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Evaluating the association between urban green spaces and subjective well-being in Mexico city during the COVID-19 pandemic

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ABSTRACT

This paper examines the association between the frequency of use of urban green spaces (UGS) and the subjective well-being (SWB) of Mexico City’s residents during the COVID-19 pandemic. We conducted an online survey (N = 1954) regarding individuals’ perceptions and use of UGS and their SWB, evaluated through the short version of the Warwick–Edinburgh mental well-being scale. Multilevel mixed-effects regression analyses were performed to investigate the association between the frequency of UGS use and SWB, including individual and municipal level characteristics as covariates. Our results suggest that respondents who used UGS once or more per week during the pandemic reported higher SWB scores (8.7%) than those with zero visits. These findings have public policy implications that could enhance the role of UGS in urban environments during times of crisis.

1. Introduction

Over the past 30 years, interest has grown regarding the contribution of urban green spaces (UGS) to quality of life and well-being (Bertram and Rehdanz, 2015; Francis et al., 2012; Sugiyama et al., 2018; Wood et al., 2017). UGS are considered a cost-effective form of built environment that are easy to modify and can improve air quality, provide recreational opportunities, increase the livability of neighborhoods, and enhance the aesthetic value of cities (Bedimo-Rung et al., 2005; Sugiyama et al., 2018; Xiao et al., 2017). Moreover, UGS can serve as a tool to mitigate stress and fatigue, increasing a sense of comfort and peacefulness and, therefore, improving the state of mind of individuals (Fan et al., 2011; Larson et al., 2016). This last feature is crucial in settings where people have limited contact with nature and population density is high (Florida et al., 2017; Solecki and Welch, 1995).

As COVID-19 grew into a global health crisis, disrupting urban life and elevating the risks of overcrowded spaces, the role of UGS in health promotion has risen sharply as a recurrent topic in the conversations surrounding public health (Venter et al., 2020). The pandemic has impacted people’s mobility, livelihoods, and overall well-being (Slater et al., 2020). In particular, unprecedented stressors have been introduced into daily life and have become a hazard to individuals’ subjective well-being (SWB)—widely understood as an attitude tied to the evaluation of the self, one’s emotions, and life satisfaction (Diener et al., 1999; Kahneman and Krueger, 2006; Wills-Herrera et al., 2011). Consequently, it is crucial to evaluate the mechanisms that can maintain or improve individuals’ well-being and build resilience within a health crisis.

To date, studies documenting the potential of UGS use in promoting well-being during the COVID-19 pandemic have been conducted in countries such as the United States, Spain, and Norway (Slater et al., 2020; Venter et al., 2020). To the best of our knowledge, the association between UGS use and well-being, particularly SWB, in the pandemic context has not yet been examined in Latin America. Policies and tools to sustain SWB during a pandemic are extremely relevant in a mega-city such as Mexico City, one of the global COVID-19 hotspots—over with over 2.4 million reported cases as of June 2021.

In the mega-cities of the Global South, residents often live in overcrowded areas where social distancing is extremely difficult, making them particularly vulnerable to mental health struggles intensified by the pandemic (Corburn et al., 2020). The objective of our exploratory study was to quantify the contribution of UGS use to the SWB of Mexico City’s residents during the social distancing period of the COVID-19 pandemic. We draw upon results from an online survey (N = 1954) that was conducted in May–June 2020 to: 1) examine the association between the frequency of UGS use and the SWB of city residents; 2) analyze if differences in perceived quality of and distance to UGS were associated with SWB; and 3) evaluate the association between maintaining or increasing SWB and UGS use.

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2. Subjective well-being

Scholars refer to subjective well-being as how individuals experience the world and the satisfaction associated with this experience (Diener and Chan, 2011; Kothencz et al., 2017; Stone and Mackie, 2013). SWB is often conditioned by gender, culture, age, socioeconomic status, marital status, and location-specific characteristics, all of which can influence an individual’s quality of life (Diener and Chan, 2011; Kothencz et al., 2017; Stone and Mackie, 2013). For instance, a study conducted in the U.S. by Inglehart (2016) shows significant differences in SWB between men and women, with American women experiencing higher SWB than American men. Furthermore, a literature review conducted by Ulio et al. (2013) found conflicting evidence regarding the association between SWB and age, with some studies presenting positive associations and others exhibiting negative results.

Ryff and Keyes, 1995 distinguish between two primary conceptualizations of SWB. The first uses happiness as its leading indicator, while the second is linked to the domain of life satisfaction. Following these two notions, current tools used to evaluate SWB, such as the World Values Survey, are comprised of questions on both life satisfaction and happiness (Kahneman and Krueger, 2006).

