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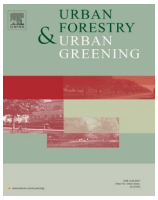

Sina microblog sentiment in Beijing city parks as measure of demand for urban green space during the COVID-19

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ABSTRACT

Urban green space is an important element of well-being. It is still, however, lacking of research on green space demand analyzing based on social platform data. This research uses social platform data to evaluate people's demand for urban green space under the background of the global COVID-19 pneumonia. Using the micro-blog database of geographical markers and keywords, this research quantified the sentiment expressed inside and outside the parks by means of manual interpretation of characters, pictures and expressions. It addresses the following problems: dose COVID-19 pneumonia reduced people's demand for green space? Our results showed that despite the restriction of epidemic situation, people still have a great demand for external green space. Older people have less negative sentiment, while younger people (under 18 years) have more negative sentiment. There were significant differences in emotional scores between inside and outside the park. During the period of pneumonia in COVID-19, tourists in Beijing Park generated more positive microblogs inside the park. Landscape and plants are the main elements of people's expression of positive emotions. The emotional scores inside and outside the park are negatively correlated with the new confirmed cases, existing confirmed cases and new deaths.

1. Introduction

Urban green space, as the main body of urban natural ecosystem, is the basic guarantee for urban residents to enjoy the service functions of natural ecosystem such as green space and water area (Burkman & Gardiner, 2014; Taylor & Hochuli, 2016; Chen et al. 2017). It has become a key consideration to measure a city's civilization degree, quality of live and sustainable development ability (Hillsdon et al. 2006; Tian et al. 2014; Bertram & Rehdanz, 2015). Urban green space contains two levels of content, one is the land used for greening within the scope of urban construction land, and the other is the area outside the urban construction land. It plays a positive role in urban ecology, landscape and residents' leisure life (Jim & Chen, 2006; Benedict & McMahon, 2012). In this study, as an important part of "urban green space", urban parks usually meet the standards of urban green space (Hillsdon et al. 2006).

A large number of studies have focused on the benefits of green space to mental health, including but not limited to well-being, stress level and community feeling. For example, the study on the benefits people feel when visiting green space during heat stress shows that visiting green space for a longer time and more frequently can significantly improve the perceived benefits and well-being of users (Lafortezza et al. 2009). In addition, some studies show that when people visit the park, they can effectively reduce fatigue and redirect people's attention to the external environment, thus helping to reduce stress level for park visitors (Stigsdotter et al., 2010; Thompson et al., 2012). Similarly, other scholars believe that sports activities in urban green spaces, especially compared to other urban areas, can enhance participants' self-esteem (Pretty et al., 2005). However, the complicated and changeable social environment usually produces physical and psychological pressure. Urban green space is an important part of the urban form which can alleviate these pressures (Rugel et al., 2019).

In 2020, a sudden COVID-19 spread all over the world. COVID-19 pneumonia is a global epidemic which has the greatest impact on human beings in the last century, and it is a serious crisis and severe test for the whole world. The safety and health of human beings are facing a great threat. Because of the sudden outbreak of pneumonia in COVID-19, people have a process of gradually understanding and improving their coping ability. People's Daily pointed out that in the beginning of the outbreak in Wuhan, China, the local government responded slowly

