

Research

People-environment relations following COVID-19 pandemic lifestyle restrictions: a multinational, explorative analysis of intended biophilic design changes

Kalterina Shulla¹ · Bernd-Friedrich Voigt² · Salim Lardjane³ · Kerstin Fischer⁴ · Piotr Kędzierski⁵ · Giuseppe Scandone⁶ · Thomas Süße⁷

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Abstract

The study analyzes the consequences of the COVID-19 pandemic restrictions for the human–environment relations through the lenses of biophilic design. The mixed-method quantitative and qualitative explanatory research combines contextual and personal variables, such as, among others, country, age group, gender, overcrowding, time spent outside, access to nature/food and the exposure to biophilic elements, during and after the lockdown. The results indicate that psychological pressure on individuals caused by pandemic restrictions imposed early 2020, triggered changes in human–environmental relation. More precisely, our comparative analysis of six European countries (Italy, Germany, Poland, Spain, Denmark and Sweden) indicates that people–environment relations do not depend on the objective severity of country-wise restrictions, but rather on the individual perceptions of these restrictions. The results complement the lack of the research for the role of biophilic design in understanding and enhancing human–environment relations during the COVID-19 pandemic restrictions and thereafter.

Keywords Biophilic design · Environmental psychology · People–environment relation · COVID-19 pandemic

1 Introduction

The power of nature for physical and mental well-being and the healing role in stressful conditions is undeniable, as human aesthetic, intellectual, cognitive and spiritual cravings are fulfilled [1]. Exposure to real or simulated natural views can quickly trigger restorative activity in the brain and reduce stress levels [2]. Contemplating a nature-integrated urban environment can enhance positive emotions [3, 4] as deprivation from it can worsen negative states [5]. In early 2020, the COVID-19 pandemic imposed worldwide restrictions that were unique because of their variety and differing severity which ultimately resulted in graduated states of psychological pressure on individuals [6, 7]. However, when people are forced to cope with crises in unusual circumstances, changes are triggered in their patterns of living and working toward a more sustainable and resilient lifestyle [8]. “Worry” can divert life priorities, but a strong self-concept of nature can serve as a buffer for a moderate impact on environmental values [9], enabling “salutogenic” experiences out of

✉ Kalterina Shulla, kalterinashulla@gmail.com; ✉ Bernd-Friedrich Voigt, voigt.bernd-friedrich@fh-swf.de | ¹University of Bonn, Bonn, Germany. ²South Westphalia University of Applied Sciences, Meschede, Germany. ³LMBA UMR CNRS 6205, University of South Brittany, Lorient, France. ⁴University of Southern Denmark, Odense, Denmark. ⁵Otwock, Poland. ⁶QG Enviro, Lecce, Italy. ⁷University of Applied Sciences and Arts, Bielefeld, Germany.



stress and psychological states even in extreme environments [10]. The restrictions of the COVID-19 global pandemic highlighted an attention towards Biophilic Design, as it embraces elements of direct and indirect experience of nature.

As personal growth is attributed to societal dynamics and changes in norms [11], the way people use and perceive the environment can be encouraged or limited by such norms and cultural contexts [12]. Ironically, despite its far-reaching negative effects, the pandemic also created a new environment for self-reflection and changes in personal perceptions and actions toward its natural surroundings [13] and the individuals' lifestyle choices, such as choice of food, housing, mobility, etc.; factors which are mainly not beyond individual control [14]. While the ecological footprint and environmental impact of the crisis have been widely considered in research of sustainable design practices [15], biophilic design (BD) encompasses the mutual benefits of connecting with nature to both humans (physiological and psychological benefits) and the environment [16]. Therefore, this study aims to understand the effects of the COVID-19 pandemic on changes of people-environment relations considering objective as well as perceived severity of lifestyle restrictions. Beyond this, the research aims to depict a pattern of predictive variables regarding the likelihood of integrating BD in future life. We do so in combining a country-comparative research approach, explorative quantitative and qualitative analysis of intended BD changes.

2 Conceptual background

The term 'biophilia' (love of life), composed of the ancient Greek words for "life" (bio) and "love" (philia), describes harmonious relationships between humans and the biosphere [17]. The term was first used by Erich Fromm in "The Heart of Man" (1964) and later by Edward Wilson in "Biophilia" [18]. The individual's physiological and psychological response to nature enables the effects of BD elements such as the direct experience of nature in the built environment (natural light, air, plants, animals, water, landscapes), the indirect experience of nature (contact with the representation or image of nature, natural materials, etc.) and the experience of space and place (spatial features of prospect refuge, etc.) [19, 20].

The human response to design stimuli allows BD elements to improve quality and sustainability by enhancing health and well-being, productivity, biodiversity, circularity, and resilience [21]. The green building movement in the early 1990s enforced the link between improved environmental quality and worker productivity [22] through the use of BD to connect with the indoor environment. Additional benefits include addressing workplace stress, student performance, patient recovery, and community cohesiveness [23] and improving well-being in prisons [24]. The BD elements in the landscape (even those not perceived as such) enable the incorporation of diverse strategies into the built environment [25]. In urban settings, these elements, the new "Hanging Gardens of Babylon", are indicators of sustainability and resilience. When there is freedom to choose for home or workplace environment relations, the choice is often dominated by a viewpoint with a generous prospect, elevated position, open, savanna-like terrain, proximity to a body of water, etc. [26].

BD research is mainly related to two theoretical concepts from environmental psychology: The first is Stress Reduction Theory (SRT) [27, 28] which explains the extent to which contemplating nature can trigger restorative activity in the brain, which in turn is responsible for reduced stress levels and positive emotions. The second explanatory concept comes from Attention Restoration Theory (ART) [29], which states that a lack of concentration as well as mental fatigue, which can be attributed to a prolonged direct attention span, can be positively influenced by a visual or physical stay in nature and the increase in concentration can be achieved through restorative processes with less energy-draining attention [30]. When a person is facing an unpleasant and stressful change in its person-environment relation because of a perceived external behavioral control, patterns of BD (see Annex 2) and biophilia values [31] can trigger individual restorative responses [10]. These responses might ultimately result in an adjustment of the environmental surroundings, or at least enhance a person's motivation to do so by effecting the likelihood of using BD. Mindsponge Theory [32] conceptualizes this relation of perceived behavioral control in nature and models it with intentions towards behavior change [33]. A crucial part of this systemic conceptualization of the person-environment relation is the element of "perception of external information by the sensory systems, such as visual or auditory information" [34].

Literature shows that pandemic restrictions have divergent but socioeconomically moderate psychological effects (either positively or negatively related to states of stress) and that enforced restrictions can be perceived differently (i.e., at the individual level). In addition, deprivation from one of the domains can have such great importance that it can dominate the totality of the measures and, as a consequence, can result in a perceived stronger severity of the measures despite the moderate or weak objective status of the country [35]. The severe restrictions imposed in Europe and all over the world (although differing across countries), especially during the first wave of the pandemic (March–June 2020), limited life choices [36, 37]. These restrictions were accompanied by psychological distress and

a decrease in psychological well-being in the general public [38], among others, due to limited access to physical activity, lack of blue/green landscapes, views of nature from home [39] and remote interactions, which caused loneliness, especially for women and younger adults [40]. During this period in Italy, the lack of adequate space, terraces and gardens resulted in increased stress and aggressiveness [41], where the correlation with the “home satisfaction” factor in those conditions was related to spatial features of adequacy, flexibility, and crowding [42]. As human risk perception can lead to immediate action, in France, hours and days before the lockdown, people moved from their homes to other places, closer to family, or with better living conditions in terms of size, crowding, landscape, etc. [43]. Additional challenges in the living environment were also due to the necessity of adapting to working from home [44, 45]. During the first wave, for instance, more than 60% of the workers in Germany were obligated to work from home, confronting the lack of a separable home-office working space and triggering a large-scale invasion of work into the private sphere [46].

