Effects of the COVID-19 pandemic on the use and perceptions of urban green space: An international exploratory study

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ARTICLE INFO

ABSTRACT

Urban green space (UGS) is an essential element in the urban environment, providing multiple ecosystem services as well as beneficial effects on physical and mental health. In a time of societal crisis these effects may be amplified, but ensuring that they are maintained requires effective planning and management – which is a complex challenge given the rapid changes in modern society and the need for continual adaptation. This study aims to identify the drivers that normally attract visitors to UGS, and to assess the effects of social isolation on the usage and perception of UGS during the COVID-19 pandemic. We conducted an online survey during the period in which restrictive measures were imposed in response to the pandemic (March-May 2020), in Croatia, Israel, Italy, Lithuania, Slovenia and Spain.

Results showed that urban residents normally have a need for accessible UGS, mainly for physical exercise, relaxing and observing nature. The reduction in UGS visitation during the containment period was related to distinct changes in the motivations of those who did visit, with a relative increase in "necessary activities" such as taking the dog out, and a reduction in activities that could be considered non-essential or high-risk such as meeting people or observing nature. Behavioral changes related to proximity were also observed, with an increase in people walking to small urban gardens nearby (e.g. in Italy) or tree-lined streets (e.g. in Spain, Israel), and people traveling by car to green areas outside the city (e.g. in Lithuania). What the respondents missed the most about UGS during the pandemic was "spending time outdoors" and "meeting other people" – highlighting that during the COVID-19 isolation, UGS was important for providing places of solace and respite, and for allowing exercise and relaxation. Respondents expressed the need for urban greenery even when legally mandated access was limited – and many proposed concrete suggestions for improved urban planning that integrates green spaces of different sizes within the fabric of cities and neighborhoods, so that all residents have access to UGS.

1. Introduction

1.1. Ecosystem services provided by urban green space

In a world of increasing urbanization and with more than half of the population living in cities, urban green space (UGS) is a crucial element for urban transformation and the sustainability of cities (Andersson et al., 2015). Prominent tendencies and movements in urbanism, such as landscape urbanism (Waldheim, 2016), ecological urbanism (Mostafavi and Doherty, 2016), ecological landscape urbanism (Steiner, 2011) and ecosystem urbanism (Rueda, 2019) emphasize that prioritizing nature and ecological considerations can improve the quality of life in cities – and that UGS is the key. UGS directly and indirectly promotes a better quality of life (Sanesi et al., 2011), as it can provide refuge from an increasingly stressful everyday lifestyle (Van der Berg et al., 2010), encourage social cohesion (Zijlema et al., 2017), stimulate physical activity (Hunter et al., 2015), improve health (van den Bosch and Sang, 2017) and even enhance a person's wellbeing and mental state (Nath et al., 2018; Tsai et al., 2018).

UGS includes a diversity of biophysical structures and their ecological processes, which combine to support the city's "green infrastructure" and provide multiple "ecosystem services": namely provisioning services, regulating services and cultural services (Haines-Young and Potschin, 2018).

The European Commission (EC, 2013) has highlighted the importance of integrating these divergent approaches to service provision in cities, and transforming the traditional concept of isolated UGS (parks and gardens) into a comprehensive vision of green infrastructure. This vision is also reinforced in the EU Biodiversity Strategy 2030 (EC, 2020) and New Green Deal (NGD) (EC, 2019). The intended optimization of ES that this implies is seen as a necessary response to the rapid changes in lifestyle that modern urban society is experiencing, as the role and functions of UGS are shifting to adapt to new demands and human needs (Derkzen et al., 2017). UGS represents an urban design resource which is not only aesthetic, but fully functional – and one that must be utilized and nurtured in accordance with the holistic and comprehensive concept of green infrastructure, integrating the perceptions and preferences of citizens in planning proposals and management of this resource in the future (Ryan, 2011).

1.2. User perceptions of the role of urban green space

Human perceptions and preferences towards nature are believed to be either innate (e.g. evolutionary theories such as "biophilia" by Wilson (1984), or Attention Restoration Theory by Kaplan and Kaplan (1989)), or learned (according to cultural theories) – in the latter case being shaped by social, cultural and personal characteristics (Tveit et al., 2019). In many studies carried out on the attitudes that people have toward UGS, significant differences have been found between various localities (de la Barrera et al., 2016; Riechers et al., 2019) and countries (Schipperijn et al., 2010; Bertram and Rehdanz, 2015) – indicating that cultural background as well as environmental factors can condition the expectations and behavior of a particular population.

There is much more to be learned about how these perceptions and usage patterns may change in response to external events. Research on how a global event of great magnitude may be perceived differently in different geographical contexts is not frequent. Given the worldwide health emergency caused by the COVID-19 pandemic, it is of great interest to explore whether and how citizens' behavior and perceptions of UGS in different places may have changed, above and beyond the ways in which the particular areas were affected by the pandemic and the social restrictions that were imposed.

1.3. UGS and COVID-19: Hypotheses and aims of the current study

While several major epidemics have occurred throughout the world

in recent decades (e.g. SARS, MERS), the COVID-19 pandemic has already had a global impact which is unprecedented in its scope and scale. As governments around the world have responded to the public health threat by imposing social distancing protocols, economic shutdowns and various forms of home quarantine, it has been hypothesized that these measures may have fundamentally changed the relation between humans and public spaces, in terms of use and perception.

The purpose of this study was to explore, from an international perspective, the ways in which human behavior, perceptions and attitudes toward UGS may have changed due to restrictions imposed by the containment of the COVID-19 outbreak in different countries, in comparison to the period prior to the restrictions. In addition, the study aimed to evaluate citizens' satisfaction with UGS in their locality and elicit constructive recommendations for improvement.