Evidence from around the world has revealed a strong correlation between SWB and overall health (Diener and Chan, 2011). For instance, it appears that SWB influences morbidity and mortality, with positive emotions, such as calmness and peacefulness, having a more substantial effect on health than the absence of negative emotions (Diener and Chan, 2011; Harling et al., 2016). Moreover, literature on the connection between urban green environments and SWB has shown a positive association between the two variables. For instance, in a study conducted in Italy and the U.K., Lafontezza et al. (2009) find that exposure to green environments was positively associated with SWB. Furthermore, in a systematic literature review consisting of 452 scholarly articles on green spaces and quality of life, Mensah et al. (2016) demonstrate that access to green spaces had a strong or moderate connection to SWB. As COVID-19 distinctly poses a threat to individuals’ mental health, the use of resilience tools that offset the pandemic’s negative impact on SWB, such as UGS, should be prioritized.

3. Study area

Our exploratory research focuses on Mexico City—the urban section of the Federal District, or CDMX—where exponential growth and the lack of urban planning strategies have not favored socioeconomically deprived areas (Checa-Artasu, 2016). With an estimated population of 8.9 million, Mexico City suffers from acute wealth inequality, excessive pollution levels, and high rates of population growth and urbanization (Rigolon et al., 2018b). The high population density is a challenge for land use management and has generated public health burdens, which have only grown following the inception of the COVID-19 pandemic (Antonio-Villa et al., 2021).

The city has an area of 1479 km² and is representative of mega-cities in Latin America, with rising environmental justice concerns and security fears, especially among women (UN-Habitat, 2017; Wright Wendel et al., 2012). The latter is due to increasing gender violence, an ongoing issue in the city that has intensified differences in the perception and use of public spaces among men and women (Sweet and Escalante, 2010). Additionally, residents are rarely consulted regarding the design and implementation of urban development policies, limiting the potential positive effects of the resultant infrastructure projects (Checa-Artasu, 2016).

Beginning in the 1990s, the city adopted a privatization approach to developing and managing public spaces, including UGS, furthering social fragmentation and segregation patterns (Bayan and Saravi, 2012). From that point on, the modernization of UGS has been selective, prioritizing the most profitable projects and contributing to an increase in land and housing prices (Delgadillo, 2016). For example, privileged neighborhoods have created gated communities. More broadly, the upper and upper-middle classes have been able to invest in their neighborhoods landscape, separating themselves from the urban fabric (Pradilla, 2005). Meanwhile, poor neighborhoods have been excluded from urban development plans.

4. The COVID-19 context in Mexico City

At the start of the COVID-19 pandemic, the government of Mexico City, like many other governments worldwide, implemented measures to reduce the spread of the disease. On March 23, 2020, the city introduced the “Healthy Distance Program,” which involved the recommended use of face coverings in public and the closure of all non-essential businesses and some parks and public spaces, among other measures (Encino, 2020). The functionality of the UGS that remained open was narrowed for the purposes of performing physical activity and relaxation (Mayen Huerta and Cafagna, 2021). Notably, passive engagement was highly discouraged and, in some spaces, forbidden (CDMX, 2020).

In May of 2020, the government of the city introduced the Gradual Plan Toward the New Normal (CDMX, 2020). This plan restricted the occupancy rates of UGS, adopting a traffic light system that considered the existing epidemiological risk (30% cap for high risk, 60% cap for moderate risk) (CDMX, 2020). Consequently, residents living in high-density areas, where UGS are small or scarce, were heavily affected by these visitation caps.

5. Methods

5.1. Survey design

Due to lockdown measures and the high risk of contagion through face-to-face interviews or face-to-face surveys during the COVID-19 pandemic, we opted for an online survey (N = 1954) to evaluate the association between the frequency of UGS use and the SWB of Mexico City’s residents.

The survey was designed with input from two urban planners, three urban sector specialists, three NGO representatives, and two academics who were interviewed to gain additional insight into the factors influencing the use and perception of UGS. Interviewees were asked to describe the main drivers or inhibitors affecting UGS use in the context of mega-cities in developing countries, particularly those in Latin America. All interviews for the questionnaire design took place between March and April of 2020. The final questionnaire was translated into Spanish and consisted of questions designed to assess:

1. Sociodemographic attributes
2. UGS value and use
3. Perception of quality of UGS in participants’ neighborhoods
4. SWB pre-COVID and during COVID-19

The final survey was uploaded to Qualtrics for two pilot tests, each with five volunteers, before it was launched.

