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RESEARCH ARTICLE

Informing the design of urban green and blue spaces through an understanding of Europeans' usage and preferences

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Abstract

1. In light of global climate change and the biodiversity crisis, making cities more resilient through an adjusted design of urban green and blue spaces is crucial. Nature-based solutions help address these challenges while providing opportunities for nature experiences, and providing cultural ecosystem services that support public health. The COVID-19 pandemic and its associated stressors highlighted the interrelated socio-ecological services provided by nature-based solutions like urban green and blue spaces.
2. This pan-European study therefore aimed to enhance the socio-ecological understanding of green and blue spaces to support their design and management. Using an online survey, green and blue space preferences, usage, and pandemic-related changes in greenspace visit and outdoor recreation frequencies were examined.
3. Greenspace visit and outdoor recreation frequencies were associated with respondents' ($N = 584$ from 15 countries) geographical location, dominant type of neighbourhood greenspace and greenspace availability during the pandemic, but not greenspace perceptions or sociodemographic background.
4. Greenspace visit and outdoor recreation frequencies were generally high; however, Southern Europeans reported lower greenspace visit and outdoor recreation frequencies both before and during the pandemic than Northern Europeans. Many Southern Europeans also reported having few neighbourhood greenspaces and low greenspace availability during the pandemic.
5. The most common outdoor recreational activity among respondents before the pandemic was walking or running with the most frequently stated purpose of time spent outdoors being restorative in nature (i.e. relaxing or calming down). Most Europeans had positive perceptions of green and blue spaces with preferences for structurally diverse and natural or unmanaged green elements.
6. This highlights the importance of accessible green and blue spaces both in everyday life and during times of crisis. Stakeholders, their preferences, and regional and cultural differences should be included in the co-design of urban green and blue spaces to maximize their potential for both people and nature.

KEYWORDS
blue infrastructure, COVID-19 (SARS-CoV-2) pandemic, green and blue space accessibility, nature-based solutions, outdoor recreation, urban green infrastructure, urban greening

1 | INTRODUCTION

Like all species on this planet, humans are an inherent part of nature arising as a product of evolution. Since its inception, humanity has developed closely alongside other species and relied on the natural world for survival and development. In addition to fulfilling basic survival needs, nature provides many ecological, social and cultural benefits for people, including cultural ecosystem services (e.g. those supporting health and well-being, recreation and aesthetic enjoyment; Oke et al., 2021). For example, exposure to nature has been associated with many physical and mental health benefits (Frumkin et al., 2017; Hartig et al., 2014). Similar health and well-being benefits of nature have also been exemplified in specifically urban environments. For example, exposure to urban nature has been associated with stress reduction and mental recovery (Hedblom et al., 2019; Ward Thompson et al., 2012), lower depression risk (Cox et al., 2017; Jakstis & Fischer, 2021; Lee & Lee, 2019) and with increased physical activity (Astell-Burt et al., 2014; Knobel et al., 2021). Similarly, the frequency of both urban green and blue space visits and outdoor recreation have been associated with positive health effects (Cox et al., 2018; Wilson & Christensen, 2012). This emphasis on the benefits of specifically urban nature for people is increasingly important, as most of the world's population (United Nations, 2019), including 75% of Europeans (The World Bank, n.d.), currently live in urban areas. Therefore, urban areas are likely the primary source of nature contact, and associated nature-derived benefits, for the majority of people.

Urban nature is not only important for humans, but can be an important part of nature in and of itself. For example, while urban areas often disrupt habitat connectivity having strong negative consequences for nature conservation and biodiversity (Liu et al., 2016; Mcdonald et al., 2008), urban green and blue spaces can partially mitigate this effect acting as stepping-stone biotopes or as part of green corridors, thereby facilitating habitat connectivity and supporting biodiversity (Beninde et al., 2015; Bonthoux et al., 2014). Green and blue spaces within cities can also harbour a large diversity of organisms (Planchuelo et al., 2019), for example due to their high spatial and environmental heterogeneity (Deák et al., 2021). However, not all urban green and blue spaces are equal in their biodiversity provisioning potential (Matthies et al., 2017), which depends greatly on their design and management (Bretzel et al., 2016), with important feedback loops regarding aesthetics and the perceived beauty of green and blue spaces (Hoyle et al., 2017).

Despite the positive benefits of urban green and blue spaces for both people and nature, people are generally becoming more separated from, and interacting less with the natural world (Bashan et al., 2021), with high variation between urban contexts (Oh et al., 2021). This large reduction of daily nature contact is often referred to as the extinction of experience, which can result in negative consequences for both humans and other forms of nature (Gaston & Soga, 2020; Soga & Gaston, 2016). For example, in addition to the loss of health and well-being benefits associated with nature exposure, a reduction in nature contact can also lead to reductions in nature-connectedness and nature-positive attitudes, and in turn nature-positive behaviours (Gifford & Nilsson, 2014). From this, compounding feedback loops can arise that may lead to both increased nature degradation and decreased nature contact (see e.g. Soga & Gaston, 2016).

However, the COVID-19 pandemic (hereafter: 'pandemic') has led to a recent resurgence in the interest of urban nature, particularly with regard to cultural ecosystem services (Kleinschroth & Kowarik, 2020). This interest can likely be partially attributed to lockdown regulations restricting human mobility in many parts of the world in the Spring of 2020. While these regulations were proven effective to help mitigate the spread of the virus, they have been reported to result in negative psychological side-effects such as increased anxiety, stress and depression (Wang et al., 2020). These negative psychological impacts of restricted mobility during the pandemic have been reported among the world's population, particularly among people living in dense urban areas with poorly distributed or limited access to green and blue spaces (Astell-Burt & Feng, 2021). In addition, urban areas with relatively lesser proportions of green and blue spaces have also been associated with a higher infection incidence (Spotswood et al., 2021). During this time, however, the general public demonstrated an awareness of cultural ecosystem services provided by urban nature, for example, recognizing the positive psychological effects associated with spending time in green and blue spaces during the pandemic (Berdejo-Espinola et al., 2021; Lopez et al., 2021). Indeed, studies examining the effects of urban nature during the initial stages of the pandemic indicated positive mental health and well-being benefits for people (Fagerholm et al., 2021; Friedman et al., 2021; Mayen Huerta & Utomo, 2021; Pouso et al., 2021; Soga, Evans, Tsuchiya, et al., 2021). Urban residents supported their well-being through outdoor recreation in private settings such as home gardens (Cerda et al., 2022; Lin et al., 2021; Marques et al., 2021), as well as more frequent visits to public green and blue spaces (Berdejo-Espinola et al., 2021; da Schio et al., 2021). In some cases, the increased frequency of outdoor recreation was sustained months after the onset of the pandemic (Venter et al., 2021). Where green and blue spaces were scarce, or less readily accessible, increased use by urban residents of informal settings such as streetscapes was noted (Gopal & Fischer, 2021).

However, green and blue space visits and recreational patterns during the pandemic differed geographically depending on their availability and the recreational and physical activities permitted

by locally applicable regulations (Dushkova et al., 2021; Venter et al., 2021; Xie et al., 2020). For example, Dushkova et al. (2021) examined recreational patterns and changes in greenspace visit frequency during the pandemic in Moscow, Russia where there were official greenspace-visitation restrictions, and in Perth, Australia where greenspaces remained open. Their results indicated that although residents of both Perth and Moscow valued green and blue spaces for their physical and mental well-being, a larger proportion of Moscow respondents compared with Perth respondents reduced their frequency of greenspace visits. In addition, a larger proportion of Perth respondents engaged in outdoor physical exercise during the pandemic compared with Moscow respondents (Dushkova et al., 2021). Similarly, in a larger-scale study considering 48 global regions it was found that park visitation increased in many areas during the pandemic, but that governmental stay at home restrictions were negatively associated with park visitation (Geng et al., 2021).

Examples such as these suggest that the pandemic conditions have led to changes in opportunities, motivations or capabilities to visit urban green and blue spaces. Consequently, the pandemic may have increased or decreased human–nature interactions more generally with important feedback loops for new dynamics in these pathways (Soga, Evans, Cox, et al., 2021). Indeed, the ongoing pandemic has highlighted the key issues regarding green and blue spaces, and corresponding human–nature interactions that existed before the pandemic and will likely continue after the pandemic. For example, it is well documented that ethnic minorities and those with a lower socioeconomic status tend to have less access to safe, high-quality greenspaces (Rigolon, 2016; Williams et al., 2020), and that both before and during the pandemic access to greenspace and derived cultural ecosystem services is often inequitable (De Luca et al., 2021; Kabisch et al., 2016).

Moving forward, integrative urban planning methods that consider the accessibility and equitable distribution of green and blue spaces are essential to counteract negative trends observed during the pandemic and beyond. The UN highlights this approach stating, 'Cities are rethinking urban space, not only from the perspective of health, but also ecology. They are recognizing the need to promote inclusive planning and to take regional dimensions into account' (UN Habitat, 2021). These aspects are crucial in the design and maintenance of green and blue spaces to optimize the benefits for people and nature. For example, aspects related to green and blue space use are often related to an individual's sociodemographic background (e.g. Pinto et al., 2021) and related cultural backgrounds and traditions (Abdul Aziz et al., 2018; Gentin, 2011). In addition, preferences regarding greenspaces can also differ between individuals or groups of people in relation to their sociodemographic background and geographical context (Madureira et al., 2018; Wang & Zhao, 2017). Yet, the link between people and qualities of urban nature is often neglected (Botzat et al., 2016), despite corresponding perceptions of greenspace having previously been found to impact their usage (Egerer et al., 2019; Fischer, Honold, Botzat, et al., 2018; Jim & Shan, 2013; Nastran et al., 2022). Furthermore, some studies have demonstrated that people tend to prefer more diverse greenspaces (Fischer, Honold, Cvejić, et al., 2018; Hoyle et al., 2017; Southon et al., 2018), which can have positive implications for both people and nature when considered in the design of these areas (Randrup et al., 2020).