The study was conducted in Croatia, Israel, Italy, Lithuania, Slovenia, and Spain. These countries constitute a diverse range of societies and cultures, each with norms and customs that might influence the use and perception of UGS – even, and perhaps especially, during the emergency situation triggered by the COVID-19 pandemic.

1.4. The COVID-19 pandemic: spread and social restrictions

The measures implemented to contain the COVID-19 outbreak in the six countries studied began on different days, and with different levels of restrictions (Supplementary materials (SM) - Table 1). Italy was the first country to adopt restrictive measures at a national level. Initially (between the 9th and 20th of March 2020), sports activities and walking outdoors were allowed, even though public gatherings were prohibited. But the rapid increase in positive cases led the Ministry of Health to ban any kind of physical exercise or walking farther than 200 m from home, and going outdoors was allowed only for essential reasons. Similar restrictions were imposed on March 22 in Israel, only allowing movement 100 m away from home.

A few days after the outbreak in Italy, Spain began recording a dramatic increase in positive cases and on the basis of the Italian experience, imposed on March 14 the strictest level of limitations – according to which going outside was allowed only for essential activities, and thus the frequentation of UGS was banned. In Slovenia, Croatia and Lithuania, outdoor activities were allowed throughout the period but with strong warnings to keep distance from other people (other than family or close relatives) and to avoid gatherings even between a few people. These restrictions lasted until April 18 in Slovenia (where some outdoor activities were allowed), until April 27 in Lithuania, and until the beginning of May in the other countries. In Italy, although with regional distinctions, vegetable gardening was generally allowed from the 20th of April. (See further details in SM – Table 1).

2. Materials and methods

At the beginning of the isolation period in Italy (March 2020), an

Table 1
Distribution of respondents by place of residence, showing category percentages in each country.

	Croatia	Israel	Italy	Lithuania	Slovenia	Spain
Big town/City	74 % A	64 % A	45 % A	60 % A	56 % A	51 % A
Small town	19 % B	18 % B	39 % A	28 % B	13 % C	27 % B
Village/Rural area	7% C	17 % C	15 % B	12 % C	31 % B	22 % B
Tot (%)	100 %	100 %	100 %	100 %	100 %	100 %
Tot (n)	460	230	431	447	315	657

Significant differences within the countries were identified by the Chi-square test between coupled options. Differences at α < 0.05 are indicated by capital letters.

online questionnaire (using *Google Forms*) was developed for distribution to the general public. Respondents were asked for informed consent prior to their participation in the survey. A link was provided with information on the researchers conducting the survey, what data would be collected, how the data would be stored, analyzed and reported, and respondents' rights regarding the provided data. Participation was voluntary, and participants had the right to leave the questionnaire at any point.

The questionnaire was divided into nine sections and contained between 30 and 45 questions, depending on whether respondents self-identified as those who usually visit UGS ("UGS visitors") or those who do not ("non-UGS visitors") and on whether they visited or not UGS during the COVID-19 pandemic. The results presented below refer to Sections 1–5 (see the structure of the questionnaire in SM – Table 2) and consider responses to an open question (which was included in all countries except Slovenia) on the *relationship between urbanization, people and nature.*

The questionnaire was originally developed as an initial exploration in Italy, where it was pre-tested by 10 people of different ages and education levels in order to ensure the clarity of the questions and overall structure. The preliminary version was corrected based on the suggestions and feedback, and then translated from Italian into English and into other languages.

3. Sampling

Data collection was concurrent in most countries, starting on the 12th of April and ending on the 4th of May 2020 (SM – Table 3) when a relaxation of restrictive measures to contain the COVID-19 outbreak was declared in most countries. Restrictions on UGS visitation during the pandemic were largely similar in most countries, despite stricter limitations in Italy, Spain and Israel.

In each country, non-probability samples were obtained through an unrestricted self-selected survey (Fricker et al., 2008). Distribution of the online questionnaire initially started through the authors' networks of professional and personal contacts, by email and through social media (Facebook, WhatsApp, etc.) or posts on websites. Participants were kindly asked to fill in the questionnaire and distribute further to their contacts. Thus, the distribution proceeded according to a snowball effect, and did not allow for personal identification of individual respondents.

3.1. Data management and statistical analysis

The datasets were analyzed by performing descriptive statistics, while logistic regression analysis was used to compare differences among countries. We transformed each item in the questionnaire into a binary variable according to the indicated preference by the respondent (Y/N) and calculated the Odds Ratio (OR) and 95 % confidence interval (CI) of the association of each item and nationality of the respondents, considering the countries with the highest score for that item as the reference group. The level of significance was set to p < 0.05. Differences within each country were also investigated by the Chi-square test between pairwise options. The same test was also used for comparisons

between two datasets (e.g. attitudes of UGS visitors before and during COVID-19 restrictions). Statistical analyses were performed using R Software (https://www.r-project.org/) and particularly the odds ratio (OR) package. It should be noted that due to the sample type (purposive sampling) and mode of administration (internet survey), conclusions could be made only for the sampled population.

Textual responses were analyzed separately. If text provided under the option "other" expressed a concept that was analogous to one of the predefined choices, the answer was coded with that choice, and if a concept that was different from the predefined options was indicated by several respondents, we assigned a common code to those responses to allow further comparative analysis.

