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Urban Green–Blue Space Utilization and Public Perceptions Amid the COVID-19 Pandemic: Insights from Northwest China

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Abstract: The COVID-19 pandemic has reshaped our daily lives and the way we interact with urban green–blue spaces (UGBS), particularly in the economically challenged regions of Northwest China. Our study, utilizing surveys and social media, delves into the pandemic's impact on UGBS engagement in this area, offering critical insights for urban planning amidst a global health crisis. We found a gender-balanced but preference-specific engagement in UGBS, with women and married couples in the Chengguan District of Lanzhou city showing affinity. Moreover, educational levels and proximity to academic institutions emerged as key factors influencing UGBS use, pointing to the importance of educational attainment in engagement diversity. Enhancing safety, creating child-friendly and leisure facilities for families, and designing vibrant spaces for socializing are vital, and placing UGBS near educational districts could also promote environmental awareness and scientific learning. Furthermore, the pandemic has reshaped public priorities, elevating the value of accessible, safe UGBS. This shift is evidenced by varied motivations for UGBS visits, with an emphasis on health, nature connectivity, and leisure. Women, older adults, and families, each with their distinct reasons, were drawn to UGBS for activities ranging from recreation to relaxation. Our findings advocate for the creation of multifunctional UGBS that cater to these varied interests, incorporating features such as air-purifying plants, scenic pathways, and zones for family activities, all underpinned by enhanced safety and accessibility. The study also highlights distinct transportation preferences among residents of Chengguan's northern and southern parts, suggesting a tailored approach to urban infrastructure that accommodates pedestrian access and public transit use. To prevent overcrowding, adjusting facility hours and event timings based on peak visitation times is recommended. Moreover, improving walkways and public transport connectivity is essential not just for convenience but also for ensuring that these green spaces are equitable and financially accessible, fostering inclusive access to these essential urban areas. During the pandemic, social media revealed a growing search for spiritual fulfillment within UGBS, highlighting their importance in societal well-being and coping mechanisms. In response, there's a compelling opportunity for UGBS to evolve by incorporating designated areas for spiritual relaxation, along with mental health support services. By actively monitoring social media feedback and trends, these spaces can adapt and refine their offerings, ensuring that they meet the community's changing needs more effectively. Our study highlights the importance of tailoring UGBS to meet diverse community needs, especially during crises. It emphasizes creating multifunctional, accessible UGBS that reflect demographic trends, transportation habits, and public preferences, aiming to boost community resilience and well-being. Drawing from research conducted amidst a worldwide crisis, our study provides key recommendations for the future evolution of UGBS, urging the creation of inclusive environments that bolster the health and well-being of urban populations.

Keywords: COVID-19; urban green–blue space; survey; social media; lockdown

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1. Introduction

Urban green–blue spaces (UGBS), comprising parks, gardens, and plazas, provide a wide range of benefits to urban residents. They are instrumental in elevating the well-being of urban dwellers 24 [1–3]. This role assumes heightened significance during periods of stress, where encounters with natural environments take center stage in safeguarding both mental and physical health. An illuminating study, conducted amid nature group walks during life's trials, unveiled substantial reductions in perceived stress and depression [4]. Additionally, nature serves as a rehabilitative force for individuals deeply impacted by crises, such as the profound loss of a loved one [5]. It is noteworthy that residing within close proximity of substantial green spaces, within a 3 km radius of residential areas, correlates strongly with enhanced mental and overall health during stressful life events [6]. These advantages conferred by UGBS become even more pivotal during crises like the COVID-19 pandemic [7]. The pandemic has intensified health-related and economic stress, escalated feelings of isolation, and imposed stringent mobility restrictions [8]. However, the utilization of UGBS during the pandemic is hampered by several obstacles, including limited access, temporary closures, and concerns about safety. This presents a distinctive challenge to city governments tasked with ensuring the equitable and secure management of UGBS.

In early 2020, the global response to COVID-19 resulted in extensive lockdown measures. These measures, though effective in curbing the virus, had profound consequences on human behavior and psychology [9]. During this period, studies revealed that quarantine, particularly among children and adolescents, led to increased psychological distress [10]. The COVID-19 lockdown accentuated the significance of urban nature as a source of solace. Contact with UGBS, even the mere ability to observe the natural world from one's residence, became catalysts for various psychological and emotional benefits. Studies during the pandemic reported increased usage of parks and natural areas due to the need for stress relief and anxiety reduction, with associated improvements in self-esteem, life satisfaction, happiness, and relief from the burdens of depression, anxiety, and loneliness [7,11]. Research also affirmed the advantages of engaging in outdoor activities within UGBS, like urban forest sports, for both physical and mental well-being, particularly during periods of restricted mobility [12]. Additionally, proximity to both indoor and outdoor environments was inherently linked to a reduction in symptoms of depression and anxiety, with students benefiting significantly [13]. This underscores the therapeutic potential of being in close contact with natural elements, whether indoors or outdoors, during challenging times.

The COVID-19 pandemic presented a distinctive opportunity to investigate the role of UGBS as nature-based coping mechanisms during global crises. Honey-Rosés et al. [14] emphasized that COVID-19 brought about noticeable shifts in how people perceived and utilized UGBS. While numerous studies have explored the effects of individual green space usage on well-being, the importance of collective UGBS utilization is underlined by multiple factors, such as accessibility, available amenities, alignment with community needs, safety, and inclusivity [15,16]. However, persistent challenges emerged, including limited physical or perceived access to UGBS. These limitations were influenced by factors like the absence of nearby green spaces, facility closures, or feelings of unwelcome in these areas, effectively hindering people from benefiting from UGBS during the pandemic. Concerns regarding the safety of visiting public spaces further diminished individuals' willingness to access the potential advantages of UGBS [17]. Additionally, the pandemic induced notable shifts in people's attitudes and perceptions toward park use [18], adding to the complex tapestry of UGBS utilization during this unique period.

Amidst the COVID-19 pandemic, the academic landscape regarding UGBS use has seen notable evolution. Scholars like Venter et al. [7], Derks et al. [19], Rice and Pan [20], Ugolini et al. [21], Curtis et al. [22], Mouratidis and Yiannakou [23], and Hidalgo-Triana et al. [24] have enriched our understanding through diverse methods such as Google Mobility data, park visit counts, and online surveys. These studies, spanning regions in Norway, Germany, the USA, Italy, and Greece, reveal varied patterns of UGBS usage

during the pandemic. In China, there is a discernible gap in such comprehensive studies. Existing research like Zhu and Xu's [25] use of Weibo data in Beijing, Li et al.'s [26] survey in Guangzhou and Shenzhen, Luo et al.'s [27] interviews in Chengdu, Cheng et al.'s [18] survey in Nanjing, and Hou et al.'s [28] application of street view data in Tianhe District, Guangzhou, offer insights but are primarily focused on the eastern regions of China.

However, the impacts of the pandemic on Northwestern Chinese residents and UGBS in this region remain under-explored. This oversight is significant, especially considering the distinct experiences and UGBS utilization patterns of urban residents in this region. Our research addresses this gap, adopting a "bottom-up" approach as recommended by Sultana and Selim [29] and Liang et al. [30]. This perspective is crucial to understanding the intricate effects of the pandemic on UGBS management and use in Northwestern China, contributing to the development of urban resilience and sustainability in response to global health crises. Our study, therefore, stands as a critical contribution to the field, offering nuanced insights into UGBS use in a region less represented in current discourse.

Our study in Lan Zhou City (LZC), a key urban center in Northwest China heavily affected by the COVID-19 pandemic, utilized a dual approach of in-person surveys and social media analysis. This comprehensive method provided insights into the pandemic's transformative impact on the patterns of visitation, public perception, and the perceived importance of UGBS. We explored the intricate relationship between these shifts and the evolving public valuation of UGBS benefits, focusing on how increased nature affinity influenced UGBS usage.

Our findings highlight the critical role of UGBS during stressful times like the COVID-19 pandemic. This study emphasizes the need for equitable access to these spaces and offers insights into effective management practices. While centered on LZC, the implications of our research are far-reaching, providing essential guidance for urban planners and policymakers in similarly affected regions worldwide, especially in underdeveloped areas. The research underscores the importance of maintaining and ensuring accessibility to UGBS, recognizing their crucial role in enhancing community resilience and well-being during challenging periods.

2. Methods

2.1. Study Area

Lanzhou City, the capital of Gansu Province in Northwestern China, holds a unique position as a key city along the historic Silk Road. Positioned between longitudes 102°30′–104°30′ E and latitudes 35°30′–37°00′ N, Lanzhou experiences four distinct seasons, with an average annual temperature of 10.3 °C and yearly rainfall of about 327 mm [31]. Despite its rich heritage, Lanzhou contends with a high population density, housing around 4.4 million people within its 1600 km^2 area [31].

In our research, we focus on three primary UGBS within Lanzhou's densely populated Chengguan district, as outlined in the Lanzhou City Fourth Urban Master Plan [32]. These UGBS are critical study areas, graphically highlighted in red on Figure 1, showcasing their strategic locations within the district. Amidst the persistent and challenging waves of the pandemic, Lanzhou faced the need to swiftly implement a series of comprehensive measures in response to the outbreak. These measures not only included recurrent lockdowns, each corresponding to a distinct wave of the epidemic, but also entailed travel restrictions, mandatory mask-wearing mandates in public spaces, strict adherence to social distancing protocols, temporary closures of public areas, and the initiation of an ambitious vaccination campaign. The year 2022 witnessed Lanzhou City grappling with an astonishing four extended lockdowns. These stringent lockdowns had a profound impact, effectively confining the local population to their homes and immediate neighborhoods. The consequences of such measures were keenly felt as daily routines were disrupted and economic productivity suffered.

