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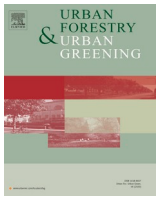

Original article

# "Unfenced" parks and residents' visit patterns: A regression discontinuity design in Shanghai

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ABSTRACT

Parks have evolved into essential urban sanctuaries, especially amid the COVID-19 pandemic. While previous studies have investigated the impact of lockdown measures on park visitation, limited attention has been given to the impacts of sudden easing of containment measures, especially the "unfencing" of parks in densely populated cities. Employing a regression discontinuity design (RDD), this study analyzes changes in park visitation behaviors among Shanghai residents (N=563) following the policy relaxation. We focus on three key aspects: visitation behavior, choice of park types, and activities undertaken within public parks compared to gated community greenspaces. The results reveal a short-term decrease in visits to nearby parks, reduced public transit use, and shorter travel times. This trend was accompanied by a reduction in visitation to various park types, especially larger ones, with waterfront greenspaces being an exception. However, visit frequency and duration remained unchanged. A significant decrease in exercise and enjoying weather was observed in both parks and community greenspaces. Additionally, there was a noticeable reduction in activities like playing with children, nature appreciation, specifically within community greenspaces. These findings extend our understanding of urban residents' engagement with greenspaces in a transitioning post-pandemic context, providing valuable insights in managing greenspaces during and after public health crises.

## 1. Introduction

In the tapestry of urban landscapes, parks stand out as critical elements for recreational and social activities in outdoor spaces, particularly during the COVID-19 pandemic (Lee et al., 2023; Wolch et al., 2014). Amid lockdowns, with restricted access to indoor activity spaces (Virmasalo et al., 2023), greenspaces provided essential venues for physical and social activities, offering respite from the confined living spaces and helping mitigate the stress and emotional strain induced by the pandemic (Fonseca et al., 2023; Ribeiro et al., 2021). The variety of parks, from intimate streetside greenspaces and pocket parks to sprawling parklands and vegetated waterfronts, underscores the adaptability of urban populations in utilizing these areas according to their spatial and social needs (Jato-Espino et al., 2022; Poudyal et al., 2009). In addition to public parks, community greenspaces, which are typically smaller and exclusive to local residents, also play a crucial role in providing immediate and accessible nature experiences and opportunities for social interaction within the gated communities they live in (Coolen and Meesters, 2011; de la Barrera et al., 2016; Haase et al., 2021). In such context, patterns of greenspaces visitation reflect the diverse functions that these spaces serve. Streetside greenspaces, pocket parks and community greenspaces provide quick escapes for nearby

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dwellers, while larger urban parks cater to a broader array of activities such as jogging, socializing, and nature appreciation (Lu et al., 2021; Ueno et al., 2022).

As the lockdown and COVID-19 containment policies change over time, so too does the relationship between residents and their greenspaces, with visitation patterns offering valuable insights into this dynamic interplay (Gu et al., 2020). The onset of the pandemic brought about a transformative shift in the public's use and perception of parks. The pandemic prompted a reorientation towards more expansive, naturalistic environments on the outskirts of urban locales, reflecting a change in residents' spatial preferences for leisure and recreation (Lu et al., 2021; Ueno et al., 2022). Meanwhile, there has been a discernible rise in individual activities such as walking pets, alongside a reduction in group socializing, such as gatherings for picnics and playing group sports, due to social distancing and health concerns (Ugolini et al., 2020; Venter et al., 2020). Although these trends were observed globally, these behavioral changes may have been further compounded by the implementation of public health policies and the distinct cultural and policy responses in China (Zhang and Li, 2023a; Zhang et al., 2022). For example, the requirements for PCR testing for park entry as well as public transit (Shanghai Municipal Government, 2022a), akin to "fenced" parks, significantly altered park accessibility and visitation patterns, leading to varied engagement with both public parks and community greenspaces. (Dzhambov et al., 2021; Fernandez Nunez et al., 2022; Fonseca et al., 2023; Isabella et al., 2022; Zhang et al., 2023).

While existing literature has extensively documented behavioral shifts during the initial phases of the pandemic, there is a paucity of studies examining the transition back to normalcy and how the "unfencing" of parks influences subsequent visitations (Tao et al., 2023). Studies on similar external shocks, such as natural disasters, indicate a potential post-disaster surge in the public's inclination towards natural settings for recuperation and leisure (Block et al., 2019; Li et al., 2021). For instance, after earthquakes or hurricanes, people often turn to parks and natural settings as places of solace and rejuvenation (Block et al., 2019). This inclination can be attributed to the restorative properties of nature, which help alleviate stress and promote mental well-being (Maas et al., 2006; Nutsford et al., 2013; Wolch et al., 2014). As communities emerge from lockdowns and social distancing mandates, it is imperative to assess how these changes affect the frequency and manner in which residents engage with parks. Thus, in an effort to elucidate the relationship between behavior changes and COVID, a focused exploration into the patterns of park visits after the lifting of containment measures is essential.

