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Attitudes towards urban green during the COVID-19 pandemic via Twitter

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ABSTRACT

COVID-19 has had economic, social and environmental impacts worldwide. Governments have adopted containment measures to limit the spread of the virus. Urban green spaces (UGSs) were included among the non-essential activities and were consequently closed during the lockdown periods in some countries. This study analysed tweets posted by users to understand the citizens' perception and sentiment in relation to the closure of UGS in Italy. Results revealed that people felt a strong deprivation feeling in relation to the restrictions imposed on UGS access, which limited the number of spaces for supporting mental and physical wellbeing of citizens. Users from urban areas were more affected by the lockdowns and more willing to share thoughts on social media, demonstrating a strong emotionality. Furthermore, findings show that users seemed concerned about their children's health, expressing awareness about the benefits of being in contact with nature. UGS is able to provide services to citizens, and close-to-home parks are fundamental for the community, in particular during a health emergency. The implementation of urban design, which includes green areas to support health and environment challenges, should be addressed by policy-makers to create opportunities for a green and resilient recovery of cities, and prepare for future emergencies.

1. Introduction

Urban green spaces (UGSs) both as a single *piece of land covered by vegetation of any kind* (W.H.O., 2017) and/or in the interacting and multiscalar diversity of functional and structural patches composing the mosaic of the urban green infrastructure (European Commission, 2013a, 2013b), provide a multitude of benefits for residents of cities, known as ecosystem services (ES) (FAO, 2016; Luederitz et al., 2015). The ability of UGS, in the form of street trees, parks, green roofs, etc., to counteract some of the negative impacts of the built environment on human health is well documented (e.g. Roy et al., 2012). Trees are capable of reducing air pollution mainly via passive deposition of pollutants, particulate matter, on leaf surfaces (Xing & Brimblecombe, 2020), and the shade provided by tree crowns, combined with evapotranspiration, reduces both surface and atmospheric temperatures, creating thermally comfortable spaces for citizens on hot, summer days (Sun et al., 2021). Urban green spaces provide people with the possibility to make different experiences: physical activities, playing, socializing, relaxing, etc. achieving a wide range of beneficial physical and mental effects (Carrus et al., 2015; Finlay et al., 2015). In addition, nature contact is associated with subconscious, autonomic cognitive processes which reduce stress and increase focus and concentration (Bratman et al., 2012; Carrus et al., 2017; Maas et al., 2006). Simply looking at UGS can create feelings of relaxation which consequently may be beneficial for combatting stress related illnesses (Elsadek et al., 2020).

In the dense built environment, accessible public UGS of any size and form thus represent essential components of urban life where people can relax, exercise, socialize, and be in contact with nature, enjoying the benefits it confers (Zhou et al., 2019), and it is apparent that separation from nature can cause psychological and spiritual impairment (Carrus et al., 2017; Lewis, 1993). Unfortunately, experience of nature by urban residents is often the exception rather than the norm (Cox et al., 2017).

Numerous studies suggest a link between socioeconomic factors and access to greenspace (Baró et al., 2019; Shanahan et al., 2014). Poorer neighbourhoods generally lack in green cover (Escobedo et al., 2015; Lakes et al., 2014), public green spaces are used less by ethnic minorities

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(Hamstead et al., 2018), and sociodemographic variables such as age, gender and the number of children in a family can influence green space accessibility (Sikorska et al., 2020). This uneven distribution and accessibility of UGS is often addressed using the environmental justice framework which postulates that disadvantaged communities are more exposed to environmental burdens and risks (Boyce et al., 2016).

Contemporary urban societies are experiencing an increasing lack of social connections, particularly for some target population groups, often belonging to hidden or invisible minorities. People of older age groups, particularly those living in one-person households, as well as divorced people (Högnäs, 2020) and other singles, and outsiders (e.g. foreign temporary workers, precarious immigrants, seasonal illegal workers) often live in substantial social isolation and loneliness. In these cases, UGS are key components for social interactions in urban everyday life and the availability of green spaces often (Enssle & Kabisch, 2020) represents the ultimate opportunity for socializing. Thus, UGS are reported as very important for developing an age-friendly urban environment (O'Brien, 2014) while providing a number of health benefits for older people and space for formal and informal events, as well as representing a key open place for recreational and social activities (FAO, 2016; Kabisch et al., 2016). The outbreak of the COVID-19 pandemic in 2020, and the subsequent restrictions on movement at local or national level in many countries during lockdown, has served to exacerbate these pre-existing inequalities and limit the number of spaces available for supporting mental, physical health and wellbeing (e.g. Mell & Whitten, 2021). The outbreak has changed the trend of access and use of UGS. As stated by the United Nations Secretary General, the COVID-19 has represented a unique case and a challenge for governments and administrators. During the health emergency, many governments worldwide established general lockdown measures with non-essential productive and non-productive activities closed, promoting home-working and setting limitations of movement and social distancing for people.

In Italy the Ministry of Health banned outdoor physical exercise, restricted walking to no further than 200 m from home, and closed all public parks with fines for those who disobeyed, in a bid to prevent the spread of the virus by curtailing public gatherings. The closure of public greenspaces in many cities in Italy outlasted the initial lockdown period with some parks remaining closed for the entire spring and summer of 2020. Access to urban greenspace during a lockdown became a privilege enjoyed solely by those with access to private gardens.