One concept that embraces the idea of inclusive planning to maximize benefits for people and nature are nature-based solutions. Nature-based solutions are increasingly implemented to help tackle complex societal challenges such as climate change, biodiversity loss and the extinction of experience. The European Commission defines nature-based solutions as,

> Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systematic interventions
>
> (European Commission, n.d.)

Nature-based solutions can include many types of well-known green and blue spaces, including green roofs and façades, green corridors, urban gardens and parks. However, the inclusion and active involvement of many stakeholders in the planning, design, implementation, monitoring and maintenance of nature-based solutions is crucial in the realization of the social (e.g. cultural ecosystem services) and economic benefits that are not typically obtained from other forms of 'typical' green and blue infrastructure that are established in a non-participatory process. In this way, nature-based solutions like urban green and blue spaces can optimally address many societal challenges when they are designed to target the specific socio-ecological context that shapes a place's society and landscape, thereby ensuring socially just and sustainable local development (Welden et al., 2021).

By connecting the fields of greenspace usage and perception, with participation and design approaches, the objective of this study was to deepen the socio-ecological understanding of urban green and blue spaces. This was achieved through an examination of greenspace user preferences and usage patterns before and during the pandemic to further support the design of such spaces and maximize their potential as fully functioning nature-based solutions. To broaden the context of this study, survey responses from individuals with diverse backgrounds across 15 European countries were evaluated and patterns for the geographical region determined. These usage and preference patterns were examined without specifying a specific type of green or blue space to gain general insight into usage and outdoor recreational behaviours that may be related to geographical and sociodemographic background, including aspects of how people perceive green and blue spaces, based upon the following research questions (RQs):

(i) Which green and blue elements do European residents prefer in public greenspaces?
(ii) What were the common outdoor recreational activities and purposes of time spent outdoors before the COVID-19 pandemic in Europe?

(iii) How do greenspace visit frequency and outdoor recreation frequency differ before and during the pandemic's first global wave in Europe?
(iv) Do differences in greenspace visit frequency and outdoor recreation frequency before and during the pandemic's first global wave relate to European residents' greenspace perception, sociodemographic backgrounds and their geographical location?

2 | METHODS

2.1 | Research design and survey development

The research was developed collaboratively with project partners and partner cities in the context of the H2020 EU-funded project Urban Nature Labs (UNaLab, www.unalab.eu). The project aims to generate evidence regarding the benefits, cost-effectiveness and economic viability of nature-based solutions for climate and water challenges by evaluating the impacts of co-created and co-implemented nature-based solutions to further support their replication and upscaling. The study at hand was developed to contribute to increased socio-ecological knowledge concerning local urban green and blue space design for optimal benefit, both as a means to enhance urban liveability in general, as well as a response to the COVID-19 pandemic and similar future events.

To address the research questions, a quantitative questionnaire was created focusing on how people generally perceive and use urban green and blue spaces, and how these usage patterns changed following the onset of the pandemic. The survey was developed on the basis of previous questionnaires that assessed green and blue space use and perceptions in urban settings at a multi-country scale both pre-pandemic (Fischer, Honold, Cvejić, et al., 2018) and during the first wave of the pandemic (Gopal & Fischer, 2021). The survey questions were adapted to the specific objectives of this study—to relate green and blue space visit frequency and outdoor recreation frequency to a set of geographic, green and blue space-related, and sociodemographic variables, as well as local restrictions. All UNaLab project partners could contribute to the development of the survey through the online project forum. In this active, open participation process, project partners could make suggestions based on their local green and blue space knowledge, experiences and interests. The wording of questions and response options was discussed with all project partners to ensure they fit the specific geographical and cultural context of the target areas. This process resulted in a four-part questionnaire corresponding closely to the four research questions.

2.2 | Questionnaire

The first part of the questionnaire addressed participants' preferences regarding urban green and blue spaces and their general perceptions of greenspace establishment. Questions about preferences were multiple choice, single response items, meaning participants could choose only one response option out of a list of provided response options for these questions. For example, regarding vegetation preferences, the question, 'When you consider vegetation for public greenspaces, which do you prefer?' was posed with five possible response options (i.e. *trees and bushes*; *low landscaping* (*such as grasses*, *perennials*, *wildflowers*); *a combination of trees*, *bushes*, *and low landscaping*; *natural habitat* (*unmanaged*); *none of the above*). The item regarding preferences for water features in greenspaces followed the same structure, also with five response options (i.e. *permanent lake or pond*; *temporary water retention area*; *natural or constructed wetland*; *stream or river* (*natural or constructed*); *none of the above*). To assess the possible negative perceptions of greenspaces a multiple choice, multiple response question was posed, 'Tell us about the negative aspects of your local public greenspaces. Are there any drawbacks to the establishment of public greenspaces in your city?' and included 10 possible response options. Response options included: *No, there are no drawbacks*, *I do not have an opinion about it* and eight responses identifying specific drawbacks to the establishment of public greenspaces (e.g. *yes, it has resulted in a notable increase in crime in the area*; *yes, it has resulted in a notable increase in noise in the area*; *yes, it has resulted in a notable increase in airborne pollen in the area*). Some response options were inspired by the review of Sreetheran and Konijnendijk van den Bosch (2014), while others originated from the on-ground experiences of our partners in practice. All questionnaire items and their respective response options used in the survey, as well as the structure of resulting variables used in the analyses at hand are provided in Table S1.

The second part of the questionnaire addressed participants' urban green and blue space use for specific outdoor recreational activities and their main purposes of time spent outdoors before the pandemic. Here, respondents were asked to retrospectively consider their activities before the outbreak of the pandemic with two multiple choice, multiple response questions (i.e. *Under normal conditions* (*before the COVID-19 crisis*), *in which types of outdoor recreational activities did you engage most within your city?*; *Under normal conditions* (*before the COVID-19 crisis*), *what was the main purpose of your time spent outdoors?*; Table S1). In all, 12 response options were provided for each of these questions. Regarding outdoor recreational activities, example response options include *I walk or run*, *I ride a bike*, *I spend time in a park* and *I spend time in a forest*. Regarding main purpose of time spent outdoors, example response options include *incidental exercise*, *meeting friends/acquaintances* and *relaxing*, *calming down*. The full list of response options for each question is provided in the appendix (Table S1). The use of some retrospective questions were important to help address the research questions in the study at hand; however, there are some limitations associated with questions such as these, which are discussed in Section 4.5.

The third part of the questionnaire addressed participants' urban green and blue space visit frequency and outdoor recreation frequency pre-pandemic and during the pandemic using four multiple choice, single response questions. The questions regarding greenspace visit frequency were, 'Under normal conditions (i.e. before the COVID-19 crisis), how frequently did you visit the public greenspaces in your city?'

and 'Between March and May 2020, how frequently did you visit the public greenspaces in your city?' Each question had five response options (i.e. 5+ *times a week*, 3–4 *times a week*, 1–2 *times a week*, *less than once a week* (*on average*), *I did not visit the public greenspaces in my city*). The two questions regarding outdoor recreation frequency were similarly structured and are listed in Table S1.

The fourth part of the questionnaire addressed respondents' age, gender, gardening behaviour, dominant type of neighbourhood greenspace, and blue and greenspace availability during the pandemic. These questions were mostly multiple choice, single response items. For example, the following item was used regarding respondents' dominant type of neighbourhood greenspace: 'Do you live in a neighbourhood with: (a) more private greenspace, such as gardens, (b) more public greenspaces, such as parks, (c) both public and private greenspaces or (d) few greenspaces'. The items regarding age, gender and gardening behaviour were also multiple choice, single response and are listed in Table S1. The only multiple choice, multiple response item in this part of the questionnaire addressed greenspace availability during the pandemic (i.e. 'Between March and May 2020, did you have access to greenspaces in your city?') with four response options (i.e. *yes*, *a garden*; *yes*, *a park*; *yes*, *a greenspace but not a garden or park*; *no*).

Throughout the questionnaire, definitions of terms such as *green and blue space* or *outdoor recreational activity* were generally not provided. This allowed for an open interpretation of these terms in recognition that participants from our target sample population, covering a large geographic region, may have very diverse ideas of what constitutes a green or blue space or what is considered recreational. However, there were a few instances within the questionnaire where some subject-specific terms included a clarification. For example, for the question, 'When you consider vegetation for public greenspaces, which do you prefer?' the response option *low landscaping* (*such as grasses*, *perennials*, *wildflowers*) included an elaboration of the term providing examples of this kind of landscaping element in parentheses. The majority of items used in the questionnaire were multiple choice, single response questions, from which exclusively categorical variables were derived to be used in analyses.

2.3 | Survey procedure

The completed four-part questionnaire was translated from English into nine additional languages with the help of local UNaLab project partners, who translated and verified the consistency of wording, terminology and underlying meaning of the translated phrases. The questionnaire was available online using Google Forms in English, Finnish, Dutch, German, Italian, Spanish, Norwegian, Turkish, Chinese and Czech.

The questionnaire-based survey was conducted from 11 November 2020 to 31 January 2021, 6 months after the initial implementation of restrictions on the movement of citizens (partial or complete lockdowns) by most countries in response to the ongoing pandemic. Participation in the survey was voluntary and respondents were not provided with compensation for their participation. The survey was distributed (a) via the official UNaLab project webpage and (b) through the partners' professional and personal networks by email and social media (e.g. LinkedIn, local channels, municipal websites). Respondents were invited to distribute the survey further among their own networks, and following snowball sampling methodology, the survey garnered a total of 760 responses from 32 different countries around the world.