The methodology for studying how changes in public space containment measures affect visitation patterns during COVID-19 pandemic remains a less explored area. While numerous studies have utilized cross-sectional designs, these approaches fall short in inferring causality. A limited number of researchers have turned to quasi-experimental methods, adopting time-series data to better understand the impact of park accessibility on resident behaviors (Kola et al., 2021; Lee et al., 2023; Zhang and Li, 2023a). For example, a study analyzing park usage during the pandemic across several Asian cities demonstrated a notable increase in the importance of accessible greenspaces for leisure activities (Lu et al., 2021). Yet, the body of work specifically applying quasi-experimental designs to trace the patterns of park visitation, especially the short-term dynamic, following the lifting of pandemic restrictions remains limited, signaling a gap ripe for further investigation.

The primary objective of this study is to investigate the impact of the abrupt easing of COVID-19 confinement measures on greenspaces visitation behaviors among Shanghai residents. The study period captured the unexpected policy change on December 6th, 2022, when Shanghai shifted from stringent lockdowns to more relaxed urban environments, effectively "unfencing" parks. Leveraging this unique opportunity, we employ the regression discontinuity design (RDD) approach to examine changes in residents' park visitation patterns before and after the policy change. The research focuses on three key aspects: (1) alterations in residents' travel behavior and visitation patterns to parks, (2) shifts in preferences for different types of parks post-policy relaxation, and (3) variations in activities pursued within parks and community greenspaces. By delving into these aspects, the study aims to offer an in-depth understanding of the redefined relationship between urban residents and greenspaces in a transitioning post-pandemic context, shedding light on the short-term dynamics of park visitation behavior in response to policy changes.

## 2. Materials and methods

### 2.1. Transition of COVID-19 policy in Shanghai

Shanghai, a densely populated metropolis in China, covers an urban area of 1242 $km^2$ and houses approximately 24.75 million residents as of 2022. Known for its economic significance and rapid urban development, Shanghai is striving to evolve into an ecologically sustainable and livable city. Shanghai provides its residents with 439 well-maintained urban parks, each averaging approximately 52.35 ha, attracting over 20 million visitors each year before the COVID pandemic. The park area per capita is 9.3 square meters. Since 2000, Shanghai has been adding at least 1000 ha of greenspaces (park and land covered by varying vegetation) annually, along with an average of 40 thousand street trees each year, resulting in each resident sharing more than 70 square meters of greenspaces by 2022 (Shanghai Municipal Statistics Bureau, 2023). Furthermore, Shanghai's urban greenspaces planning aims to ensure that every resident has access to a public park within a 500-meter radius by 2035 (Shanghai Municipal Government, 2017). This comprehensive plan also includes increasing the forest coverage rate to approximately 23 %, expanding wetland areas, and developing over 2000 kilometers of greenways by 2035. This vision involves integrating natural elements into the urban fabric, aiming to realize the concept of "a city in the forest, a forest in the city" (Wu et al., 2019; Xiong et al., 2024).

Since the COVID-19 outbreak in 2019, China, including Shanghai, enforced comprehensive public health measures to prevent the spread of the virus (Xu et al., 2023). This included measures such as extensive nucleic acid testing, isolating infected individuals, rapid contact tracing, and mandatory quarantine for those potentially exposed. While these measures were effective in controlling the virus spread, they greatly restricted people's movement due to social distancing rules, the closure of indoor facilities, limited access to public transit and open spaces, and the fear of being identified as a close contact or infected person. Instead of a complete shutdown of park entrances, the containment measures in fact "fenced" the park by discouraging residents' usage such as requiring residents to present a negative test result or limiting the volume of visitors in a park. Additionally, limited access to buses and subways hindered residents who visited parks by public transit. However, a significant shift occurred on December 6th, 2022, when Shanghai relaxed these public health measures, signaling the end of strict COVID-19 containment (Shanghai Municipal Government, 2022a). The new policy removed all limitations to access parks and public transit—an important way to travel to parks in Shanghai, and therefore, the parks were "unfenced" from then on. This change marks a pivotal moment in the city's approach to managing the pandemic and might potentially alter residents' visitation patterns to parks.