An online survey in several European countries, including Italy, revealed how people missed the opportunity to spend time outdoors and meet other people while UGS became more important as a space for solace and respite from the pandemic (Ugolini et al., 2020). Lu et al. (2021) proposed five pathways in which visiting UGS during a lockdown can be beneficial to health: maintaining physical activity, avoiding home stressors related to confinement, reducing electronic device use, reducing stress by contact with UGS, and increasing social cohesion. The closure of UGS gained even more poignancy given the fact that exposure to greenspace and the facilitation of outdoor exercise can in fact help build resilience to the COVID-19 virus, and people with active, healthy lifestyles are at a lower risk of severe symptoms (Filgueira et al., 2021).

In a study made in nine countries around the world, Pouso et al. (2021) found that people with no access (or restricted access) to nature during lockdown perceived nature as an important element to cope with isolation (as also found by Robinson et al., 2021), and people with accessible green spaces had in general more positive mood and emotions. In countries where access to green spaces was not restricted, there was an increase in the usage: in Norway recreational outdoors activities increased by almost 300% (Venter et al., 2021) and in other countries, greater visitation was observed as these were likely considered the only alternative to domestic life for a large part of the population. Astell-Burt and Feng (2021) found residents of Melbourne, Australia were more likely to benefit from visits to UGS and discover previously unknown spaces than residents of Sydney, where there was not a lockdown. In the UK, people were found to change their behavior during the pandemic, visiting UGS more frequently (Robinson et al., 2021). The same pattern was observed in Asia, where geolocated Instagram posts revealed people escaping to city parks to avoid the pandemic, and park visit frequency was actually positively correlated with weekly new virus cases (Lu et al., 2021), potentially revealing that as the severity of the pandemic increased, the more people sought solace in nature.

The restrictions on social interactions during the pandemic have shifted research methodologies more towards remote methods such as surveys (e.g. Astell-Burt & Feng, 2021; Ugolini et al., 2020) and analysis of social media data. Social media networks, such as Twitter and Instagram, allow users to share information about their location, sentiments and activities and can provide insights into the motivations and trends of population behavior (Silva et al., 2013). This crowdsourced data is promising for use in urban sustainability research related to UGS (Ilieva & McPhearson, 2018). Speak et al. (2021) showed how urban trees are frequently featured in photos tagged with the city of Bolzano, and a wide range of cultural ecosystem services were represented in the images and the associated text descriptions. Roberts (2017) searched tweets using the names of parks in Birmingham, UK and found parks were used for a wide range of activities which enabled social, cultural and religious events with community involvement.

This paper aims to deeply assess how UGS was perceived in Italy during the COVID-19 pandemic through an analysis of posts on Twitter. The analysis compared two different phases of the pandemic in Italy: during the first lockdown imposed by the government in 2020 (April–May) and the same months of the following year - 2021. These periods were characterized by different restrictions and limitations on the use of UGS. As mentioned above, during the lockdown of 2020 the government imposed the prohibition of access to parks in the entire national territory; while during 2021 the government made decisions based on each regional situation, but UGSs were allowed to open. The hypothesis was that the limitations to UGS access and social distancing affected people's feelings and attitudes shared on social media. Answering this research question, we aim to reveal the importance of UGS for citizens during a pandemic. This study contributes to the knowledge in the literature about the impact of COVID-19 on the attitudes to UGS by highlighting how communication changed as a consequence of the government restrictions imposed, and particularly focusing on the iconic significance of UGSs in times of severe limitations to outdoor activities.

2. Data and methods

This study used a mixed approach, based on qualitative and quantitative analysis, to allow a deeper investigation into the communication adopted online by social media users during the COVID-19 pandemic. Based on the premise that User Generated Contents represent an important source useful to trace the interaction and the experiences among users (Silva et al., 2013), this research focused on unstructured data retrieved from Twitter. Twitter, as a microblogging and social networking service, was chosen for several reasons. First, it has been frequently used in previous research to analyse the public's behavior and reaction in relation to specific events and happenings (Roberts, 2017). Furthermore, Twitter is one of the leading social media platforms constantly increasing in popularity, with 290.5 million monthly active users worldwide and estimates predict it to keep increasing up to over 340 million users by 2024 (Statista, 2021).

Fig. 1 summarizes the methodology adopted in this research which is described in the following sections.

2.1. Data collection

To investigate the reactions of users to the closure of public greenspaces and the limitations on movement imposed by the Italian government, this research first identified six keywords (in Italian language) most used to talk about UGS. The collection of data is based on tweets