First, for the sociodemographic section of the survey, we asked respondents to indicate their gender; age range; the municipality where they live; the number of people living in their household; the household’s net income per month (by income decile); the respondent’s highest level of education, marital status, employment status; and the type of housing in which they live. We included these specific variables as all of them have been correlated with SWB in previous studies (Heckert, 2012; Kahneman et al., 2006; Kim and Jin, 2018; Yuan et al., 2018).

Second, for the value and use of UGS section of the survey, we first asked participants to rate the value of UGS as a contributor to urban quality of life using a scale from 0 to 10. We then asked if this rating had increased, decreased, or stayed the same since the pandemic started.
Following these two questions, we asked about the frequency and types of activities performed in UGS and the distance traveled to access the nearest green space. For this section, we specified that the term “UGS” encompassed parks, playgrounds, gardens, reserves, road verges, greenways, greening squares and plazas, and privately-owned public spaces (Rigolon et al., 2018b). The period following the implementation of the Healthy Distance Program was referred to in this study as the COVID period. The frequency of UGS use during the COVID period was divided into no use, use once or twice per month (sometimes), and once or more than once per week (often) as only three months had passed since the start of the lockdown measures. To be consistent with the COVID period, the frequency of UGS use pre-COVID also had three categories: rarely or never (no use), once or twice per month (sometimes), and once per week or more (often).

Third, we evaluated respondents’ perceptions of the quality of UGS in their neighborhood. We explored perceptions of quality and walking time instead of objective measures, such as the use of pedometers, following earlier studies that center on perceptions and suggest a strong correlation between these and SWB (Balram and Dragiev, 2005). Following the advice from interviewees and some recently developed tools for measuring the quality of UGS, such as the Community Park Audit Tool, the Neighborhood Green Space Tool, the Public Open Space Desktop Auditing Tool, and the QUAility INdex of Parks for Youth (Edwards et al., 2013; Gidlow et al., 2012; Kaczynski et al., 2012; Rigolon, 2017; Rigolon et al., 2018a), we decided to incorporate the following ten characteristics: 1) cleanliness and maintenance, 2) presence of good lighting, 3) a sufficient number of benches, 4) tranquility, 5) the presence of markets or street sellers, 6) the availability of toilets and wheelchair ramps, 7) large size of the area, 8) organization of cultural events, 9) police activity, and 10) the existence of facilities for children to play.

Finally, for the SWB section, we included the short version of the Warwick-Edinburgh Mental Well-being Scale (WEMWS) to evaluate SWB pre-COVID (the experience of feelings during the month prior to the pandemic) and SWB COVID (the experience of emotions throughout the two weeks before answering the survey). Though retrospective experiences have proven to be less accurate in measuring well-being than recent experiences, both assessments are considered valid in capturing and understanding feelings and life judgments (Diener et al., 2010). Past research on well-being has depended almost entirely on retrospective assessments (Kahneman et al., 2006). Therefore, we chose to include both measures.

The WEMWS is a reliable instrument used internationally to monitor SWB among the general population (Tennant et al., 2007). It has previously been used in Mexico to evaluate mental well-being in Michoacán and was found to be adequate and reliable in the Mexican context (Hoffman et al., 2017). The short version of the WEMWS consists of seven statements (see Annex 1) that respondents must evaluate on a scale from 1 to 5, with one being the lowest and five the highest score. The value assigned to SWB is the sum of the individual scores for all seven statements. Thus, the highest possible value for SWB is 35, and the lowest is 7.

5.2. Data collection

Our survey was administered via Facebook from May 26 to June 15, 2020 (20 days) through targeted advertisements. These advertisements were shown to adults (18 years and older) whose profile indicated that they lived in one of the 16 municipalities of Mexico City. We selected Facebook because it has over 81 million registered users in Mexico, making it the most-used social media application (Statista, 2019). In addition, Mexico is one of the top ten countries globally in terms of internet users: 89 million (2020), with 79% of them using internet daily (Statista, 2019).

Administering non-representative online surveys has been a valuable data collection approach to explore numerous dimensions of public perceptions, behavior, and well-being following the onset of the COVID-19 pandemic. For example, Mertens et al. (2020) have conducted an online survey (N = 439) to identify predictors of fear of the coronavirus across cross-country respondents recruited through targeted advertisements on Facebook. In Brazil, Schuch et al. (2020) have recruited 937 participants through Facebook, Twitter, WhatsApp, and researcher networks to explore the associations of moderate to vigorous physical activity and sedentary behavior with depressive and anxiety symptoms among self-isolating residents. Similarly, convenience samples recruited through social media have been used in a recent study in the U.S. on public concerns regarding COVID-19 (Nelson et al., 2020) and in a cross-country study on the effects of home confinement on eating behavior and physical activity (Ammar et al., 2020).