### 2.2. Survey design

We used an online survey to gather data from residents who had lived in Shanghai for at least six months and were over the age of 18. This approach was necessitated due to the prevalence of gated communities, which limit the feasibility of conducting in-person surveys. Additionally, considering the high internet accessibility among the residents, online surveys emerged as the most effective means of data

collection, aligning with previous studies (Chen, 2020; de Bell et al., 2020). The survey's participant selection was structured around a quota sampling method, encompassing diverse demographics including gender, age, sub-districts, and education levels. Comparative details between our sample and the Shanghai population census are documented in the supplementary material Table S1. To enhance response rates and ensure a substantial sample size, various strategies were employed, including offering monetary incentives through digital payment platforms or online bank transactions. To maintain the integrity and quality of the data, several quality control measures were implemented. These included logic checks, monitoring for unusually rapid completion times, and the inclusion of unique 'oddball' questions designed to identify and exclude invalid responses.

The initial phase of the survey involved a pilot test, conducted by a reputable online polling firm, which yielded 50 complete responses. Following this, the final version of the survey was disseminated through the same agency, spanning from October 11th, 2022, to December 29th, 2022. This timeframe accidently spanned over the critical date of December 6th, 2022, when significant policy changes were implemented. We excluded from the survey any residents who tested positive for COVID-19 or resided in areas designated as "high-risk." Infected individuals were identified through PCR testing and additional self-reports. During the survey, participants were queried about their COVID-19 status and whether they lived in "high-risk" areas—defined as locales with multiple confirmed cases in the last 48 hours. Those who answered affirmatively were excluded due to movement restrictions. The final tally of respondents amounted to 563, with 430 responses gathered before the evening of December 6, 2022, and the remaining 133 collected after that date. Detailed questions can be found in the supplementary material.

### 2.3. Dependent variables and covariates

This study focuses on four primary sets of dependent variables, each capturing a unique facet of residents' interactions with greenspaces. We investigated two types of greenspaces, parks and community greenspaces, along with the associated activities. The distinction between parks and community greenspaces is essential for understanding their different roles and impacts on residents' lives. Following official standard in urban greening, we define parks as publicly accessible areas with at least 35 % of the area is covered by vegetation and offer a wide range of facilities and outdoor spaces for recreation, exercise, and social activities (Ministry of Housing and Urban-Rural Development, 2017). These spaces include large regional parks, street-side greenspaces, waterfront greenspaces, and plazas that are open for all residents (Jato-Espino et al., 2022; Poudyal et al., 2009). In contrast, community greenspaces are defined as vegetated open spaces or affiliated gardens within a gated community that are exclusive for the community residents (Ministry of Housing and Urban-Rural Development, 2017). These spaces provide a convenient and familiar backdrop for daily relaxation and smaller social exchanges, supporting a more intimate and immediate interaction with nature (de la Barrera et al., 2016; Haase et al., 2021). The images of examples of parks and community greenspaces in Shanghai can be found in Supplementary Materials Fig S1 and S2.

We investigated various aspects of visitation behavior in parks, such as visitation behavior in parks, the types of parks visited, and activities within parks. Visitation behavior encompasses several aspects: the distance to the park visited (Supplementary Materials Questions 1), time spent in travel to the park (Questions 2), duration of park visits (Question 3), usage of public transit for accessing parks (Question 5), and the pandemic's influence on visitation frequency (Question 6). For community greenspaces, we focused on the types of activities performed, given their daily and immediate accessibility for residents.

The survey categorizes parks into four groups (Question 7), street-side greenspaces, waterfront (riverside) open greenspaces, plazas with trees, and large parks. This classification reveals the varied parks in urban areas and highlights the specific characteristics that attract residents. Activities within both park and community greenspaces, as reported by residents (Questions 8 and 9), include walking dogs and other pets, exercises, playing with children, relaxation, socializing, enjoying the weather, and appreciating nature wildlife. Aligned with previous studies (Benton et al., 2018; Fernandez Nunez et al., 2022; Han and Ruan, 2019), demographic factors such as gender, age, and marital status, and socioeconomic variables like employment status, highest educational attainment, and after-tax household income in 2021, are included for a comprehensive analysis.

### 2.4. Estimation procedures using RDD

Our survey's timing uniquely positions us to employ the RDD approach to evaluate the impact of the relaxation of COVID-19 containment measures. This method is particularly suited to our study because the policy shift in Shanghai was abrupt and unexpected. Such a sudden change aligns with the critical RDD assumption of 'minimal continuity,' where residents have no foreknowledge or control over the implementation of these changes (Van Hauwaert and Huber, 2020). The responses collected after the policy implementation serve as a plausible counterfactual to those gathered before the policy change.

We utilize the date as the running variable, with the announcement of the policy change on December 6th, 2022, marking the intervention point. The control group comprises residents who completed the survey prior to this date, while the treatment group consists of those who responded afterward. The policy change was implemented immediately and uniformly across the city, qualifying our approach for a sharp RDD model. The treatment effect, in this case, is the change in residents' interaction with parks—ranging from travel behavior to parks to the types of activities pursued therein—identified through any significant shifts in the dependent variables around the policy change date. To assess the effects of the policy shift, we opted for a local linear analysis, in line with recommendations for instances where the running variable is discrete (Skovron and Titiunik, 2015). The selection of polynomial order was guided by standard procedures, employing a local polynomial of the first order, a triangular kernel function, and bandwidth optimized for mean squared error (MSE).