The related post pandemic research has analyzed the role of biophilic features for recovery from COVID-19. Afacan (2021) explores the role of biophilic design in enhancing psychological resilience during the pandemic, related to recovery tension mood, depression and anger [47]. Furthermore, integrating natural elements into both residential and public spaces, especially in times of crisis, can significantly improve mental and physical health and foster a sense of community and connection [48]. BD principles are vital for enhancing post-pandemic living spaces, through maximizing natural light and ventilation, incorporating plants and green spaces, using natural materials, and designing flexible, multi-functional spaces. These approaches not only create aesthetically pleasing environments but also support well-being and sustainability, making living spaces more adaptable and resilient to future crises [49]. Incorporating natural elements into architectural design not only create aesthetically pleasing environments but also encourage deeper connections with nature, leading to healthier, more resilient living spaces, and better mental and physical health [50]. Furthermore, investigations on the relevance of various influential factors for the efficiency and effectiveness of working from home, for physical and mental well-being have been conducted [51, 52]. There is a need for coordinated cross-disciplinary research to address COVID-19’s mental health impacts and understanding the pandemic’s psychological effects during and after the pandemic [53]. However, the role of BD as an indicator of enhancing connection between nature and humans triggered by lived experiences during the pandemic is under-researched. This study aims to fill this gap, by analyzing people-environment relations following COVID-19 pandemic lifestyle restrictions, through a multinational, explorative analysis of intended BD changes.

3 Systematization of restrictive measures during the pandemic in Italy, Germany, Poland, Spain, Denmark and Sweden

The restrictive measures taken during the COVID-19 pandemic for most of the countries, consists on establishing lockdowns, declaring state of emergency, ban on outside activities, border and travel/international flights, and events. The Oxford COVID-19 Government Response Tracker (OxCGRT) defines the stringency of the measures in eight domains: school and workplace closings, canceling public events, restrictions on gathering size, close public transport, stay-at-home requirements, restrictions on internal movement and international travel [54, 55]. These restrictions were considered as basis for defining the comparative groups, contrasting case/country selections: (1) countries that experienced strong/moderate restrictions (Italy, Spain, Germany and Poland) and (2) countries with relatively weak restrictions (Denmark and Sweden). Countries are used as proxies, not considering internal differences (i.e., Italy, “in November 2020, was divided into three zones (red, orange, and yellow)) depending on the severity of the outbreak, with different restrictions applied in each zone.

The six selected countries were affected differently by the pandemic, as reflected by the varying severity of the measures taken. During the first wave of the pandemic, the state of emergency was declared in Italy, Spain, and Denmark. The lockdown was implemented in Italy, Spain and Poland, partially in Germany, while Denmark and Sweden had no national lockdowns (see Table 1, below) for an overview of the restrictions considering the above domains, plus the lockdown status and the state of the emergency in the six countries). Sections 3.1. and 3.2. display detailed illustrations of the restrictive measures in the groups.

Table 1 Severity of measures taken during the COVID-19 pandemic, considering lockdown status, state of emergency, ban on outside activities, border and travel/international flights, and events, for Italy, Spain, Germany, Poland, Denmark and Sweden (COVID-19 Government Response Tracker | Blavatnik School of Government (ox.ac.uk) [79])

Country	Lockdown status	State of emergency	Outside activities	Border and travel/international flights	Events	Lock down severity considered for this study
Italy	Yes, strict lockdown and non-essential production halted	Yes	Allowed, but only alone and near home, for essential reasons, e.g. buying groceries and going to the doctor	Open, but all neighbouring countries have restricted entry/restricted	All events and gatherings banned	Strong
Spain	Yes. National lockdown extended. Certain sectors allowed to work again as of April 14 2020	Yes	Outdoor physical exercise banned, exceptions for walks for certain groups	Restricted	All events and gatherings banned	Strong
Germany	Partial lockdown, with rules differing across states. Many shops closed	No	Yes, but only alone or with a person from same household	Closed/restricted	All events and gatherings banned	Strong/moderate
Poland	Yes. Nonessential movement banned	No	Allowed only in pairs. Gloves are mandatory in supermarkets	Closed/stopped	All events and gatherings banned	Strong/moderate
Denmark	No national lockdown, but schools, restaurants and many shops closed until May 10 2020	Yes	Allowed	Closed/stopped	Gatherings of more than 10 people banned	Weak
Sweden	No lock-down. Response package that includes both legally binding regulations and strong but voluntary recommendations	No	Allowed	Closed on nonessential/restricted	Gatherings of more than 50 people banned	Weak

3.1 Countries with strong/moderate restrictions, Italy and Spain

Italy, one of the first countries in Europe to be heavily impacted by the COVID-19 pandemic, took a series of strict measures to curb the spread of the virus, with a significant impact on citizens, among the positioned in the group of countries with more self-protective measures [56]. The Italian government declared a state of emergency on January 31st, 2020 (which lasted until 1st of April 2022), and a nationwide lockdown on March 9th, 2020, closing all non-essential businesses and allowing people to leave their homes for essential reasons, such as buying groceries or going to the doctor [57]. Face masks were mandatory in all public spaces, and social distancing was enforced. In the summer of 2020, restrictions were gradually lifted, and people were allowed to travel within the country for tourism purposes. However, new restrictions were imposed in the fall due to a rise in cases; nevertheless, these restrictions were less severe, although social distancing was still enforced. Vaccination campaigns were underway, and people who were fully vaccinated had more freedom, such as attending events and travelling abroad. The pandemic resulted in an increase in remote work, with many companies allowing their employees to work from home [58]. This consequently led people to move out of cities toward smaller towns and villages with more affordable housing and space. The pandemic has accelerated the trend of suburbanization in Italy, with more people looking for larger homes with outdoor spaces [59]. According to the Digital Innovation Observatories of the School of Management of the Politecnico di Milano, in 2022, there were approximately 3.6 million remote workers, almost 500 thousand fewer than in 2021, with a decrease in particular in the Public Administration (PA) and Small Medium Enterprises (SMEs); however, there is slight but constant growth in large companies, which, with 1.84 million workers, accounted for approximately half of the total smart workers. Despite this, there is increased awareness and action in organizations to create workspace environments that motivate and give meaning to work in the office. Approximately 52% of large companies, 30% of SMEs and 25% of PAs have already carried out interventions to modify the environment or are doing so in recent months. In the future, these initiatives are planned or under evaluation for 26% of large companies, 21% of public administrations and 14% of SMEs [60]. Furthermore, during the pandemic parks and public gardens have become more important as places for people to exercise and relax while maintaining social distance. A study conducted in Italy during the first COVID-19 pandemic wave (April–May 2020) highlighted the fact that restrictions influenced citizens' perceptions of urban green spaces, with a consequent increase in general interest in parks and public garden [61].

Spain was one of the European countries with the highest incidence during the first wave [62], and in the global context, Spain experienced one of the worst situations [63]. The government imposed a nationwide lockdown by mid-March 2020, which included the prohibition of nonessential transit and blanket recommendations for WFH. Easing measures started later in May through several phases. Having high heterogeneity across the territory, the lifting of limitations would progress through the phases as rearranged during the process, making the progressive lifting of the restrictions challenging due to the highly decentralized system [64]. First, outside exercise was allowed, but borders remained closed, and no travel between different territorial units was permitted. Face masks were highly recommended both on public transport and outside. Afterward, shops, food markets and restaurants reopened with social distancing and reduced capacity, while public transit reopened with full service but reduced passenger numbers. The country entered a 'new normality' in late June, where travel between provinces was also allowed again. These restrictions were difficult to implement because of the conflicted political environment, which resulted in some territorial administrations taking preliminary measures at the subnational level in an uncoordinated manner [65]. Apart from the economic impact, the lockdown measures also had a significant social impact in Spain. Official data indicate an increase in gender-based violence (a 48% increase in calls for gender violence helplines during the first weeks of April 2020 compared to before the lockdown) [66]. Regarding WFH in Spain, nearly 83% of professionals were not granted the opportunity to WFH in 2020, whereas only 9.8% were telecommuting. In 2021, however, there was an increase in home office use to 25.2%. During the first month of the pandemic, there was a 38% reduction in physical activity [67].

Germany has taken a medium amount of protective measures during the pandemic [56]. The first contact restrictions were already announced in March 2020, followed by restrictions on travel and the closing of small shops and schools. In April, the obligation to remain in quarantine for 2 weeks when returning from another country and the recommendation to wear a face mask were lifted. Soon after, face masks were required for public transportation. In May 2020, schools and small shops opened slowly again. Contact restrictions depended on the number of cases in the district. In October, there were increasing lockdowns and contact restrictions introduced across the country, which lasted until January 2021. In August 2021, shops, restaurants, etc., are increasingly being opened for people

who have gone through an infection, have been vaccinated twice or have a recent negative test. In December, these opportunities held wide only for people who were fully vaccinated or had recovered. The pandemic resulted in intensified suburbanization in Germany during 2020, although this process has steadily increased due to internal migration because of the lowest rates since the mid-1990s [68]. The residential green spaces attached to residential buildings, mostly designed with “semi-public access”, were appreciated by residents as creating refugia in challenging times and were more actively used than they were in prepandemic times, especially when sitting in parks was not allowed [69]. During the pandemic in Hamburg, a larger number of visitors were recorded in protected nature areas and local nature reserves, to an extent causing considerable problems for the wildlife there. For instance, in the nature reserve Duvenstedter Brook, many people nature parks more as urban recreational areas, chasing deer or playing badminton on protected stretches of heath.

