$). No other differences in psychosocial aspects were observed.
Zhuo and Zacharias (2020), China	Young adults (284, 19–30 years, 59.7%, n. a.)	February 2020	Observational, cross-sectional, quantitative, online survey	Investigates associations between leisure types and living environments with subjective well-being during COVID-19.	City greenness	Self-reported view from home on city greenery	Overall well-being Mental well-being Function well-being Social well-being	14 items on the four domains with 5-point Likert scale, 1 additional item with range 1–11	View from home on city greenery was unrelated to all types of well-being ($p > 0.06$).

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