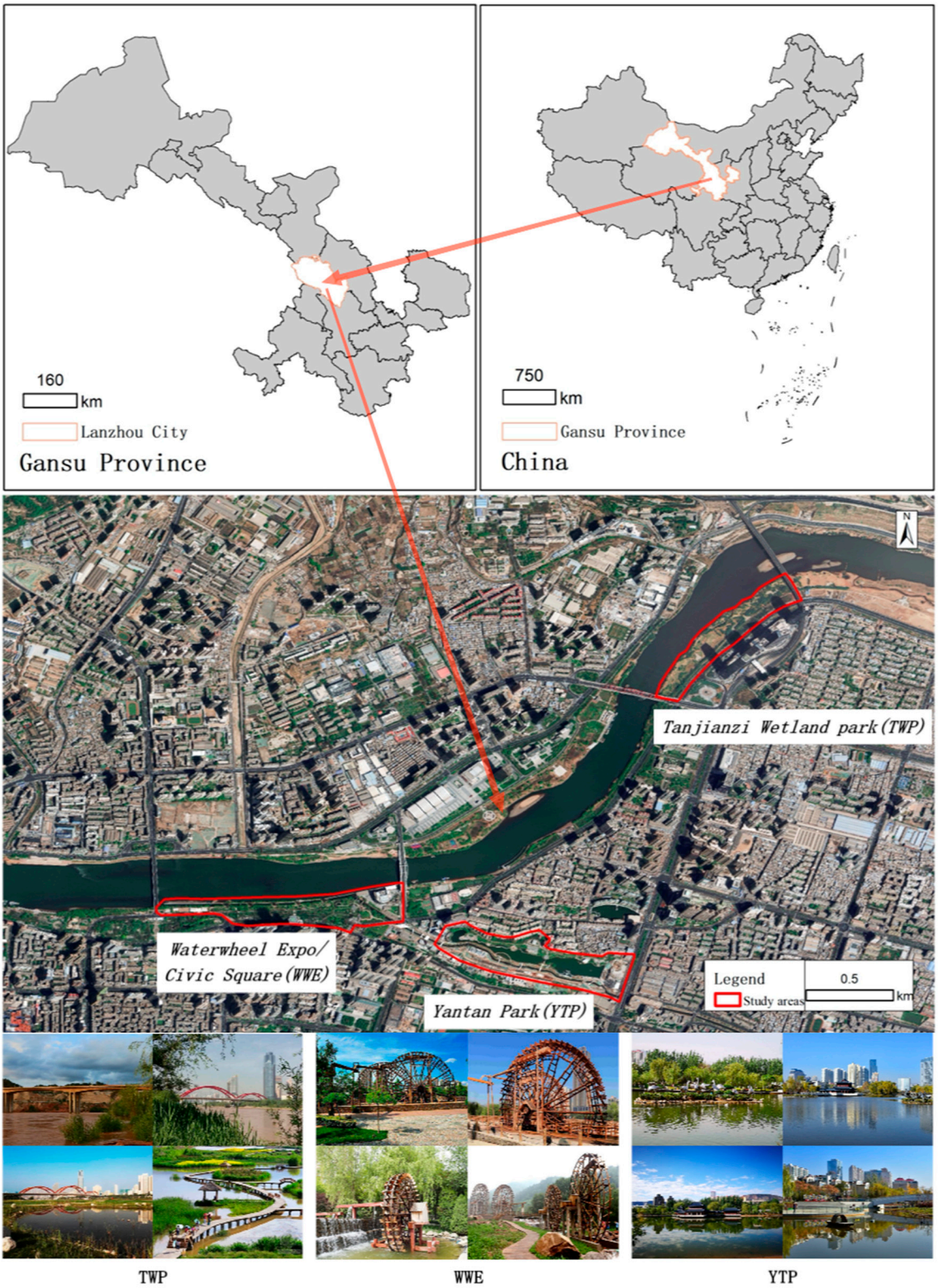

Figure 1. The distribution of three UGBS (parks) in Chenguan District, Lanzhou City.

2.2. Collection of Questionnaire Survey and Social Media Data

In this study, we conducted an in-person survey to gain insights into the utilization and perceptions of UGBS during the COVID-19 pandemic in Lanzhou city. The survey focused on individuals currently engaging in activities within these spaces. Our analysis drew from a subset of questions, which were organized into three distinct sections. The first

section explored participants' UGBS usage patterns during the pandemic, encompassing visit frequency, transportation modes, travel durations, and primary reasons for park visits. Furthermore, we examined the importance participants attributed to various UGBS features, whether the spaces they frequented aligned with their feature preferences, and their evaluation of UGBS functions and current park conditions. To comprehensively profile participants, we gathered demographic data such as zip codes, LZC boroughs and neighbourhoods, gender, age, marital status, occupation, education level, income, and residency duration. Our questionnaire incorporated both single-choice questions and multiple-choice, allowing respondents to select multiple responses for queries concerning concerns and UGBS feature significance, as well as social identity.

In our exploration, we tapped into the wealth of Weibo check-in data, capitalizing on its extensive reach as a leading social media platform in China, with a user base exceeding 500 million as of May 2020 [33]. Weibo stands as a vibrant forum for a wide array of discussions, from cultural happenings to the minutiae of everyday life, its geotagging feature playing a crucial role in pinpointing posts with relevance to social–ecological themes. Our dataset, capturing the breadth of 2021—a year significantly shaped by the COVID-19 pandemic—encompassed a diverse range of themes from personal reflections and emotional disclosures to shared activities, scenic descriptions, and recounted events, providing a layered perspective on public discourse during this period. To uphold the integrity of our analysis, we employed a stringent selection process, zeroing in on social–ecological indicators pertinent to UGBS, thereby augmenting the depth of our study. The acquisition of Weibo text data was facilitated through the Python programming language (version 3.11), utilizing the mobile Weibo geolocation API (https://m.weibo.cn/ (accessed on 15 December 2022)). It is noteworthy that the constraints of the geolocation API precluded the capture of demographic specifics such as users' age and gender. The data harvested, strictly from the public domain, were collected without impeding the platform's functionality, using readily accessible Python libraries. Temporal data were confined to the log-in instances of visitors, omitting the duration of their stay within UGBS, thus pinpointing the precise moments of engagement without deducing the extent of their visits. After filtering out promotional material and discarding data from invalid users, 1027 valid pieces of information were obtained for the analysis. This process provided detailed insights into the patterns of visits to UGBS during the worldwide health crisis, thereby enhancing the depth and richness of our study's narrative.

2.3. Data Analysis

In our investigation, SPSS27 played a crucial role in analyzing survey data, focusing on the influence of socioeconomic and demographic factors on respondent choices. We employed a variety of statistical tests, including ANOVA (Welch's F test) and Fisher-exact tests, to assess variations among multiple independent groups and used Pearson's Chi-squared and Fisher's Exact Tests for categorical variables. This methodological approach effectively elucidated the complex relationship between socioeconomic demographics and preferences.

Our research evaluates the dimensions of Cultural Ecosystem Services (CES)—aesthetics, history, science/education, recreation, and spirit—as outlined in Appendix A, drawing upon the foundational frameworks established in prior studies by Dickinson and Hobbs [34], Gordon [35], Gould et al. [36], and Wang et al. [37]. We meticulously prepared and segmented the data using Python and Jieba, a Chinese word segmentation tool, ensuring precise categorization of terms based on their occurrence rate in a random sample of primary texts. This foundational data were crucial for our subsequent analyses.

Utilizing social network analysis (SNA) via Gephi 0.10.1, our investigation unraveled the complicated network of relationships within cultural ecosystem services (CES), focusing on the spatial distribution, categorization, and terminology associated with these services. To navigate the complexity of these interactions, we confined our dataset to 100 nodes, enabling a detailed examination of network configurations and connectivity patterns. This

delineation provided a macroscopic view of the network's architecture and allowed for targeted scrutiny of nodes with significant centrality, revealing pivotal elements in the CES landscape. Our methodology harnessed SNA's capacity to visually map and quantify social connections, depicting these as graphs composed of nodes, which symbolize individual entities, and edges, which delineate the relationships between them. In this context, we extracted mentions of park locations in Lanzhou city from original Weibo posts as the foundational nodes, linking them to CES-related keywords to form a comprehensive network. This necessitated a manual curation of the dataset within Gephi, categorizing "source" as park locations and "target" as associated CES terms, further defining the intensity of these connections ("weight") and the nature of CES ("type"). The analytical process was underpinned by the Fruchterman Reingold layout algorithm, which initially mapped the network structure, followed by the employment of the PageRank algorithm to ascertain the relative significance of each node, thus calibrating their visual representation. The thematic and relational aspects were visually coded through variations in node and edge colors, corresponding to CES categories, and edge thickness based on the frequency of associations, highlighting the strength of linkages between parks and specific CES themes. This analytical framework enabled a profound exploration of the dynamics and key actors within the CES ecosystem, utilizing the Fruchterman Reingold layout and modularity classes to illuminate essential network interactions. This comprehensive method provided a nuanced understanding of the social dynamics in CES utilization and perception, contributing to the field of ecosystem services research [38].