Ethical procedures for the acquisition and processing of survey data outlined by the European Union's General Data Protection Regulation were followed. The first page of the survey informed respondents that participation and response to every question was voluntary and that answers would be treated confidentially (e.g. only analysing values of larger groups and not the individual, independent of any identifying information). Respondents confirmed informed consent by continuing to the survey questions. An ethical review statement from a human sciences ethics committee was not required for this study according to the guidelines published by the Finnish National Board on Research Integrity (Finnish National Board on Research Integrity, 2019).

2.4 | Data preparation

After the survey period was completed in January 2021, original survey questions and responses were transcribed into variables for analyses. Responses from those that did not answer the question about their gender or selected the option 'Prefer not to say' ($n = 8$), were under 18 years old ($n = 2$) or were missing information for any of the variables of interest were removed from analyses ($n = 139$). Responses from non-European locations ($n = 27$) were also removed from analyses, as they were outside the focus of this specific study and generally yielded considerably fewer responses. In total, 584 survey responses from 15 European countries were used in this study.

Due to small or uneven selection rates for several response options, some combination of levels was necessary to allow for reliable statistical analyses (see Table S1). Two predictor variables (i.e. *Greenspace availability*: *Pandemic* and *Negative perceptions of greenspace*) were derived from multiple choice, multiple response survey questions. In these two cases, the variables were restructured to have a bivariate response before statistical analyses were conducted. *Pre-pandemic outdoor recreational activities* and *Pre-pandemic main purposes of time spent outdoors* were also derived from multiple response questions, but were only used in descriptive analyses and therefore their original structure was maintained.

To examine research questions (i) and (ii), four variables pertaining to preferences regarding *vegetation* and *natural or naturalized water features*, respectively, as well as *pre-pandemic outdoor recreational activities*, and *pre-pandemic main purposes of time spent outdoors* were stratified by regional location and included in descriptive analyses. In all, 11 variables (i.e. *Greenspace visit frequency*: *Pre-pandemic*, *Greenspace visit frequency*: *Pandemic*, *Outdoor recreation frequency*: *Pre-pandemic*, *Outdoor recreation frequency*: *Pandemic*, *Regional*

location, *Dominant type of neighbourhood greenspace*, *Greenspace availability*: *Pandemic*, *Negative perceptions of greenspace*, *Gardening behaviour*, *Age* and *Gender*) were considered in the statistical analyses of research questions (iii) and (iv) (see Table 1 for variables used in statistical analyses and their structure). All variables including the term 'pandemic' refer to the first wave of the COVID-19 pandemic from March to May 2020.

All data used in the study at hand are primary data derived from responses to the questionnaire-based survey detailed in Sections 2.2 and 2.3. Since all variables were derived from the items in the questionnaire, they should be considered as self-reported.

2.5 | Analyses

First, descriptive statistics were conducted to understand the sample population (Table 1). In examination of research questions (i) and (ii), further descriptive statistics were used to illustrate preferences for urban green and blue spaces according to regional location regarding vegetation and natural or naturalized water features, respectively, pre-pandemic outdoor recreational activities, and pre-pandemic main purposes of time spent outdoors (Table S2).

To examine the research question (iii), Sankey diagrams were created depicting the proportional flow, according to regional location, from *Greenspace visit frequency*: *Pre-pandemic* to *Greenspace visit frequency*: *Pandemic*. The same was done for *Outdoor recreation frequency*: *Pre-pandemic* to *Outdoor recreation frequency*: *Pandemic*. All Sankey diagrams were created using the online, open-source tool: SankeyMATIC (www.sankeymatic.com). To see whether greenspace visit and outdoor recreation frequencies during the pandemic were related to pre-pandemic greenspace and recreation behaviours, chi-squared analyses were conducted between these pre-pandemic and pandemic variables and the results are provided in Table S3.

To examine the research question (iv), chi-squared analyses were conducted between *Greenspace visit frequency*: *Pre-pandemic*, *Greenspace visit frequency*: *Pandemic*, *Outdoor recreation frequency*: *Pre-pandemic* and *Outdoor recreation frequency*: *Pandemic* and each predictor variable (i.e. *Regional location*, *Dominant type of greenspace*, *Greenspace availability*: *Pandemic*, *Gardening behaviour*, *Age*, and *Gender*). Chi-squared analyses were also conducted between predictor variables to identify the possible bivariate associations between predictors, with the results reported in Table S4. From this table, three relationships were selected to more closely examine how regional location was related to the three greenspace-specific predictor variables used in this study (i.e. *Regional location* with *Dominant type of neighbourhood greenspace*, *Greenspace availability*: *Pandemic* and *Negative perceptions of greenspace*). Mosaic plots were created for each of these three associations to assess the directionality of these relationships.

In total, 49 Chi-squared tests were conducted using the full dataset. It was determined that the sample size of 584 was sufficient to conduct reliable Chi-squared analyses, as cell values within contingency tables were never below 10. However, because many tests

TABLE 1 Variables considered in statistical analyses for the sample population ($N = 584$). Absolute counts and the corresponding percent sample population are provided for each variable level. For the derivation of these variables, see Table S1

Variable	Absolute count (*n*)	Percent sample population (%)
Greenspace visit frequency: Pre-pandemic		
5+ times per week	114	19.5
3–4 times per week	177	30.3
1–2 times per week	215	36.8
<1 time per week	78	13.4
Greenspace visit frequency: Pandemic		
5+ times per week	119	20.4
3–4 times per week	140	24.0
1–2 times per week	98	16.8
<1 time per week	227	38.9
Outdoor recreation frequency: Pre-pandemic		
5+ times per week	141	24.1
3–4 times per week	182	31.2
≤2 times per week	261	44.7
Outdoor recreation frequency: Pandemic		
5+ times per week	140	24.0
3–4 times per week	116	19.9
≤2 times per week	328	56.2
Regional location		
Northern Europe	212	36.3
Central Europe	97	16.6
Southern Europe	275	47.1
Dominant type of neighbourhood greenspace		
Public	69	11.8
Private	132	22.6
Both	248	42.5
Few greenspaces	135	23.1
Greenspace availability: Pandemic		
Yes	449	76.9
No	135	23.1
Negative perceptions of greenspace		
Yes	137	23.5
No	447	76.6
Gardening behaviour		
Gardener	400	68.8
Non-gardener	184	31.5
Age		
18–25	44	7.5
26–40	224	38.4
41–55	192	32.9
56+	124	21.2
Gender		
Male	185	31.7
Female	399	68.3

using the same dataset lead to an increased chance of Type I error, *p*-values were adjusted using the Bonferroni correction, in which original *p*-values were multiplied by the number of tests performed on each set or subset of data (here, 49). The threshold for significance remains $p_c < 0.05$. Effect sizes were estimated using Cramer's *V* and corresponding degrees of freedom, according to Cohen's rules (Cohen, 1988).

Next, to examine these bivariate associations (excluding those between predictor variables) according to regional location, the full dataset was stratified by regional location and Fisher's exact tests were conducted. Fisher's exact tests were used for the regional subsets rather than Chi-squared tests, because the smaller sample size resulted in some instances of contingency table cell values of less than 10. A total of 24 Fisher's exact tests were conducted on each regional location subset. Again, to reduce Type I error, *p*-values were adjusted using the Bonferroni correction, and corrected *p*-values (p_c) and Cramer's *V* are reported in Table S5. All statistical analyses were conducted in R version 4.0.3 (R Core Team, 2021).

3 | RESULTS

3.1 | Sample description

Responses from 15 European countries were considered in the analyses reported herein. The majority of respondents were from Southern Europe ($n = 275$), followed by Northern Europe ($n = 212$), and then Central Europe ($n = 97$, Table 1). The sample was biased towards females, with 68.3% of respondents identifying as female and 31.7% as male. In addition, only 7.5% of respondents were aged 18–25, with the other age categories being more evenly distributed: 38.4% were aged 26–40, 32.9% were 41–55 and 21.2% were 56 years or older. See Tables 1 and S1 for the structure and description of each variable considered in analyses.

3.2 | Green and blue element preferences in public greenspaces (RQ i)

Respondents clearly stated that for the vegetation in public greenspaces they preferred a combination of trees, bushes and low landscaping elements (70% in the full sample, ranging from 63.2% in Northern Europe to 76.7% in Southern Europe, see Table S2 and Figure 1). Respondents also had a preference for unmanaged, natural habitat features (17.8%), especially in the regional locations of Central and Northern Europe (24.7% and 28.3%, respectively), whereas in Southern Europe the secondary preference was trees and bushes (12%). When asked about their preference regarding natural or naturalized water features, respondents from Southern and Central Europe named streams or rivers (natural or restored) as their preferred feature (49.3%), followed by permanent lakes or ponds (34.2%). These two features were preferred in all regional locations; however, respondents from Northern Europe exhibited a preference for permanent lakes or ponds over streams or rivers (46.2% for permanent lake or pond, 41.5% for stream or river).

3.3 | Outdoor recreation and purposes of time spent outdoors before the pandemic (RQ ii)

Before the pandemic, respondents across Europe reported that they took a walk or went for a run as their primary outdoor recreational activity (84.4%; Table S2). This also remained the main reported activity in each of the three regional locations when examined separately. In the overall sample, this was followed by spending time in a park (total sample: 50.9%) and spending time in a forest (total sample: 50.3%). Among respondents from Southern Europe, people also reported spending time in a park as second most frequent activity (46.9%), followed by swimming or spending time at a beach or lake (39.3%). In Central Europe, the second most frequent activity was also spending time at a park (63.9%), followed by spending time in the forest (58.8%). The only regional location where spending time in a park was not one of the top three outdoor recreational activities was Northern Europe. Here, time spent in the forest was the second most frequent activity (67.0%), followed by riding a bike (65.6%).