Several robustness tests were conducted to affirm the RDD assumptions, in line with established researches (Cattaneo et al., 2019; Van Hauwaert and Huber, 2020). Initially, balance tests were conducted across predetermined variables such as gender, age, education, marital status, employment, and household income, all subjected to the same regression discontinuity (RD) analysis. Additionally, a density test was performed to examine the distribution of observations around the cutoff. We also implemented placebo cutoffs, varying from three to twenty days before the actual policy change, to check the potential influence of concurrent events on the survey. A further analysis involved omitting observations within one or two days of the cutoff. Lastly, we tested varying bandwidths, ranging from the smallest available four to ten days to assess the consistency of RD estimations. All estimations and robustness checks were executed using Stata.

## 3. Results

### 3.1. Statistic descriptions of variables

Table 1 shows an overview of the key variables in our study. The data indicates diverse preferences for various types of parks, with street-side greenspaces being the most popular (69.40 % visited), followed by waterfront open greenspaces (57.90 %), plazas with trees (50.80 %), and large parks (44.20 %). Predominant activities across these settings include relaxation, enjoying good weather, and engaging in exercise and fitness routines. In terms of travel time, more than 35 % respondents reported spending between 5 and 10 minutes to reach parks, with less than a quarter experiencing travel times exceeding 15 minutes.

**Table 1**
Statistic summary of variables (N=563).

| Variables | Description | Number of responses | Percentage of responses |
|---|---|---|---|
| Types of parks visited (multi-choice) | Street-side greenspace | 391 | 69.40 % |
| | Waterfront open greenspace | 326 | 57.90 % |
| | Plaza with trees | 286 | 50.80 % |
| | Large parks | 249 | 44.20 % |
| Activities within parks (multi-choice) | Walking dogs or other pets | 128 | 22.70 % |
| | Exercise and fitness | 228 | 40.50 % |
| | Playing with children | 141 | 25.00 % |
| | Relaxation and stress relief | 365 | 64.80 % |
| | Socializing | 136 | 24.20 % |
| | Enjoying good weather | 284 | 50.40 % |
| | Appreciating wildlife and plants | 155 | 27.50 % |
| Activities within community greenspaces (multi-choice) | Walking dogs or other pets | 111 | 19.70 % |
| | Exercise and fitness | 220 | 39.10 % |
| | Playing with children | 136 | 24.20 % |
| | Relaxation and stress relief | 350 | 62.20 % |
| | Socializing | 142 | 25.20 % |
| | Enjoying good weather | 259 | 46.00 % |
| | Appreciating wildlife and plants | 104 | 18.50 % |
| Travel time spent | less than 5 minutes | 65 | 11.50 % |
| | 5–10 minutes | 202 | 35.90 % |
| | 10–15 minutes | 162 | 28.80 % |
| | more than 15 minutes | 134 | 23.80 % |
| Change of visit frequency | Significantly increased | 51 | 9.00 % |
| | Slightly increased | 106 | 18.80 % |
| | Remained the same | 180 | 32.00 % |
| | Slightly decreased | 180 | 32.00 % |
| | Significantly decreased | 46 | 8.20 % |
| Visit duration | Less than 30 minutes | 107 | 19.00 % |
| | 30 minutes to 1 hour | 266 | 47.20 % |
| | 1–2 hours | 126 | 22.40 % |
| | 2–3 hours | 43 | 7.60 % |
| | 3–4 hours | 8 | 1.40 % |
| | 4–5 hours | 7 | 1.20 % |
| | More than 5 hours | 6 | 1.10 % |
| Visit park by public transit | Number of positive responses | 77 | 13.70 % |
| Visit park within 800 m | Number of positive responses | 288 | 51.20 % |
| Age (years old) | 18–29 | 236 | 41.92 % |
| | 30–49 | 299 | 52.93 % |
| | 50 or above | 28 | 4.97 % |
| Gender | Number of male responses | 263 | 46.70 % |
| Marital status | Single | 237 | 42.10 % |
| | Cohabiting | 30 | 5.30 % |
| | Married with spouse, and living together | 271 | 48.10 % |
| | Married with spouse, but not living together | 9 | 1.60 % |
| | Divorced | 9 | 1.60 % |
| | Widowed | 7 | 1.20 % |
| Highest degree earned | Primary school and below | 1 | 0.20 % |
| | Junior high school | 77 | 13.70 % |
| | High school | 199 | 35.30 % |
| | Junior College | 74 | 13.10 % |
| | Undergraduate | 168 | 29.80 % |
| | Master's degree and above | 44 | 7.80 % |
| Employment status | Employed | 305 | 54.20 % |
| | Farming | 5 | 0.90 % |
| | Unemployed or job-seeking | 37 | 6.60 % |
| | Retired | 56 | 9.90 % |
| | Lost labor capacity | 1 | 0.20 % |
| | Student | 80 | 14.20 % |
| | Housekeeping | 25 | 4.40 % |
| | Others | 54 | 9.60 % |
| Household income | Less than 30 thousand yuan | 39 | 6.90 % |
| | 30–49.9 thousand yuan | 47 | 8.30 % |
| | 50–99.9 thousand yuan | 86 | 15.30 % |
| | 100–199.9 thousand yuan | 177 | 31.40 % |
| | 200–499.9 thousand yuan | 172 | 30.60 % |
| | 500–999.9 thousand yuan | 37 | 6.60 % |
| | 1 million yuan and above | 5 | 0.90 % |