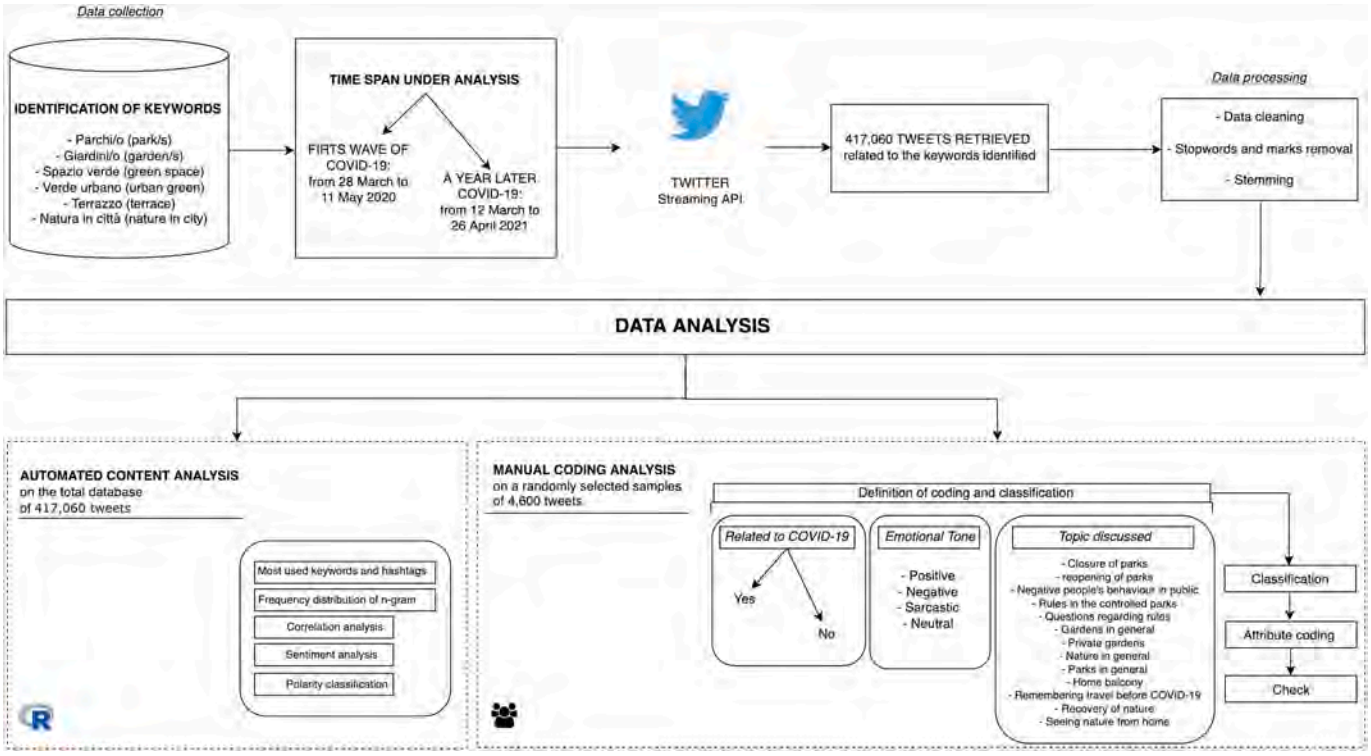

Fig. 1. Phases and methodologies adopted to carry out this research.

that contain the following six keywords: park(s), garden(s), greenspace, urban green, nature in the city and terrace (Fig. 1). The word 'terrace' was included because during the quarantine period (in Italy) a lot of people used their private terrace as 'green space' as it was their only access to the outdoors. The inclusion of these keywords allowed us to capture feelings and needs of citizens during times of crisis.

Data were collected in two different periods: i) from the 28th of March 2020 to the 11th of May 2020; ii) from the 12th of March 2021 to the 26th of April 2021. The first period was during the general national lockdown (from 11 March 2020 to 17 May 2020), when UGS access was forbidden, while the second period was characterized by regional lockdowns with different restrictions on the basis of the number of positive cases of COVID-19 at local level. In this period, despite many territories adopting restrictive measures, UGSs were mostly open and accessible (apart from the closure imposed in some parks over the Easter weekend on the 4th of April 2021).

Tweets were collected by using the filter method of Twitter's streaming Application Programming Interface (API), utilising the *rtweet* library developed for R software. The function *searchTwitter()* allowed us to download all tweets containing the keywords, along with metadata which included posting date and time, number of retweets, hashtags, mentions, occasionally geolocation and tweets written in Italian language. Data were collected following the policy and the maximum data rate per minute for APIs of Twitter.

2.2. Data analysis

More than 400,000 anonymous tweets were collected (255,032 in 2020 and 162,028 in 2021) in relation to the six keywords identified. Data were analysed using R software. Firstly data were processed with the aim of deleting punctuation marks and stop words, reducing a word to its word stem (stemming process) and preparing data for the content analysis. Descriptive statistics were applied to analyse the temporal trend of Twitter activity through the posting date and posting time variables.

Consequently, content analysis was applied to detect the main words used in tweets related to the UGS and restrictions imposed. Content analysis techniques allowed analysis of the text of tweets, such as the most used keywords, the frequency distribution of every n-gram in a string (bigram and trigram) and the correlation analysis performed on the six keywords. Given the use and importance of trend topics in communicating on Twitter (such as words, hashtags or phrases that are mentioned frequently to become popular) the content analysis was also carried out on the Twitter trend topics used during the quarantine. The trend topics considered in our analysis are: covid, covid19, coronavirus, virus, quarantena - "quarantine", isolamento - "isolation", lockdown, pandemia - "pandemic", andratuttobene - "everything will be fine", staysafe, stayhome, iorestoacasa, iostoacasa - "stay at home", allunited, coronavirusitalia, vaccino - "vaccine".