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to the development of the epidemic. For example, the information disclosure of the Wuhan epidemic was not timely and accurate, the travel of infected patients, the source of the epidemic was not blocked in time (Debora, 2020). In this context, China has gone through several important processes in its fight against the epidemic: (1) responding to sudden outbreak rapidly; (2) preliminary containment of the spread of epidemic; (3) the number of new cases in China decreased to single digits; (4) Wuhan has made decisive achievements in epidemic defense ; (5) China's epidemic prevention and control work has become the norm. From January 20, 2020 to July 1, 2020, there were 923 confirmed cases in Beijing, 9 died and 589 were cured. Beijing, as the capital of China, has taken decisive, precise and strict preventive measures since the outbreak of the epidemic, successfully demonstrated how to effectively control the spread of the epidemic in the shortest time. This provides valuable experience for China and even the whole world to cope with sudden epidemic under the new stage of normalized epidemic prevention and control, realize the comprehensive implementation of epidemic prevention and control, and resume working and production. During the period of epidemic prevention and control, Beijing adjusted the park opening policy appropriately according to the development of the epidemic situation. Eleven parks and the Chinese Garden Museum in Beijing temporarily closed indoor exhibition halls in the scenic spots, and recreational facilities in the parks were also suspended. The purchase of ticket for park tours is divided into intervals. Beijing Park Management Center requires visitors to wear masks, cooperate with body temperature examination, show the green code of Beijing Health Treasure, and keep a social distance of more than 1 m when entering the park.

In the process of epidemic prevention, people's daily life and work have been affected to a certain extent, which further indirectly affects people's physical state and psychological mood, especially those who were isolated due to the pneumonia epidemic in COVID-19. (Gaëlle et al., 2020; Qian & Yahara, 2020; Filgueiras & Stults-Kolehmainen, 2020; Choi & Bum 2020). In view of the research history of urban green space, we are interested in understanding the emotional changes of parks and non-green spaces residents during pneumonia in COVID-19. With the popularity of social platforms such as Facebook, Twitter and Sina microblog, their open, real-time and accessible data provide a new investigation method for scientific research. To this end, more and more studies analyze urban green spaces based on Twitter data (Bertrand et al. 2013; Roberts, 2017; Plunz et al. 2019), which indicates that geolocation Twitter data can be used as an alternative information source for urban planners to describe the characteristics of business, leisure and residential areas in cities where Twitter is popular. For example, based on Twitter data as an indicator of public opinion expression, this paper proposes that Twitter popularity can be used as an indicator to measure the happiness of urban residents (Plunz et al. 2019).

As the most influential Chinese social media in China and even in the world, Sina microblog has set up an efficient platform for public interaction, communication and collaboration. According to the data, the number of microblog users in China in 2018 was 337 million, accounting for 42.3% of the total number of netizens (data source: China Business Intelligence Network, https://www.askci.com/). The real-time nature of Sina microblog reveals people's response to the surrounding environment and their movement patterns. At present, however, there are no reports on the analysis of urban green space demand or urban residents' emotion based on microblog data. In this paper, we introduce a study, which mainly focuses on micro-blog users who have published microblogs inside and outside the park since the outbreak of the local epidemic in Beijing. We try to quantify and compare their positive degree of expressing emotions on micro-blogs inside and outside the park. In addition, we aim to reflect people's demand for green space during the epidemic period through the emotional scores of Sina microblog.

The main general problems emphasized in this study are as follows: will people feel the benefits and improve their happiness by visiting green spaces during the COVID-19? By answering this question, urban foresters, ecologists and landscape planners will get more information about how to meet the urban residents' demand for urban green space through the planning, design and management of green space.

2. Methodology

2.1. Data collection

The time range of case data collection is from January 20th, 2020 (the first case of COVID-19 pneumonia in Beijing) to July 1 st, 2020. Fig. 1 shows new confirmed cases, new cured cases, new deaths and existing confirmed cases of pneumonia in COVID-19 in Beijing (data from Beijing Center for Disease Control and Prevention: https://www.bjcdc.org/). As can be seen from the Fig. 1, the curve of new confirmed cases in Beijing from January 20 to July 1, 2020 has three major peaks in, which are February 2, March 23 and June 13.

The parks include Olympic Forest Park, Xishan National Forest Park and Zizhuyuan Park. Unlike previous studies (Plunz et al. 2019), we conducted two screenings during data collection (automatic screening by software platform and manual screening). The first screening is based on Sina microblog platform. According to comprehensive filtering options in Sina microblog, including characters, geographical location, keywords, tags and other indicators, then then filter out the trends of all relevant places. After the automatic screening of Sina microblog platform was completed, we made a second screening. In this step, we mainly eliminate the following blog posts: 1) official announcements, announcements, news, etc., 2) unpublished posts on the same day, 3) forwarded, non-original and repeated posts, 4) posts posted by foreign tourists for a short-time visit. Here, distinguish foreign tourists based on several important information: the nationality information displayed by the users of Sina microblog, ② the text content, ③ the photos posted in the past.