3. Results

3.1. Sample Profile

Table 1 presents an insightful demographic profile of the survey participants. A balanced gender representation was evident, with 51.7% of respondents identifying as female (n = 882) and 48.3% as male (n = 824). The sample encompassed diverse age groups, with 47.0% falling within the 18–29 age bracket (n = 802). Employment was a common characteristic, with 45.9% of participants reported being employed (n = 783). The majority of respondents were notably well educated, with 65.9% holding at least a bachelor's degree (n = 1124). Marital status varied among the participants, with 63.7% indicating they were married (n = 1087). Regarding their length of residency, the group exhibited a broad spectrum, with the highest proportion being individuals who had resided in the area for more than 15 years (44.2%, n = 754). An interesting facet of the demographic landscape was the income distribution, with a significant portion (40.2%) reporting an annual income of less than 20,000 CNY (n = 686). In essence, the study featured a richly diverse sample, reflecting a multitude of demographic characteristics.

Table 1. Summary of the independent socioeconomic characteristics of the responses.

Personal Characteristics	Index Value	Frequency	Ration%
Gender	Male	824	48.3
	Female	882	51.7
Age	18–29	802	47.0
	30–39	195	11.4
	40–49	146	8.5
	50–59	173	10.1
	60–69	49	2.9
	70+	341	20.0
Occupation	Student	367	21.5
	Employed	783	45.9
	Unemployed	128	7.5
	Retired	428	25.1

Table 1. *Cont.*

Personal Characteristics	Index Value	Frequency	Ration%
Education Level	Middle school or lower	155	9.1
	High school	427	25.0
	bachelor	969	56.8
	Master or higher	155	9.1
Marital status	Unmarried	619	36.3
	Married	1087	63.7
Residency length	0–2 years	306	17.9
	3–5 years	241	14.1
	6–10 years	217	12.7
	11–15 years	188	11.0
	16 years and more	754	44.2
Annual income	Under 20,000 CNY	686	40.2
	20,000–40,000 CNY	267	15.7
	40,000–60,000 CNY	280	16.4
	60,000–80,000 CNY	245	14.4
	80,000–100,000 CNY	196	11.5
	Over 100,000 CNY	32	1.9

Note: 1.00 USD = 6.96 CNY (as of December 2022).

3.2. Public Attitudes towards UGBS

3.2.1. Functions of UGBS

We employed a comprehensive five-point Likert scale to gauge public perceptions regarding the various functions of UGBS (Figure 2). Among the respondents, 49.7% identified "sightseeing value" as the most significant aspect of their UGBS visits. Other functions closely followed, with recognition levels ranging from 40% to 44%. The function most prominently acknowledged by the respondents was "sightseeing value", boasting an average rating of 4.32, while "habitat provisioning" received the lowest rating, averaging at 4.09.

Notably, the importance attributed to different UGBS functions displayed distinct patterns within various demographic groups. When considering gender, women consistently placed greater value on UGBS functions, with a notable preference for "air pollution abatement" ($p = 0.003$; effect size DBA (women–men) = 0.156) and "habitat provisioning" ($p = 0.043$; effect size DBA (women–men) = 0.116). Age groups also exhibited divergent preferences, where individuals aged 50–69 demonstrated a heightened appreciation for the "sightseeing value" of UGBS ($p = 0.016$; Cohen's f = 0.192), alongside a robust acknowledgment of "air pollution abatement" ($p = 0.008$; Cohen's f = 0.188). Further pairwise tests uncovered that the 60–69 age group particularly recognized the importance of "soil/water conservation" ($p = 0.046$; Cohen's f = 0.152) and "habitat provisioning" ($p = 0.012$, Cohen's f = 0.163), despite being a relatively smaller cohort. Notably, the 40–49 age group maintained a relatively lower level of recognition regarding the park's functions. Furthermore, respondents with over 16 years of residency exhibited a greater propensity to select "habitat provisioning" ($p = 0.031$; Cohen's f = 0.100) and "sightseeing value" ($p < 0.001$; Cohen's f = 0.132).

3.2.2. Conditions of UGBS

During the pandemic, UGBS visitors valued "easy access" (mean = 4.30) and the assurance of "feeling safe" (mean = 4.21) in UGBS the most. In contrast, features such as "No wastes in waterbodies" (mean = 3.73) and "quiet and no noise" (mean = 3.77) received the lowest recognition. Factors linked to public health and pandemic management, like "people not practicing social distancing" (mean = 4.09), "mask-wearing" (mean = 3.79), and "restroom cleanliness" (mean = 3.82), garnered a more neutral rating.

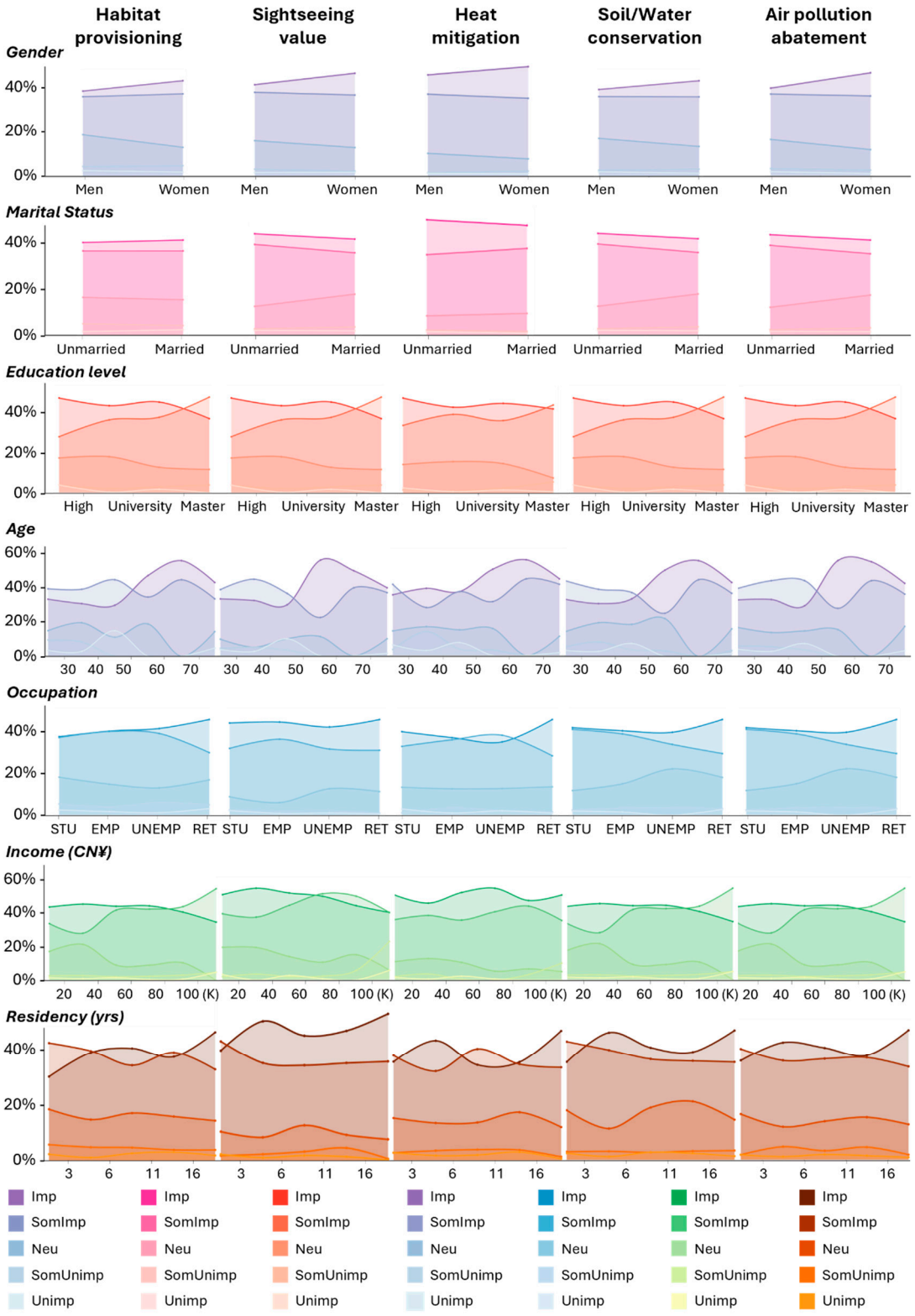

Figure 2. Public perceptions regarding the functions of UGBS during the pandemic. (Important: Imp; somewhat important: SomImp; neutral: Neu; somewhat unimportant: SomUnimp; unimportant: Unimp).

Perceptions of park conditions varied by demographics (Figure 3). Those aged 40–49 expressed significant dissatisfaction with noise levels ($p < 0.01$; Cramér's V = 0.239). The 18–29 age group held a largely neutral stance toward park cleanliness ($p < 0.001$;

Cramér's V = 0.211) and restroom cleanliness ($p = 0.001$; Cramér's V = 0.190). The 40–49 age group notably expressed dissatisfaction with "proper waste disposal" ($p = 0.003$; Cramér's V = 0.181) and park overcrowding ($p = 0.004$; Cramér's V = 0.180). Furthermore, the 30–39 age group expressed more concern about "people not practicing social distancing" ($p = 0.012$; Cramér's V = 0.171). Respondents with university education displayed more neutral attitudes toward park conditions, including "absence of waste in water bodies" ($p < 0.001$; Cramér's V = 0.135), "appropriate vegetation planning and management" ($p = 0.004$; Cramér's V = 0.180), "quiet, noise-free surroundings" ($p < 0.001$; Cramér's V = 0.109), and "clean restrooms" ($p < 0.001$; Cramér's V = 0.103). Employed individuals expressed dissatisfaction with noise ($p < 0.001$; Cramér's V = 0.121) and mask-wearing ($p = 0.023$; Cramér's V = 0.124). Respondents with an annual income below 20,000 CNY reported higher satisfaction with park conditions during the pandemic, as did married individuals. Notably, local residents with over 16 years of residency showed high satisfaction with park conditions.