For the open-ended question, respondents were invited to share *"thoughts about urbanization and the relationship between people and nature in the city"* which were analyzed using text mining. Text mining is a computer-based technique that extracts information from large data sets (Feldman and Sanger, 2007; Fuller et al., 2011). All responses to open-ended questions were translated into English in order to unify them in a single dataset. The analysis was performed using Statistica Soft, 2012 (Release 12, StatSoft, Inc. 1984–2014). The preliminary phase consisted of filtering the text in order to reduce the presence of insignificant words, and words with the same meaning were combined. "Indexing" produced a draft list of words that could be further "cleaned" by combining further synonyms and deleting more words. The program computed the raw frequencies of word occurrences, enumerating the number of times that a given word occurs in each text unit. The list of frequencies was used to create a matrix of all the words, which indicates the concurrent presence of words in the same text units. Exploratory analysis of the word matrix was done to find the most relevant words

Table 3
Percentage of respondents in the two groups (pre-pandemic UGS visitors and non-UGS visitors), visiting (Yes) vs. not visiting (No) a UGS during the COVID-19 containment.

Visit to a UGS during COVID-19		Croatia	Israel	Italy	Lithuania	Slovenia	Spain
UGS visitors	Yes (%)	86 %***	88 %***	36 %	100 %***	99 %***	36 %
	No (%)	14 %	12 %	64 %***	0%	1%	64 %***
Total UGS visitors (n)		437	214	366	376	300	571
UGS non-visitors	Yes (%)	83 %***	56 %	11 %	28 %	93 %***	17 %
	No (%)	17 %	44 %	89 %***	72 %***	7%	83 %***
Total non-UGS visitors (n)		23	16	65	71	15	86
Total (n)		460	230	431	447	315	657

Significant differences between the two categories (UGS visitors vs. non-UGS visitors) were identified by the Chi-square test. Differences are indicated by * at α < 0.05, ** at < 0.01 and *** at α < 0.005.

Table 2
Percentage of UGS visitation in the place of residence and percentage of visitation within each category of place of residence.

	Croatia		Israel		Italy		Lithuania		Slovenia		Spain	
Visitation of UGS	95 %	*a*	93 %	*a*	85 %	*b*	84 %	*b*	95 %	*a*	87 %	*b*
Big town/City	96 %A	*a*	94 %A	*a*	92 %A	*a*	87 %A	*b*	97 %A	*a*	87 %A	*b*
Small town	90 %A	*b*	88 %A	*b*	78 %B	*b*	82 %A	*b*	98 %A	*a*	86 %A	*b*
Village/Rural area	94 %A	*a*	95 %A	*a*	80 %B	*b*	78 %A	*b*	92 %A	*a*	88 %A	*a*

Statistical differences between countries are identified by the Odds-ratio test, taking as reference the country with the highest percentage. Different lowercase letters in *italics* indicate that OR were significantly different (p < 0.05), *ns* means no difference. Significant differences between town size within the same country were identified by the Chi-square test and differences are indicated by capital letters at α < 0.05.

and connections between them from the perspective of the respondents. Two approaches were applied: correlation analysis (with mapping of p-values to visualize the results), and principal component analysis (PCA). In order to derive the content of the text units with much greater detail, we also performed content analysis (Krippendorff, 2004) and thematic analysis (Braun and Clarke, 2006).

4. Results

4.1. Description of the national samples

Collected data (n = 2560) were checked for consistency, and records that were missing essential information were excluded (n = 20). The final sample thus consisted of 2540 responses distributed over the six countries, ranging from 230 respondents in Israel to 657 in Spain.

The majority of the respondents in all countries were female (see SM – Table 4), with especially high percentages in Lithuania (84 %), Croatia (76 %) and Slovenia (74 %) ($\alpha < 0.005$). Respondents were mostly adults in the age range of 30–69 years old, with some differences between countries: the dominant age groups in Spain were 50–59 and 60–69 and in Slovenia 40–49 and 50–59, while in other countries the proportions of respondents were more evenly distributed between 40 and 69. In Israel, younger respondents (20–29) were also well represented (SM – Fig. 1). The majority of respondents in most of the national samples had completed some form of higher education, most notably in Lithuania, Israel, Slovenia, and Spain (SM – Fig. 2A). The Italian and Croatian samples also included some respondents (on average 25 %) whose educational level was listed as a high school diploma ($\alpha < 0.005$). The large majority were employed in a public or private company ($\alpha < 0.005$) (SM – Fig. 2B), while Israel counted the highest percentage of students (22 %).

Most respondents (Table 1) reported living in large towns or cities with more than 100,000 inhabitants. The percentage was highest in Croatia (74 %), and exceeded 50 % in every country except Italy (45 %). If we consider all the respondents living in urban areas, the largest proportions were found in Croatia and Lithuania (93 % and 88 %, respectively), followed by Italy, Israel, Spain and Slovenia.

4.2. Visitation to UGS pre-pandemic

Respondents were firstly asked whether they generally (pre-pandemic) tended to visit or spend significant periods of time in UGS in the place where they live. Most respondents (85–95 % depending on country) stated that they do visit UGS frequently (Table 2). Despite Croatia and Slovenia showing different percentages of respondents living in urbanized contexts, both recorded the highest rates of visitation, especially among those living in urban areas, with a score significantly different from Italy, Lithuania, or Spain. In Italy and Lithuania, respondents from large towns and cities were also much more frequent visitors of UGS than those living in small towns and villages or in rural areas – though this was not the case in Israel, Croatia and Slovenia.

Regarding the habits of UGS visitors (SM – Table 5), Slovenians (Table 5A), generally travel shorter distances (<200 m) to visit a UGS ($\alpha < 0.05$) than UGS visitors in other countries. In Spain, Croatia and particularly Italy people travel further ($\alpha < 0.05$) to reach a UGS (>500 m). Moreover, in Italy, Spain, Lithuania and Slovenia, longer distances are traveled especially by people living in large towns and cities (SM – Table 6).