The survey’s advertisement was shown to 127,776 users, of which 3320 clicked the survey link. The location of respondents was corroborated with Qualtrics’ geospatial data. Sixteen surveys were eliminated because the location of respondents did not correspond to Mexico City. Given the travel ban imposed by most countries, we expected city residents to remain within the city during this period, and all respondents whose location was not in Mexico City were excluded. Of the 3304 remaining surveys, 11 surveys were eliminated because Qualtrics flagged them as potential bots due to unusual response times. Of the remaining surveys, 1954 were fully completed and included in the analysis, representing 59% of the returned surveys.

Around 87% of respondents who did not finish the survey stopped during the first section (sociodemographic data). Several Facebook users expressed security concerns in the advertisement comments section. Despite specifying that no personally identifiable information would be collected and that all responses would be confidential, people stated that they felt unsure about providing any data that might put them at risk of being targeted. Distrust with the data collection process was an issue that we tried to address by providing additional details in the advertisement; nonetheless, such skepticism could not be avoided entirely. Mistrust toward institutions and data collection processes is a common theme in Mexico (Vargas-Hernández and Estrada Zamora, 2018).

Previous studies have shown similar response rates for online surveys. For instance, a study aimed at comparing the completion rates between online and mail surveys found that the online method had a 64.8% completion rate (Barrios et al., 2010). More recently, a study examining completion rates for over 25,000 web surveys found out that surveys over 5 min usually have significantly lower completion rates, which is the case of our survey (Liu and Wronski, 2017).

Table 1 illustrates the number of survey respondents from each municipality.

| Municipality       | Respondents | Total Population (2015) |
|--------------------|-------------|-------------------------|
| Álvaro Obregón     | 148         | 749,982                 |
| Azcapotzalco       | 100         | 400,161                 |
| Benito Juárez      | 230         | 417,416                 |
| Coyocán            | 226         | 608,479                 |
| Cuahtémoc          | 25          | 199,224                 |
| Gustavo A Madero   | 208         | 1,146,477               |
| Iztacalco          | 77          | 390,348                 |
| Iztapalapa         | 210         | 1,827,868               |
| Magdalena Contreras| 58          | 243,886                 |
| Miguel Hidalgo     | 116         | 364,439                 |
| Milpa Alta         | 11          | 137,927                 |
| Tláhuac            | 159         | 361,593                 |
| Tlalpan            | 56          | 677,104                 |
| Venustiano Carranza| 71          | 427,263                 |
| Xochimilco         | 56          | 415,933                 |
| Total              | 1954        | 8,918,653               |
municipality, compared to the percentage of people from Mexico City who live in the same municipality. All municipalities are represented in the survey. According to official data from the National Evaluation Council (CONEVAL), in 2015, the three municipalities with the highest percentage of poverty in Mexico City were Milpa Alta, Xochimilco, and Tláhuac (CONEVAL, 2020). Notably, Milpa Alta and Xochimilco are underrepresented in our survey by 1 and 1.8 percentage points, respectively, while Tláhuac is overrepresented by four percentage points.

5.2. Analytical strategy

The research question centered on the extent to which UGS use is associated with the SWB of Mexico City’s residents both before and during the lockdown period resulting from the COVID-19 pandemic. We hypothesized that 1) SWB would be positively associated with UGS use for both periods; 2) respondents who used UGS more often (i.e., once or more than once per week) would have better SWB outcomes than others, and 3) the perceived quality of UGS and the distance traveled to the closest UGS will be strongly associated with SWB.

In the first part of the analysis, we used descriptive statistics to obtain information about the sociodemographic characteristics of the study participants, the value participants assign to UGS, their use of UGS, their perceived neighborhood’s UGS quality, and their SWB during the pre- and COVID periods.