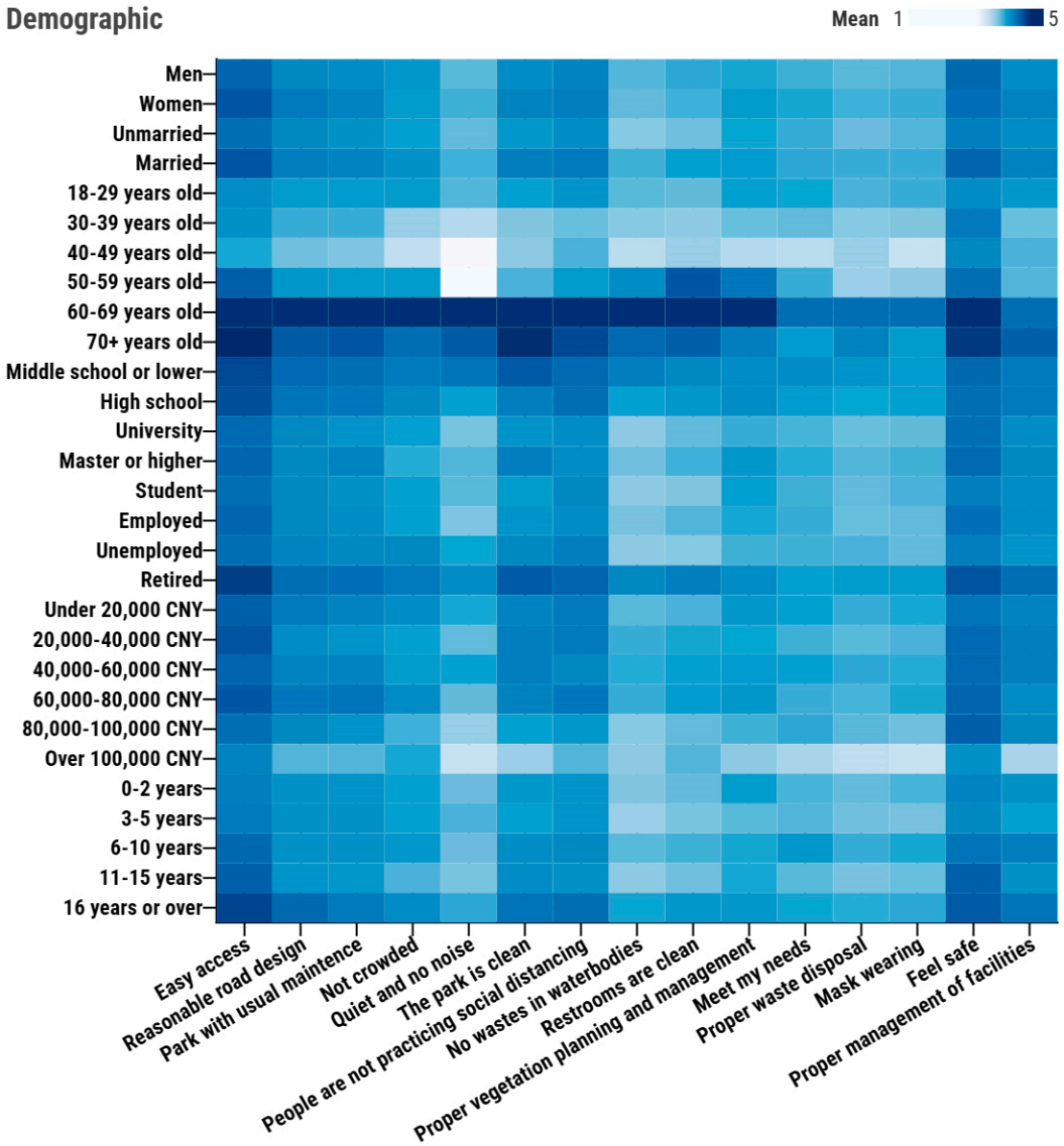

Figure 3. Public perceptions regarding the conditions of UGBS during the pandemic.

3.3. Reasons for Visiting UGBS during the Pandemic

In a fascinating exploration of visitor behavior in UGBS during the pandemic, demographic variables have emerged as key influencers of individuals' visiting reasons (Table 2). "Walking/jogging" and "close to nature" were selected as important reasons of UGBS visits by over 40% of respondents, and one third of respondents selected "just to relax" and 23% selected "excise".

Table 2. Individuals' visiting reasons of various demographics during the pandemic.

	Demographic Variables Significantly Associated with the Visiting Reasons	**Chi Square (χ^2)**	**Cramér's V**
Walking/jogging	50–59 years old	11.8 *	0.214
	Women	5.7 *	0.109
	Unmarried	41.2 ***	0.290
	18–29 years old	26.0 ***	0.319
Close to nature	University level	24 ***	0.222
	Student	56.8 ***	0.341
	Under 20,000 CNY income	20.7 ***	0.211
	0–2 years residency	33.6 ***	0.262
	Unmarried	32.5 ***	0.258
	University level	27.0 ***	0.235
Just to relax	Student	44.8 ***	0.303
	Over 100,000 CNY income	16.0 **	0.186
	0–2 years residency	21.4 ***	0.209
Exercise	Master level or higher	8.5 *	0.132
	Student	13.2 **	0.164
	Married	34.4 ***	0.265
	30–39 years old	57.2 ***	0.473
Accompanying children	Employed	45 ***	0.303
	80,000–100,000 CNY income	22.6 ***	0.221
	11–15 years residency	29.6 ***	0.246
	Unmarried	11.7 ***	0.155
Play (football, skating...)	University level	14.5 ***	0.172
	Student	27.5 ***	0.237
	Under 20,000 CNY income	14.5 *	0.177
	Unmarried	13.4 ***	0.166
Meet friends/relatives	University level	10.6 *	0.148
	Student	11.1 *	0.151
	Men	8.0 **	0.128
	Unmarried	25 ***	0.226
Riding a bicycle	18–29 years old	11.9 *	0.216
	Student	32.7 ***	0.259
	Under 20,000 CNY income	19.0 **	0.202
Others	/	/	/

Notes: * < 0.05; ** < 0.01; *** < 0.001.

For the 50–59-year-old group, green spaces served as pathways for walking and jogging, highlighting their critical role in promoting physical activity. Women, unmarried individuals, university-level students in the 18–29 age bracket, those with modest incomes under 20,000 CNY, and residents of 0–2 years residency found themselves irresistibly drawn to these green oases due to their proximity to nature. In contrast, relaxation seekers were predominantly unmarried, university-level students, high earners with incomes exceeding 100,000 CNY, and residents with shorter residency of 0–2 years. Visitors with advanced education or those pursuing higher studies gravitated towards these spaces for exercise. Accompanying children became a central theme for married individuals aged 30–39, the employed, those with a solid income of 80,000–100,000 CNY, and long-term residents of 11–15 years. For enthusiasts of play, like football and skating, the unmarried, university-level students, and individuals with lower incomes under 20,000 CNY reveled in these

recreational activities. Meeting friends and relatives flourished among the unmarried, university-level students, and students, reinforcing the social fabric woven within these green havens. And for those with a need for speed and open air, cycling beckoned, which was most enticing to men, the unmarried, students in the 18–29 age range, and those with lower incomes under 20,000 CNY. Amid this tapestry of preferences, the overarching message is clear: UGBS assumed a myriad of roles, becoming a reflection of diverse human needs and a testament to the power of nature during times of upheaval.

3.4. UGBS Use during the Pandemic

3.4.1. Demographic and UGBS Utilization

Through a meticulous examination of temporal and spatial dimensions, our analysis unveils the intricate interplay between park visitors' demographic profiles and residential locales (Figure 4). A discernible pattern emerges as we scrutinize the residence distribution among male and female tourists. While male tourists exhibit a relatively uniform distribution, their female counterparts tend to cluster more prominently on the eastern fringes of the Chengguan District. Intriguingly, the married demographic dominates across the residential landscape, with unmarried park visitors gravitating towards both the eastern and western extremities of the residential expanse. This demographic disposition aligns seamlessly with occupational distributions. Unmarried individuals, constituting a substantial portion of the respondents, exhibit a predilection for residing in the eastern and western sectors, a phenomenon mirrored by the prevalence of students in these areas. This confluence suggests a correlation between unmarried status and academic pursuits, substantiating the notion that many student visitors primarily reside in the eastern and western reaches of the residential zone.

Education emerges as a pivotal factor influencing residential patterns. A majority of respondents, boasting at least a bachelor's degree (65.9%), are ubiquitously dispersed throughout the area. Notably, those with higher educational attainments exhibit a proclivity for inhabiting the southeastern quadrant, a locale in close proximity to Lanzhou University. This nuanced spatial distribution underscores the role of educational institutions in shaping the residential geography of the populace.

Delving into the economic landscape, the income map accentuates distinct clusters within the residential areas. Individuals with incomes ranging between 40,000 and 60,000 CNY coalesce predominantly in the central region, while those with more modest earnings, below 20,000 CNY, tend to cluster towards the eastern and western peripheries of the district. A temporal dimension is introduced through an exploration of residency duration. A significant cohort, constituting 44% of participants with a residency duration exceeding 16 years, emerges as a dominant presence on the map.