Most respondents declared that they reach the UGS by foot, despite some differences among countries (Table 5B). For instance in Slovenia, the percentage was significantly higher than in Italy, Croatia, and Lithuania. Private cars were selected as a means of transportation to UGS by Lithuanians, significantly more than Italians, Slovenians, Spaniards and Israelis. Croatians and Slovenians tend to use bikes to visit UGS more than Spaniards, Israelis, and Lithuanians, while some Italians go by motorcycle. On the other hand, the option of public transportation was only selected by a small minority, though higher in Italy than in Croatia, Slovenia or Israel.

Regarding the type of UGS visited (Table 5C), in all countries except Slovenia most respondents indicated visiting an *urban park*. The largest proportion of visitors to *urban parks* was in Italy (57 %), slightly higher than in Croatia (55 %) and significantly higher than in Lithuania, Spain, Israel and Slovenia. *Urban gardens* were most frequented by Israelis (15 %), with percentages relatively lower among Italians and Spaniards and near-zero among Lithuanians, Croatians and Slovenians.

In Slovenia, over half of the respondents (52 %) selected *green area outside the town*; which included *forest*, as Slovenians listed this term separately. *Riverbanks* were frequented by 16 % of Spanish respondents and slightly less by respondents from other countries (except Israel, with only 4%) – while the option of *tree-lined was* largely selected by Lithuanians (8%).

In all countries, most respondents declared that they visit a green space *more than once a week* (Table 5D), with the largest majorities in Slovenia and Spain. Italy also recorded the highest percentage for the
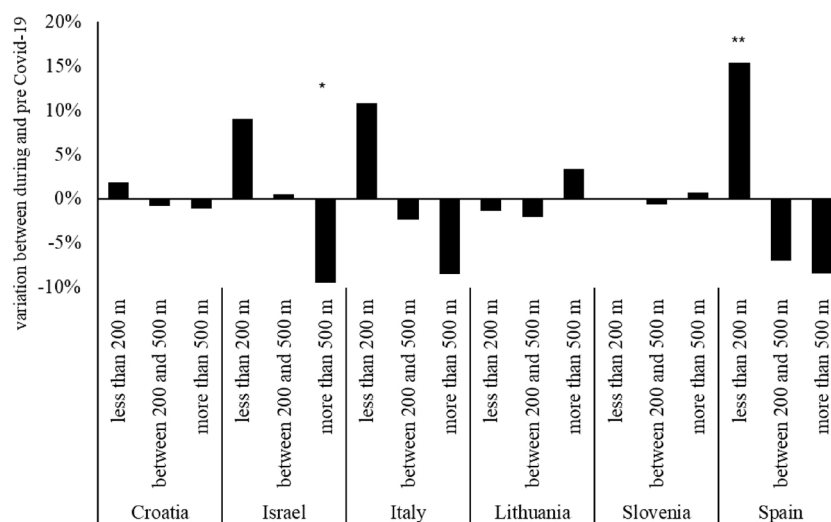
Fig. 1. Percentage of variation in the distance traveled to UGS during the containment period relative to the pre-pandemic period, among UGS visitors. Significant differences between the two situations (before vs. during COVID-19) were identified by the Chi-square test. Differences are indicated by * at $\alpha < 0.05$, ** at $\alpha < 0.01$ and *** at $\alpha < 0.005$.
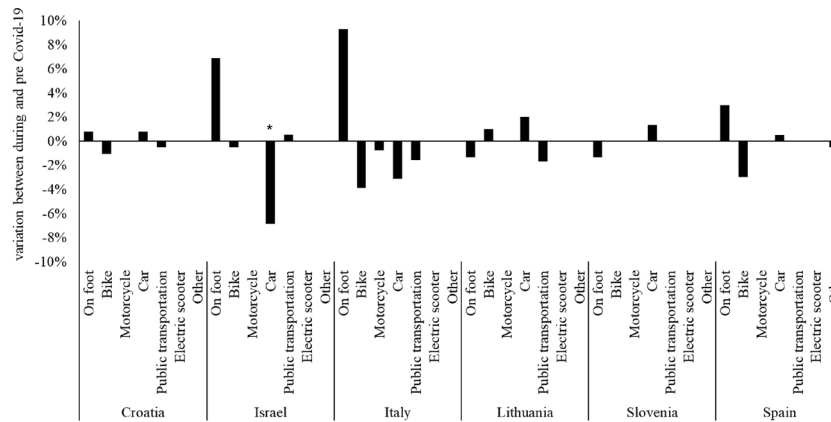
Fig. 2. Percentage of variation in the means of transportation used by UGS visitors during the containment period relative to the pre-pandemic period. Significant differences between the two situations (before vs. during COVID-19) were identified by the Chi-square test. Differences are indicated by * at $\alpha < 0.05$, ** at $\alpha < 0.01$ and *** at $\alpha < 0.005$.

option *several times a month* as compared to other countries, whereas Slovenia recorded the highest percentages of respondents visiting a UGS *once a month*. Few respondents, ranging from 0% in Slovenia to 7% in Lithuania, declared going to UGS less than once a month.

Table 5E shows the main reasons given for visiting UGS. Overall, *physical exercise* was the most frequently selected motivation ($\alpha < 0.05$), with Spain having a somewhat higher percentage (36 %) than Slovenia (29 %) and significantly more than Israel, Italy or Croatia – with an even greater difference from Lithuania. However, the option of *relaxing* was also frequently selected, especially in Slovenia, Italy and Croatia, and this was the main reason mentioned for visiting a green space in Lithuania (34 %).