Poland experienced a relatively mild first phase of the pandemic compared to other European countries, where the first case was identified a month later than in Germany and France. The government declared lockdown and enforced self-isolation measures (24 March 2020) and even applied measures that were not yet recommended by international institutions; for example, the first EU country to shut down its external borders, including those with other EU Member States. Factors slowing the progression of the initial phases of the pandemic include the relatively younger population compared to the most affected European countries, the larger population living in rural areas and the low rate of mobility domestically and internationally among the Polish people [70]. The impact of COVID-19 also resulted in changes in real estate and suburbanization in Poland, driving a wave of people to buy property (houses with land plots) to escape the dread of living in apartment buildings, either occasionally or permanently [71]. In addition, the pandemic fostered many measures by the Polish government related to the economy, taxes, employment and extraordinary changes in court proceedings and the system of justice.

3.2 Countries with weak restrictions, Denmark and Sweden

In Denmark, the anti-COVID-19 measures taken were comparatively brief [72]. Denmark was indeed in the group of countries in which there were fewer self-protective measures [56]. Starting in the middle of March 2020, schools, public institutions, hairdressers, restaurants, shopping malls, etc., were closed down, but on April 20th, 2020, these were opened again, with fitness centers and swimming pools being the last ones to open again on June 1st. Over the course of the summer, face masks were first recommended and then needed, first for public transport and later for restaurants, shops and public institutions. In northern Jutland, seven municipalities were completely isolated from their environment due to an outbreak of a new variant on some mink farms. Apart from those restrictions, no mobility restrictions were imposed within the country. This changed shortly before Christmas 2020, when schools, restaurants, public institutions, theatres, etc., were closed for almost two months; starting on February 28th, the country started opening everything again. On May 21st, almost all restrictions were lifted. Furthermore, many Danes have their own houses, gardens and/or summer houses. In 2020, 2.7 million Danes lived in detached houses, whereas 1.6 million lived in multiunit houses where they did not own themselves; this relationship has not changed between 2021 and 2022 [73]. Given the short period in which public life was restricted and given access to nature for a large proportion of the population, it can be expected that the impact of COVID-19 measures on the Danish population’s attitude towards the environment is not very pronounced.

Sweden chose a different strategy during the pandemic, mainly based on voluntary measures and citizen behaviors and recommendations rather than restrictions, and a complete lockdown was never implemented (Sweden country snapshot: public health agencies and services in the response to COVID-19, according to World Health Organization WHO. No state of emergency was declared because the Swedish Constitution does not provide for a state of emergency during a public health crisis. This less rigid approach focused more on mitigation measures for slowing, but not stopping, the pandemic and relied on existing high levels of institutional and interpersonal trust. The affected geographical regions or households were not under enforced quarantine, and facemasks were not recommended outside health care [74]. Recommendations consisted mainly of “staying at home even with the slightest symptom of an infection, physical distancing, enhanced hygiene measures, avoiding public transportation, and working from home if possible” [75]. Physical distancing was recommended in public spaces but mandatory in bars, restaurants and events. A maximum of 50 people was allowed to gather. In some opinions, this was considered to have caused less serious consequences than did the severe policies used in most countries [76]. WFH, which accounts for approximately 40% of the total workforce in Sweden and is independent of previous work experience, influences the establishment of new habits [77]. Studies suggest that workload, performance and well-being decreased during the pandemic [78].

4 Methods

Assuming positive effects on well-being through a stronger connection between individuals and the natural environment while also considering the unusual circumstances of the world pandemic, this study addresses individuals' likelihood of using BD after the pandemic. More precisely, the research interest stretches out to identify contextual variables (country, overcrowding, time spent outside, and access to nature/food,) and personal variables (age group and sex) influencing the likelihood of using BD by focusing on the following:

- 1) Individuals' exposure (during and after the lockdown) to several BD elements intentionally or unintentionally, including indoors (color, water, air, sunlight, plants, animals, natural materials, views and vistas, façade greening, geology and landscape, habitats and ecosystems) and outdoors (location, green neighborhood, wide prospect, proximity to natural resorts, etc.), as reported through a questionnaire to test whether the severity of the lockdown restriction of the COVID-19 pandemic fostered stronger people-environment relations, as valued by the likelihood of using BD elements.
- 2) The role of the context of (strong/weak) restrictions in several European countries (Italy, Germany, Poland, Spain, Denmark and Sweden) to test whether people-environment relations differ according to the objective and/or perceived severity of the measures in a country context.

The study design was exploratory, mixed-method, cross-sectoral and comparative. The data were collected through a survey directed to European countries via an online Google form conducted from 30 January to 28 February 2023 (see Annex 1). Following a random, uncontrolled sampling strategy, the survey was shared with learning networks such as the Bosch Alumni Network (an international network across 140 countries currently hosting more than 8000 members), the network of European RCEs (Regional Centers of Expertise on Education for Sustainable Development), and the COST (European Cooperation in Science and Technology) action networks of Indoor Air Pollution and Circular city, as well as with practitioners of several universities in Europe. The questions were closed and open (with the purpose of revealing the unexpected elements of change) and organized into four sections: (1) background questions containing variables such as age (different generations have different attitudes and approaches to restrictions), gender and countries (which are used as proxies); (2) questions about exposure to BD elements (color, water, air, sunlight, plants, animals, views and vistas, geology and landscape, habitats and ecosystems) indoors and outdoors, before and after the lockdown; based on the indoor and outdoor elements of the BD [80–82], from the framework of 14 Biophilic Patterns [31]; (3) questions about flexibility and adaptation of the living environment after the lockdown concerning the elements of BD; and (4) additional information on any major changes incentivized by the lockdown restrictions concerning lifestyle and wellbeing.

The data were processed through mixed methods, namely, descriptive statistics, statistical model building and testing and a thematic analysis [83] of the qualitative data using affinity diagramming (Lucero) [84]. Table 2 provides an overview of the methodological approach.

To facilitate quantitative correspondence analyses [88, 89], numerical variables were recorded in three modalities (less, same, more) or (low, intermediate, high). Data visualizations were derived as two-dimensional planes using the FactoMiner package [85] of R statistical software [90]. Finally, a logistic model of the included variables was estimated to explain the likelihood of including BD using R statistical software.

The qualitative data were analyzed using affinity diagrams [84] to identify the categories that emerged. Affinity diagramming is a variant of thematic analysis [83]. In this process, all the comments were printed in different colors depending on the country and were clustered and labeled in several iterative steps so that the categories emerged bottom up in several different steps: (a) initial familiarization with the data, (b) creating initial codes, (c) collating codes with supporting quotes, (d) grouping codes into themes, (e) reviewing and revising themes, and (f) writing up the narrative based on the categories emerging. This thematic analysis process was carried out using the affinity mapping technique by creating large visual representations of the data points (chart making and 'walking the wall'). Affinity diagrams allow identifying patterns in participants' answers, illustrating what consequences of the restrictions on their lifestyles they were foregrounding themselves. For the quantification of the comments, the instances in each category per country were counted and divided by the total number of comments for each country, in line with the recommendations provided by Lucero [84]. For instance, seven Swedish participants made a comment that reported a change toward a healthier lifestyle, which corresponds to 16.7% of the total number of comments (42) made by the Swedish participants.