3.4.2. Visiting Dynamics in UGBS

In Figure 5a,b, the commuting dynamics of residents from diverse locations unfold, illuminating walking and public transit as the predominant modes of park travel, collectively constituting 73.6%. Intriguingly, residents in the northern sector favor walking, while their southern counterparts predominantly embrace public transit. Conversely, an examination of park visitors from various locales reveals a uniform dispersion without conspicuous clustering effects.

Shifting focus to Figure 5c–e, evident fluctuations in the cutoff range, indicative of distinct transportation modes and parks, become apparent. Notably, The walking cutoff range is consistent across locations because the road network imposes fewer restrictions on walking. Conversely, cutoff ranges for automobiles and bicycling exhibit variable sizes, particularly in response to alterations in the road network. A perceptible, relatively steady expansion is evident as cutoff times increase across all transportation modes.

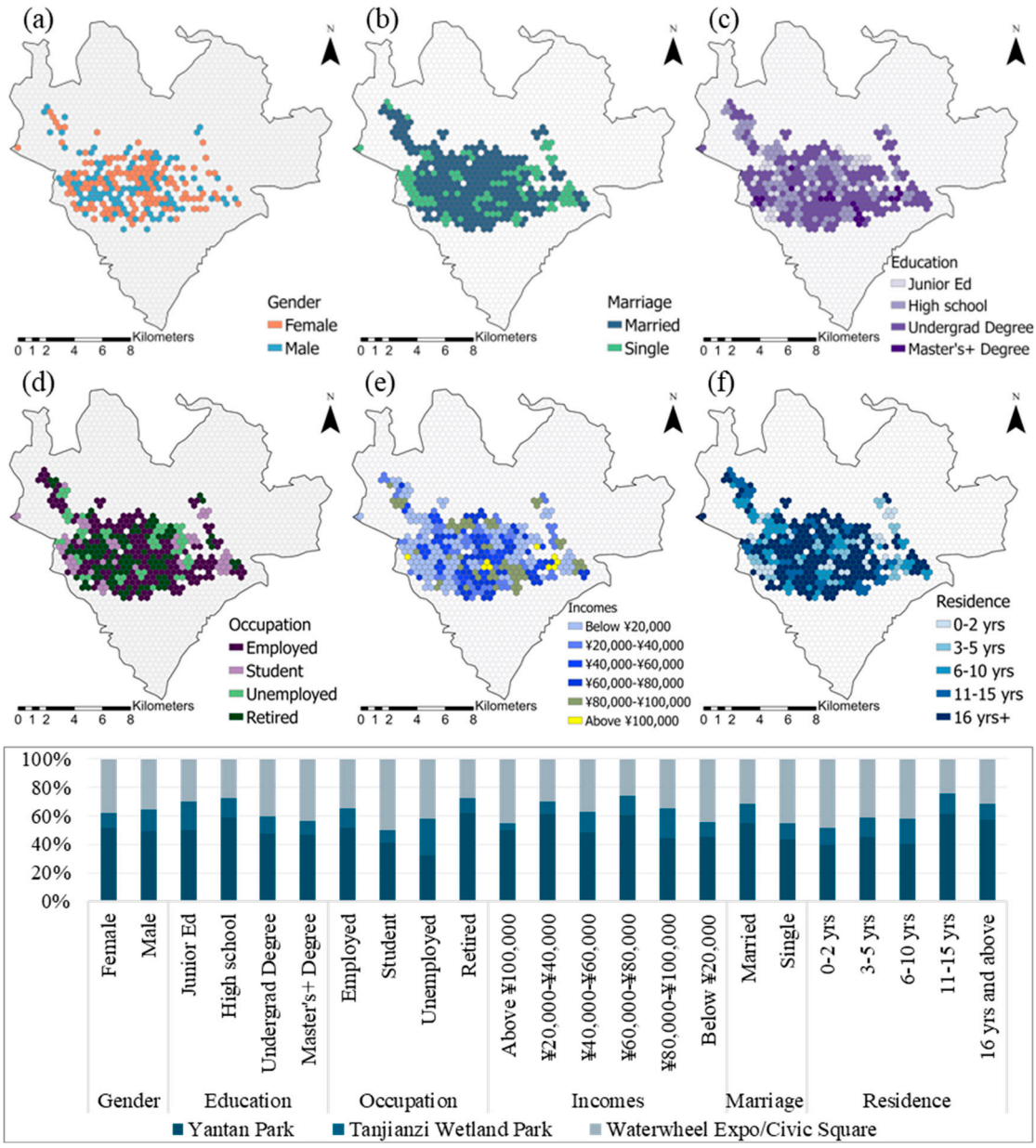

Figure 4. Demographic distribution of UGBS visitors: (**a**) gender, (**b**) marital status, (**c**) education level, (**d**) occupation, (**e**) income, and (**f**) residency length.

Figure 5c–e illustrate the service areas encompassing the parks under study. Service areas are representations of the spatial extent to which specific locations can be accessed within given distances or travel times. In our analysis, we utilized service areas to delineate the accessible regions surrounding the parks, considering various modes of transportation. Each subFig. within Figure 5, denoted as c, d, and e, respectively, visually depicts the areas that can be reached within specified time frames using corresponding transportation modes—walking, bicycling, and driving. These depictions provide valuable insights into the accessibility and reachability of the parks by different means of transportation, thereby facilitating informed decision-making in urban planning and transportation management efforts.

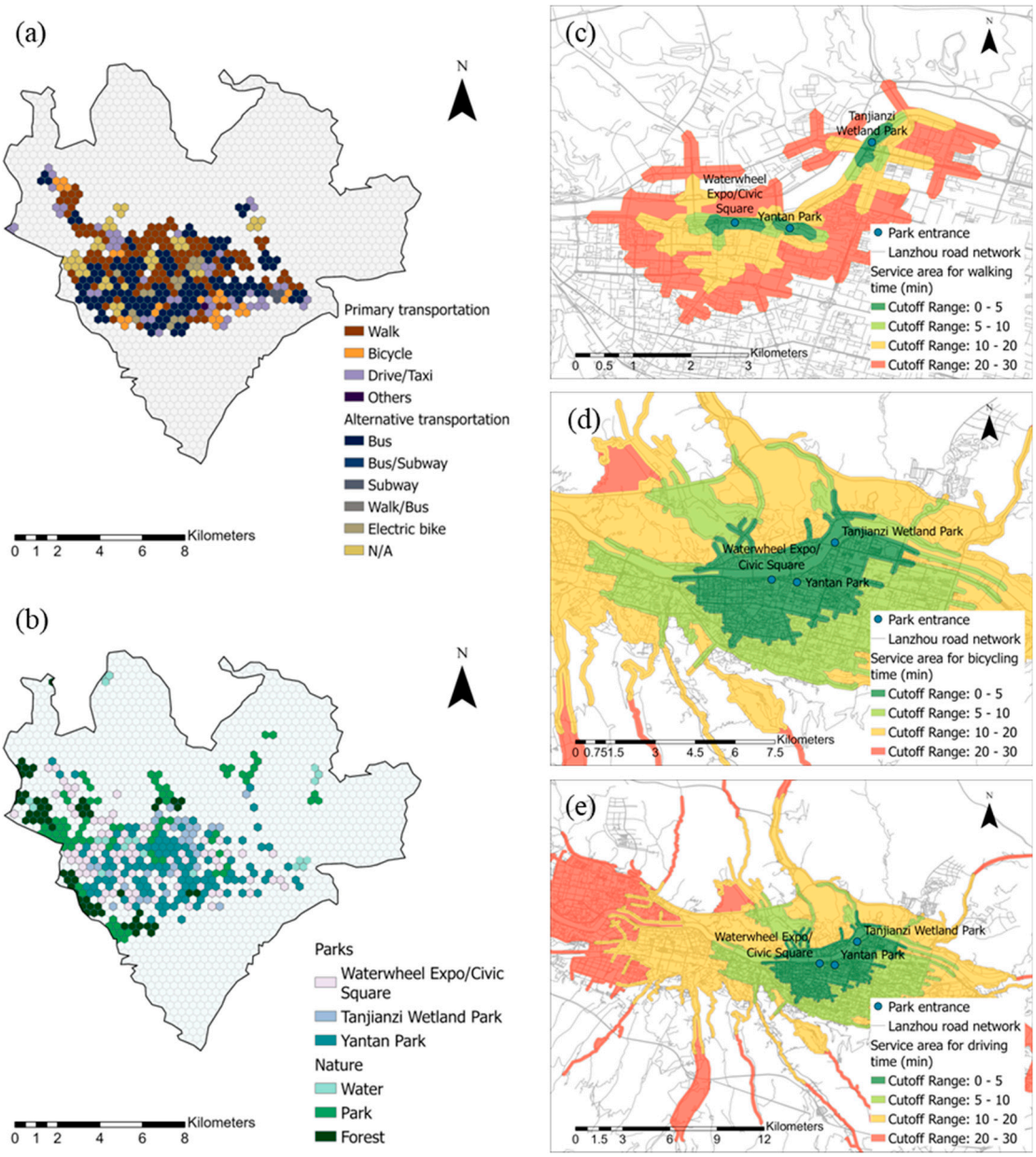

Figure 5. UGBS accessibility and transportation preferences. (subfigure (**a**)—visitors' commuting methods, (**b**)—types of destinations visited, (**c**–**e**)—park service areas accessible by walking, bicycling, and driving).