Observing nature, going out with children and *walking the dog* were selected as secondary options. In particular, *observing nature* was selected mainly by Italians, significantly more than Croatians and Slovenians. Respondents from the latter countries more often selected *walking the dog* than those from Lithuania, Italy, Spain or Israel – and Lithuanians selected *taking the kids outdoors* more than Spaniards, Slovenians, Italians or Israelis. *Meeting people* was scarcely selected, though registering more as a priority for Croatians, Israelis and Slovenians than for Italians, Lithuanians or Spaniards.

4.3. Visitation to UGS during the Covid-19 containment period

Respondents were asked whether or not they had visited any UGS during the period of COVID-19 containment measures. Those who used to visit some type of UGS before the pandemic (UGS visitors) generally continued to do so (Table 3) in Croatia, Israel, Lithuania and Slovenia, while in Italy and Spain the majority of them (64 % in both countries) did not ($\alpha < 0.005$). Details regarding respondents who were not usual visitors to UGS prior to the pandemic (non-UGS visitors), can be found in the Supplementary materials.

Regarding the pre-pandemic UGS visitors, who represent the large majority in all countries, significant differences were observed during the containment period in the distance traveled to UGS with respect to the pre-COVID situation (Fig. 1). In general, there was a tendency to visit green spaces at closer distances (< 200 m) in Israel, Italy and Spain, although the differences were only significant in Spain ($\alpha < 0.01$). However, in Croatia, Italy, Lithuania and Spain the percentage of respondents traveling farther was slightly higher than the percentage of those going shorter distances ($\alpha < 0.05$) (SM – Table 7A), while in Slovenia, respondents going less than 200 m were the majority ($\alpha < 0.05$) – a significant difference with respect to the other countries (p < 0.05).

The OR cross-analysis comparing travel distance with place of residence (large city, small town, rural etc.), showed significant correlations

in Israel, Italy, Lithuania and Slovenia (SM – Table 8). People living in a village or a rural area in Israel were more likely to travel more than 500 m to visit a green area than those living in a large town or city. Italy and Lithuania showed opposite results, with people living in big towns or cities more likely than people living in small towns (or in villages/rural areas, in Italy) to travel over 500 m. The latter trend was also found in Slovenia, particularly among people living in villages or rural areas, who preferred travelling shorter distances than urbanites.

The most commonly reported way of reaching UGS in all countries during the containment period was *on foot* ($\alpha < 0.05$). Israel showed the highest percentage, while Croatia and Lithuania had significantly lower percentages (SM – Table 7B). *Bicycle* travel was mostly selected by Slovenians, to a considerably greater extent than Israelis and Spaniards, while the *car* was mainly a choice of Lithuanians. Very few differences within countries were observed between visitor behavior before and during the COVID-19 containment in terms of the preferred means of transportation (Fig. 2). The only statistically significant difference was a decrease in car use in Israel (-7%, $\alpha < 0.05$), which was similar to an increase of Israelis reaching the green area *on foot* when compared to the pre-pandemic behavior. An even larger increase (of 10 %, though not statistically significant) in going *on foot* was seen in Italy.

Regarding the type of green space visited during the pandemic containment period, the majority of respondents in most countries chose *urban parks*, though to a lesser extent than before (SM – Table 7C). The main exceptions were in Slovenia ($\alpha < 0.05$) where *green areas outside the town* were preferred by a large margin, and in Italy where the margin was narrower. In fact a relative increase in travel to *green areas outside* the respondents' place of residence was seen in several other countries as well, reaching 7% ($\alpha < 0.05$) in Croatia– where there was a 15 % reduction in visitation to *urban parks* ($\alpha < 0.01$) – and smaller percentages in Israel, Lithuania and Spain (Fig. 3). In Italy there was a similar reduction of 12 % ($\alpha < 0.05$) in frequentation of *urban parks*, and in Spain there was a significant 4% increase in visitors of *tree-lined streets* ($\alpha < 0.05$) – a preference also noticed in Israel and Croatia. Urban gardens were also increasingly appreciated, especially by Italians – as compared with Croatians, Lithuanians, and Slovenians.

Excluding the option *"I have not gone"*, which was mainly selected option by respondents in Italy and Spain (64 % in both countries), the main motivation to visit a green area in many countries was to do *physical exercise* (indicated as walking or running) followed by *relaxing*, which was particularly common in Lithuania (SM – Table 7D).

The motivations showing a large decline during the containment (Fig. 4) were those that could increase the risk of contagion, such as *meeting people*, and those we might consider "non-essential", such as *observing nature* – which was less selected in every country (reduction by 6–8 %), but was still one of the top motivations for Lithuanians (SM –
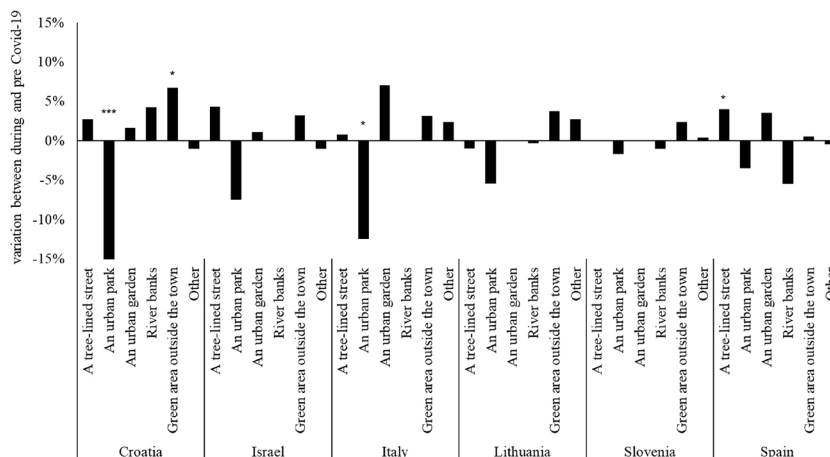
Fig. 3. Percentage of variation in the type of UGS reached by UGS visitors during the containment period relative to the pre-pandemic period. Significant differences between the two situations (before vs. during COVID-19) were identified by the Chi-square test. Differences are indicated by * at $\alpha < 0.05$, ** at $\alpha < 0.01$ and *** at $\alpha < 0.005$.