Table 2 Overview of the methodological approach, research questions/variables/hypotheses, associated survey questions, methods used for the respective survey questions and corresponding results subchapters

Research questions/variables/hypotheses	Associated survey questions/sections and sample size	Method	Results subchapters
Illustration of pandemic severity and response measures in Italy, Spain, Germany, Poland, Denmark and Sweden	n/a	Systematization of restrictive measures during the pandemic in Italy, Germany, Poland, Spain, Denmark and Sweden	Section 3
Objective/subjective restrictions; Major limitations related to all variables and major changing trends	Survey questions from Sects. 1–4 403 responses	Quantitative analyses; Descriptive statistics	4.1
Likelihood of using BD elements divided per country groups	Survey questions from Sects. 1–3 (304) responses into 2 groups: First group (293) Italy (67), Germany (65), Spain (35), Poland (46), and second group (91) Denmark (36) and Sweden (55)	Quantitative analyses; Statistical analyses using R.4.0.5 (2021–03–31) Correspondence Analyses-CA; all responses Logistic regression and structural dependence analysis. FactoMineR (version 2.9) (for geometrical data analysis (CA): [85])). *Stats (version 3.6.2) (standard R package) for logistic regression. [86], EpiTools (version 0.5–10.1): Epidemiology Tools, for odds ratios computations [87]	4.2
Lifestyle changes variables	Survey question from Sect. 4- open regarding major changes in the lifestyle and wellbeing incentivized by the lock-down. (210 comments in total from the respective countries, 193 of which were valid: 28 from Italy, 35 from Germany, 26 from Spain, 34 from Poland, 30 from Denmark and 42 from Sweden)	Qualitative analyses; Affinity diagram [84]	4.3

5 Findings

5.1 General descriptive analyses

The 403 participants in the survey were mainly from European Union countries and the United Kingdom (89%), such as Italy (17%), Germany (16%), Sweden (14%), Poland (11%), Denmark (9%), Spain (9%), the UK (3%), France (2%), and other EU countries (8% Czech Republic, Belgium, Greece, Romania, Bulgaria, The Netherlands, Portugal and Lithuania). The rest were from EU neighboring countries (9%, Albania, Serbia, Bosnia-Herzegovina, Belarus, Moldova and Turkey) and from other countries in the world (2% United States of America, Canada, Cameroon, Jordan, Kenya and Saudi Arabia). Ninety percent of the respondents had a level of education as a graduate/postgraduate from different fields. The majority of respondents belong to the 90-ties and 80-ties (37% and 27%, respectively). The rest were born on 70-ties (16.5%), 60-ties (9.5%), and 2000s (6%) in the 50-ties (2%). A total of 58% of the respondents were female, 41% were male, and 1% other.

The perceived severity of the restrictions from the respondents corresponds with the objective severity of restriction in Italy and Spain (strong) and in Germany and Poland (moderate) for Sweden (weak); for the Danish participants, the restrictive measures are perceived as moderate and strong by the majority of the respondents in contrast with the countries' weak objective status. Table 3 displays objective restrictions (based on the criteria followed by the Oxford Covid-19 government response tracker; as also displayed in Table 1) and subjective restrictions as perceived by the respondents of the six countries. In total, 403 participants in this survey perceived the restrictive measures taken in their countries as strong and moderate.

The descriptive statistics revealed that the most influential variables were (1) overcrowding/limited space discomfort (58%), (2) difficulties to work (50%), and (3) difficulties accessing green spaces (33%). Although no significant limits were reported for the choice of food (only 10%), the respondents reported changes in their nutritional status after the pandemic related to: the use of regional products (52.7%), switching to organic products (48.7%) and growing their own vegetation through urban gardening or farming (43.3%). Approximately 80% of the respondents considered visual and nonvisual connections with nature after the pandemic to be very important.

A comparison of the "time spent outside in nature", "during" and "after" the pandemic with that "before" the pandemic revealed that "during", for 43% of the respondents is "less", and "after" for, 60% of the participants is "more". One-quarter of the participants had a steady attitude "same" for "before" and "after" the pandemic.

Figure 1 shows the "Likelihood of including Biophilic design" in relation to the "Time spent outside", indicating that this is more likely for respondents who have spent "more" or "less" time outside. The graph was generated using the data from the six selected countries: Denmark, Germany, Italy, Poland, Spain, and Sweden.

Figure 2 shows the exposure to BD in the living environment before and after the pandemic, specifically to the following elements: balcony/terrace; private garden/common garden; green roof/façade; views and vistas from home, green or blue; plants/vegetation growing in home gardens/roofs/vases; glass surfaces, sunlight illumination (dynamic & diffuse light); orientation, ventilation, thermal and airflow variability; natural materials (natural wood grains; leather; stone, fossil textures; bamboo, rattan, dried grasses, cork, organic palette. There were no major changes in the specific elements of BD in indoor living environments despite slight increases in the amount of vegetation growing in home gardens/roofs/vases and in vistas from home and glass surfaces, sunlight and illumination. Nevertheless, the majority of respondents reported that they would like to include these BD elements in the future.

Table 3 Objective restrictions per country (according to Table 1) subjective restrictions per country as perceived by survey participants, and the severity of the measures as perceived by all survey respondents

Countries	Objective restrictions based on Oxford covid-19 government response tracker (Table 1)	Subjective restrictions as perceived by survey respondents measured in % of countries sample		
		Strong (%)	Moderate (%)	Weak (%)
	Strong/moderate/weak			
Italy	Strong	71	29	0
Spain	Strong	53	39	8
Germany	Strong/Moderate	43	57	0
Poland	Strong/Moderate	38	55	6
Denmark	Weak	26	54	20
Sweden	Weak	4	33	63

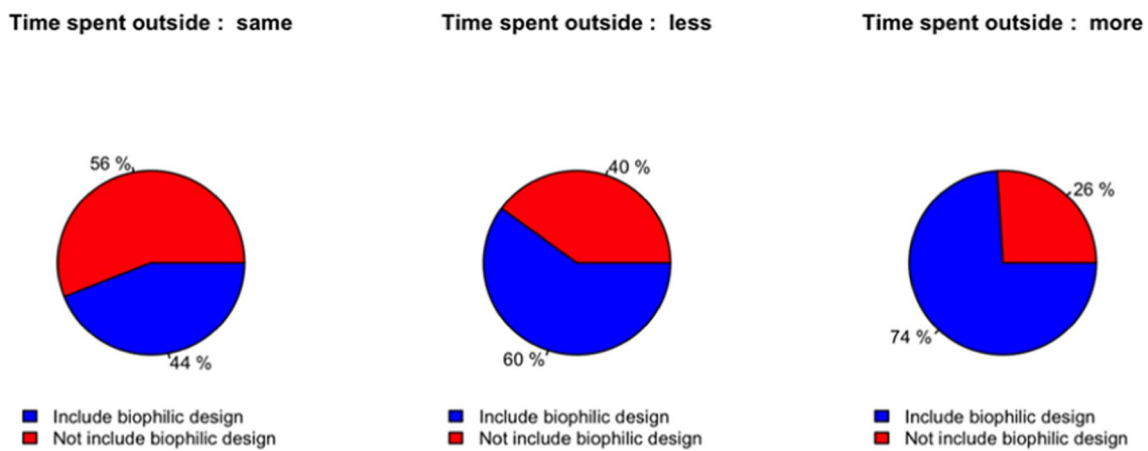


Fig. 1 Likelihood of including biophilic design in relation to “time spent outside” during the pandemic

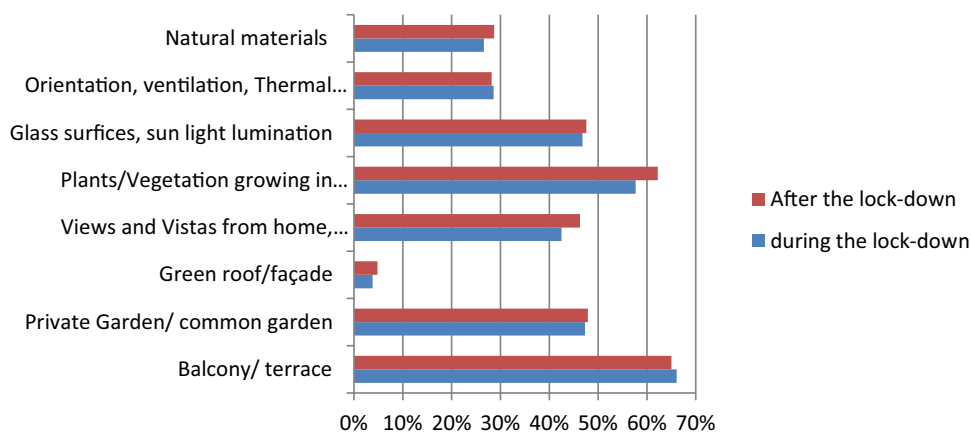


Fig. 2 Exposure to BD elements before and after the pandemic: balcony/terrace; private garden/common garden; green roof/façade; views and vistas from home, green or blue; plants/vegetation growing in home gardens/roofs/vases; glass surfaces, sunlight illumination (dynamic & diffuse light); orientation, ventilation, thermal and airflow variability; natural materials (natural wood grains; leather; stone, fossil textures; bamboo, rattan, dried grasses, cork, organic palette. Axes x- represents the BD elements. Axes y-represent the % of survey participants

Furthermore, the likelihood of BD outdoors when changing habitation is considered important, especially linked to proximity to urban gardens/green areas (53.1%), proximity to a water body (sea, lake, river, etc.) 45.1%, proximity to rural areas/suburbs (natural terrain with trees and vegetation) 42.7%, proximity to city centers and services (39.1%), proximity to relatives or family (36.7%), and elevated position (i.e., looking downhill or a viewpoint with a wide prospect) by 22.7% of respondents. Other changes are related to working habits, where 65% of respondents preferred flexible virtual/office presence time, 44% fewer working hours, 21% preferred to switch to a full-time home office and only 8% preferred full-time presence. One-quarter of the respondents had changed jobs/occupations after the lockdown. As a result, 63% of participants reported having adopted their home to create space for home office and 39% for recreational activities.