The creation of service areas and the subsequent development of line charts followed a structured methodology. Initially, service areas were generated for each park utilizing network analysis tools within ArcGIS Pro. These areas were meticulously delineated, taking into consideration diverse transportation modes such as walking, bicycling, and driving. The calculation of travel time or distance to various parks within these service areas was then conducted across a range of cutoff times from 5 to 120 min, enabling a comprehensive analysis of accessibility. Subsequently, line charts were constructed to depict population accessibility trends. Through organization of data, these charts illustrated population accessibility in relation to cutoff times, facilitating an exploration of transportation mode choices, commute durations, and visit durations within the service areas. This analysis offers insights into the dynamics of population accessibility and transportation preferences within urban contexts.

To further investigate the relationship between service area distances to parks and transportation and visitation preferences, we conducted a detailed analysis of population demographics and preferences. Figure 6 presents a comprehensive examination of transportation preferences and the corresponding time allocations for commuting to and staying at the park. Figure 6a–c highlight walking as the predominant mode of transit, consistently chosen by 64%, 58%, and 55% of individuals within 30-min walking, bicycling, and driving distances to the park, respectively. This underscores the significance of walking in park accessibility and urban mobility. Following walking, other preferred transport choices include bus, drive/taxi, and bicycle, in order. Regarding commute time, approximately 10% of individuals can reach the park within 10 min when residing within 30 min of bicycling or driving distance, compared to 18% within 30 min of walking distance. Interestingly, irrespective of residence distance, similar percentages of individuals spend 10–20 min, 20–30 min, and more than 30 min commuting to the park. When it comes to stay time, regardless of residence distance and commute duration, the preferred duration in the park is 30–60 min, followed by 60–120 min, more than 120 min, 10–30 min, and less than 10 min, indicating a preference for extended park visits. These findings underscore the importance of understanding transportation dynamics and stay preferences in promoting park accessibility and urban recreational activities.

A profound graphical exploration is undertaken to understand the implications of the cut-off time for accessibility, revealing intricate interplays (Figure 6). In an ideal linear scenario, any cut-off time would precisely delineate the line. However, non-linearity surfaces in all transportation modes. Figure 6a–c, focusing on walking, cycling, and driving cut-off times, unveil diverse commuting choices, emphasizing substantial disparities. Walking prevails as the majority's choice, with a linear surge observed beyond 20 min in both cycling and driving cut-off times. Meanwhile, we (Figure 6d–f) explore the temporal dynamics of commuting under these modes, with linear growth in walking beyond ten minutes, plateauing beyond 40 min, except for instances categorized as "less than 10 min". Notably, the cycling cut-off time displays a turning point at 20 min, while the driving cut-off time exhibits a turning point around 10 min, concentrated mainly within the 10–30-min commuting time range.

The analysis extends to park dwell times (Figure 6g–i), where scarce populations stay for less than 10 min. A substantial cohort experiences dwell times of 30–60 min, tapering off beyond 10 min in the context of the driving cut-off time. Examining comprehensive trends (Figure 6j,k), a convergence is observed around 90 min between driving and walking populations in terms of cut-off time, suggesting saturation in accessibility. Simultaneously, the walking population exhibits a linear increase. Analyzing commuting times (Figure 6l) reveals a considerable proportion exceeding 30 min, stabilizing beyond 85 min for the cycling cut-off time and beyond 40 min for the driving cut-off time, signifying diminishing returns with larger cut-off times, as the primary visitor population is already encompassed within these temporal bounds. Finally, considering visitation times (Figure 6m), a substantial proportion falls within the 30–60 min range, with turning points within 20 min for cycling and walking cut-off times, underscoring a convergence in trends for both excessively small and large cut-off times.

3.5. Social Network Analysis of UGBS Utilization during the Pandemic

In crafting our analysis, we meticulously curated a collection of spatially representative and commonly employed words to formulate a comprehensive social network graph, exemplified in Figure 7. Within this framework, the pandemic era witnessed the YTP landscape being predominantly influenced by recreational services, while WWE and TWP emerged as bastions primarily offering spiritual services. A holistic evaluation of the entire dataset was conducted to ascertain the CES value of the three parks. Notably, the Weibo data for these parks exhibited disparities, prompting us to standardize the dataset by refining the top tags. Consequently, the CES values for TWP and WWE underwent modifications, with aesthetic and recreational services emerging as dominant facets. This

delineates a discernible shift in public demand, accentuating a pronounced surge in the desire for spiritual services during the COVID-19 lockdowns.

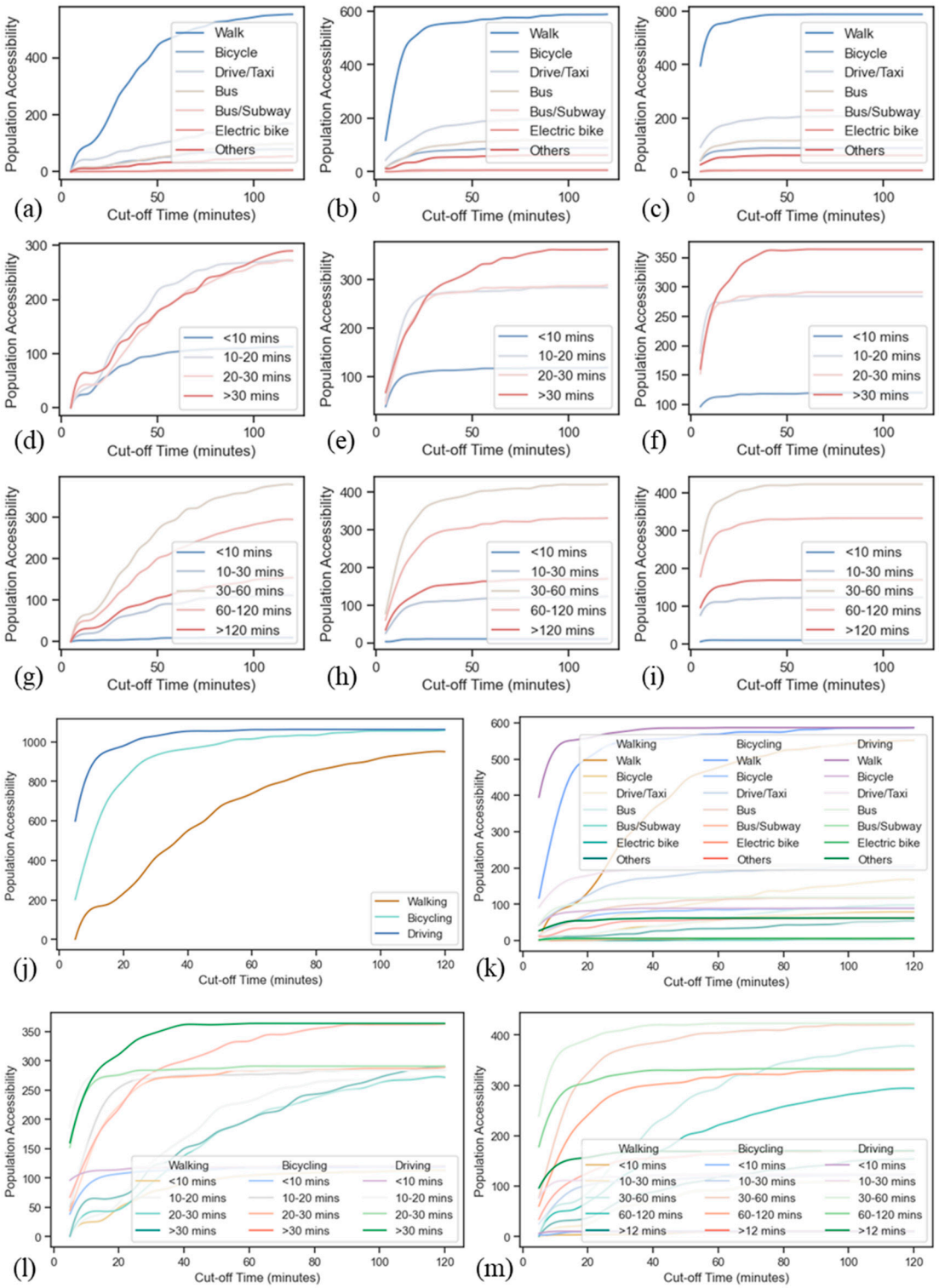

Figure 6. Graphical analysis of population accessibility: (**a**–**c**) transport preferences across service areas (walking, bicycling, and driving time); (**d**–**f**) commuting time across service areas (walking, bicycling, and driving time); (**g**–**i**) staying time across service areas (walking, bicycling, and driving time); (**j**) population accessibility within service areas by different transport distances; (**k**–**m**) transport choices, commute time, and staying time within each service area, respectively.