2.2. Quantification of sentiment score

In the process of data collection, we collected the municipal district where the microblog publisher is located, the age composition, the projects carried out in the park, publishing date, works and the pictures, etc. When recording the information of posts publishers, we refer to the content of users' profiles, and correct them according to their past posts. In this way, the error of age and location information can be avoided.

We score based on micro-blogging text content and pictures. When a poster expresses his positive emotions on a topic, the micro-blogging is marked as positive. When expressed emotions are negative, they are

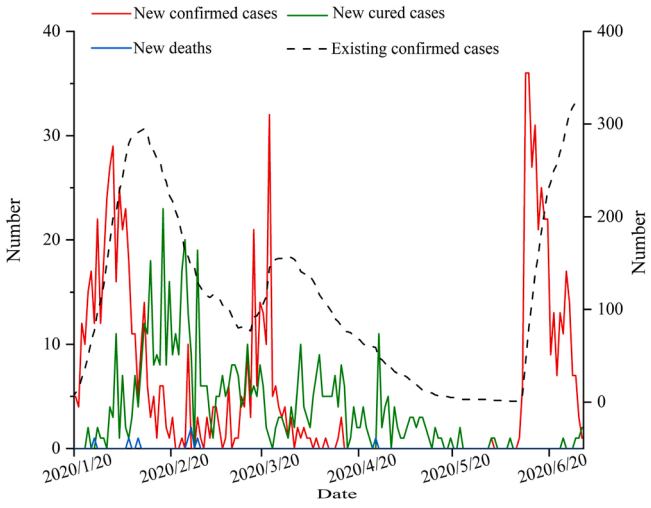

Fig. 1. New confirmed cases, new cured cases, new deaths and existing confirmed cases during COVID-19 in Beijing city.

marked as negative. When the emotions expressed are neither positive nor negative, they are marked as neutral. Chinese is the language environment of this thesis. Unlike previous studies (Plunz et al. 2019), we make comprehensive scores according to the text context, expression packs and facial expressions on Sina microblog, so as to avoid confusing real emotions and literal meanings. For example, as shown in the third micro-blogging text in Table 1, although the emotional judgment is initially neutral (0), it can be judged as positive (1) according to the facial expressions of the figures in the illustrations, so the final score is 1. Similarly, in the fifth micro-blogging text in Table 1, we judge the emotion as neutral (0), and the characters in the illustrations are expressionless, so the final judgment is 0. Table 1 shows some dynamic examples, marked as positive (1), neutral (0) and negative (-1).

2.3. Data analysis

All data were sorted in Excel 2020. Origin 2019b was used for analysis and mapping. Pearson correlation coefficient was used to analyze the relationship between Covid-19 infected cases and citizens' sentiment. Significance was determined as $P < 0.05$ (Table 2).

Table 1
Micro-blogging sample and sentiment labeling.

	Micro-blogging text	Pictures	Facial expression	Sentiment label
1	There are beautiful flowers all over. Come to Beijing and have fun with your friends. # Beijing Olympic Forest Park #	Plant	-	1
2	To tell the truth, the peach blossom in front of my house is better than that in the park, and I swear never go to this park again.	Plant	-	−1
3	Share spring.	Selfie	Smile	1
4	In May, the Olympic Park was in full bloom all over. Flowers reflect the blue sky and white clouds. People are running and around here and having fun.	Plant	-	1
5	Olympic Forest Park.	Landscape and selfie	No expression	0
6	Orson is not crowded today. The temperature is suitable and the scenery is beautiful. It is the best time for the whole family to go out. I hope that the epidemic as soon as possible, and I hope that the country's peace and security will prevail.	Plant and landscape	-	1
7	Olympic Forest Park, you can start spring this season. Although there are queues during the epidemic, there is no need to purchase tickets in advance.	Selfie	Smile	1
8	I wanted to spend a full afternoon in the park, but it was too hot.	Landscape	-	−1
9	I haven't traveled for six months. Fortunately, there is a park to visit.	Plant and landscape	-	1
10	Xishan National Forest Park is beautiful and full of mountains. Peach blossoms will look better next week	Plant and landscape	-	1