Only a small percentage (11%) of respondents reported having created an indoor individual space for Prospect (an unimpeded view over a distance for surveillance and planning), Refuge (withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead), Mystery (partially obscured views or other sensory devices that entice the individual to travel deeper into the environment) and Risk (an identifiable threat coupled with a reliable safeguard). Furthermore, these elements are considered very likely to be included in the future by the majority of the respondents. Fifty-three percent of the respondents reported other changes, especially related to activities in nature, meditation and self-reflection, work, nutrition towards a more vegetal diet and taking a pet.

5.2 Statistical analysis

A first logistic model was estimated using all the available data (all countries) (see Table 3) to evaluate the effect of variables on the high vs. low/moderate Likelihood of including BD elements in the environment". Variables that have significant descriptive power can be described by three cluster types: age and sex; variables pertaining to the severity of the experience lived during lockdown (overcrowding, limited choice of food, and time spent outside during lockdown); and variables reflecting the need for interaction (pet). The most significant variable is undoubtedly the degree of "overcrowding" experienced during lockdown, which may, as the time spent outside during lockdown, act as a proxy for the experienced severity of the restrictions (as distinguished from the perceived severity and from the objective severity of the restrictions-) see Table 4).

Based on these overall results, we conducted narrower correspondence analyses to focus the dependence of the "likelihood" on the above identified variables with respect to the subsample of the six selected cluster countries. Figures 3, 4 and 5 show the results for the variables "Age", "Time spent outside during the pandemic" and "Overcrowding".

Figure 3 indicates a moderate "Likelihood of including BD in the environment" for males, while females and individuals who chose the "other" option have more extreme points of view (either low or high likelihood). Figure 4 indicates that the "Likelihood of including BD elements in the environment" is high for respondents who went outside "less" during the pandemic but also for those who went outside "more". The other dependencies are as follows: the more severe the effect of the lockdown is, the higher the "Likelihood of including BD elements in the environment" as shown in Fig. 5, for the dependence on overcrowding. An analysis of the variable "Choice of food" did not reveal relevant additional information.

Based on these insights, we ran further analyses on the subsample of 6 countries, aggregated by country. We included objective variables, such as the severity of the restrictions and country. However, neither variable showed a significant influence. After recursively discarding the nonsignificant factors, the final logistic model obtained is displayed in Table 5.

Two factors appear to correlate the most with the "Likelihood of including BD in the environment" (which was also found by the descriptive analysis): "Time spent outside during lockdown" and the "Will to change the environment". In particular, it was found that (1) having spent "less" time outside or "more" time outside during lockdown was positively correlated with the likelihood of including BD in the environment, and (2) the higher the willingness to change the environment after experiencing COVID-19 lockdown restrictions was, the higher the likelihood of including BD in the environment. Those who spent "less" time outside during lockdown had approximately two times greater chances of including BD in their environment in the future than those who spent the "same" amount of time outside. Those who spent "more" time outside during lockdown had approximately four times greater chances of including BD in their environment in the future (than those who spent the "same" amount of time outside). Those for whom the "Will to change the environment" is "high" have approximately seven times more chances to include BD in their environment in the future (than those for which the "Will to change the environment is "low"). Those for whom the "Will to change the environment" is "moderate" have approximately the same chances of including BD in their environment in the future (as those for whom the "Will to change the environment" is "low") (Figs. 6, 7 and 8).

Table 4 Results of logistic regression analysis of all available data

Coefficients	Estimate	Std. Error	z value	Pr (< z)
Intercept	- 1.67136	0.86964	- 1.922	0.054620
Age	0.01746	0.01015	1.720	0.085434
Gender male	- 0.47375	0.22984	- 2.061	0.039280*
Gender other	0.74754	1.18041	0.633	0.526546
Overcrowding "low"	- 1.14335	0.32787	- 3.487	0.000488***
Overcrowding "moderate"	- 0.99375	0.30413	- 3.267	0.001085**
Limited choice of food "low"	2.29508	0.74904	3.064	0.002184**
Limited choice of food "moderate"	2.10457	0.75774	2.777	0.005479**
Time spent outside during the lockdown "more"	0.68387	0.31238	2.189	0.028581*
Time spent outside during the lockdown "same"	- 0.45972	0.25562	- 1.798	0.072105
Pet yes	0.51288	0.23635	2.170	0.030008*
Signif. Codes: 0 '***'	0.001	'**'	0.01 '0.05'	0.1 '1'

Fig. 3 Correspondence Analyses factors maps for the likelihood of using biophilic design related to the variable: age

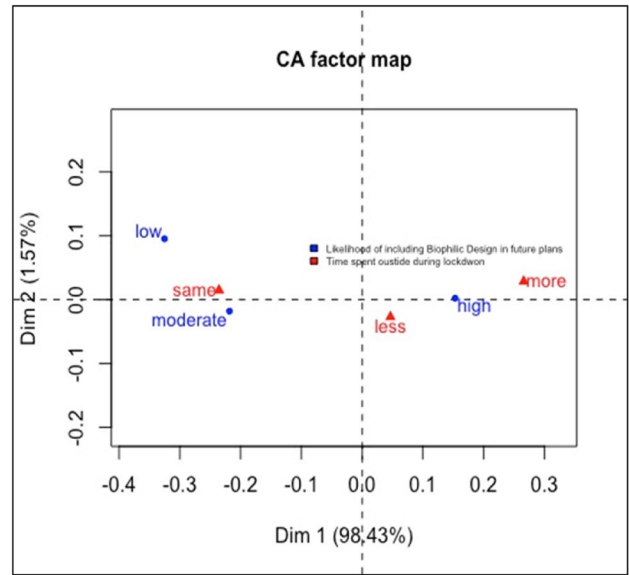


Fig. 4 Correspondence Analyses factors maps for the likelihood of using biophilic design related to the variable: time spent outside during the pandemic

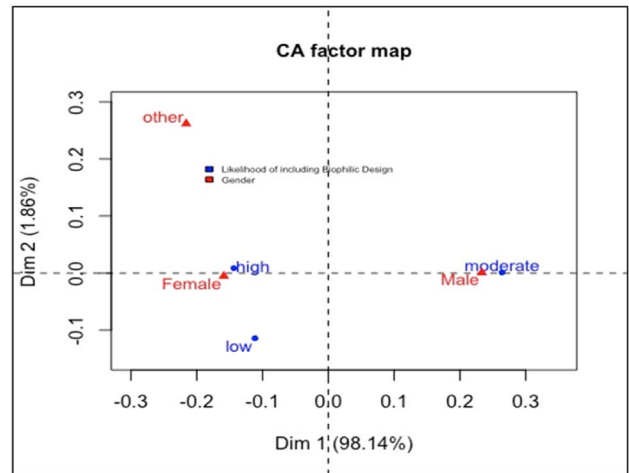
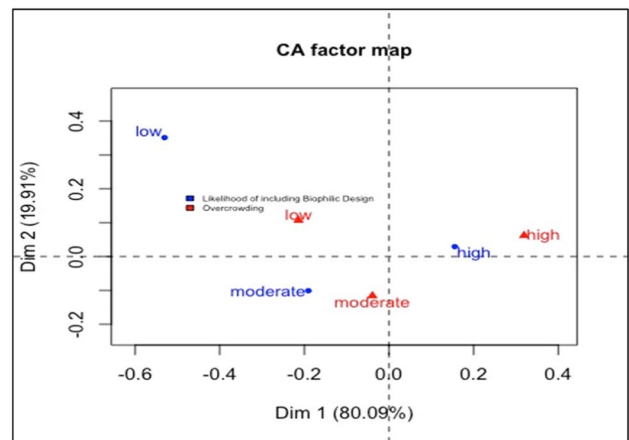


Fig. 5 Correspondence Analyses factors maps for the likelihood of using biophilic design related to the variable: overcrowding



The strongest combination of factors appears to be: “Will to change the environment”- “high” and “Time spent outside during lockdown”- “more”. For this combination, the probability of including BD in the environment in the future

Table 5 Final logistic model

Coefficients	Estimate	Std. Error	z value	Pr (< z)
Intercept	- 1.1154	0.3485	- 3.201	0.00137**
Time spent outside during lockdown "les"	0.7061	0.2900	2.435	0.01489*
Time spent outside during lockdown "more"	1.4946	0.3742	3.994	6.5e-05***
Will to change the environment "high"	2.0313	0.4112	4.940	7.8e-07***
Will to change environment "moderate"	0.4214	0.3524	1.196	0.23174

is estimated to be 91%. The weakest combination of factors appears to be: "Will to change the environment" - "low", and "Time spent outside during lockdown" - "same". For this combination, the probability of including BD in the environment in the future is estimated to be 24%. Finally, these two variables may act as proxies for the severity of the restrictions experienced (as a subjective indicator of severity rather than objective severity by lockdown measures, as indicated through indices of the Oxford COVID-19 government response tracker).