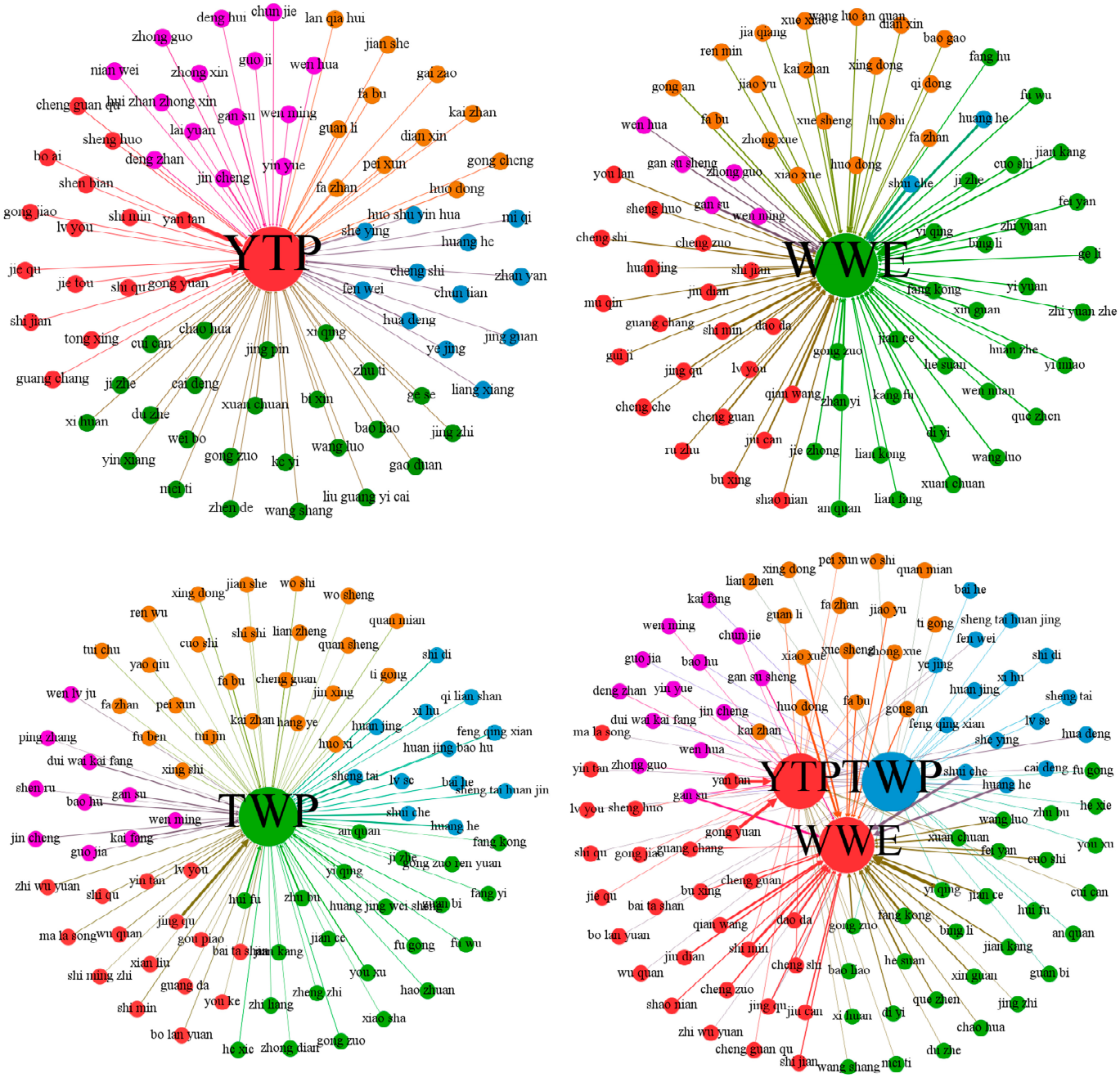

Figure 7. Temporal dynamics of CES tag networks: relationships between parks and tags during the pandemic ((**top left**) for YTP, (**top right**) for WWE, (**bottom left**) for TWP, and (**bottom right**) combines data for all three parks). Depiction of CES-related labels and study sites, with size and color signifying frequency and tag category. Colors: blue for aesthetic services; purple for historical services; orange for scientific and educational services; red for recreational services; green for spiritual services.

Venturing into temporal network analysis, the intricate interplay of nodes and connections forged an expansive social network graph. Modularity indices, standing at 0.458 for YTP, 0.412 for WWE, and 0.403 for TWP, with a cumulative value of 0.522 for all three parks, consistently surpassed the threshold of 0.3. This underscores the substantive clustering structures inherent in these networks, emphasizing the nuanced interconnections and categorizations within.

YTP emerges as a paramount contributor, boasting remarkable spatial distinctiveness. Encompassing nearly all CES values, it solidifies YTP as a symbolic Chengguan district site,

echoing "*Yantan*" with its profound sense of place, "*musical*" ambiance, and a historically rich "*Golden City*". These facets signify YTP as a symbolic hub, characterized by a comprehensive CES profile. Furthermore, TWP prominently features "*Scenic Spot*", "*Restoring*", and "*Pandemic*", while WWE sparks extensive discussions on "*Waterwheel*", "*Yellow River*", and "*Pandemic*". Each site, through nuanced service emphases, enriches the overall tapestry of diverse CES experiences.

4. Discussion

4.1. Pandemic UGBS Utilization and Attitudes across Demographics

The COVID-19 pandemic, a sweeping global crisis, drastically altered lifestyles [39], travel behaviors [40], and the use of public spaces, significantly impacting the public utilization and attitudes of UGBS.

Our research revealed an equitable gender distribution in the engagement with urban green–blue spaces (UGBS), underscoring their wide-ranging allure. However, a closer spatial examination highlighted distinct preferences, with women particularly drawn to the eastern Chengguan District, suggesting the need for designs that cater to specific demographic groups. Marital status also influenced UGBS usage, with married individuals and families showing a preference for these spaces, in contrast to singles and students who favored more peripheral areas, echoing findings by Lopez et al. [41] and Poortinga et al. [2] regarding the enhanced value and usage of UGBS among women and married people. The concentration of educated individuals near Lanzhou University indicated that higher education levels might lead to greater recognition or valuation of UGBS, highlighting the influential role of academic institutions. Furthermore, our study identified income-related barriers to UGBS access, pointing to the necessity of inclusive urban planning. This intricate dynamic between demographic factors and UGBS utilization was evident, with a notable preference among women for the qualitative aspects of green spaces in the eastern Chengguan District, as supported by Richardson and Mitchell [42]. This contrasts with married individuals' central area of residency and the periphery-focused distribution of singles and students. The significant presence of educated individuals near educational institutions suggests a correlation between higher education and UGBS appreciation, resonating with insights by Ugolini et al. [21]. This intricate web of factors calls for a nuanced approach to UGBS design and policy, emphasizing accessibility, inclusivity, and the alignment of green spaces with the diverse needs and values of the urban populace. Therefore, when designing UGBS, it is essential to account for the varied socioeconomic backgrounds of the community. Strategies might focus on improving safety, creating spaces suitable for children, and providing leisure options for families and couples. It is also vital to develop lively areas that encourage socializing and cater to the interests of both singles and students. Positioning UGBS close to educational institutions can further leverage these spaces for spreading scientific knowledge and raising environmental consciousness. The overarching goal of these approaches is to create UGBS environments that are secure, family-friendly, rich in recreational options, and accessible to the entire community.

Our study revealed distinct preferences for "sightseeing" in UGBS, with variations across demographic groups. Women showed a propensity for "air pollution abatement" and "habitat provisioning," in contrast to older adults who favored "sightseeing", indicating the need for UGBS to cater to diverse interests. The pandemic era brought a notable shift in UGBS user priorities, emphasizing accessibility and safety, a change highlighted by Mayen Huerta and Cafagna [43]. However, this overall trend concealed specific demographic variations, such as increased noise sensitivity among middle-aged users. Zhu and Chen [44]) note that noise sensitivity particularly affects those over 60, suggesting the pandemic might have intensified noise sensitivity across a broader age range. Contrarily, younger users appeared indifferent towards park cleanliness, contradicting Hong and Fan's [45] findings of a negative correlation between age and environmental cleanliness concerns, typically higher among the educated youth. This could imply a pandemic-induced decline in environmental concerns among younger populations. Therefore, it is important to craft

multifunctional UGBS that cater to the wide-ranging needs of different groups. This could include integrating air-cleaning plants, picturesque pathways, and areas geared towards families, all while prioritizing safety and ease of access to guarantee that everyone can enjoy these spaces securely and effortlessly.

During the pandemic, motivations for visiting UGBS shifted, highlighting their role in promoting health and nature connections. Physical activities and nature experiences drew older adults, women, and varied marital and income groups, while relaxation was a primary motive for unmarried and university-educated individuals. Younger, unmarried users and families with higher incomes in the young middle-aged bracket particularly utilized UGBS for social, recreational, and family activities. These trends align with findings by Girma et al. [46], Campagnaro et al. [47], and Włodarczyk-Marciniak et al. [48], who identified a range of motivations for visiting green spaces, such as clean air, nature enjoyment, relaxation, and socializing. Luo et al. [27] further noted that pandemic-induced stress and lockdowns intensified the public's inclination towards green spaces, albeit tempered by the risk of COVID-19 infection. This highlights the necessity for balancing UGBS demands during exceptional times and focusing on the specific needs of different groups, illustrating UGBS's crucial role in addressing diverse urban community needs.

4.2. Transport and Visit Dynamics and UGBS Accessibility

In our exploration of UGBS usage, the analysis during the pandemic reveals distinct commuting behaviors, with walking being the favored mode of park access in the northern areas of Chengguan District, and public transit preferred in the south. This shift towards increased pedestrian movement, documented by Poortinga et al. [2], calls for diversified urban planning strategies, especially during health crises, to enhance both pedestrian pathways and public transit systems, catering to the varied mobility needs of urban dwellers. These insights underline the necessity for urban planners to consider varied transportation needs and preferences in their strategies, emphasizing enhanced pedestrian and public transit infrastructure.