Table 7D). *Physical exercise* was the most frequently mentioned motivation during the pandemic in every country except Spain and Lithuania, most notably in Italy, Israel and Croatia. Finally, *taking the dog out* increased in relative importance in every single country, most significantly in Spain (where it rose by over 8%). *Taking the kids outdoors* was most cited by Croatians.

Surprisingly, respondents who visited UGS during the COVID-19 pandemic declared that they did it quite often (SM – Table 7E), with the option of *more than once a week* selected by a majority in nearly every country (reaching 93 % in Slovenia). Only in Spain *once a week* was selected more frequently (43 % vs. 41 %), and Italy was the country with the highest proportion of respondents (19 %) declaring that they only went out *once* – moderately higher than Croatia (15 %), Lithuania (14 %) and Israel, and much higher than Slovenia and Spain.

When respondents were asked if the UGS visited during the period of containment was the same as the one they visited pre-pandemic, the majority in all countries (except Croatia) answered that it indeed was (SM – Table 9). The percentage of those who declared that their visitation changed to a different UGS ranged from 52 % in Croatia to 10 % in Slovenia. In an open-ended question (SM – Table 10), the majority of these respondents in Israel, Italy and in Spain wrote that their main reason was to *stay closer to home* (presumably following the rules set by local legislation) – while in Lithuania and Slovenia (and by a small margin also Croatia) the main rationale given was to *avoid people*. Another consideration that was linked to the local restrictions was the non-accessibility of UGS in Italy and in Spain, for the simple reason that

they were closed (25 % in both countries).

4.4. Perceptions of UGS during the COVID-19 containment period

Respondents were also asked about their perceptions regarding UGS during the period of home quarantine, specifically: a) the possibility of seeing some outdoor "greenery" from the window of their residence, b) the extent to which they "miss" accessing green areas directly, and c) what particular activities related to UGS they miss the most (SM – Table 13).

In terms of a "green view" from the window (Table 13A), the great majority of respondents reported being able to see some form of UGS – with highest percentages lacking any such view found in Lithuania (17 %), Italy (14 %) and Spain (14 %). Overall the most commonly reported views were of *private gardens* (ranging from 38 % in Israel to 20 % in Spain), with the notable exception of Slovenia, where respondents instead referred to *natural landscape* (34 %) or *other* (52 %), represented mostly by a generic green space near buildings, vegetable gardens and playgrounds (45 %, 26 and 16 % respectively within *other*). Also, the possibility of seeing *tree-lined streets* was prominently mentioned in Spain (32 %), Israel (28 %) and Croatia (28 %).

In response to the question *"During the period of closure, how much do you miss going to a green area?"*, over half of the Lithuanians (and nearly half of the Slovenians) declared that they did not miss UGS *at all*, or if so *just a little*. These cases were exceptional, however, as a clear majority reported missing UGS *a lot* in Italy (64 %), Spain (64 %) and Israel (62
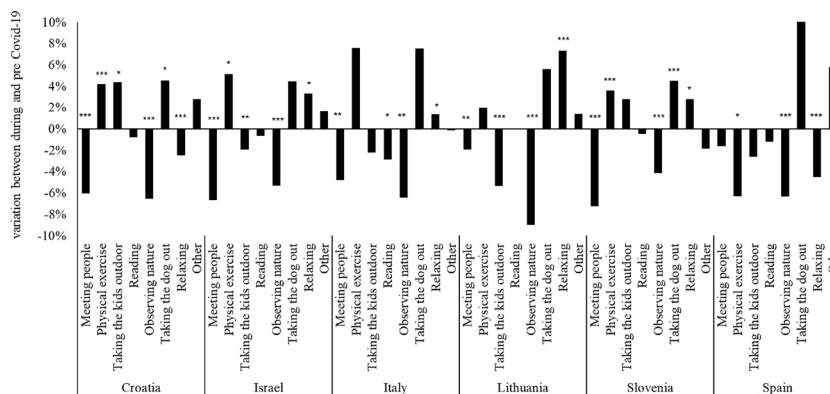

Fig. 4. Percentage of variation in the reasons given for visiting UGS during the containment period (among those who did so) relative to the pre-pandemic period, by UGS visitors. Significant differences between the two situations (before vs. during COVID-19) were identified by the Chi-square test. Differences are indicated by * at $\alpha < 0.05$, ** at $\alpha < 0.01$ and *** at $\alpha < 0.005$.

%) – and this was also the top response in Croatia (35 %) and even in Slovenia (30 %), where the distribution of responses was especially wide (Table 13B).

Regarding the aspects of UGS that respondents missed the most (Table 13C), there was considerable variation among countries but several significant patterns do emerge. First of all, respondents from most countries prioritized *spending time outdoors*, which was the top response in Italy (29 %) and Israel (23 %) and nearly so in Lithuania (23 %) and Croatia (22 %). In Slovenia, on the other hand, this sentiment was not expressed at all; instead *meeting other people* was missed the most (40 %), which was also the top response in Croatia (25 %) and among the top responses in Israel (20 %). For Spaniards, *exercising outdoors* was the activity most missed (40 %), followed by observing nature (20 %) – both of which were also missed in Israel (21 % and 19 % respectively) and the latter in Italy (19 %). Finally, it may be noted that Lithuanian respondents missed, above all else, *breathing fresh air* (28 %).