We conducted further analysis to explain the motivation to include BD elements in the future environment by running a Bayesian causal analysis [88, 89] using the R package bnlearn [90]. The dataset included the six cluster countries. A first Bayesian network representation of the joint distribution of all variables coded at two levels (high vs. low or moderate, more vs. less or same) was obtained and gradually modified to account for causal dependencies while not degrading the fitness measure retained (BIC criterion). For the final model, two main causal factors explain the "Likelihood of including BD elements in the future environment": "Importance given to BD" and "Importance of spending time outside". Moreover, following the causal path, the lockdown had a causal impact on these two factors, mainly through the experience of "Overcrowding during lockdown", which may be considered a good proxy of the perceived severity of restrictions. The obtained causal structure can be summarized by the following diagram:

As indicated, individuals who experienced strong overcrowding during lockdown are more likely to attach high importance to BD elements in their environment and hence are more likely to change their environment through BD elements and to value spending time outside. Interestingly, people who are less willing to change their environment, give less importance to BD in general and are less likely to have experienced overcrowding during lockdown. Furthermore, people who experienced more overcrowding during lockdown may have had fewer opportunities to go outside during lockdown and may have had problems accessing food, and being "stuck at home", which explains the relevance of these variables in our logistic regressions. We confirmed this insight by running the following contingency Tables 6 and 7:

5.3 Qualitative analyses

Altogether and across countries, 32 comments concerned a healthier lifestyle, which amounted to 16.4% of the total number of comments (195). The qualitative analysis of a total of 210 qualitative comments from the Danish, German, Italian, Polish, Spanish and Swedish participants yielded 12 different thematic categories, while participants were free to write as much as they wanted; most participants made exactly one point; only three comments were assigned to two different categories. First, there is one group of 20 comments that seem to refer to the time during the pandemic, not afterwards. In the following, we disregard these comments, leaving us with 193 valid data points. In addition, 44 comments (mostly by the Swedish participants) suggested that there were no changes in their lifestyle due to the pandemic.

The next largest category comprises comments in which participants describe how they perform more outdoor activities. For instance, participants reported on longer walks, spending time in the garden and enjoying fresh air; for example, participants wrote "*I spend more time in my city's park*", that they "*try to integrate exercise and fresh air*" or that they "*take time to enjoy nature*." Relatedly, eighteen participants reported having resumed a healthier lifestyle, eating less meat, performing more physical activity and cooking more at home. One participant writes, "*The COVID-19 pandemic and lockdown were starting points for changing what I don't like in my life. The years after the lockdown were full of news in my life and radically changed myself.*" An additional ten participants reported doing more sports, for instance, "*starting fitness at home*", "*doing more sports*" or doing "*more physical activities outdoors*". In addition, eleven participants reported more attention given to their mental health. Many have taken up regular meditation exercises, while others report more

Fig. 6 Causal structure diagram explaining the likelihood of including biophilic design in person-environment relation

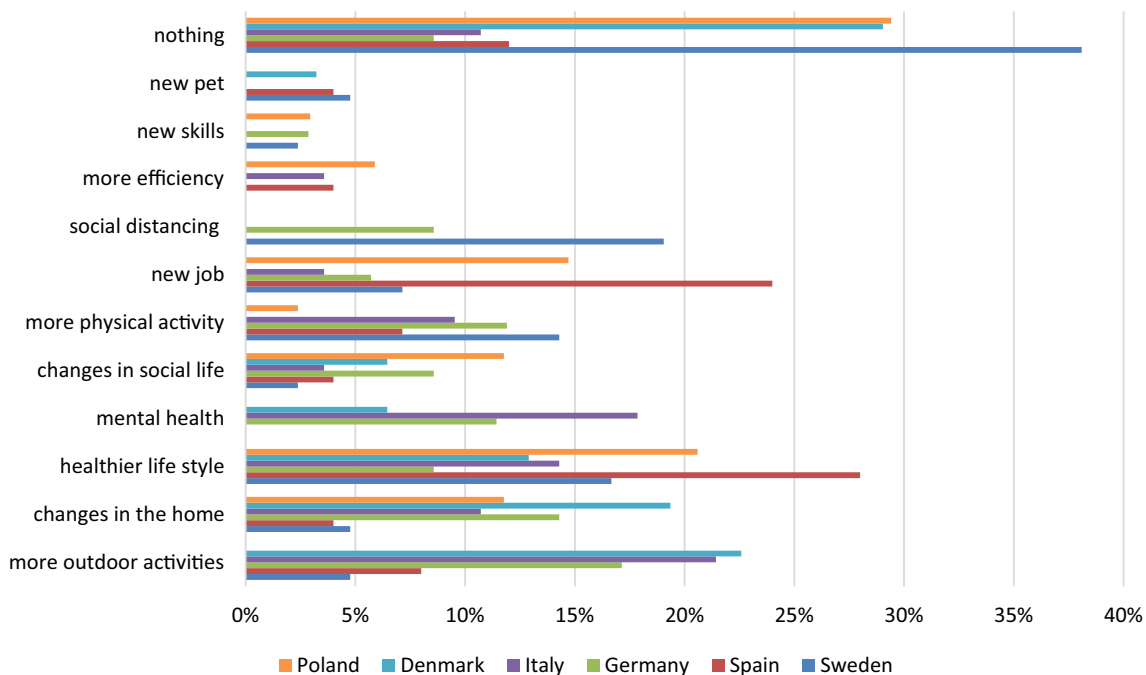
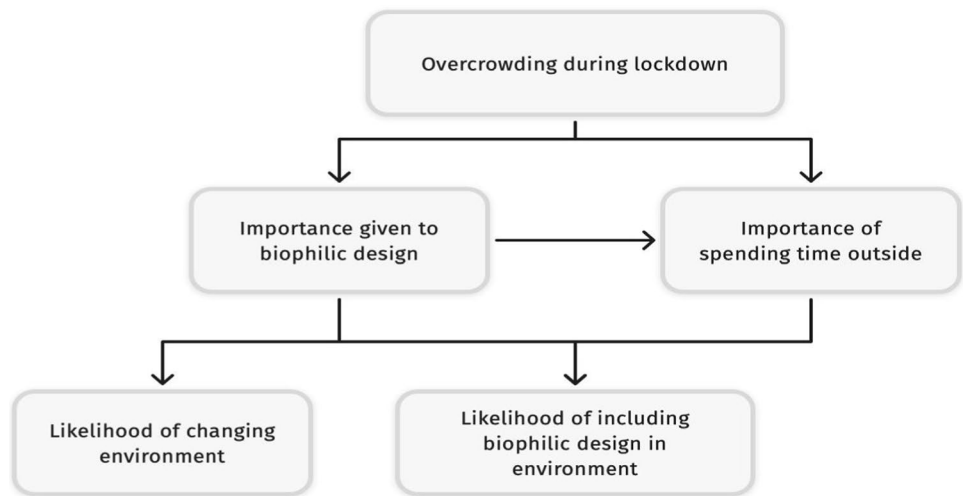


Fig. 7 Lifestyle changes as reported by the survey participants by country. Axes y represent the % of survey participants and Axes x represent the reporting lifestyle changes

awareness and appreciation of the small things of life; for instance, some simply take “*more time for meditation*”, another wrote, “*The overwhelming anxiety forced me to become more meditative*” and again, others state that they prioritize time for themselves now and value time alone, outside or time for recreational purposes more.