Regarding visitation frequency, responses indicated stability or a slight decrease since the onset of COVID-19, reflecting potential shifts in public behavior during the pandemic. Visit duration patterns show that nearly half of residents reported the most common length of park visits ranged from 30 minutes to 1 hour, while longer visits exceeding 3 hours were notably less frequent. Regarding transportation, 13.70 % of residents visited parks by using public transportation, and over half of the park visits occurred within an 800-meter proximity to the residential community.

A demographic and socio-economic profile comparison between the survey sample and the urban residents of Shanghai is presented in supplementary materials Table S1. Both the sample and the population have a similar gender distribution (50 % female in the sample vs. 49 % in the total population) and employment rate (57 % employed in the sample vs. 56 % in the population). However, the age distribution in our sample shows a higher proportion of individuals aged 18–34 and 35–59, and a lower proportion of those aged 60 and above. Additionally, the sample includes fewer married individuals compared to the population. The sample also has lower educational attainment and a higher percentage of students.

### 3.2. RDD estimation results

Fig. 1 presents the RDD estimations, elucidating the changes in park visitation patterns, types of parks visited, and activities conducted in both parks and community greenspaces following the easing of "fenced" park measures. For park visitation patterns (Fig. 1a), the results indicate a statistically significant decrease in the frequency of visits to parks within 800 m from home ($p<0.05$), as well as a decline in the use of public transit for visiting parks ($p<0.05$) and in travel time to parks ($p<0.05$) following policy relaxation. However, the overall frequency and duration of park visits did not show statistically significant changes. Detailed statistical results are available in the supplementary material Table S2.

Fig. 1b illustrates shifts in the types of parks visited. Visits to street-side greenspaces and plazas with trees saw a significant decrease ($p<0.001$), as did visits to large parks ($p<0.05$). In contrast, visitation to waterfront open greenspaces did not experience a significant change (refer to Table S3 for full estimation results). Regarding activities, there was a significant decrease in exercise activities within parks ($p<0.001$), whereas other recreational activities such as walking pets, playing with children, relaxation, socializing, and enjoying wildlife and plants observed no significant changes (Fig. 1c). A similar trend of reduction was observed across several activities in community greenspaces, although playing with children, relaxation, and enjoyment of wildlife and plants also showed a significant decline (Fig. 1d). Detailed estimation outcomes are presented in Tables S4 and S5 of the supplementary materials.