Table 2
Pearson correlation coefficient between emotional scores of microblogs inside and outside the park and the number of infected cases. * indicates that the correlation reaches significant difference at the level of $p < 0.05$.

	New confirmed cases	Existing confirmed cases	New deaths
Inside-park	−0.071	−0.169*	−0.044
Outside-park	−0.597*	−0.208*	−0.088

3. Results

3.1. Analysis of Sina micro-blogging content of citizens in the park during the epidemic

Fig. 2 shows the statistical data of microblog information in three parks in Beijing from January 20, 2020 to July 1, 2020. During the epidemic period, there were 348 microblogs in the park. Among them, male accounted for 45.69% of the total number of micro-blog publishers, while female accounted for 54.31%. The age composition was 18-29 years old (40.07%), 30-39 years old (28.01%), 40-49 years old (16.31%), 50-59 years old (10.64%), under 18 years old (2.48%) and over 60 years old (2.48%). The main purpose of citizens in the park was sightseeing, strolling, taking pictures, exercise and running. The number of sightseeing was the highest, reaching 88.83%. Landscape (51.91%), selfie (27.13%), plant (22.7%), and vlog (9.14%) were the main content of microblog with pictures, and a few of them were characters without pictures (1.77%).

Fig. 3 shows the location information of the municipal districts where the tourists from three parks live during the epidemic period. The places where tourist live belong to the same municipal district as the three parks, with the proportions of 39.1% (Olympic Forest Park), 55.56% (Xishan National Forest Park) and 42.7% (Zizhuyuan Park) respectively. When choosing parks, tourists basically follow the principle of "proximity", and more residents tend to choose parks in their jurisdiction. However, there were more people visiting across municipal districts, which indicates that the epidemic situation has little impact on people's demand for urban green space.

3.2. Analysis based on sentiment scores of Sina microblog users during the epidemic

3.2.1. The impact of the epidemic on the emotional scores of different age groups

It can be seen from Fig. 4 that there were certain differences in emotional scores at different ages. The average emotional scores of different age groups from big to small are over 60 years old (0.636), 18-29 years old (0.601), 30-39 years old (0.6), 40-49 years old (0.597), 50-59 years old (0.57), and under 18 years old (0.553). We found that people over 60 years old showed more positive emotions, followed by those aged 18-29, and the age group with the lowest emotional score was under 18. This may indicate that under the influence of epidemic control, the in negative emotions fluctuation of the elderly is relatively small. The younger minors (under 18 years old) showed more negative emotions.

3.2.2. Comparative analysis of emotional evaluation scores of microblogs inside and outside the park

As shown in Fig. 5, the emotional score curve in the park was generally larger than that outside the park. The significance analysis of the scores of emotions inside and outside the park shows that there was a significant difference between the scores of emotions inside the park (M = 0.439, standard deviation = 0.455) and those outside the park (M = 0.085, standard deviation = 0.371) (p-value<0.01).