Respondents indicated a wide range of purposes for time spent outdoors before the pandemic (Table S2). Among the most frequently mentioned purposes were relaxing or calming down (total sample: 68%), incidental exercise (e.g. journey to work, a trip to the grocery store; 63%) and viewing natural landscapes (54.8%). This pattern was not the same in all regional locations. For example, meeting friends or acquaintances (Central Europe: 64.9%) and experiencing health or well-being effects of outdoor activities (Northern Europe 69.3%) were among the top three reported purposes, depending on European region.

3.4 | Greenspace visit frequency before and during the pandemic (RQ iii)

Considering all responses across Europe ($N = 584$), the bivariate association between *Greenspace visit frequency*: *Pre-pandemic* and *Greenspace visit frequency*: *Pandemic* was significant with a large estimated effect size (Table S3). This suggests that pre-pandemic greenspace behaviour was related to greenspace behaviour during the pandemic. In addition, the proportional distribution of the data suggests some people changed their frequency of visits to greenspaces during the pandemic, compared to before the pandemic. For example, examining responses from all geographical regions together, the proportion of respondents that visited greenspace 1-2 times a week pre-pandemic decreased from 37% to 17% during the pandemic. The remaining 20% of the pre-pandemic greenspace visit frequency changed to both higher (mostly 3–4 times a week) and lower frequencies (<1 time per week; purple lines in Figure 2a). In parallel, the proportion of people that visited greenspaces less than once a week pre-pandemic increased from 13% to 39% (yellow

sections in Figure 2a). That is, around 26% of the respondents reduced their greenspace visit frequency to one time per week or less during the pandemic.

Individual examination of the three European regions—Northern Europe (n = 212), Central Europe (n = 97) and Southern Europe (n = 275)—offered mixed results. Each bivariate association between *Greenspace visit frequency*: *Pre-pandemic* and *Greenspace visit frequency*: *Pandemic* was significant, with large estimated effect sizes for each regional location (Table S3). This suggests that greenspace visit behaviour before the pandemic was related to behaviour during the pandemic for each geographic region examined. However, visual examination of the Sankey diagrams suggests differing patterns among the European regions considering both baselines and the proportional flows. For example, in Northern Europe the proportion of respondents visiting greenspaces five or more times per week increased from 31% pre-pandemic to 40% during the pandemic (red sections in Figure 2b). In addition, the proportion of people visiting greenspaces less than once per week only increased from 6% pre-pandemic to 10% during the pandemic (yellow sections in Figure 2b). However, in Southern Europe, the proportion of people visiting greenspaces decreased across all frequency categories from pre-pandemic to pandemic, excluding less than once per week, which increased from 21% pre-pandemic to 68% during the pandemic (Figure 2d).

3.5 | Outdoor recreation frequency before and during the pandemic (RQ iii)

Considering all responses from Europe (N = 584), the bivariate association between *Outdoor recreation frequency*: *pre-pandemic* and *Outdoor recreation frequency*: *Pandemic* was significant, with a large estimated effect size (Table S3). This suggests that outdoor

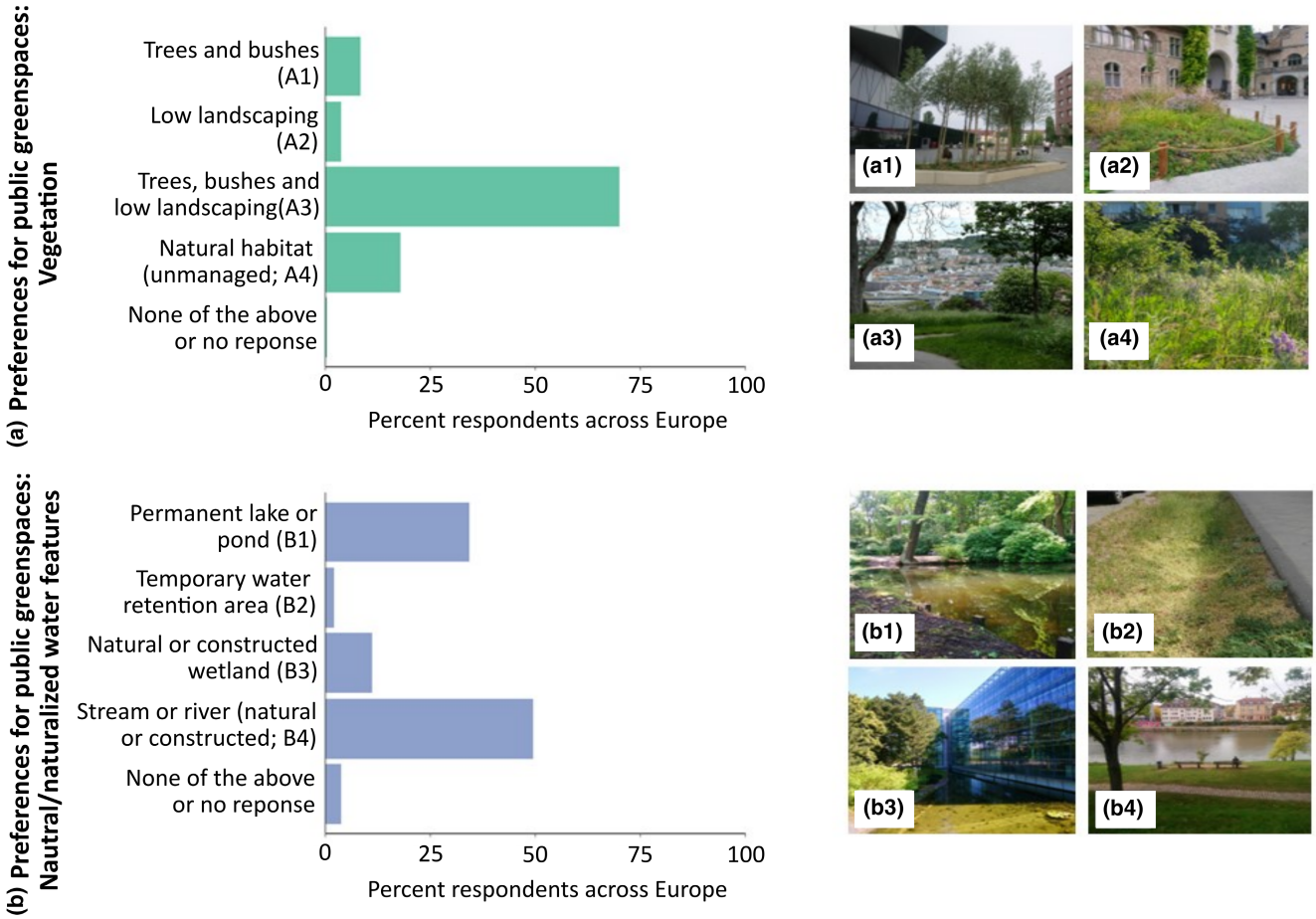
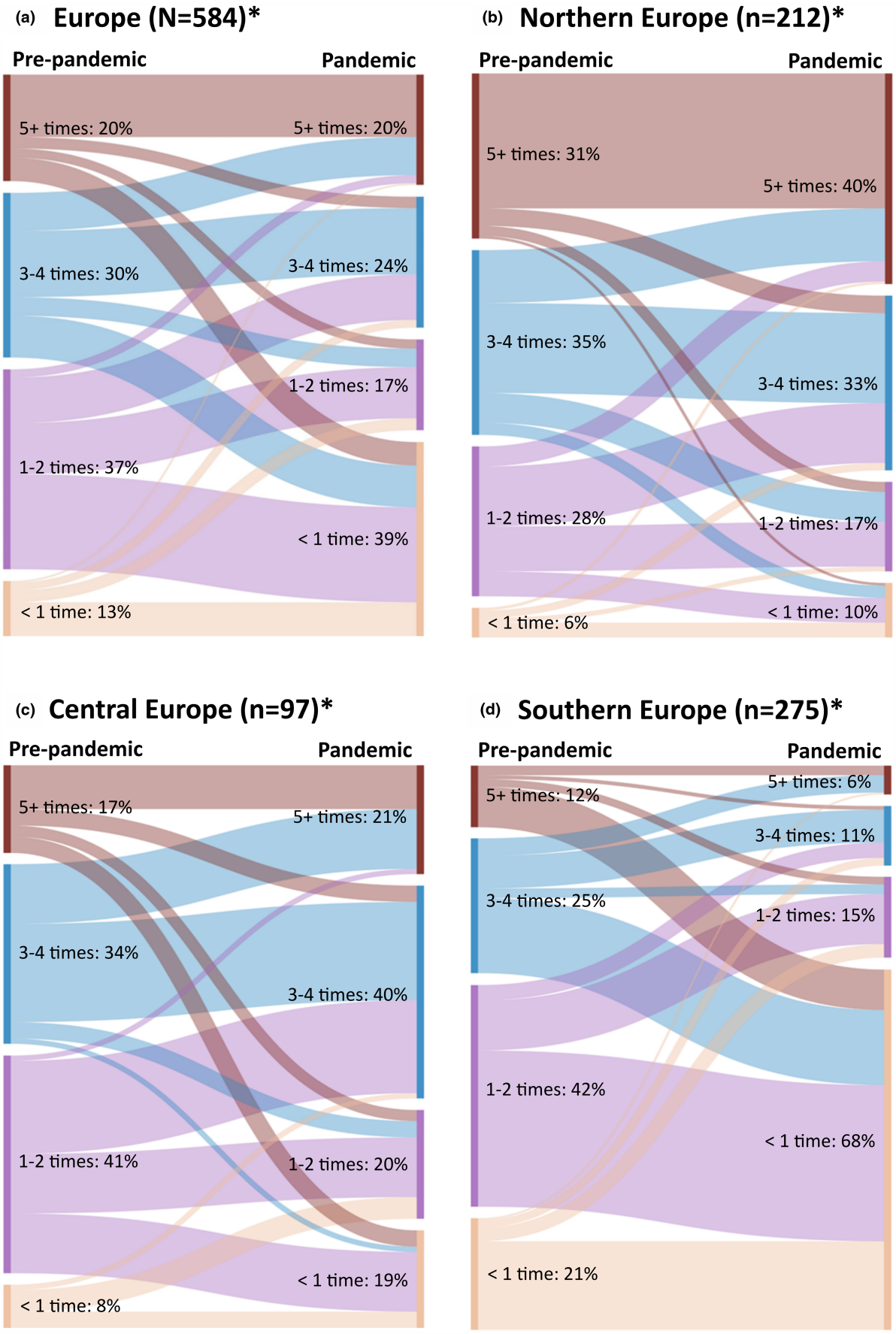


FIGURE 1 Preferences for (a) vegetation and (b) natural/naturalized water features in urban green and blue spaces. Numbering a1–a4 and b1–b4 refer to European examples of each vegetation or water feature depicted in the images (right) that we include here for illustration of the categories only. Exact values and preferences stratified by regional location are shown in Table S2.