Through text and sentiment analysis, the affective and emotive appeal of contents published by citizens was evaluated. The sentiment analysis was based on the OpeNER Sentiment Lexicon developed in six languages, including Italian (Maks et al., 2014). Thanks to this analysis it was possible to determine the sentiment polarity of tweets collected, classifying them as: positive, negative or neutral. Although focusing on one language allows us to abstract away the nuances associated with sentiment analysis, it was not possible to perform the sentiment analysis using text analysis tools and dictionaries tested in other studies based on Twitter data as they are developed for the English language (Lim et al., 2019; Plunz et al., 2019). Our sentiment analysis provided fragmented results, also because Twitter has a maximum limit of characters that can be used for each tweet, thus reducing the articulation of the sentence, encouraging abbreviations and the use of emoticons. For this reason, a further analysis was performed to capture the nuances associated with sentiment analysis by users.

A manual coding analysis on 4600 tweets, randomly selected, was carried out (3000 in 2020 and 1600 in 2021). The first step of the manual analysis consisted of a definition of categories. It was iterative and involved three levels:

1. the tweet was related to COVID-19 or not. The content of the tweets and the trend topics previously identified were taken into account to determine if the tweet was related or not to COVID-19.
2. the general tone of the tweet. After a preliminary screening of a few hundred tweets it became apparent that there were four main tones: celebratory, complaining, sarcastic, and neutral. The complaining and sarcastic tweets were similar as they were both lamenting negative aspects of the pandemic, however, the sarcastic tweets did it with humour.
3. the topic discussed in the tweet (e.g. closure of parks, reopening of parks, recovery of nature, rules in controlled parks).

Three researchers undertook the classification after an initial session of classifying tweets together in order to agree on the categories. The discrepancies in coding were resolved by the researcher discussing with the coders until an agreement was reached for each specific case.

3. Results

Out of the more than 400,000 tweets extrapolated, about 90% were related to the keywords park*(56%) and garden* (34%), while we observed a lower percentage of tweets containing the words related to "greenspace" or "urban green". Furthermore, in 2021 there was a marked decrease in posts containing the word "terrace" (4.9%), compared to 2020 (8.1%).

Findings reveal a difference in posting attitudes with regard to UGS during the COVID-19 pandemic in 2020, compared to 2021. Despite the two compared periods being in the same season, we observe a −57% of UGS tweets posted during 2021 compared to 2020. In 2020, results show that about 25% of tweets contained the most used trend topics during COVID-19 in Italy, while in 2021 the number of tweets directly linked to COVID-19 dropped drastically to 3%. It is emphasized that in the period of lockdown, from 01 to 15 April 2020, it was observed that over 60% of tweets on UGS are related to COVID-19. While in 2021 there was a drastic decrease in tweets closely linked to the COVID-19 (see Supplemental Appendix A1). Regarding the day of posting and the time of the day (see Supplemental Appendix A2), we observed an increasing trend from Tuesday to Thursday and to a greater extent in the afternoon and in the evening. However, in 2021 there was a decrease in posting on weekend days (−22.1% on Saturday and −38.1% on Sunday). Again in 2021, there was a greater posting activity at night (+300%) compared to 2020.

The content analysis carried out revealed a different communication mood between the periods under analysis and allowed us to identify four main topics to talk about UGS during the pandemic period (Fig. 2). The correlation analysis (on the six keywords - see Supplemental Appendix A3 - and the trend topics - see Supplemental Appendix A4), and the bigram and trigram analysis (see Supplemental Appendix A5) helped us to clearly read the perception of UGS during COVID-19. Results showed direct references to the restrictions and closures imposed in 2020. This type of communication is particularly marked in the first week of April 2020. Users emphasized this deprivation of access to parks, through the following words: "prevented", "allowed", "granted", "closed parks", "not allowed to go to the park" or "forbidden go to the park". It's interesting to note that the main subject deprived of green spaces were children, both in 2020 and in 2021. Families underlined the importance of UGS for children by denouncing restricted access to parks for children, forcing them to stay indoors for whole days. There is no lack of direct references to the world of politics. In particular, we can find names of Italian politicians, such as "Conte" who was the President of the Council of Ministers or "Raggi "the mayor of Rome during the pandemic. In 2021, we noted greater communicative emphasis on peoples' behaviors and emphasizing the incompliance with rules, for example there were a lot of tweets that denounce the improper use of masks or crowding in UGS.

Fig. 3 presents results of the sentiment analysis, which includes the occurrences of positive, negative and neutral words in twitter communication across 2020 and 2021. Results relative to the total tweets show the greatest majority of neutral sentiments in both periods but also a higher percentage of positive with respect to negative sentiments. Moreover, they show a greater percentage increase in positive (+9.9%) and negative (+15.4%) sentiments in 2021 compared to 2020. The analysis performed on the twitter trend topics shows a general reduction of −61.9% of tweets with references to COVID-19 in 2021, compared to 2020. Furthermore, we can observe a more pronounced frequency variation related to positive and negative sentiment in 2021.

Despite this, findings reveal a higher percentage of words not identified by the analysis. This could be related to the fact that the lexicon adopted was not developed specifically for Twitter contents. The further exploration of sentiment through the manual coding analysis showed a marked difference in the nature of tweets tagged with the keywords between 2020 and 2021 with 61% of tweets in 2020 being about COVID-19, dropping to 25% in 2021 (Table 1).