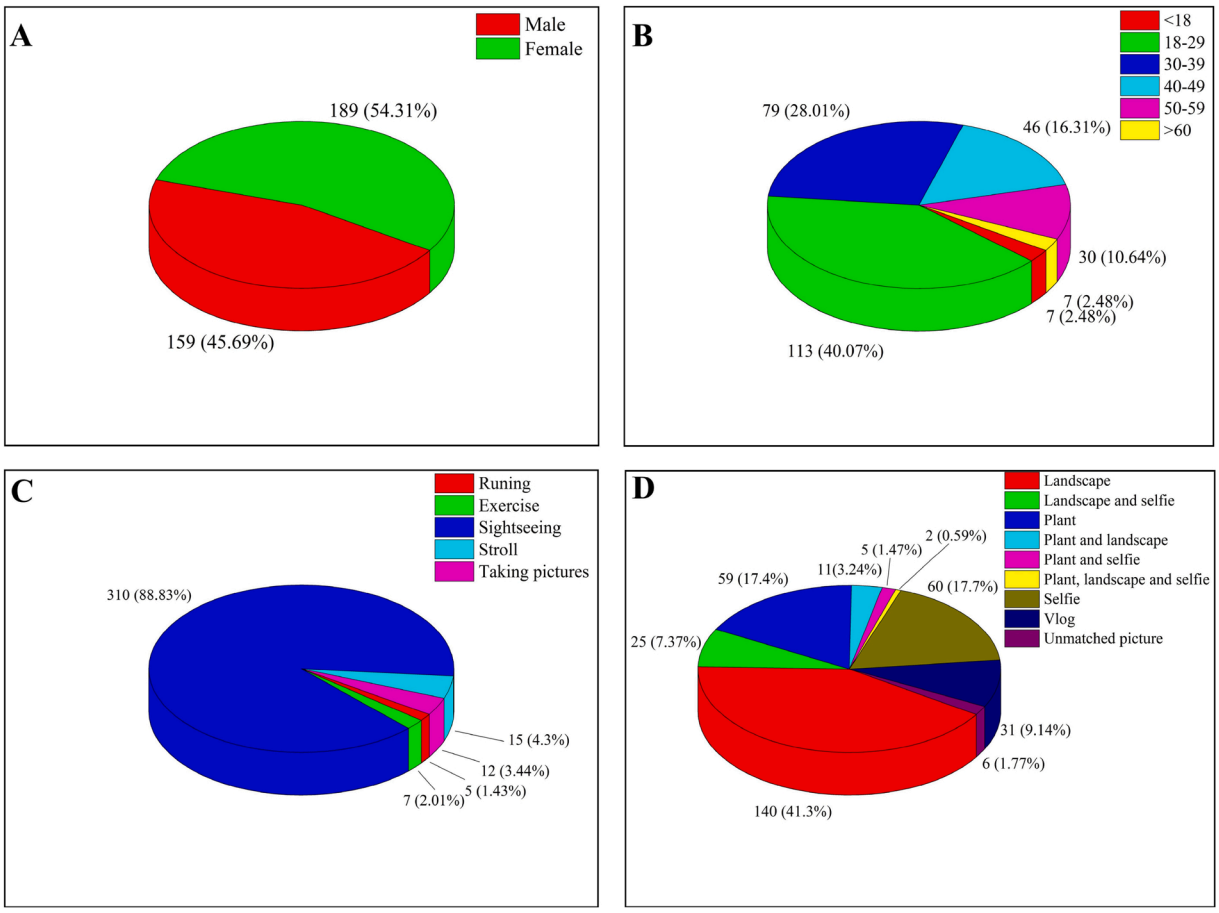

Fig. 2. Microblog content of citizens in the park during the epidemic. A. gender composition of microblog publishers in the park during the period of the outbreak. B. age composition of microblog publishers in the park during the epidemic. C. purpose of citizens going to the park during the epidemic. D. microblog mapping content in the park during the epidemic.

3.2.3. Correlation between the emotional scores of microblogs inside and outside the park and the number of infected cases

We analyzed the correlation between the sentiment scores of Sina microblog inside and outside the park with new confirmed cases, existing confirmed cases and new deaths. The results showed that the scores of emotions inside and outside the park were negatively correlated with new confirmed cases, existing confirmed cases, and new deaths. And we found that the correlation coefficients in the park were smaller than that outside the park. Among them, the emotional score in the park has a significant negative correlation with the number of existing confirmed cases, but has no significant difference with the number of new confirmed cases. There was a significant negative correlation between the emotional score in the park and the number of new confirmed cases and existing confirmed cases. People's emotional scores inside and outside the park were all negatively correlated with the number of new deaths, but the difference has not reached a significant level.