FIGURE 2 Greenspace visit frequency. Sankey diagrams illustrating the proportional flow of pre-pandemic greenspace visit frequency per week to greenspace visit frequency per week during the pandemic. Panel (a) depicts the European-wide results (N = 584), panel (b) Northern Europe (n = 212), panel (c) Central Europe (n = 97) and panel (d) Southern Europe (n = 275). Significant bivariate associations ($p_c < 0.05$) between pre-pandemic and pandemic greenspace visit frequency are denoted with (*) in the individual heading of each plot.


(a) Europe (N=584)*
Pre-pandemic
Pandemic
5+ times: 20%
3-4 times: 30%
1-2 times: 37%
< 1 time: 13%
5+ times: 20%
3-4 times: 24%
1-2 times: 17%
< 1 time: 39%
(b) Northern Europe (n=212)*
Pre-pandemic
Pandemic
5+ times: 31%
3-4 times: 35%
1-2 times: 28%
< 1 time: 6%
5+ times: 40%
3-4 times: 33%
1-2 times: 17%
< 1 time: 10%
(c) Central Europe (n=97)*
Pre-pandemic
Pandemic
5+ times: 17%
3-4 times: 34%
1-2 times: 41%
< 1 time: 8%
5+ times: 21%
3-4 times: 40%
1-2 times: 20%
< 1 time: 19%
(d) Southern Europe (n=275)*
Pre-pandemic
Pandemic
5+ times: 12%
3-4 times: 25%
1-2 times: 42%
< 1 time: 21%
5+ times: 6%
3-4 times: 11%
1-2 times: 15%
< 1 time: 68%

recreation behaviour before and during the pandemic is related. The largest proportion of respondents (45%) reported engaging in outdoor recreational activities two times per week or less pre-pandemic, with this increasing to 56% during the pandemic (yellow lines in Figure 3a). The proportion of respondents engaging in outdoor recreational activities 3–4 times per week decreased from 31% to 20% (purple lines and sections in Figure 3a), while those engaging in outdoor recreational activities five or more times per week remained consistent before and during the pandemic (blue lines and sections in Figure 3a).

Regarding each of the three European regions individually, bivariate associations between *Outdoor recreation frequency*: *Pre-pandemic* and *Outdoor recreation frequency*: *Pandemic* were significant, with medium to large estimated effect sizes for each European region (Table S3). Again, this suggests that also for each separate regional location considered in analyses, outdoor recreation behaviour before and during the pandemic was related. Visual examination of the Sankey diagrams depicting the change in outdoor recreation frequency suggests differing patterns among the European regions considering both baselines and proportional flows (Figure 3b–d). For example, in the Northern European sample, the greatest proportion of respondents (41%) reported engaging in outdoor recreational activities five or more times per week pre-pandemic with this increasing to 50% during the pandemic (blue sections in Figure 3b). With this, Northern Europeans are the people in the sample that reported engaging most often in outdoor recreation both pre-pandemic and during the pandemic, when compared to the other regions. Conversely, in Southern Europe the largest proportion of respondents reported engaging in outdoor recreational activities two times per week or less pre-pandemic (58%), with this increasing to 85% during the pandemic (yellow sections in Figure 3d). In Central Europe, although there were changes in the frequency of outdoor recreation during the pandemic compared to before the pandemic, the overall proportion of respondents in each group remained fairly consistent (Figure 3c).

3.6 | Associations between socio-ecological background variables with greenspace visit and outdoor recreation frequency (RQ iv)

Some distinct patterns were found in the examination of the full dataset concerning how greenspace visit and outdoor recreation frequency associated with greenspace and sociodemographic background. *Regional location* was significantly associated with *Greenspace visit frequency*: *Pre-pan*demic and *Greenspace visit frequency*: *Pandemic*, and with *Outdoor recreation frequency*: *Pre-pandemic* and *Outdoor recreation frequency*: *Pandemic*. In other words, the European region in which respondents resided was related to how often they visited urban greenspaces and engaged in outdoor recreational activity both before and during the pandemic. Also, the *Dominant type of neighbourhood greenspace* was significantly associated with each response variable. This suggests the type of greenspace in a neighbourhood (e.g. predominately private, predominately public or a mix of both) is also related to respondents' greenspace visit and outdoor recreation behaviour. Finally, respondents' access to urban greenspaces during the pandemic (i.e. *Greenspace availability*: *Pandemic*) was significantly associated with both *Greenspace visit frequency*: *Pandemic* and *Outdoor recreation frequency*: *Pandemic*, meaning that respondents' reported availability of greenspaces during the pandemic was also related to their use of these areas, and their outdoor recreation behaviour more generally. In addition, Cramer's *V* suggests a large estimated effect size for each of these significant associations. None of the other greenspace-related or sociodemographic variables (i.e. *Negative perceptions of greenspace*, *Gardening behaviour*, *Age* or *Gender*) were significantly associated with greenspace visit frequency or outdoor recreation frequency for the full dataset across all regions (see Table 2). The results for the different regional locations were similar. In all regional datasets, there were few significant associations between response variables and the greenspace or sociodemographic background variables (Table S5).

To provide more detail on how the different background variables relate to geographical region, we examined three bivariate relationships among predictor variables using mosaic plots: *Regional location* with *Dominant type of neighbourhood greenspace*, *Greenspace availability*: *Pandemic* and *Negative perceptions of greenspace*. Visual interpretation of these plots suggests that many respondents had both public and private greenspaces in their neighbourhood, and few people reported having access to only private greenspaces (Figure 4a, blue and green sections of the diagram, respectively). The largest proportion of those reporting few greenspaces were from Southern Europe (Figure 4a, pink sections of the diagram). Similarly, most respondents reported having access to greenspaces during the pandemic, but the largest proportion of those who did not have ready access were from Southern Europe (Figure 4b). Finally, the majority of respondents did not see any drawbacks to the establishment of public greenspaces in their cities (i.e. *Negative perceptions of greenspaces*), such as notable increases in crime, noise or airborne pollen. This pattern was relatively evenly distributed among European regions (Figure 4c). According to Chi-Squared analyses, *Regional location* and *Dominant type of neighbourhood greenspace* were significantly associated, as well as *Regional location and Greenspace availability*: *Pandemic* (Table S4).

FIGURE 3 Outdoor recreation frequency. Sankey diagrams illustrating the proportional flow of pre-pandemic outdoor recreation frequency per week to outdoor recreation frequency per week during the pandemic. Panel (a) depicts the European-wide results ($N = 584$), panel (b) Northern Europe ($n = 212$), panel (c) Central Europe ($n = 97$) and panel (d) Southern Europe ($n = 275$). Significant bivariate associations ($p_c < 0.05$) between pre-pandemic and pandemic outdoor recreation frequency are denoted with (*) in the individual heading of each plot. Due to rounding to full numbers, the sum in some charts may slightly exceed 100%.