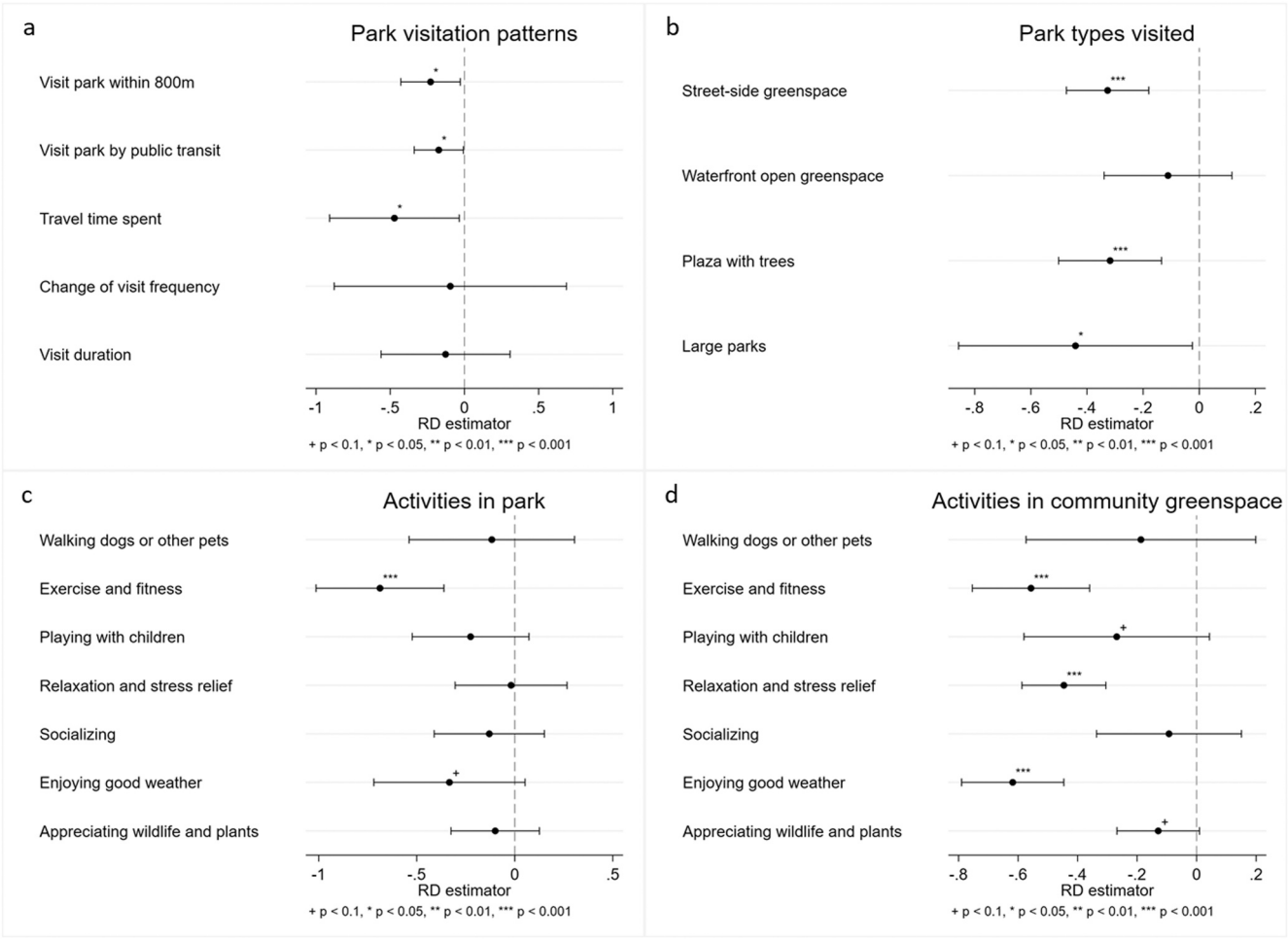


**Fig. 1.** RD estimations for park visitation patterns (a), types of parks visited (b), activities in parks (c), and activities in community greenspaces (d).

### *3.3. Robustness checks*

Results from balance tests indicated no significant effects (all p-values $> 0.05$), suggesting no discontinuity at the cutoff, as detailed in Supplementary Materials Fig. S3 and Table S6. The density test yielded a t-statistic of 0.352 with a p-value of 0.725, confirming no significant differences in densities between the treatment and control groups. Additionally, placebo cutoffs revealed no strong systematic patterns prior to the actual cutoff, underscoring the validity of our RD approach (Supplementary Materials Figs. S4–S7). The sensitivity analysis confirmed most estimation outcomes, except for the visit to parks by transit, visit duration, exercise activity in park, walking dogs and socializing in community greenspaces (Supplementary Materials Figs. S8–S11). Finally, varying the bandwidths confirmed the consistency of RD estimations with the core results (Supplementary Materials Figs. S12–S15). Collectively, these five robustness checks strengthen the credibility of our findings, assuring the reliability of our conclusions regarding park visitation behaviors post-COVID-19 policy changes.

## 4. Discussion

### *4.1. Changes of park visitation patterns*

The observed decline in the frequency of visits to nearby parks may be attributed to concerns about overcrowding and fears of virus transmission (Dzhambov et al., 2021; Labib et al., 2022), leading residents to seek less congested environments such as countryside parks for activities like camping (Gu et al., 2020). This aversion to crowded spaces is further evidenced by the decreased use of public transit, suggesting a preference for minimizing exposure to potential infection risks (Noszczyk et al., 2022; Zhang and Li, 2023b). Furthermore, the reduction in travel times to parks may not solely be indicative of a shift towards private transportation, such as personal vehicles or taxis, but also a streamlined journey resulting from the discontinuation of prior health-related detours (Jay et al., 2022; Lopez et al., 2021). Previously, residents may have combined outings to “fenced” parks with COVID-19 testing—integrating health compliance into their recreational activities (Harris et al., 2021; Hetyorini and Ekawati, 2022), given that nucleic testing booths are located close to or even within parks (Shanghai Municipal Government, 2022b). Nonetheless, the frequency and duration of park visits remain unaffected by these policy changes, indicating a societal settling into the ’new normal’ of pandemic-influenced life (Addas and Maghrabi, 2022; Cui et al., 2022; Zhang et al., 2022). This adaptation suggests that residents have recalibrated their leisure patterns not just in response to immediate policy shifts, but in alignment with the broader lifestyle changes and heightened health awareness brought by the extended pandemic period and subsequent outbreaks, even after the containment measures were lifted (Korpilo et al., 2021; Xiong et al., 2024; Zhang et al., 2022).