Like those with greater appreciation of life and nature, ten participants also reported greater appreciation of social connections; one participant reported moving into the city because the countryside was lonely. More generally, participants described spending more time with friends and family; many stated that they go out more often and “*spend more time with family*” organize “*weekly potlucks with my friends to create a sense of community*” or “*think about friendship in a new way*”.

Eighteen participants also reported changes in their homes; several had obtained a pet or more plants, i.e., “*took a pet and changed home*”, but some also described creating a separate space for a home office; for instance, “*I created a home office with a good amount of daylight and a view outside*”. Some even bought a house or moved into the countryside—one even changed country. Eight participants reported on improvements to their homes: “*cleaning my room more often and having less things there, making it a productive space*” or “*general home and garden improvements*”. Furthermore, participants

Fig. 8 The relative role of lifestyle changes as reported by the participants

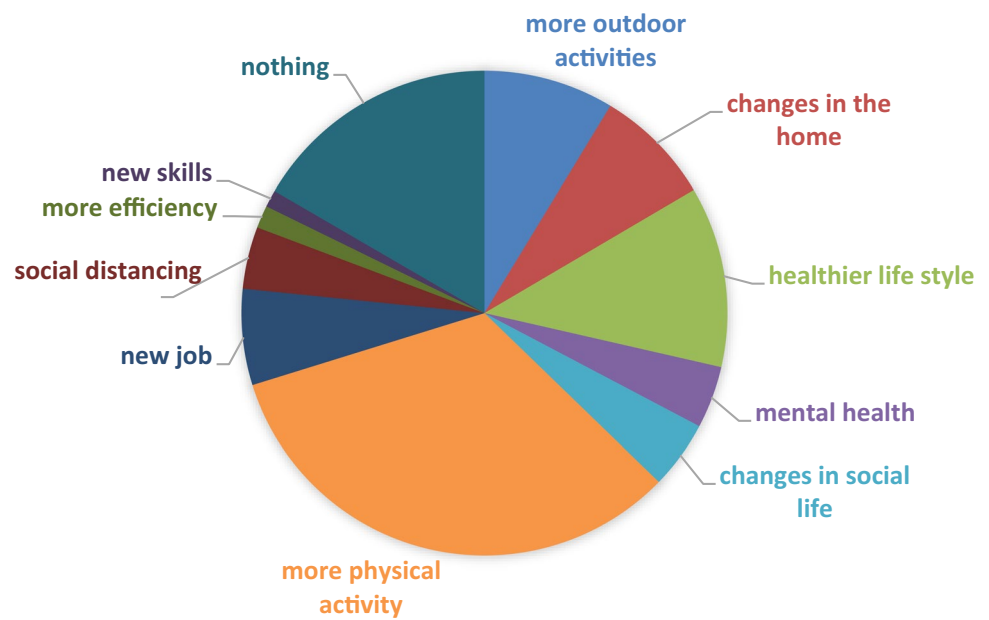


Table 6 Contingency table of time spent outside during the “lock-down” in relation to overcrowding

		Time spent outside during lockdown		
		Less (%)	Same (%)	More (%)
Overcrowding	High	50	26	24
	Moderate	45	34	21
	Low	35	46	18

Table 7 Contingency table of limited access to food during the “lock-down” in relation to overcrowding

		Limited access to food	
		Low (%)	Moderate or high (%)
Overcrowding	high	53	47
	moderate	68	32
	low	78	22

reported that they improved the efficiency of their work or achieved a better work-life balance, i.e., by means of “*smart working*” or the use of “*new technologies that allow me to rest better*”. Eight participants had found a new job or changed careers. Three reported new skills that they acquired during the pandemic. Finally, three participants state that they are still careful and attend to social distancing; for instance, they say that they are still “*careful*”, “*keep distance from people*” and “*pay more attention to hygiene in public spaces*”. A family in Poland sold their apartment to buy a house in the suburbs, which they had never considered before the pandemic, to obtain more living space and better air quality, with a sizable plot of land, a vegetable garden, and a small orchard.

Participants’ qualitative data thus align with the quantitative survey data, suggesting that the pandemic indeed had an effect on lifestyle choices such that they became more attentive to nature, value nature and outdoor activities in the sun and fresh air. For some, these new preferences have led to changes in habitation. Regarding the differences among the six countries under consideration, the Polish participants reported more career changes than did the participants from other countries and less than the effect of the pandemic on their outdoor activities and attention to mental health and physical activity; however, they seem to have used the pandemic widely to change their eating habits. Among the Swedish, Polish and Danish participants, many reported no changes; especially among the Swedish participants, 38.1% stated that there were no changes at all. These results are in line with the severity of the restrictions imposed in these countries during the

pandemic. Furthermore, extended social distancing effects were mentioned only by German and Swedish participants. In all other respects, participants from all six countries reported similar changes in lifestyle; this is interesting in its own right since across countries, people seem to have used the pandemic to rethink their lifestyles, where many of the changes reported are towards a more biophilic and sustainable lifestyle. However, it needs to be stated that these conclusions do only apply for those participants who responded to the qualitative part of the questionnaire.

The qualitative analysis added further insights to the interpretation of our quantitative analysis because it indicated that whether people changed their lifestyles was related to the severity of the country lockdown measures, but how and what changed depended to some extent on the respondents' personal circumstances. There are also other changes that are not related to BD concepts, such as new jobs, increased efficiency, and new education.

6 Conclusions

The study background reinforces the idea that the COVID-19 pandemic restrictions and lockdowns were accompanied by general discomfort due to alterations in livelihood, work, and activities in nature and in-person social interaction. Based on the findings of this study, it can be argued that the severity of restrictive measures (strong/moderate/weak) imposed by countries during the global COVID-19 pandemic influenced the likelihood of including BD for changes in people-environment relationships. However, this effect occurs mainly when restrictions are individually perceived or experienced as severe due to personal circumstances. Our findings suggest that pandemic restrictions triggered a motivation to include BD and by this to change the person-environment relation. In this regard, individual-level perceived severity of restrictions appears to be a stronger proxy of the intended environmental behavior change than country-level objective indicators. These findings underline the relevance of the element of individual environment perception within the systemic reasoning of mindsponge theory [22]. It can also be concluded, that, in times of perceived crisis of the person-environment relation, the restorative effects of BD proposed by SRT [] and ART [] may serve as an explanation of an individual's intention to change the lifestyle towards more natural surroundings. The mixed method analyses conducted at different sample levels revealed that, despite drastic social distancing measures, the experienced discomfort created by "Overcrowding" was identified as the most influential variable in relation to the "Time spent outside nature", independent of other variables such as country, gender, and age. Likewise, the comparative data evaluation between Italy, Spain, Germany, Poland, Sweden and Denmark does not reinforce the assumption that people-environment relations differ according to the severity of the measures in a country context but rather according to individual responses to crises.

Experienced restrictions (mainly defined by "Overcrowding" and "Time spent outside in nature") influence the likelihood of including BD elements in the future. Individuals who experienced changes in their individual person-environment relations through pandemic restrictions by having "more" or "less" access to nature were more likely to change their behavior, as indicated by the use of BD elements, both indoors and outdoors, compared to individuals who experienced "same" (unaffected) nature access. However, "Overcrowding" here is also subjective to individual perceptions (unrelated, for example, to the official definition for person/sqm²) and may have created more discomfort for individuals who were less likely to have had the opportunity to go outside during lockdown and may have had problems accessing food, being "stuck at home" or "difficulties to work", as also explained by the role of these variables in the logistic regressions.

The COVID-19 pandemic appears to have influenced the trend toward relocation in proximity to urban gardens/green areas, water (sea, lake, river, etc.) or to rural areas/suburbs and not so much in specific elements indoors (as supported by the suburbanization statistics in the 6 countries). Often, the desired changes contradict with possibilities, as the results indicate an appreciation of natural elements but not always being possible to change, linked with "whenever is freedom to choose".

To conclude, there is a post pandemic tendency toward greater connection with nature and healthier habits regarding nutrition and lifestyle within the freedom of individual choice. The likelihood of changing the environment through BD elements is related to experienced and perceived changes during the pandemic. Individuals who were experiencing "Overcrowding" are more likely to place high importance on BD elements in their environment now and hence are more willing to change their person-environment relationships. Given these preconditions, respondents revealed higher likelihood of including BD elements in the future, while a relatively unchanged routine during the pandemic did not result in post pandemic changes or increased attention to BD elements, both indoors and outdoors.