4. Discussion

A recent European Twitter study pointed out that Twitter sentiment analysis is very useful as an important data source for urban planning (Rao & Srivastava, 2012; Kagan et al. 2015; Roberts et al. 2018). However, as the most popular social platform in China, there are few reports on the emotional analysis of urban residents based on micro-blog data. T This paper attempts to use geolocation microblog data to find out whether it is easier for Beijing residents to express positive emotions when using microblogs in parks than when using microblogs outside parks during the epidemic. We can see that the Sina microblog users were expressing their opinions on traffic, weather or hot news. In these cases, emotions do not in conform to their inner happiness, but to their views on other things. In order to accurately quantify the user's emotions, we use the software platform to automatically screen and manually judge the micro-blog emotion. Here, we synthesize the text content of Sina microblog, the facial expressions of the characters in the pictures, emotional identifiers and emoticons to comprehensively express the whole feeling expressed in Sina microblog.

It should be pointed out that Sina microblog users only represent a small part of the actual number of tourists in the park, and social media data using geographical location and content keywords as a novel investigation means provide a powerful supplementary tool for modern new media technology. In addition, the purpose of this study is to study whether a large group of park visitors will report different degrees of positive emotions on microblogs inside and outside the park. Although it can be seen from our research results that during the epidemic period, microblog users expressed more positive emotions in the park than outside the park, and they not only expressed their own emotions. We may think that when people are in a more relaxed environment, such as parks, it is easier for them to express positive views on the world.

The research results show that the emotions expressed by urban residents on Sina microblog were negatively correlated with new confirmed cases, existing confirmed cases and new deaths. During the period of pneumonia in COVID-19, due to the strong infectivity of the new coronavirus, Chinese residents consciously adopted home isolation measures. Although home isolation reduces the chance of people contracting the new crown pneumonia and effectively prevents the spread