We can observe a different use of tone in tweets by users in the two different periods under analysis. The largest percentage of tweets was classified with the tone of complaint, both in 2020 (36%) and in 2021 (62.6%). The main topics in which users expressed more disappointment were related to the closure of parks (e.g. "Locking ourselves in the house is an absolute criminal misunderstanding after a year"; "Six-year-old girl instead of playing in the park forced to do physical activity in front of a screen"; "They closed parks and cemeteries thinking that fresh air is contagious!"), the negative people's behavior in public (e.g. "parks and gardens in Milan overflow with people"; "Crowd on the Navigli in Milan and disregarded prohibitions in parks"; "Young people without masks gathered in the park") and the rules in the controlled parks (e.g. "Even in parks it is mandatory for everyone to maintain social distance"). In addition, comparing the two years, in 2020 more people used a complaining tone in relation to private gardens - to highlight the difficulty of living in an apartment without external spaces (e.g. "I repeat, those who have a house with a garden are not in #quarantine you have no idea what it's like to stay in the apartment"), the reopening of parks, public parks in general and regarding the absence of maintenance and recovery of nature during lockdown period (e.g. "Five weeks of lockdown. Roads, bridges, tunnels could be maintained, thousands of holes could be

	Topic	Terms
2020	*Politics*	Raggi, Conte, Zingaretti, Meloni, annuities
	Children restrictions	Closed playground, children at home, no children, children cannot go, prevented from playing
	Lack of maintenance	Holes, no maintenance, italy spends euros, dirty, abandoned
	Inaccessibility	Forbidden go, not allowed, closed parks, deprivation, granted
2021	*Politics*	Conte, Raggi, Lamorgese, government, politicians
	Children restrictions	No children, prevented from playing, forbidden play, play togheter, closed playground
	Lack of maintenance	Holes, no maintenance, redevelopment, abandoned, dirty
	Incompliance with the rules	Full of people, without mask, lowered mask, gatherings, spacing

Fig. 2. Four main topics identified to talk about UGS during 2020 and 2021 and related five main terms.

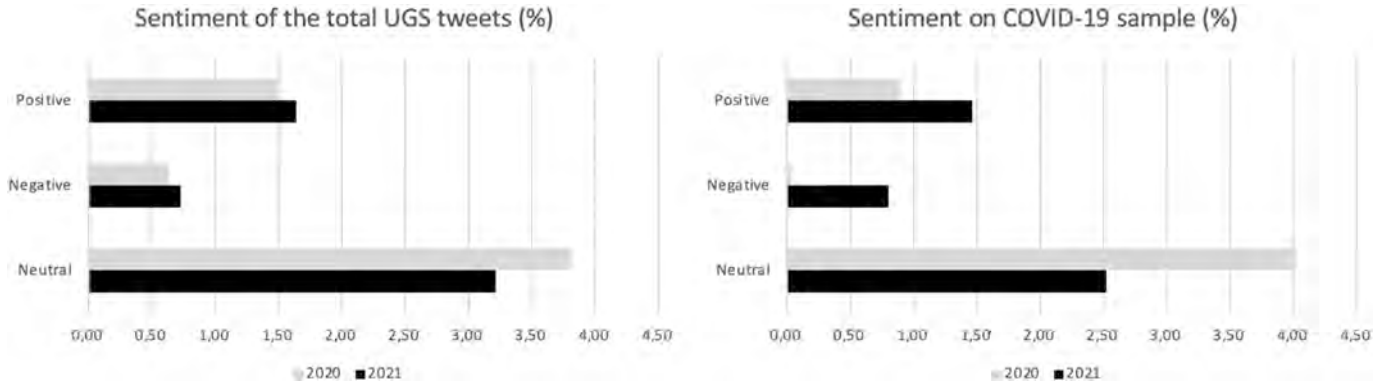

Fig. 3. Sentiment analysis of UGS tweets and of the trending topics and main hashtags identified.

Table 1
Frequency (%) of tweets (N = 3000 in 2020 and N = 1600 in 2021) in each of the four tone categories by topic matter in both study periods.

	Celebratory		Complaining		Sarcastic		Neutral	
	2020	2021	2020	2021	2020	2021	2020	2021
% of all COVID tweets	20.3	7	36	62.6	15.3	12.8	28.4	17.5
Topics								
Closure of parks	0.3	–	31.9	46.7	8.4	28.0	7.9	16.2
Reopening of parks	27.1	30.0	3.4	–	28.5	4.0	19.3	6.8
Negative people's behavior in public	–	3.3	36.7	36.9	15.0	26.0	3.6	12.2
Rules in the controlled parks	0.3	–	13.2	13.2	11.7	–	5.7	6.8
Questions regarding rules	–	–	0.5	–	0.7	–	6.3	–
Gardens in general	1.4	–	0.6	–	3.3	–	9.3	4.1
Private gardens	28.4	20.0	5.3	0.8	13.5	20.0	17.2	10.8
Nature in general	10.5	13.3	0.5	–	0.4	–	1.0	–
Parks in general	5.2	33.3	4.0	2.3	6.2	14.0	17.0	41.9
Home balcony	21.0	–	1.2	–	12.0	8.0	11.2	1.4
Remembering travel before COVID	0.6	–	0.2	–	–	–	0.4	–
Recovery of nature	3.8	–	2.2	–	0.4	–	0.6	–
Seeing nature from home	1.4	–	0.3	–	–	–	0.6	–

plugged. Maintenance and care of urban greenery, parks, gardens").