The extent to which citizens missed UGS depended on their frequency of visitation. Those who never went out during the pandemic missed the UGS the most (SM – Table 14), and this relationship also occurred with the group who did visit UGS during the isolation – as visitors who went to UGS more frequently (e.g. more than once a week) missed UGS less than the other groups (SM – Table 15). Respondents missed visiting UGS, although those who could see natural landscape missed it only to a minor extent (SM – Table 16).

Finally, the questionnaire respondents were asked for an open-ended reflection on the *relationship between urbanization, people and nature*. A total of 2280 valid responses were collected, in which the automated text mining identified a total of 59 significant words as the most commonly used by the respondents (SM – Table 17). The five most used terms were "green area" (1791 counts), "city" (603 counts), "nature" (544 counts), "trees" (434 counts) and "human" (289 counts).

The correlation analysis of the word matrix (SM – Fig. 3) showed how "green areas" were conceptually linked to other key terms such as "awareness", "city", "greenery", as well as "lack" and "urbanization". Moreover, the word "city" was frequently used together with the words "nature" and "trees," and the word "man" was often connected to "health," "nature" and "trees". Another perspective was offered by the PCA analysis, conducted on the same word matrix: thirteen components were selected explaining 80 % of the word matrix variability (SM – Table 18). The most relevant association (P1) was between "green areas", "trees" and "citizens" (39 % variability explained). Associated to such words were several terms from P2: "Nature", "man" and "to create" (13 % variability explained). The concepts of "urban" and "life" appeared from P3, and "health", "quality" and "urbanization" from P4.

Thematic analysis of the entire body of text, identifying text units by their content within the respondent's answer for a total of 2367 valid text units, allowed us to identify 39 individual concepts which were grouped into nine categories, on the basis of the objective and conceptual meaning derived from the original text (SM – Table 19). These categories were further grouped into three macro-categories, in which 60 % of the individual concepts were assigned to the macro-category *governance*, 23 % to *awareness* and 16 % to *benefits and services*. The concepts associated with the macro-category of *Governance* were the most mentioned in all countries – most prominently in Croatia (accounting there for 92 % of the total), followed by Lithuania (74 %) and by Italy, Spain and Israel with ~50 % each (see Table 20 in SM for a comparison of the five countries; the Slovenian survey did not include this open question). Within *Governance*, the greatest number of concepts were related to the category of *Planning* (40 %) – including tangible recommendations such as the need to *"increase the quantity of green surfaces," "adopt approaches to urban planning which integrate green space and tree plantations into new neighborhoods,"* and *"reduce paving and building."* An additional 14 % of all the individual concepts were related to the category of *Management*, such as *"maintenance of green areas"* and *"quality of management."*

Respondents showed a certain level of *awareness* of the importance of green areas, emphasizing environmental *consciousness*, and to a somewhat lesser extent also expressed the need to *educate* adults and children to care for the environment. Indeed, under *awareness*, the majority of texts referred to *consciousness* (16 %), a term that identifies the text units expressing respondents' own personal awareness in relation to the *importance of urban greenery*, including have a greater *contact with nature* and *respect for nature*. Minor categories included *education* (6%) and *valuation* (1%), which included concepts that express the importance of recognizing the added value of green areas.

Texts indicated respondents' awareness either in general terms or with special emphasis on specific *benefits* (11 %) – mostly related to *health and well-being* and *psychological state*.

5. Discussion and conclusions

This study was motivated by the social isolation that was imposed during the COVID-19 pandemic in 2020. Findings from our online survey in six European countries highlighted some of the changes in behavior and attitude related to the visitation of urban green space that resulted from this altered reality.

The samples in Croatia, Israel, Italy, Slovenia, Lithuania, and Spain were all overwhelmingly *urban*, with most respondents living in large cities (Table 1). This is highly reflective of the European population overall, and it indicates that most people cannot take UGS for granted. The results demonstrate how adults not only share this need, but they are willing, in general, to travel long distances within or beyond the city to access UGS. In order for UGS to be accessible to the population, they need to be created and maintained within the urban fabric, which is often densely built and characterized by competing land uses.

In terms of the reasons that urban dwellers have this need for UGS, it was clearly seen from pre-pandemic results that the most sought-after activities in UGS were physical exercise and relaxing (SM - Table). This was the case for all countries, though Italians and Lithuanians in particular also expressed an appreciation for nature observation. The use of UGS for running, walking and outdoor sports has been widely studied and found to depend on numerous interconnected variables and aspects of the urban fabric – including built density and green surface area, pedestrian access, safety and protection from traffic and crime (Sreetheran and Van Den Bosch, 2014). Taking children outdoors and walking the dog were also commonly cited activities, the latter also associated with physical exercise (Christian et al., 2016).

A key objective of the survey was to discern *changes* in UGS visitation after the COVID-19 restrictions were enacted. In Italy and Spain, the two largest countries in the survey and the two hardest hit by the pandemic, nearly two-thirds of those who previously visited UGS on a regular basis responded that they simply stopped going (SM - Table 7). While this can easily be attributed to the government restrictions on personal mobility during the period of containment, 36 % of respondents in each of these two countries did continue making their way to some UGS. This indicates that the need for greenery and open air certainly did not disappear with the legal restrictions to access to such places. The reduced visitation was in fact not evenly distributed among different population groups; for example a larger reduction was seen among female respondents (SM – Table 21) – many of whom may have been put off by other duties or the insecurity of parks that were relatively deserted (Sreetheran and Van Den Bosch, 2014).