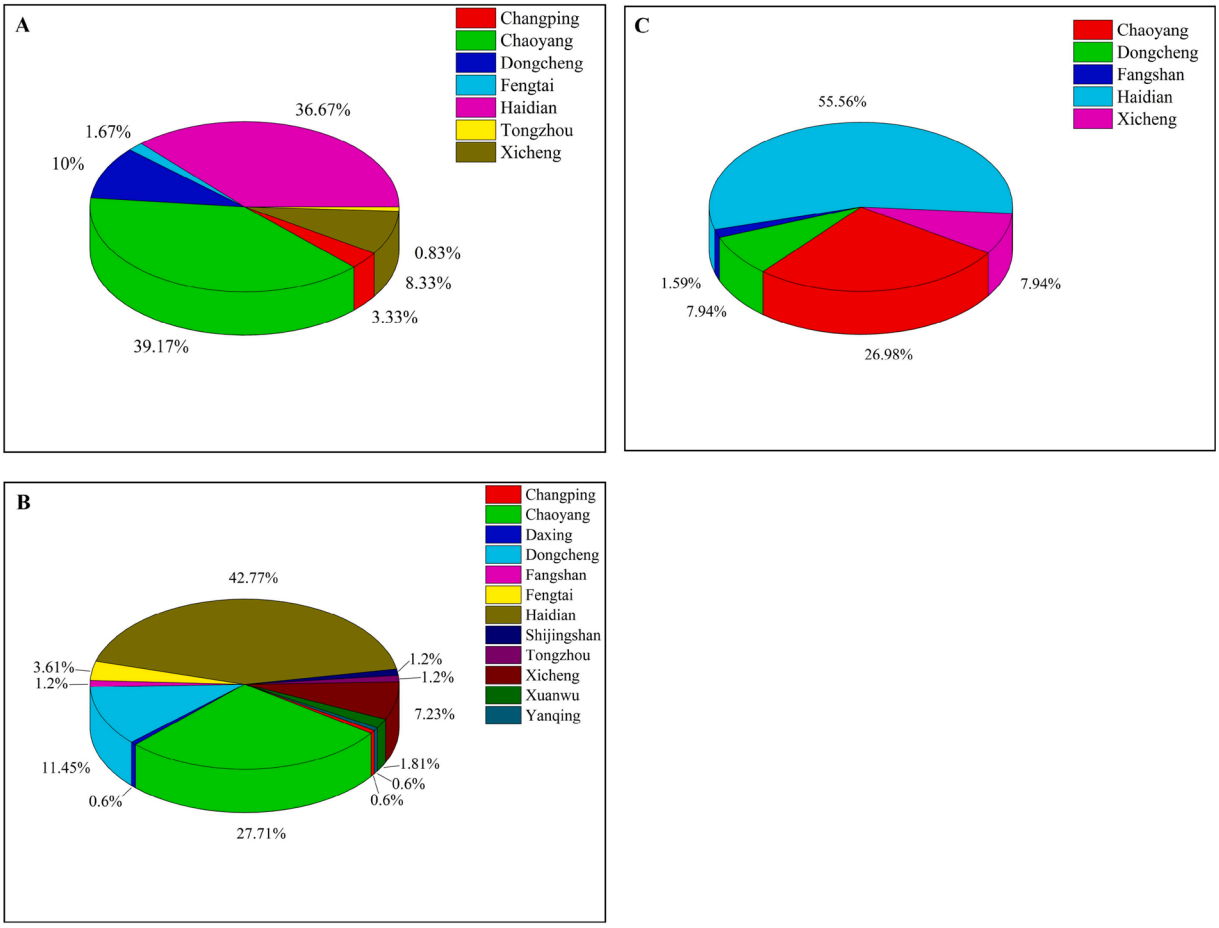

Fig. 3. Tour of park visitors across municipal districts. A. Olympic Forest Park (located in Chaoyang District). B. Xishan National Forest Park (located in Haidian District). C. Zizhuyuan Park (located in Haidian District).

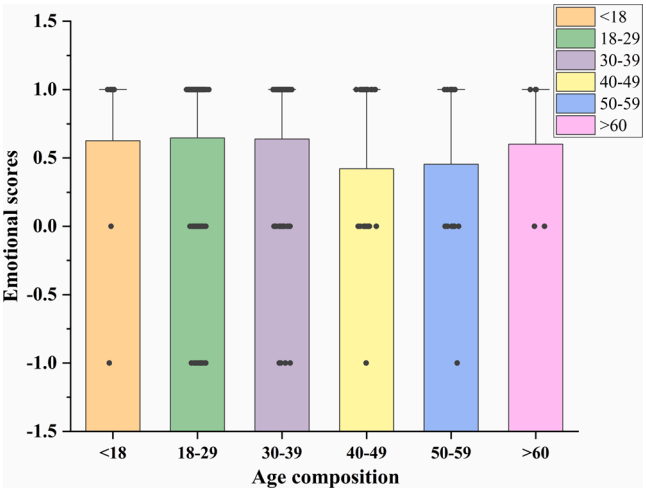

Fig. 4. Comparison of emotional scores at different ages.

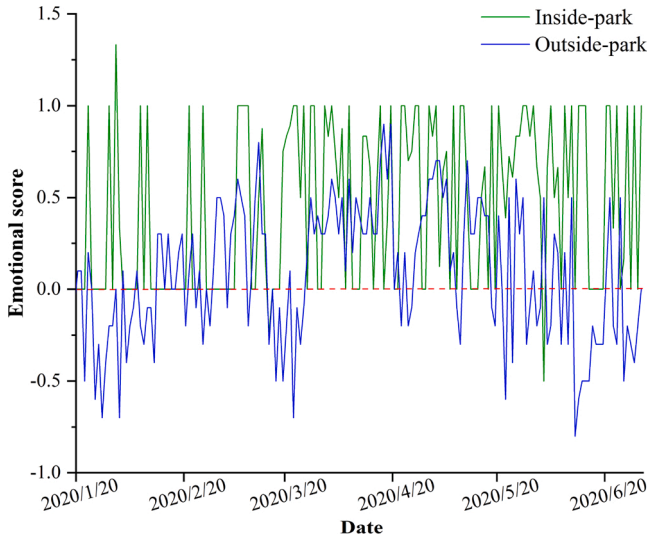

Fig. 5. Emotional scores inside and outside the park during the epidemic are based on microblog content.