### *4.2. Changes of park types visited*

The reduction in visits to smaller urban parks, such as street-side greenspaces and plazas, corroborate the concern among residents regarding the potential for crowded conditions and heightened infection risks (Korpilo et al., 2021; Lopez et al., 2021; Zhang and Li, 2023b). This

hesitancy aligns with the broader trend of reduced patronage of large parks, which may be partly attributed to the perceived risks associated with using public transit during the journey (Cui et al., 2022; Zhang and Li, 2023b). The concurrent decline in the use of public transportation for park visits lends further support to this interpretation (Noszczyk et al., 2022). The constancy in waterfront park visitation, despite the pandemic, may be multifaceted. Waterfronts, such as riverside greenways, are often characterized by their extended, linear park layout and the presence of refreshing breezes (Zhang et al., 2019), which could be perceived as safer and allow for easier social distancing compared to enclosed or narrower urban parks (Wang et al., 2020). In Shanghai, where waterfront spaces are a widely available and prominent feature of the urban landscape, their continued visitation could also be related to the established cultural practices and lifestyle preferences of the residents (Korpilo et al., 2021; Liu et al., 2021; Zhang et al., 2023).

### 4.3. Changes of activities in parks and community greenspaces

This study's analysis of activities within parks and community greenspaces post-COVID-19 policy changes highlights nuanced shifts in recreational behaviors. Notably, there was a reduction in activities traditionally associated with higher levels of physical engagement and outdoor enjoyment, such as exercising and relishing good weather (Benton et al., 2018; Cui et al., 2022). The decline in exercising within these spaces can be attributed to the potential for increased close contact with others, heightening perceived infection risks (Isabella et al., 2022; Labib et al., 2022; Vos et al., 2022). During the pandemic, public consciousness about social distancing and minimizing physical interactions may have led to a cautious approach towards activities that typically involve proximity or shared equipment. In contrast, the enjoyment of good weather saw a decline possibly due to the lower prioritization of such leisurely activities in the face of health concerns and altered daily routines (Cui et al., 2022; Ribeiro et al., 2021). The pandemic may have shifted the focus of visiting green spaces from leisurely pursuits to more essential or routine activities.

Conversely, socializing and pet walking within these spaces remained constant. This steadiness suggests that while socializing is perceived as essential for maintaining social connections, pet walking is reflective of a routine daily activity, fulfilling responsibilities towards pets. Both activities might be integral to mental well-being (Fonseca et al., 2023; Noszczyk et al., 2022; Zhang et al., 2023). These activities inherently offer more control over physical distancing, which could explain their sustained popularity. Walking pets, in particular, is an activity that can be conducted with minimal direct interaction with others, making it a safer option in the context of pandemic-related health concerns (Labib et al., 2022). Further, this study observed divergent trends in activities such as playing with children, relaxation, and engaging with wildlife or plants, which saw a reduction in community greenspaces but remained stable in parks. This distinction might be driven by the spatial attributes of these areas. Parks typically offer more varied environments, providing ample space for these activities while social distancing is being guaranteed. They often host diverse wildlife and flora, making them attractive for recreational activities that involve nature interaction (Cui et al., 2022; de Bell et al., 2020; Lopez et al., 2021; Perez-Urrestarazu et al., 2021), which assists to explain the unchanged rate of nature appreciating activities. Community greenspaces, being more compact and often more crowded, might not offer the same level of space or diversity, leading to a reduction in these activities. Moreover, parks may serve as a destination for specific recreational purposes (Lu et al., 2021; Zhang and Zhou, 2018), whereas community greenspaces are often used for more casual or spontaneous use (Coolen and Meesters, 2011; de la Barrera et al., 2016; Haase et al., 2021).