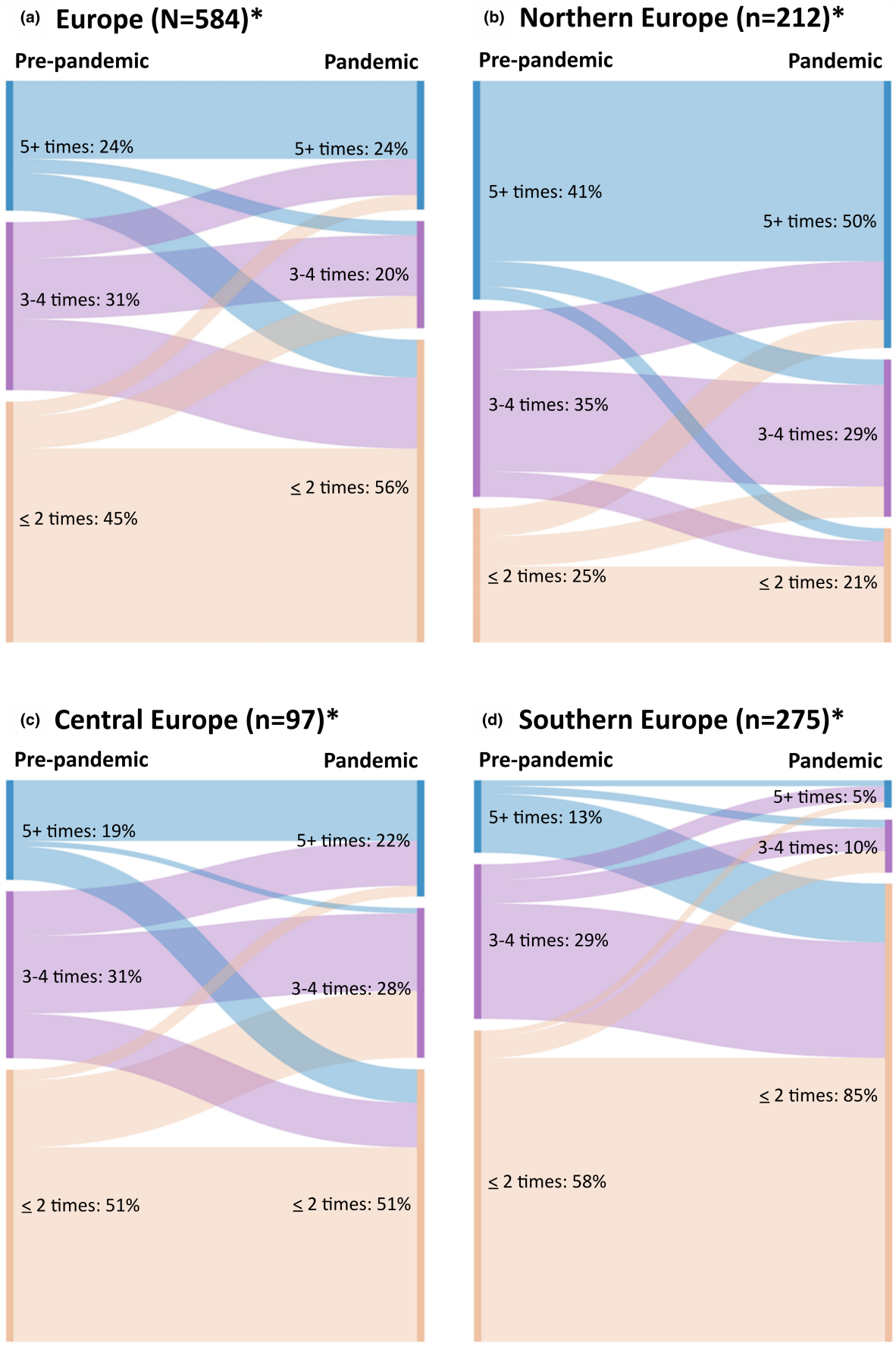

(a) Europe (N=584)*
Pre-pandemic
Pandemic
5+ times: 24%
3-4 times: 31%
≤ 2 times: 45%
5+ times: 24%
3-4 times: 20%
≤ 2 times: 56%
(b) Northern Europe (n=212)*
Pre-pandemic
Pandemic
5+ times: 41%
3-4 times: 35%
≤ 2 times: 25%
5+ times: 50%
3-4 times: 29%
≤ 2 times: 21%
(c) Central Europe (n=97)*
Pre-pandemic
Pandemic
5+ times: 19%
3-4 times: 31%
≤ 2 times: 51%
5+ times: 22%
3-4 times: 28%
≤ 2 times: 51%
(d) Southern Europe (n=275)*
Pre-pandemic
Pandemic
5+ times: 13%
3-4 times: 29%
≤ 2 times: 58%
5+ times: 5%
3-4 times: 10%
≤ 2 times: 85%

TABLE 2 Adjusted *p*-values (p_c) and Cramer's *V* (*V*) according to Chi Squared Analyses examining bivariate relationships between predictor variables (i.e. *Regional location*, *Dominant type of greenspace*, *Greenspace availability*: *Pandemic*, *Negative perceptions of greenspace*, *Gardening behaviour*, *Age*, and Gender) and response variables (i.e. *Greenspace visit frequency*: *Pre-pandemic*, *Greenspace visit frequency*: *Pandemic*, *Outdoor recreation frequency*: *Pre-pandemic* and *Outdoor recreation frequency*: *pandemic*). Original *p*-values (*p*) were adjusted using the Bonferroni correction ($p_c = p \times m$; $m = 49$). Significant bivariate associations ($p_c < 0.05$) are indicated in bold. In parallel, all details for the associations split by regional location are provided in Table S5

	Greenspace visit frequency		Outdoor recreation frequency	
Variable	**Pre-pandemic**	**Pandemic**	**Pre-pandemic**	**Pandemic**
Regional location	**$p_c < 0.001$** $V = 0.22$	**$p_c < 0.001$** $V = 0.44$	**$p_c < 0.001$** $V = 0.24$	**$p_c < 0.001$** $V = 0.43$
Dominant type of neighbourhood greenspace	**$p_c < 0.001$** $V = 0.16$	**$p_c < 0.001$** $V = 0.23$	**$p_c = 0.003$** $V = 0.16$	**$p_c < 0.001$** $V = 0.27$
Greenspace availability: Pandemic	—	**$p_c < 0.001$** $V = 0.59$	—	**$p_c < 0.001$** $V = 0.44$
Negative perceptions of greenspace	$p_c = 45.77$ $V = 0.03$	$p_c = 0.59$ $V = 0.14$	$p_c = 44.49$ $V = 0.02$	$p_c = 16.99$ $V = 0.06$
Gardening behaviour	$p_c = 6.70$ $V = 0.10$	$p_c = 17.17$ $V = 0.08$	$p_c = 0.31$ $V = 0.13$	$p_c = 0.45$ $V = 0.13$
Age	$p_c = 0.50$ $V = 0.13$	$p_c = 0.14$ $V = 0.12$	$p_c = 0.18$ $V = 0.13$	$p_c = 8.05$ $V = 0.09$
Gender	$p_c = 40.26$ $V = 0.04$	$p_c = 22.13$ $V = 0.07$	$p_c = 36.29$ $V = 0.03$	$p_c = 14.99$ $V = 0.06$

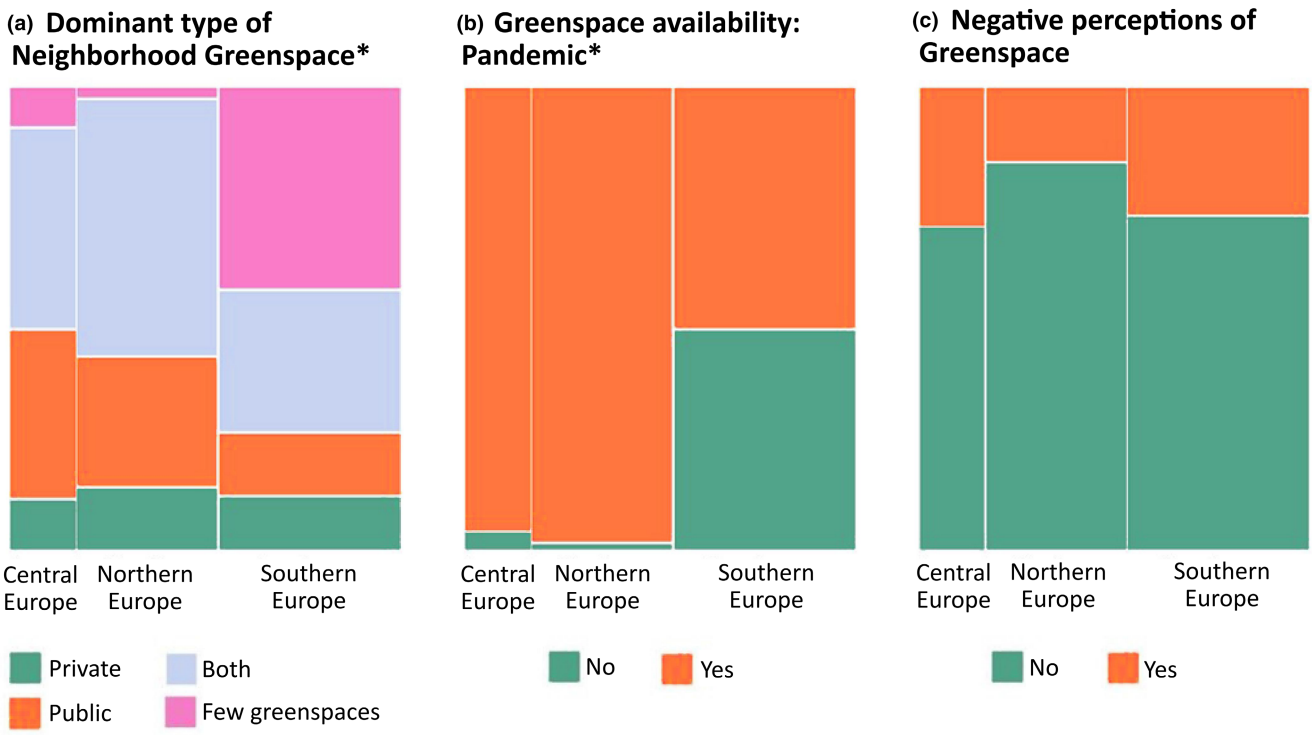


FIGURE 4 Mosaic plots depicting bivariate relationships between *Regional location* and (a) *Dominant type of neighbourhood greenspace*, (b) *Greenspace availability*: *Pandemic* and (c) *Negative perceptions of greenspace*. The width of each bar represents the proportion of respondents ($N = 582$) in each regional subset. The height of the individual-coloured sections within each bar represents the proportion of respondents in each group according to response. Significant bivariate associations ($p_c < 0.05$) according to Chi-squared analyses are denoted with (*) in the individual headings of each plot.

4 | DISCUSSION

Improving the resilience of cities and adapting neighbourhoods to climate change will require more effort in regard to holistic approaches in city planning that combine social and ecological aspects, and are inspired by the goal to balance anthropocentric and ecocentric values (Randrup et al., 2020). In this regard, the results of this cross-European survey provide insight into the usage patterns

of urban green and blue spaces, including people's greenspace visit and outdoor recreation frequencies in the specific context of the pandemic. Preferences for specific green and blue space landscape features, purposes of time spent outdoors and greenspace perceptions were also examined to contribute to an understanding of how green and blue spaces can be designed to fit the needs of people and nature. This broadens the existing knowledge base of both the social and ecological dimensions of urban green and blue spaces and, in extension, of nature-based solutions to support just and sustainable cities (Welden et al., 2021).