Results underline the second higher percentage of tweets coded as celebratory, especially in 2020 (20.3%), compared to those of 2021 (7%), with some differences also regarding the topics. In 2020, users celebrated private domestic outdoor spaces, such as gardens (28.4%) and balconies (21%) and the reopening of the parks (27.1%). This topic was also celebrated in 2021 (30%), as well as parks in general (33.3%), private gardens (20%) and nature (13.3%). It's interesting to note that, in 2021 there are no references to the celebration of private terraces, recovery of nature and about seeing nature from home. The positive, celebratory tweets in 2020 were mostly describing the gratitude at having a private garden or terrace to enjoy during the strict lockdown or celebrating the reopening of parks (with restrictions) towards the end of the lockdown, with some tweets discussing the positive benefits of nature in general. Examples are "I look for my new office at home, I'm happy because it overlooks the garden and I have light and green", "My terrace is in bloom, the colours cheer me up" and "My son's joy of running free in the park after almost three months is priceless". Some tweets specifically reference UGS as a relief from the stresses of the pandemic such as "If I don't work, at least I enjoy this #greatbeauty, I am in the park of #posillipo #Napoli, one of the #greenlungs of the city". Others celebrated the recovery of nature due to the absence of the usual destructive activities of humans: "Hares roaming the parks. Wild boars roaming the streets. Dolphins run around the coasts. Pollution decreases visibly. When this pandemic end, let us remember that we are guests on this planet, not owners".

Users have also used sarcastic tones in their tweets to communicate their sentiment on UGSs. During the 2020 lockdown, users joked mainly about issues related to the reopening of parks (28.5%) and to a lesser extent to the negative people's public behavior (15%), private gardens (13.5%) and balconies (12%). While in 2021, the sarcasm focused mainly on the closure of parks (28%), on the negative behavior of people in public (26%) and then on private gardens (20%) and parks in general (14%). For instance, in 2020 the sarcastic tones expressed in relation to parks' closure often referred to the political context, such as "According to Virginia Raggi (Mayor of Rome), opening parks is "a concession made by the Prime Minister but we must deserve it". The excessive police patrolling in parks, once they were opened, was often lamented (as an example: "Old man surrounded by helicopters while walking in the park"), especially if compared to normal times, as indicated by this highly retweeted statement: "Dear government, dear fucking mayors. Where were the armed teams, the drones, the helicopters, when we asked you to clear our parks, our courtyards, of the drug dealers that you have imported into Italy?". Finally, 53 tweets expressed jealousy towards people with a private garden or terrace, for example "Lucky you who have a garden where you can go out. I would pay gold for it, since I live in a condominium".

In 2021 sarcastic tweets were mostly about gatherings of people in parks without masks. In other cases, some tweets discussed the widespread position of right-wing supporters against illegal migrants and identifying the closure of parks as an iconic example of the governmental policy of slowing down the freedom of people. Access to parks becomes, even in the sarcastic tweets, a symbol of freedom. This is supported by many tweets highlighting the closure of parks and the opening of ports, as the following tweet example: "The desperation of a 4-year-old girl after finding her favourite playground closed by the

politicians of Draghi's government meanwhile, a few meters away", *Anonymous* continues selling drugs undisturbed. Ports open, parks closed". Furthermore, the excessive police presence was still hotly discussed e.g. "Embarrassed policemen ask people sitting on benches and wearing mask to get up because "if you want to stay in the park you have to walk". After a year we are still on the edge of the surreal".

4. Discussion

Social networks allow users to immediately communicate content and express opinions to a more or less wide and known public. However, studies argue that users' attitudes and opinions may be consistently altered when an opinion gains voice and forces others into silence (Banisch et al., 2020), recalling the *theory of the spiral of silence* (Noelle-Neumann, 1974), while also social-structural conditions can influence the public opinion predominance (Gaisbauer et al., 2020). Therefore, our results, elaborated from an analysis of Twitter's posts related to UGS during the pandemic, may represent only a partial view, not necessarily representing the opinion of the general public. It is widely confirmed that the lockdown measures set by governments to control the spread of the Coronavirus, greatly affected people's behavior and usage of public green spaces in both positive and negative ways, depending on the extent to which the measures allowed people to move (Theodorou et al., 2021; Ugolini et al., 2020; Venter et al., 2021).

The results of this study in a way reflect the slightly different situations in the two years. The greater number of tweets posted during the first lockdown in 2020 were likely in response to the strong deprivation feeling and the need for being virtually connected to others and sharing opinions and dissent mostly in relation to policy-makers' decisions. In the period considered (April–May 2020), when people were facing over a month of strict lockdown, most tweets were made during the weekends (Saturday and Sunday) and on holidays, probably when the deprivation feeling was more intense due to the impossibility to move from home except for essential reasons. In 2021, the tweets were less numerous as compared to 2020 likely because of a situation characterized by the reopening of businesses and fewer restrictions at national level. Specifically, we noticed the higher number of tweets at night than in 2020, that could be linked to the fact that from March to May 2021 curfew was active from 9 p.m. Hence, it seems that the governmental restrictions to control the spread of the pandemic have caused a behavioral change in the use of social media to post about green spaces, with forced deprivation and home-staying as triggering factors to share opinions and thoughts. This behavior is also confirmed by Valdez et al. (2020) who evidenced a significant increase of posts during the stay-at-home mandates in the US.