### 4.4. Implementation in urban greening practice

Our results provide several inputs for adapting greenspaces in preparing for future crises and upgrading the resilience of cities. First, redesigning parks to accommodate social distancing comfortably without reducing their accessibility and appeal is encouraged. Measures might include increasing the number and distribution of entrances and exits and designing more open and versatile spaces. In this way, cities can make parks safer and more inviting, encouraging continued use even during public health crises. Second, urban planning could focus on improving the connectivity and amenities of waterfront greenspaces and similar expansive green areas. This approach would not only cater to cultural preferences but also alleviate crowding in smaller urban parks by providing attractive alternatives that encourage dispersion. Enhancing such spaces could serve as a model for other cities with similar cultural ties to water, promoting a safer and more enjoyable outdoor experience in densely populated urban environments. Third, urban planners and landscape architects could focus on redesigning parks and community greenspaces to better accommodate social distancing without sacrificing functionality. This includes enhancing the physical layout to allow for activities that require less interaction, such as separate walking paths and clearly marked exercise zones. Prioritizing features that facilitate individual and small group activities can also help maintain park usage during health crises while adhering to public health recommendations.

### 4.5. Strength and limitations

This research contributes significantly to understanding changes in park visitation during the pandemic's transition period, marked by several strengths. Primarily, the use of a quasi-experimental design, specifically RDD, offers stronger causal inference (Benton et al., 2018; Hamidi and Zandiatashbar, 2021; Lee et al., 2023; Yang et al., 2021; Zhang and Li, 2023b). This approach positions our study at the forefront of exploring park visitation patterns during policy shifts. Furthermore, our analysis extends the existing body of work on behavioral changes during the initial pandemic stages by examining the post-lockdown phase (Cui et al., 2022; Jay et al., 2022; Vos et al., 2022; Zhang and Li, 2023b; Zhang et al., 2022), particularly focusing on the impact of lifting park access restrictions on visitation behaviors. We provide a comprehensive assessment encompassing various park types and a range of activities in both parks and community greenspaces post-policy easing.

Nonetheless, the study is not without limitations. The RDD approach, while robust, primarily captures immediate responses to policy changes, possibly reflecting short-term behavioral shifts rather than long-term trends. This necessitates further research using methodologies that extend observation periods before and after policy changes to determine lasting impacts. Additionally, the demographic profile of our survey respondents, potentially skewed towards younger internet users due to monetary incentives, calls for caution when interpreting our results. The reliance on online survey methods and convenience sampling may limit the generalizability of our findings to a broader urban demographic, suggesting the need for more diverse sampling strategies in subsequent studies. Furthermore, although our analysis covers visitation patterns, it does not extensively examine the long-term surrounding built environment or specific park features such as vegetation density, biodiversity, and amenities that might influence these patterns. Future research could benefit from exploring these qualitative aspects to determine which features most significantly impact visitation behaviors.

## 5. Conclusion

This study adopted the RDD to explore the short-term impact of easing COVID-19 containment measures, particularly the "unfencing" of parks, on visitation patterns in Shanghai. Analysis of data from 563

residents indicated notable shifts in park visitation patterns, preferences for types of parks, and activities in both parks and community greenspaces. Key findings included a marked decrease in the frequency of visits to nearby parks, along with diminished reliance on public transport for these visits, and shorter travel times. Visitation to various types of parks also decreased except for waterfront greenspace. Regarding activities, there was a reduction in physical activities and enjoyment of good weather within both parks and community greenspaces. Community greenspaces also experienced a reduction in activities like playing with children, relaxing for stress relief, and wildlife observation. However, both parks and community greenspaces sustained levels of dog-walking and social interactions. This research sheds light on the evolving patterns of park utilization during a period of social transition and extends current observations about urban residents' engagement with natural spaces in a transitioning post-pandemic context.

These findings suggest that the behavioral impact of "fencing" continued to influence visitor behaviors even after parks were "unfenced", indicating a potential remaining preference for social distancing in greenspaces. Such insights are crucial for urban planners and public health officials as they indicate a need to adapt urban and health policies to align with evolving public behaviors and preferences. By understanding these shifts, decision makers can better design and manage greenspaces to fulfill the changing needs of the community, enhancing public well-being and ensuring that greenspaces serve as resilient, inclusive, and functional spaces during and beyond periods of crisis.

## Author Statement

The revision has been developed in consultation with all coauthors, and each of us has given approval on this final revision. We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

## CRediT authorship contribution statement

**ChengHe Guan:** Writing – review & editing, Validation, Supervision, Funding acquisition. **Yuhan Shao:** Writing – review & editing, Project administration, Funding acquisition. **Longfeng Wu:** Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Yichun Zhou:** Writing – original draft, Visualization, Validation, Software, Formal analysis. **Xuanyi Nie:** Writing – review & editing. **Seung Kyum Kim:** Writing – review & editing.

## Declaration of Generative AI and AI-assisted technologies in the writing process

Statement: During the preparation of this work, the authors used ChatGPT in order to improve readability and language. After using the tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

## Declaration of Competing Interest

The authors declare no competing interests.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2024.128459.

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