Overall, the results of the present survey indicate that green and blue spaces played an important role in respondents' outdoor activities during the pandemic, and were connected to diverse uses and preferences. Most importantly, patterns in green and blue space use (i.e. greenspace visit frequencies, outdoor recreation frequencies—both pre-pandemic and during the pandemic) and preferences for specific natural elements differed across some European urban regions. Surprisingly, the sociodemographic background of respondents was not related to the observed frequencies of greenspace use and outdoor recreation, but rather pre-pandemic greenspace habits, the dominant type of neighbourhood greenspace, and greenspace availability during the pandemic. From the results of this study, it can be ascertained that a range of urban people use green and blue spaces in diverse ways in regions where they are readily available.

4.1 | People prefer diverse green and blue elements

Approximately three-quarters of survey respondents clearly stated a preference for landscape features that combine trees, shrubs and low landscaping elements. This strong preference for structurally diverse natural elements is in accordance with results from previous studies that indicated similar preferences for structurally diverse vegetation in informal urban greenspaces that facilitated residents' regular physical activity during the pandemic (Gopal & Fischer, 2021). Also before the pandemic, people often preferred green elements with structural richness (Lindemann-Matthies & Bose, 2007; Southon et al., 2017). Results such as these provide important insight for green and blue space design, both in general and specifically for times of crisis, that help support both people and nature. On the human side, preferences should be considered because people are more likely to use greenspaces, and experience the corresponding benefits associated with nature, when they are positively perceived (Jim & Shan, 2013; Maller & Mahmoudi Farahani, 2018). The results of our study indicated that European residents preferred vegetation with structural richness in greenspaces, which could therefore influence how and which greenspaces people choose to visit. This is important because structural diversity of vegetation can help support cultural ecosystem services of greenspaces. For example, structural diversity or complexity of vegetation has previously been associated with positive physical (Donovan et al., 2019; Wu et al., 2021) and mental (Hoyle et al., 2017; Pazhouhanfar & Kamal, 2014) health benefits. It should be noted, however, that structural diversity of vegetation is not unanimously associated with positive outcomes. For example, Berdejo-Espinola et al. (2022) found that diversity of vegetation height was associated with reduced greenspace visit frequency during the pandemic in urban Australia. Despite mixed results regarding the effect of vegetative structural diversity for the provisioning of cultural ecosystem services, planning and managing urban green and blue spaces to be structurally diverse can greatly benefit nature. This effect can be direct, in that urban greenspaces with high structural diversity can inherently be comprised of more, and more variable, species (e.g. trees, shrubs, perennials, grasses) than structurally homogenous greenspaces. This effect can then also cascade, as structural and species diversity of vegetation can increase habitat heterogeneity, thereby supporting the species-level diversity of other organisms (Norton et al., 2019; Tews et al., 2004).

Although the majority of respondents across Europe preferred a structurally diverse combination of different vegetative elements, our study also demonstrated that geographical region influenced respondents' preferences for other green elements. For example, the preferred combination of trees, bushes, and low landscaping was followed by a preference for unmanaged, natural habitat in both Central and Northern Europe, whereas Southern Europeans preferred trees and bushes. This mixed opinion regarding unmanaged or near-natural urban habitat corresponds with results of previous studies (Fischer et al., 2020; Lampinen et al., 2021). For example, converting lawns into tall-grass meadows that are managed in a more biodiversity-friendly manner, gained more support in temperate regions than in summer-dry regions of Europe (Fischer et al., 2020). These preferences regarding near-natural urban habitats likely affect how people experience and use urban greenspaces, and could therefore impact the potential benefits they may derive from these spaces. Indeed, studies examining the mental health impact of urban greenspace naturalness or near-natural management have also yielded mixed results. For example, Carrus et al. (2013) found that perceived mental restoration increased in accordance with naturalness, whereas the results of Martens et al. (2011) indicated a greater mental health benefit corresponding to more managed urban forests compared with those that had a more natural aesthetic. Whether mental health outcomes like these are directly linked to specific user preferences regarding near-natural urban habitats requires further investigation. However, despite mixed results regarding preferences and health benefits of natural or unmanaged greenspaces, near-natural management strategies of green and blue spaces can have strong, positive effects for biodiversity. For example, it is well established that the adoption of less intensive management strategies like reduced mowing frequency and abstaining from leaf-litter removal, positively affect the diversity of vegetation and other organisms (Chollet et al., 2018; Sehrt et al., 2020).

Preferences with regard to blue infrastructure were more similar between regions, with respondents across Europe sharing a preference for natural or restored streams or rivers and permanent lakes or ponds. In other European regions not explicitly considered in our study, water features were revealed as an important element

for people during the pandemic. For example, a study in Belgium revealed that access to the coast was positively correlated with respondents' well-being (Severin et al., 2021). Already before the pandemic, blue infrastructures such as rivers and lakes provided important benefits to people through, for example, stormwater regulation and the potential for recreation that are often deliberately supported by the implementation of nature-based solutions (Grizzetti et al., 2019; Oral et al., 2020).

The intrinsic value of nature itself, the potential of urban nature to support biodiversity, and people's preferences of green and blue space elements should all be considered in the design and management of urban greenspaces to balance environmental and societal challenges. It is well established that structural and species diversity of greenspaces beget more biodiversity (Norton et al., 2019; Tews et al., 2004). Preferences, however, should also be considered since they can influence greenspace usage and therefore potential nature-derived health benefits (Jim & Shan, 2013; Maller & Mahmoudi Farahani, 2018). Because many urban people are currently facing significant reductions in daily nature interaction (i.e. extinction of experience, Soga & Gaston, 2016), taking steps to encourage human–nature interaction is increasingly important to support both people's well-being and instil nature-positive beliefs and behaviours that support nature long term.

4.2 | People spent time outdoors for restorative purposes with walking and running as common outdoor recreational activities pre-pandemic

Walking and running were the most common recreational activities in all geographical regions among survey respondents. Respondents across Europe also showed a clear purpose for time spent outdoors before the pandemic, mainly for the restorative purpose of relaxing and calming down. While these results are explicitly linked to the time period before the pandemic, other studies have reported similar findings both before and during the pandemic. For example, Ugolini et al. (2020) reported physical exercise and relaxing as main reasons for visiting green and blue spaces prior to the pandemic. In addition, during strict lockdown periods of the pandemic, walking was reported as the most frequent outdoor activity in Perth, Australia and in Moscow, Russia (Dushkova et al., 2021), and as the most common activity during the pandemic in streetscapes at a global scale, regardless of sociocultural characteristics (Gopal & Fischer, 2021). Also consistent with the results reported herein, Heo et al. (2021) found that relaxation was the most common reason for green and blue space visits both before and during the pandemic in a non-European context. These results suggest that people intentionally go outdoors and visit greenspaces for restorative purposes. Indeed, there are now insights explicitly for the pandemic suggesting that nature exercise and nature therapy in urban greenspaces can help reduce stress, anxiety and depressive symptoms (Sundara Rajoo et al., 2021). Furthermore, there is evidence that even brief outdoor experiences in green and blue spaces or having green window views during the strictest lockdown periods provide mental health benefits (Pouso et al., 2021; Soga, Evans, Tsuchiya, et al., 2021).

4.3 | Changes in greenspace visit and outdoor recreation frequencies before and during the pandemic

Survey results highlight that urban greenspace visit frequency and outdoor recreation frequency differed before and during the pandemic's first global wave, with observed differences between European regions. For the full European sample, about half of participants that visited urban greenspaces quite often pre-pandemic continued to do so during the pandemic, with some respondents who previously visited greenspace less often becoming more frequent visitors. At the same time, the proportion of respondents with very few greenspace visits pre-pandemic increased in the full European sample. This may relate to outdoor restrictions in some cities during strict lockdown periods that greatly reduced residents' mobility and access to green and blue spaces, but also to other aspects such as fear of COVID-19 infection (Heo et al., 2021; Mateer et al., 2021). In other urban areas, changes in greenspace visit frequencies were also reported on a local basis, for example, in Moscow, Russia and Perth, Australia (Dushkova et al., 2021), across families in the UK (Friedman et al., 2021), and internationally using Google mobility data (Geng et al., 2021). While many factors may affect an individual's green and blue space usage, such evident differences in visit frequencies across many scales highlight the necessity of facilitating equitable access to green and blue spaces both during times of crisis and more generally.

4.4 | Importance of geographical region in observed patterns

Our results indicate that during the pandemic, the part of Europe in which a respondent resided related significantly to the dominant type of neighbourhood greenspace, general greenspace availability during the pandemic, and both greenspace visit frequencies and outdoor recreation frequencies. We found that respondents from Northern Europe used greenspaces and engaged in outdoor recreation more frequently than respondents from Southern Europe before the pandemic, and that this trend was enhanced during the pandemic.

Several factors may contribute to the observed trends in greenspace visit and outdoor recreation frequencies. First, it is likely related to differences in the general availability of greenspace across Europe. Our results indicated that a much larger proportion of Southern European respondents reported having few greenspaces in their neighbourhood, compared to Central and Northern Europeans. Larger-scale studies examining non-subjective greenspace availability in Europe corroborate these results. For example, Kabisch et al. (2016) found that Southern European cities

demonstrated below-average greenspace availability in contrast to Northern European cites, which demonstrated above-average greenspace availability. This gap in geographical greenspace availability may also be widening, with recent evidence suggesting that access to urban greenspace is declining in Southern European countries (Xu et al., 2022). These geographical trends in greenspace availability should be considered with regard to patterns in greenspace usage—and related cultural and ecological benefits—as usage has previously been associated with perceived accessibility and proximity of greenspaces (Lau et al., 2021; Zhang & Tan, 2019; Žlender & Ward Thompson, 2017). Previous studies have also reported geographical differences in outdoor recreation behaviour before the pandemic that correspond with these North-South greenspace availability trends. For example, a study examining green and blue space usage in five European cities found that 68% of respondents in the Northern European city of Malmö, Sweden predominately used greenspaces for physical activity compared to only 40% of respondents in the Southern European city of Bari, Italy (Fischer, Honold, Botzat, et al., 2018).