Regarding the posts' content in relation to UGS, in 2020, people used Twitter to express their dissent and complain about the "closure of parks, closure of playground and movement restrictions", particularly underlining the discomfort caused to children. This might be connected to the fact that most tweets were made by urban dwellers as the georeferenced tweets were nearby the main Italian metropolitan areas. We can suppose that users from urban areas were more affected by the lockdowns and more willing to share thoughts on social media than their rural counterparts. Urban fabric may represent a stressor for urban dwellers in times of lockdowns and stimulates the use of social media. However, Wang, Di, et al. (2021) found that in China the way people used social media during the lockdown depended on many variables connected to the personal sphere and life conditions, with people with higher levels of life satisfaction more inclined to give positive information and less inclined to be involved in discussions about COVID-19 as compared to people with lower life satisfaction and sense of adequacy. Moreover, people's attitudes, once communicated, may contaminate those of others through certain social media activities (Li et al., 2020). In addition, findings reveal that several people seemed concerned about their children's health, expressing awareness about the benefits of being in contact with nature and complaining about the forbidden access to nature. As highlighted in previous research, confinement at home reduces physical activity and, in some cases, increases the risk of depression (Pfefferbaum & North, 2020) with the worst effects on vulnerable groups such as children, elderly population (Daoust, 2020), and disadvantaged communities (Shoari et al., 2020) or on people living in compact neighbourhoods and in apartments as found by Mitra et al. (2020). These authors found that people living in a house with a private garden increased outdoor activity with respect to those living in an apartment, and that people living in highly dense neighbourhoods increased outdoor activities during the pandemic as compared to those living in low dwelling density. Following the reopening of UGS after the first lockdown in 2020, in Italy there was a surprising increase of the number of UGS visitors (Geng et al., 2021). This phenomenon also occurred globally, such as in the United States (Pregitzer et al., 2020), Asia (Lu et al., 2021) and Australia (Astell-Burt & Feng, 2021).

During the pandemic people sought solace in nature while "staying-at-home" domestic outdoor spaces, such as private gardens and balconies and terraces were useful alternatives to UGS for contact with nature. Megahed and Ghoneim (2020) highlighted the multiple benefits of taking care of gardens and terraces either towards environmental sustainability or facilitating psychological well-being as it can alleviate most self-isolation problems. Similar results are also provided by Theodorou et al. (2021): gardening has been identified as a convincing tool buffering the mental health consequences of forced home confinement, and social isolation. Also our findings highlight how balconies and terraces became places of identity during the lockdown, being elected by many people as their own 'green space'. Spano et al. (2021) found out that the presence of plants at home was associated with a lower increase in anxiety, anger, fear, irritability, and sleep disturbance and a greater amount of green view and access to private green spaces can ensure psychological health. Greater green view from the window also decreases the negative perception of "missing" UGS access (Ugolini et al., 2021).

The limitations imposed by the government, with the mandatory closure of the parks, resulted in greater emotionality in users. "The topic of 'recovery of nature', classified as celebratory (3,8%) and complaint (3,3%) tones, could reveal the perception of urban nature as a driver of stress relief. This result can be referred to the emerging research on the psychological stressors induced during covid lockdown. The prolonged home confinement during the disease outbreak has been interpreted as potentially affecting people's physical and mental health (Invitto et al., 2021; Wang et al., 2020). The state of stress has been related to the reduced level of physical activity and exposure to daylight, as well as to social isolation and to the state of interdiction of satisfying outdoor activities. On the latter, green spaces were instrumental in accompanying stress relief both outdoors and indoors (Maury-Mora et al., 2022; Spano et al., 2021)".

The communicative mood in the two periods under analysis underlines the different willingness of users to 'publicly denounce' two aspects: in 2020 complaints and sarcasm were mostly concerning the imposed restrictions and the decision of the closure of parks adopted by the government, while in 2021, complaints were mostly related to the misconduct of people in parks (for example the wrong use -or non-use- of the mask). Despite the high percentage of neutral posts, positive posts were more frequent than negative posts in both periods, although a more detailed content analysis with manual coding found out that complaining tweets were more frequent than celebratory ones. This predominant sentiment very often was associated with political references, underlining the disappointment with the restrictions and statements issued by policy-makers. In contrast, celebratory tweets were related to private spaces and to the announcements of the reopening of public parks and gardens.

Moreover, the results showed a greater expression of the sentiment in 2021 with a higher percentage of positive and negative sentiment with respect to the former lockdown in 2020. In 2021, lockdown was less restrictive with most business activities open with the exception of

restaurants, sport and entertainment facilities, although people again were under limitation of movement depending on the local pressure of positive cases on hospitals and social distancing and mandatory isolation. In 2021, there was greater general awareness about the COVID-19 transmission and disagreement towards political decisions regarding the limitations imposed, especially regarding the maximum distance reachable from home preventing many users from visiting green spaces. Such a situation likely created an emerging and pervasive frustration well represented by expressions of physical and mental discomfort, and by a recurrent negative sentiment in lexical choices. It appears a harder condition as compared to the lockdown during the 2020 first wave of COVID-19 when trust and hope were the main triggers for respecting the behavioral rules. It is acknowledged that the risks of SARS-CoV-2 infection spreading is limited during outdoor activities (Morawska & Milton, 2020; Slater et al., 2020), with one in every thousand cases of COVID-19 attributable to outdoor transmission (Weed & Foad, 2020).