Our urban study elucidates the preferences for park access within the city, demonstrating a strong inclination towards walking and public transit, with profound geographic distinctions; the northern city dwellers predominantly walk, whereas southern residents prefer public transit. The analysis uncovers a non-linear accessibility pattern across all transport modes, particularly noting an upsurge in walking as the primary access to parks after a 20-min threshold. This observation suggests the need for UGBS planning to cater to diverse commuting habits. Reinforcing this, Kim and Yang [49] highlight that urban design promoting walkability can significantly enhance community engagement and trust. Concurrently, the critical role of green spaces within walking distance, as emphasized by Berdejo-Espinola et al. [50], has been particularly salient during the restrictive periods of the pandemic, offering essential restorative benefits. Our findings advocate for a pedestrian-friendly infrastructure that remains consistently accessible across the city, while also recognizing that the accessibility via automobile and bicycle is contingent upon the road network. This variation calls for a dynamic approach to urban planning that is responsive to infrastructural shifts, ultimately aiming for an urban environment that integrates the evolving transport preferences of its residents into a cohesive, accessible green space network.

Our investigation into the interaction between residents and UGBS has identified that visitors typically dedicate between 30 to 60 min to these areas, reflecting the reasonable proximity of these spaces to their urban dwellings. Intriguingly, a saturation point emerges around the 90 min mark, suggesting that beyond this travel time, the benefits of increased accessibility to UGBS do not significantly enhance their usage. This threshold of diminishing returns implies an optimal travel time frame within which UGBS access is most effective. This insight, consistent with the work of Geneletti et al. [51], underscores the non-linear relationship between the accessibility of green spaces and their use. Such findings are particularly relevant for urban planning during periods of travel restrictions, where the

balance between access and utility must be carefully calibrated. Our research emphasizes the importance of shaping urban policies and infrastructure to guarantee seamless access to green spaces, maintaining their status as vital components of city life, particularly when movement restrictions are in place. Key to this is the strategic management of visitor numbers and the prevention of overcrowding in UGBS, which necessitates careful monitoring of peak visitation periods and the subsequent adjustment of operating hours and event timetables to accommodate these patterns.

Our research sheds light on the intricate dynamics of urban mobility and the use of UGBS, advocating for urban designs that address the diverse transportation preferences of city dwellers to ensure equitable access to green spaces. The findings emphasize the significance of UGBS as sanctuaries for rest and recreation, particularly under the shadow of public health crises like the COVID-19 pandemic. This understanding is paramount for urban planners and policymakers, who must craft transport strategies that reflect the needs of various urban communities, encompassing both infrastructural improvements and the socioeconomic factors influencing park usage patterns. Our study thus highlights the imperative of providing equitable access to UGBS, positioning them as essential amenities for all urban inhabitants. In essence, the insights from our examination of UGBS usage during the pandemic furnish valuable directions for shaping accessible, inclusive, and adaptable UGBS.

4.3. Social Media and UGBS Visitation Trends

Our study, conducted amidst the COVID-19 pandemic, has uncovered a discernible shift in public preferences towards UGBS, with a notable upsurge in demand for spiritual services as gleaned from Weibo data analysis. This shift, likely reflective of a societal coping strategy during the stringent lockdowns, was particularly pronounced within WWE and TWP, signifying a paradigm shift in public needs and preferences during crises. The augmentation in aesthetic and recreational This aligns with Berdejo-Espinola's [50] observations of a heightened public gravitation toward natural and spiritual experiences during the pandemic offerings further underscores this transformation, seeking psychological and physical solace in UGBS. In response to this trend, UGBS could establish dedicated zones for spiritual relaxation, such as areas for meditation and yoga, complemented by mental health support services.

Our exploration of CES unveils a dynamic interplay between parks and their associated CES tags within the Chengguan district. YTP stands out as a hub, offering a spectrum of CES such as aesthetics, history, recreation, and spirituality. This diversity is crucial, aligning with Rigolon et al. [52], who advocate for the multifunctionality of UGBS, contending that a park should transcend its traditional role to integrate health, food, employment, and emergency management functions. The pandemic has amplified the need to reimagine parks as versatile spaces that support community resilience. To achieve such multifunctionality, collaboration between green space funders, both public and private, and various agencies is essential. This would entail investing in park infrastructure that supports a broader range of services, fostering partnerships across different sectors, such as public health and emergency management, and cultivating wide-ranging expertise within green space agencies themselves.

Our social network analysis discerned pronounced clustering within park networks, as evidenced by modularity indices surpassing 0.3. This finding, echoing Lopez et al. [41] and Cui et al. [53], highlights the diversity in preferences and concerns among various community groups during the COVID-19 pandemic, underscoring the necessity of tailored design and management of UGBS to meet specific community needs. YTP exhibits a high modularity index, indicative of its appeal to a broad spectrum of users, while TWP and WWE demonstrate significant clustering, reflecting distinct user groups and service demands. Each park uniquely contributes to the cultural ecosystem services landscape; YTP offers a comprehensive array of services, whereas TWP and WWE serve more specialized functions, catering to the nuanced needs of different urban communities. This intricate

network of connections, services, and public interactions highlights the multifaceted role of UGBS in urban life, particularly in times of crisis. Our research not only delineates the current state of UGBS but also provides critical guidance for future city development, underscoring the significance of ecosystem services tailored to the varied demands and welfare of city dwellers. Through ongoing observation and evaluation of social media feedback and trends, we can refine the offerings and activities in UGBS to better meet the community's changing requirements.

5. Conclusions

Amid the COVID-19 pandemic, a profound global challenge, our study offers essential insights into the evolving use and perceptions of urban green-blue spaces (UGBS), contributing to urban planning and policymaking. Our investigation reveals an equitable gender distribution in UGBS utilization yet uncovers distinct gender-specific preferences and marital status influences. Women, particularly in the eastern Chengguan District, and married individuals are more inclined towards UGBS, suggesting varied patterns of engagement that span family activities and individual interests. This study also finds a strong correlation between educational attainment and UGBS usage, with a notable concentration of well-educated individuals around university areas, indicating a diverse array of needs and preferences in UGBS engagement. In developing UGBS, recognizing the diversity in socioeconomic backgrounds is crucial. The approach should include enhancing safety and providing child-friendly spaces, alongside leisure facilities designed for families and married individuals. Equally important is creating vibrant spaces for social interactions and activities catering to singles and students. Additionally, strategically situating UGBS near educational districts can enhance their role in promoting scientific knowledge and environmental awareness. These strategies collectively aim to foster an environment within UGBS that is safe, welcoming to families, offers a variety of recreational activities, and is easily accessible to all community members. The research further discerns specific preferences for UGBS functions among different demographics, with women gravitating towards "air pollution abatement" and "habitat provisioning", while older adults predominantly opt for "sightseeing". The pandemic has notably shifted public priorities towards accessible and safe UGBS. The changing motivations for visiting UGBS during the pandemic underscore their vital role in promoting health, nature connection, and relaxation. A range of users, from older adults to families with higher incomes, seek physical activities, nature experiences, and social and recreational opportunities in UGBS. Thus, design multifunctional UGBS tailored to the diverse needs of various groups, featuring air-purifying vegetation, scenic tour routes, and family-friendly activity zones, while enhancing safety measures and accessibility design to ensure convenient and secure access for all.

Our analysis highlights distinct transportation preferences within the Chengguan District, with a notable inclination for walking in the north and public transit usage in the south. This variation underscores the need for tailored urban planning strategies that focus on enhancing both pedestrian pathways and public transportation infrastructure. To effectively manage visitor flow and mitigate overcrowding in UGBS, it is crucial to monitor peak visitation times and adjust facility hours and event scheduling accordingly. Improving access through better walkways and public transportation links not only facilitates preferred modes of access to UGBS but also ensures that these options are equitable and financially accessible to individuals across various economic backgrounds, promoting inclusive access to these vital green spaces. Furthermore, our examination of social media trends reveals a significant shift towards seeking spiritual services in parks amidst the pandemic, showcasing how society adapts and the multifaceted role UGBS play in delivering ecosystem services. To align with this trend, UGBS could introduce areas dedicated to spiritual relaxation, like meditation and yoga zones, coupled with mental health support offerings. By continuously monitoring and analyzing feedback and trends from social media, adjustments to the services and activities within UGBS will be made to more effectively cater to the evolving needs of the community.

Conclusively, this research underscores the imperative of considering demographic factors, transportation preferences, and public attitudes in UGBS planning and management. It stresses the need for creating multifunctional, accessible, and inclusive UGBS, adaptable to the diverse needs of urban communities, particularly in challenging times. These insights chart a course for future UGBS policies, emphasizing the creation of spaces that bolster community resilience and enhance overall well-being. Through this study, conducted during an unprecedented global crisis, we provide pivotal guidance for the future development of UGBS, advocating for designs that resonate with the diverse needs and enhance the well-being of urban communities.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Classifications and Explanations of CES

CES Value	Explanation
Aesthetic services	Connection to a specific locale; artistic portrayals of the natural world
Historical services	Historical documentation; cultural legacy, and symbolic engagements with the environment
Scientific and educational services	Rich material for on-site research and educational initiatives
Recreational services	Facilitation of leisure activities across varying environments, as well as experiencing the natural realm through alternative mediums.
Spiritual services	Appreciating and deriving spiritual benefits from particular locations, valuing and cherishing these places.

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