Regarding pandemic-related changes in greenspace visit and outdoor recreation frequencies, pandemic conditions may have reinforced already existing habits. While there was always some change observed among frequency groups between pre-pandemic and pandemic behaviour concerning both greenspace visit and outdoor recreation for all geographical locations, a large proportion of the population maintained their pre-pandemic behaviour during the pandemic. For example, the majority of Northern European respondents engaging in outdoor recreational activity five or more times a week before the pandemic continued to do so during the pandemic; the majority of Southern European respondents who engaged in outdoor recreational activity two times a week or less pre-pandemic, also continued to do so during the pandemic. This is in accordance with initial studies examining pandemic-related changes in greenspace usage and outdoor recreation that also found the majority of respondents visiting green and blue spaces and participating in outdoor recreation before the pandemic continued to do so during the pandemic's first wave (Mateer et al., 2021; Ugolini et al., 2020).

Importantly, incidences and subsequent government restrictions likely had a substantial impact on the regional changes in greenspace visitation and outdoor recreation frequency patterns observed in the present study. This is particularly relevant since the European regions in our study were established based on a North-South gradient, and outbreak severity and mobility restrictions tended to be greater in Southern Europe than in Northern Europe during the first wave of the pandemic (Bosa et al., 2022; Tragaki & Richard, 2022). Studies examining greenspace usage during the pandemic have found geographical patterns were related to pandemic and lockdown severity. For example, Geng et al. (2021) reported a decrease in green and blue space visitation for the hardest hit regions, including Italy and Spain, during the first wave of the pandemic. Similarly, Ugolini et al. (2020) also reported that two-thirds of southern European individuals who regularly visited green and blue spaces before the pandemic stopped doing so during the first wave of the pandemic, whereas individuals from other parts of Europe maintained their greenspace habits. In addition, Geng et al. (2021) found that in areas with high COVID-19 incidences, government restrictions were associated with a decrease in green and blue space visits, while in areas with low COVID-19 incidences, such as Denmark, government restrictions were associated with an increase in green and blue space visits. This may be because government restrictions in hard-hit areas typically involved stay-at-home orders or restricted mobility, whereas in areas with low incidences of COVID-19 infection, government restrictions such as workplace closures may have induced increased green and blue space visitation (Geng et al., 2021). This supposition is further supported by Astell-Burt and Feng (2021) whose study results indicated that individuals who were able to work from home during the pandemic visited green and blue spaces more frequently, and for longer periods of time per visit, as compared with those who were not able to work from home.

While geographical region was important with regard to the dominant type of neighbourhood greenspace, general green and blue space availability during the pandemic, and both greenspace visit frequencies and outdoor recreation frequencies, we did not find any association between these factors and our demographic variables. This result is unexpected, as many previous studies have found associations between greenspace variables and sociodemographics (e.g. Browning & Rigolon, 2018; Schüle et al., 2019; Wolch et al., 2014). For example, there is much evidence that ethnic minorities and those with a lower socioeconomic status tend to have less access to safe, high-quality greenspaces (Rigolon, 2016; Williams et al., 2020). This is especially relevant as people with a lower socioeconomic status may stand to benefit more from greenspaces than those with a higher socioeconomic status (Rigolon et al., 2021). Specifically within the pandemic context, sociodemographics have been found to be associated with how, and how frequently, people use urban greenspaces with differences associated with income and race (Burnett et al., 2021; Geng et al., 2021; Pipitone & Jović, 2021), age (Borkenhagen et al., 2021; Burnett et al., 2021) and gender (Borkenhagen et al., 2021; Burnett et al., 2021). In addition, Spotswood et al. (2021) found that communities with lower income and majority persons of colour were both hardest hit by the pandemic and had the least nearby nature. While we did not find any significant relationships between sociodemographic and greenspace variables in the study at hand, we only considered age and gender, and acknowledge that other sociodemographic variables such as ethnicity, cultural aspects, or income may play a greater role in the examined greenspace relationships.

Of note, whether or not respondents gardened (e.g. in home gardens, balconies, allotments or community gardens) also did not relate to patterns in greenspace visit or outdoor recreation frequencies before and during the pandemic. This was an unexpected result and in contrast to other findings that indicated the majority of people who gardened also engaged in other, often nature-based, outdoor activities during the pandemic (Gerdes et al., 2022).

Furthermore, respondents' perceptions of greenspace were also not associated with their greenspace visit or outdoor recreation

frequency. Overall, relatively few respondents indicated a negative perception towards urban greenspace features (e.g. noise, pollen, pests, crime), which was consistent across all geographical regions. So, regardless of the geographical location, the majority of survey respondents reported a generally positive perception towards urban greenspace. Before the pandemic, positive associations with green elements and their maintenance in diverse European cities could be traced to ecological and socio-cultural assigned values, including links to health and recreation (Lampinen et al., 2021). Whether the positive connotations towards greenspaces in the study at hand are related to the specific pandemic situation or underlying values and norms requires further investigation.

4.5 | Limitations

Although this study offers valuable insights, it also has several limitations. First, data were derived from an online survey rather than a mixed approach with both online and face-to-face distribution. Therefore, survey responses are inherently biased towards groups of society with access to the internet. Also, due to the survey distribution method (i.e. snowball sampling), responses were not evenly distributed among world regions. As a result, survey responses were grouped geographically by region rather than examining each country individually and regions with very few responses (e.g. Asia, North America) were excluded from analysis. In addition, the survey asked respondents to reflect on their behaviour before the pandemic. Retrospective questions like these that are used to examine changes in past and present conditions or behaviours may be less accurate and, in specifically COVID-19-related studies, may lead to underestimations of change (Hipp et al., 2020). Furthermore, because many tests were conducted using the same data, the Bonferroni correction was used to limit potential Type I error. However, the Bonferroni correction is conservative, so it is possible there may be more significant associations than indicated by the results reported herein. Questions regarding participants' ethnicity, education or income levels were not included in the questionnaire, although these factors may be related to greenspace perceptions and use, as well as outdoor recreation type and frequency. Finally, we recognize that while we grouped individual responses based on geographical region and reported our results as such, individuals within these groups likely have diverse sociocultural backgrounds that may influence their greenspace relationships, perhaps more so than location alone (see Section 4.4).

4.6 | Recommendations

Our results suggest that urban green and blue spaces were important for Europeans both before and during the first wave of the global pandemic, with generally high frequencies of greenspace visits and outdoor recreation. There were also distinct regional patterns, with a large proportion of Southern European respondents reporting they have few greenspaces in their neighbourhoods, low greenspace availability during the pandemic, and generally lower greenspace visitation and outdoor recreation frequency both before and during the pandemic than Northern Europeans. This finding supports the need for equitable and socially just access to urban green and blue spaces (e.g. regardless of age, gender or sociocultural background) so that all people can use these spaces and enjoy the benefits of urban nature in both daily life and during times of crisis. In light of these cultural and social dimensions, it is noteworthy that a high proportion of the general public seem aware of and actively seek out the restorative effects of nature, with the majority of respondents to the present survey indicating that their main purpose of time spent outdoors before the pandemic was to relax or calm down. Indeed, other studies examining the relationship between urban nature and mental health both before and during the pandemic found that exposure to urban nature has positive mental health effects (Hartig et al., 2014; Lee & Maheswaran, 2011; Pouso et al., 2021). To better understand how urban green and blue spaces can be optimally designed to provide restorative effects, additional research is needed to examine which aspects of urban greenspaces or specific green elements are conducive to improved mental health and well-being (see, e.g. Barnes et al., 2019).

Regional patterns were also observed concerning preferences for specific green elements within urban green and blue spaces. These results suggest that urban green and blue space planners and designers should not employ a 'one approach fits all' strategy, but rather account for regionally specific differences in patterns of use, design preferences and cultural traditions to maximize green and blue space visitation and time spent in urban nature to yield optimal public health benefits. Considering user preferences is also important with regard to maximizing the potential to support urban nature, as increasing support for structurally diverse green elements and unmanaged or natural habitats may allow for the inclusion of more biodiversity-friendly urban green and blue space design and management, depending on the local context.

Service design and co-creation methods that include legitimate citizen engagement are especially beneficial approaches for the design of urban green and blue spaces. This inclusion and active involvement of many stakeholders throughout the creation, implementation and maintenance of urban green and blue spaces is what brings people and nature together and separates more typical green and blue infrastructure from nature-based solutions that maximize their environmental, ecological, social and economic potential. These methods were employed in UNaLab partner cities for the implementation of nature-based solutions and are recommendable greenspace design approaches, as they facilitate the understanding of users' needs and cultural traditions (www.unalab.eu).

5 | CONCLUSION

Although the public health benefits of urban nature exposure are increasingly studied, the pandemic has highlighted the importance

of green and blue spaces for urban residents globally. The objective of this study was to contribute to the socio-ecological understanding of urban green and blue spaces by examining preferences and usage patterns related to green and blue elements within these spaces, along with changes to greenspace visitation and outdoor recreation frequency in Europe during the first wave of the pandemic compared to the pre-pandemic period. Our results highlight that green and blue spaces should be equitably distributed within an urban area and readily accessible to all people, while co-creative design approaches should consider differences in regionally specific green and blue element preferences, as well as local cultural traditions to optimize the ecological and public health benefits of urban green and blue spaces.

AUTHOR CONTRIBUTIONS

Leonie K. Fischer, Laura Wendling, Kaisa Mustajärvi, Arto Laikari and Maria Dubovik conceived the ideas and designed methodology; Laura Wendling and Kaisa Mustajärvi coordinated participation from the UNaLab cities; Arto Laikari and Kristen Jakstis processed and analysed the data; Leonie K. Fischer, Maria Dubovik and Kristen Jakstis led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data used for analysis in this study are archived on Dryad Digital Repository https://doi.org/10.5061/dryad.rn8pk0pfm (Jakstis et al., 2022).

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