While the restrictions may not have changed people's basic need for UGS, they did lead to an increase in the diversity of UGS that were accessed – with some traveling out of town, and others relying more on tree-lined streets and urban gardens (Fig. 3, SM - Table 7). This finding points to a possible dichotomy in which limitations on regular access to parks could result in trends toward either more localized or more long-distance travel (SM – Table 22), both of which have environmental implications.

The evidence for this dichotomy is also suggested by changes in the modes of transportation used for reaching UGS. While in most countries

such changes were not pronounced, a significant reduction in the use of private cars was registered in Israel, accompanied by an increase among those arriving on foot – and in Italy there was an even larger rise in the number of pedestrians (Fig. 2).

An especially striking result, and one that could have tangible implications for UGS planning, pertains to the stated motivations for changing one's behavior. A strong reduction was seen among people going to UGS for reasons that could be seen as *non-essential*, such as observing nature or which could pose a risk for possible contagion, such as meeting people (Fig. 4). This is significant because it shows that parks and other UGS have essential functions that are fundamentally different from other types of public places like shops or restaurants. While UGS can indeed serve as centers of public gathering, they can also be vital for the opposite reason – to serve as places where people can find respite and isolation within the crowded city.

All of these findings have implications for the design, management, and indeed the appreciation of UGS.

When respondents were asked how much they missed UGS, the response was clear, with the large majority missing UGS to a large extent UGS (SM - Table 13). However this feeling depended on their frequency of visitation, with deeper feelings expressed by those who never went to UGS or went just once during the pandemic (SM - Table 15). The view of greenery from peoples' windows played only a minor role, although those who could see natural landscapes missed UGS only to a minor extent, likely because such views induced a perception of freedom or sense of exploration (SM - Table 16).

Regarding what they missed the most during the period of home quarantine, respondents in most countries prioritized the simple idea of spending time outdoors – and while this might seem like a fairly straightforward reaction to the circumstances of being confined to one's home for an extended period, it should be stressed that the question referred specifically to *green* space, and not to outdoor areas in general. This could be an indicator of the special biophilic importance that greenery has for city dwellers, above and beyond the need for open space such as may be found in a public square that is relatively devoid of vegetation. In this sense, parks and tree-lined streets may once again be seen as having added value not just as public open spaces for gathering, but also – as indicated during the time of the pandemic – places of personal refuge within the city (Fig. 3).

This in no way diminishes the tremendous value of large public parks, and in fact urban parks were the most selected type of UGS during the pandemic. What many respondents missed most during the pandemic was park-related activity like exercising outdoors and meeting other people (SM - Table 13); in other words, parks are seen as vital places. In some cases (e.g. Israel and Italy), observing nature and breathing fresh air were also highly missed. These findings express the wide range of needs fulfilled by UGS – from the physical to the cognitive and emotional, and from the tangible to the ethereal.

When it came to expressing their general feelings about the relationship between people and nature in the context of urbanization, most respondents focused on tangible issues related to the planning and management of UGS. Many focused on design and planning decisions made by local actors, such as increasing the spatial extent of green areas and improving residents' access to them.

This reflects a forward-looking, action-oriented attitude on the part of many respondents within the survey sample. It also reflects the large percentage of respondents with higher education (see Supplementary material) and presumably with a high level of knowledge or interest in the topic, as demonstrated by the familiarity with specific definitions and laws related to the management of urban green (as expressed in individual textual responses).

A concurrent theme, appearing through the selected options of UGS and the responses to the open-ended questions, is related to the importance for urban green infrastructure to be well articulated and inclusive of different types of greenery. In order to create resilient cities, urban planning and design should consider a diverse mix including large parks

which can offer spacious open-air green settings, which are useful for visitation (even without large gatherings) of UGS during times of pandemic, together with smaller pocket parks and gardens – which can guarantee, as much as possible, that all residents will have access to UGS within walking distance from their home. From this perspective, it becomes important to foster the multiple services that different types of UGS provide in the city and to re-think urban policy and planning to respond to new behaviors and needs that have arisen from the COVID-19 pandemic (Honey-Rosés et al., 2020). For instance, the rise of pedestrian movement and green mobility observed in some countries should be accompanied by the provision of streets, sidewalks and biking trails that are shaded with healthy, appropriately selected and well nurtured trees, connecting green spaces throughout the city through vital green corridors.

CRediT authorship contribution statement

Francesca Ugolini: Conceptualization, Methodology, Formal analysis, Writing - original draft. **Luciano Massetti:** Methodology, Data curation, Formal analysis, Writing - original draft. **Pedro Calaza-Martínez:** Investigation, Data curation, Writing - original draft. **Paloma Cariñanos:** Investigation, Data curation, Writing - original draft. **Cynnamon Dobbs:** Investigation, Data curation, Writing - original draft. **Silvija Krajter Ostoić:** Investigation, Data curation, Writing - original draft. **Ana Marija Marin:** Investigation, Data curation. **David Pearlmutter:** Investigation, Data curation, Writing - review & editing. **Hadas Saaroni:** Investigation, Data curation, Writing - original draft. **Ingrida Šaulienė:** Investigation, Data curation, Writing - original draft. **Maja Simoneti:** Investigation, Data curation, Writing - original draft. **Andrej Verlič:** Investigation, Data curation, Writing - original draft. **Dijana Vuletić:** Investigation, Data curation, Writing - original draft. **Giovanni Sanesi:** Methodology, Supervision, Investigation, Data curation, Writing - original draft.

Declaration of Competing Interest

The authors reported no declarations of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ufug.2020.126888.

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