of the epidemic, COVID-19 may still have an emotional impact on people. We assume that, on the one hand, people may panic about the officially reported number of infections (new confirmed cases, existing confirmed cases and new deaths). On the other hand, long-term isolation at home limits people's participation in outdoor activities or green spaces, which may also be one of the main reasons affecting their sentiment.

It can be seen from the content of Sina Weibo that during the epidemic, the main purpose of people coming to the park is to see the scenery. We found that the landscape of the park, especially the plants, is an important factor to attract tourists. For example, cherry blossoms in Olympic Forest Park, lotus flowers in Yuyuantan Park and red leaves in Xishan National Forest Park, etc., and some people go to the park to

exercise. It can be seen that people's enthusiasm for outdoor sports remains undiminished during the epidemic. It is worth noting that we find that people's micro-blog pictures mainly focus on landscapes and plants, which shows that when people visit the park, the landscapes and green plants in the park are important elements for people to express positive emotions. It has important guiding significance to the planning, design and management of the park. Based on the results of this study, we put forward some suggestions for the planning, design and management of urban parks. First, when planting in the park, we should pay attention to the selection and arrangement of plants in the park. According to the phenology of plants, choose characteristic plants in different seasons, such as peach blossoms and cherry blossoms in spring, lotus flowers in summer, color-leaf plants in autumn, and fruit-bearing plants in winter, which will be more attractive to tourists. Secondly, combining with the location of the park, creating unique natural landscapes, such as lakes, wetlands, etc., not only attracts tourists, but also create habitats for some animals. Third, the rational allocation of parks' plays and exercise facilities, especially during the epidemic, and the enhancement of personal fitness drove the upsurge of "national sports". Therefore, we believe that the addition or improvement of sports facilities is very necessary.

5. Conclusion

Based on Sina microblog data, this study analyzed people's the emotional expression inside and outside the park during the epidemic, and further explored people's demand for urban green space. The data on Sina microblog provide users' social (emotional) reaction to the pneumonia epidemic in COVID-19. Therefore, it can provide a planning tool to help the overall design decision, instead of the traditional method of paying attention to specific issues at specific times. It is cognitive in nature, so it represents great progress in understanding how to interact with the environment.

Our research shows that microblogs with geographical location and keywords are helpful to understand people's emotions expressed during the epidemic. Compared with the whole emotion outside the park, there are obvious differences in the emotion in the urban park. During the epidemic period, the mood of the people in the park were significantly higher than that outside the park. Park landscape and green plants are important elements for people to express their positive feelings. Despite the influence of the epidemic situation and the restriction of the "reservation system", people still have a great demand for external green space. We found that the development and control of the epidemic will also have an important influence on people's emotional expression. Under the influence of epidemic control, the negative emotional fluctuations of the elder is relatively small. The younger minors (under 18 years old) showed more negative emotions. We suspect that the number of new confirmed cases and the cumulative number of existing cases may be one of the main reasons affecting people's emotions, which may come from the fear of virus, strict control of urban epidemic, and long-term isolation at home. Admittedly, the mood of micro-blog user will be affected by many factors, such as their personal life and working status, and the events in the park.

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Authorship contribution statement

Jiyou Zhu conceived and designed this research, collected and summarized the research frontier, materials and tools, carried out the experiments, data analysis, paper preparation, writing and revision. Chengyang Xu contributed to supervision and project administration. All the authors agreed to publish this article.

Declaration of Competing Interest

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

The English in this document has been checked by at least two professional editors; both were native speakers of English. The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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