Furthermore, in addition to expressing opposition to the closure of UGSs, users often resorted to Twitter as a tool to obtain information on what could and could not be done and such information was classified as neutral. Wang, Hao, and Platt (2021) investigated crisis risk communication on Twitter during the early stages of COVID-19 and highlighted how the communication regarding the pandemic and its risks can be insufficient, incongruent and inconsistent in such media. This underlines a fragmented communication by institutions on closure of UGS with important implications for effective health safety and social interaction instruction.

5. Limitations and future research

This research suffers from some limitations which however can be considered for possible development of the study. Firstly, the automated sentiment analysis was not sufficiently explanatory. It was necessary to implement a manual coding analysis to capture the nuances associated with sentiment and feelings of users. In future studies, it could be important to automate this process to make our approach easily generalizable and usable also to examine other research questions. Secondly, the analysis is based on Twitter posts but future studies could investigate different social networks (such as Facebook or Instagram). Comparing results of communication on different social networks could support administrators in implementing different communication strategies. Thirdly, our analysis is focused on contents published in Italy, but future studies should be dedicated to exploring the COVID-19 communication about UGS also in other European countries. This would allow us to analyse users' perception in relation to government restrictions at EU level, supporting administrators to adopt measures which support the wellbeing of citizens during risk situations, such as a pandemic. Future research might usefully repeat the analysis with the expansion of periods analysed including other subperiods such as “after national vaccination” to investigate the changes of sentiment towards urban green space accordingly. Finally, it could be interesting to focus the attention on geo-localized tweets. Results of a preliminary analysis show that tweets were published by users in cities with higher population density. For this reason, future study could be oriented to understand the sentiment in relation to the cities and specific UGS.

6. Conclusion

The European Environment Agency declared (2021) that cities are facing a triple crisis in the wake of the pandemic, related to the health impacts of COVID-19; social and economic inequality and climate and ecological emergency. In addressing these epochal challenges, cities can represent the driving forces for a conscious and sustainable recovery where UGS are key components that favor people's cohesion and well-being. This research has applied big data obtained from a social network to explore citizens' perception and sentiment in relation to the closure of UGS in Italy. Firstly, findings of the study highlighted the important role of UGS for citizens, for this reason protecting and enhancing UGS and urban forests should be a higher priority not only as a reaction to lockdown critical issues but also in building urban resilience to future communicable and non-communicable diseases. The COVID-19 recovery plan launched by the European Commission has unprecedentedly included €1.8 trillion with the aim of reshaping cities and helping to build a greener, more digital and more resilient Europe (European Commission, 2020). The investments that will be adopted require planning and design integrated optimization responding to the three main challenges highlighted by the EU, oriented to create opportunities for a green future that aims at: rethinking urban mobility and land use; retrofitting the urban building stock; enhancing the role of green infrastructure and nature-based solutions; and transforming urban food systems and the circular economy (European Environmental E.E.A., 2021). Findings show the themes promoted by the EU represent the necessary conditions for the quality of life of citizens. The results of our study also suggest to institutions the importance of designing urban green spaces that take into account the needs of young people and children.

European policy-makers are calling to consider the potential of UGS when allocating financial resources involving cities in the decision-making process. Therefore, considering that “by 2050 the population of the world is projected to be 68 % urban, with urban dwellers numbering 6.7 billion” (United Nations, 2019), financial commitments to UGS should be considered as long-term investment. As emerged on Twitter, Investing in urban green areas not only improves the quality of life and public health, but can also influence the appreciation of one's neighborhood, fostering processes of involvement in governance and a sense of belonging to places. An interesting study conducted by the University of Exeter and Vivid Economics (2017) highlighted and calculated the economic value of green spaces to help decision makers to make informed decisions about how they spend their budgets. Findings of their research underline the importance of taking care of the amount and quality of UGS. It has been estimated that for each £1 spent by local authorities and their partners on public parks, Londoners enjoy at least £27 in value.

During the COVID-19 pandemic, people have turned to UGS like never before. Research shows that UGS are able to provide a series of services to citizens and close-to-home parks are fundamental for the community, in particular during a health emergency. People in Italy have been greatly affected by the closure of parks during 2020 springtime. National and local administrators are advised to take into consideration the possible social repercussions following their restrictions and limitations imposed. During periods of greatest crisis, administrators could foresee specific measures for access to parks, without having to impose their closure. For example, administrators could define times for different age groups or entry allocation systems which monitor the total number of people using the UGS. At the same time, findings underline the importance of planning and promoting a clear and congruent communication strategy, which helps to support citizens in understanding the rules to follow and the limitations imposed. Findings of this study are useful, for practitioners, to understand the different behaviors of people in using social networks to communicate their sentiments on urban green spaces and how restrictions imposed by the government were perceived.

CRediT authorship contribution statement

Valentina Marchi: Conceptualisation, methodology, data curation, investigation, analysis, writing, visualisation

Andrew Speak: Methodology, data curation, investigation, analysis, writing

Francesca Ugolini: Conceptualisation, methodology, investigation, writing

Giovanni Sanesi: Conceptualisation, writing

Giuseppe Carrus: Conceptualisation, writing

Fabio Salbitano: Conceptualisation, writing

Declaration of competing interest

We have no conflicts of interest to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2022.103707.

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