7 Limitations and implications for theory and practice

This is a cross-sectoral and not longitudinal survey-based data collection study due to the impossibility of starting a survey during the pandemic. Thus, we referred to people recalling, considering the survey time in early 2023, when the pandemic had not yet officially ended. For the purpose of this study, the survey questions that relate to the perceived severity of the restrictions are limited to discomfort by overcrowding, difficulties working, access to green spaces, exposure to BD elements and choice of food, excluding other elements, for example, travelling (local and international), and access to social events and contacts.

Regarding the lifestyle changes reported by the participants, it must be considered that all those who did not complete the open question in the survey may not have actually changed anything (the reason for not providing information on lifestyle changes is not known). Furthermore, when reporting on their lifestyle changes, the participants had recently been primed to consider biophilic lifestyle changes since they were asked about those changes in the questions before. The order in which the questions were asked may thus have introduced a certain bias regarding the reporting of biophilic lifestyle changes, meaning that these changes may have occurred, but people may have been less inclined to report on other kinds of changes.

Our study relies on data of a specific demographic group, particularly educational background, which may not be representative of the general population. The survey was distributed among participants from particular organizations or institutions, and 90% of the respondents had a higher level of education which may not mirror a generalization for the broader population. Therefore, our evaluations must be interpreted in light of the preferences of this specific demographic group. Furthermore, our conclusions consider the data of only six countries. While the country selection was specifically motivated by a classification of objective severity of measures, we understand, that a different or extended set of countries may have resulted in different results and interpretations. Future research can extend the range and heterogeneity of the data based on country and further demographic variables to enhance generalizability of conclusions. At the same time, this may serve as an evaluation of our conclusion, that it is the perceived severity (at most over-crowding) rather than the objective severity of restrictions that has the stronger impact on the likelihood of including BD in future life. To this regard, a shift of level of analysis towards regional or local surroundings may provide further insights on the relevance of (perceived) overcrowding for the likelihood of BD in person-environment relations. This will ultimately help extending the scope of this research approach beyond effects related to COVID-19 pandemic.

The pandemic highlighted the value of nature in cities and the living environment for the health and well-being of citizens and it uncovered the unhealthy aspects of current urbanization and living-working styles. Our qualitative data underline the general finding that the pandemic has increased the trend of suburbanization, stressing that accessible urban nature is a key component of creating sustainable urban communities and human health and well-being. However, we need to point out, that the majority of respondents in our study wishes/plans for changes rather than does. As such, our results emphasize that proper societal structures and long-term measures are important for enabling larger-scale changes in people-environment relations. Future longitudinal studies will have to find out if such measures will be effective.

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Author contributions KSH and BFV contributed to the conceptualization and design, writing and revision and methodological framework, the SL contributed to the statistical analyses, the KF contributed to the qualitative analyses and country background, and the PL, GS and TS contributed to corresponding countries’ background and introduction. All the authors contributed to the data collection.

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Data availability The datasets generated during and/or analyses during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate Ethics approval and consent to participate were obtained from all the participants.

Consent for publication The research does not involve human research participants. The survey was anonymous.

Competing interests The authors declare no competing interests.

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Appendix 1

Survey: changes in people-environment relations in a post-pandemic society

Section 1: General and background questions

1. Country
2. Decade of birth (1960, 1970, 1980, 1990, 2000)
3. Gender
4. Occupation/level of education
5. In your opinion, the COVID-19 lockdown restrictions in your country/city were relatively (weak, moderate, strong)
6. During the lockdown, did you experience discomfort related to (overcrowding/limited home space, no access to parks or natural areas, recreation, limited choice of food, difficulties to work)?
7. On a scale from 1 (not at all) to 7 (very much), did you have problems accessing parks or green spaces?
8. On a scale from 1 (not at all) to 7 (very much), did you have limited choice of foods?
9. On a scale from 1 (not at all) to 7 (very much), did you experience difficulties to work?
10. Are you a member of the Bosch Alumni Network? (Yes/No)

Section 2: Exposure to biophilic design (design that reconnects us with nature and helps healing, reduces stress, improves creativity and our well-being) elements, indoors and outdoors, before and after the lockdown of the COVID-19 pandemic (color, water, air, sunlight, plants, animals, views and vistas, geology and landscape, habitats and ecosystems)

11. The time you spent outside during the lockdown, compared to before that (walking, sport activities; visual (a view to elements of nature living systems and natural processes)/nonvisual (auditory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes) connection with nature; in the presence of water (a condition that enhances the experience of a place through seeing, hearing or touching water); and sounds (nonrhythmic sensory stimuli) is? (Less/the same/more)
 12. The time you spend outside now compared to before the lockdown (walking, sport activities, visual/nonvisual connection with nature, presence of water, sounds) is? (Less/the same/more)
 13. On a scale from 1 to 7, how important are these elements for you?
 14. Which of the elements of biophilic design were present in your indoor living environment before the lockdown? balcony/terrace; private garden/common garden; green roof/façade; views and vistas from home, green or blue; plants/vegetation growing in home gardens/roofs/vases; glass surfaces, sunlight illumination (dynamic & diffuse light and varying intensities of light and shadow that change over time to create conditions that occur in nature); orientation, ventilation, thermal and airflow variability (subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments); any of these natural materials (natural wood grains; leather; stone, fossil textures; bamboo, rattan, dried grasses, cork, organic palette)
 15. Which of the elements of biophilic design are present in your living environment now? balcony/terrace/private garden/common garden/green roof/façade/views and vistas from home, green or blue/plants/vegetation growing in home gardens/roofs/vases/glass surfaces, sunlight illumination/Orientation, ventilation, thermal and airflow variability/any of these natural materials (natural wood grains; leather; stone, fossil textures; bamboo, rattan, dried grasses, cork, organic palette)
 16. On a scale from 1 to 7 (1- the lowest- 7 the highest), how likely is it that you will include the biophilic design elements in the future in your living environment (if possible)?
-

Section 3: Flexibility and adaptation of the living environment after lockdown in relation to the elements of "Biophilic Design" and "Biophilic Urban Design"

17. Did you adapt your home environment after the lockdown to create space for: Home office/Recreational activities/Individual space for (biophilic elements of Prospect (An unimpeded view over a distance, for surveillance and planning) Refuge (A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead)), Mystery (The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment) and Risk (An identifiable threat coupled with a reliable safeguard)
18. On a scale from 1 to 7 (1- the lowest- 7 the highest), how likely is that you will change your environment (home office, recreational/ physical activities, individual space) in the future?
19. If you changed/would change your habitation after the lockdown, did/would you consider any of the elements of Biophilic Urban Design? Proximity to urban gardens, green areas/proximity to water bodies (see, lake, river, etc.), proximity to city centres and services/proximity to rural areas/suburbs (natural terrain with trees and vegetation), and elevated position (i.e., looking downhill or a view point with a wide prospect/proximity to relatives or family/other (please specify)
20. On a scale 1 less to 7 very, how important are for you the elements of Biophilic Urban Design for choosing your habitation?
21. After the lockdown, would you consider any of these changes in your working conditions: flexible virtual/office presence time/switch to full-time home office/total office presence/change in job/occupation/working fewer hours/other?
22. After the lockdown, would you consider any of these changes related to food: Organic/Regional/Growing your own vegetation through urban gardening or farming?

Section 4: Additional information

23. After the lockdown, did you/would you consider taking a pet/animal?
24. Please describe any major changes that you have made incentivized by the lockdown restrictions concerning your lifestyle and wellbeing, based on the above or other factors

Appendix 2

Three categories of the 14 biophilic patterns according to Browning, Ryan and Clancy [67]

Nature in the Space Patterns

1. Visual Connection with Nature (A view to elements of nature, living systems and natural processes)
2. Non-Visual Connection with Nature (auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes)
3. Non-Rhythmic Sensory Stimuli (Stochastic and ephemeral connections with nature that may be analysed statistically but may not be predicted precisely)
4. Thermal & Airflow Variability (Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments)
5. Presence of Water (A condition that enhances the experience of a place through seeing, hearing or touching water)
6. Dynamic & Diffuse Light (averages varying intensities of light and shadow that change over time to create conditions that occur in nature)
7. Connection with Natural Systems (Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem)

Natural Analogues Patterns

8. Biomorphic Forms & Patterns (Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature)
9. Material Connection with Nature (Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place)
10. Complexity & Order (Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature)

Nature of the Space Patterns

11. Prospect (An unimpeded view over a distance for surveillance and planning)
12. Refuge (A place for withdrawal from environmental conditions or the main flow of activity in which the individual is protected from behind and overhead)
13. Mystery (The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment)
14. Risk/Peril (An identifiable threat coupled with a reliable safeguard)

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