For the perceived quality of neighborhoods’ UGS, respondents were asked to evaluate the importance of the presence of the ten characteristics previously mentioned, using a five-point Likert scale (1 = not important to 5 = very important) and, subsequently, rate their satisfaction with those same characteristics for the UGS in their neighborhood (1 = strongly dissatisfied to 5 = strongly satisfied). According to their average importance score, the characteristics were assigned weights so that the most important had a greater significance in the overall quality score. We assigned a 1.5 wt to the highest-rated characteristic, 1.4 to the following one, and so forth until the lowest-rated characteristic was given a weight of 0.6. Subsequently, we multiplied the score for the satisfaction with each characteristic of UGS by the weighted importance score. To obtain the final quality score, we summed the multiplied scores for each of the ten characteristics. The lowest possible grade for perceived quality of UGS was zero, and the highest was 52.5.

Weighted scores have been previously used in studies that investigate participants’ perceptions of quality and satisfaction. For instance, a study by Bradley and Speight, 2002, examining the perception of a diabetes treatment and its impact on quality of life, also included a similar process for weighting scores to measure patients’ treatment satisfaction. Likewise, Altuntas et al. (2012) evaluated the perceived service quality of hospitals in Turkey through a set of dimensions that were assigned weights according to their significance with respect to responses.

We continued with an analysis of variance (ANOVA) to distinguish if there were significant differences in people’s SWB according to their UGS use (no use, sometimes, often). Following the ANOVA, to examine the association between the frequency of UGS use (independent variable) and SWB (dependent variable), we chose a hierarchical linear regression model, also known as a multilevel model, for both periods. This decision was motivated by the hierarchical structure of the data, which has residents nested within municipalities. Multilevel models are used to consider the effects of the clustering of residents into geographic regions, allowing for the effects of regional and individual-level factors (Rundel et al., 2008).

For the multilevel analysis of SWB pre-COVID, the first model was unadjusted and included only the respondents’ frequency of UGS use in this period. The second model incorporated respondents’ individual-level characteristics: age group, gender, employment status, and income decile. Finally, the third model added municipal level characteristics. Participants’ perceptions of the quality of and distance to the UGS in their neighborhood were considered variables at the municipal level, given the homogeneity of UGS availability and quality found at this level by previous studies (Fernández-Alvarez, 2017; Pradilla, 2005). We applied the same reasoning for the analysis of SWB during the COVID period. We sought to determine if the direction of the relationship was similar during both periods and if the association of the variables changed.

To simplify the analysis, we divided respondents into three main income categories: low-income comprised of respondents from income deciles 1 to 4 (n = 677); middle-income encompassed respondents from income deciles 5 to 7 (n = 441), and high-income, which included respondents from the three highest income deciles (n = 836). Similarly, we classified time to the closest UGS into three categories: from 0 to 10 min walking, which is often considered a good accessibility threshold in literature (Xiao et al., 2017), from 11 to 20 min walking (fair accessibility), and over 21 min walking (low accessibility).

To conclude, we tested the association between maintaining or increasing SWB during COVID with UGS use through an additional hierarchical logistic regression model. For doing so, our dependent variable (sustained or increased SWB COVID) was recoded as a dummy variable, with the value 1 for people that maintained or increased their SWB during COVID, and 0 for people that saw a decrease in their SWB. Similarly, the use of UGS during COVID was recoded as a dummy (1 for use, 0 no use).

6. Results

6.1. Sociodemographic statistics

Table 2 provides a summary of the study participants’ sociodemographic characteristics. The Federal District is the entity with the highest average education level—11.1 compared to the 9.2-year national average—and income in Mexico, with an average of 15,588 pesos per person per month compared to the national average of 6252 pesos (STPS-INEGI, 2019). These averages were reflected in the results of the survey: close to two-thirds of participants reported having a tertiary education, and 26% of participants reported belonging to the highest income decile. Nonetheless, we had respondents representing all levels of income and education. The response rate was similar for all age groups, with the exception of people aged 18–24 years old, who were more likely to respond and constituted 27% of respondents. This selection issue can be explained on the one hand by the selection medium, with older adults being less inclined to use Facebook.

6.2. UGS value and use

When asked to rate the value of UGS as a contributor to urban quality of life using a scale from 0 to 10, 64.8% of respondents assigned the highest value, 10; 13.6% and 13.3% of respondents gave UGS scores of 9 and 8, respectively; and only 0.3% of respondents rated the value of UGS as 0. Over 89% of respondents reported using UGS before the COVID-19 pandemic started: 73.6% of the users reported using the UGS closest to their home more frequently, while 26.4% said they used other UGS more often. Additionally, 49.4% of people who used UGS before the COVID-19 pandemic claimed to use them for walking, which is often considered a good accessibility threshold in literature (Xiao et al., 2017), from 11 to 20 min walking (fair accessibility), and over 21 min walking (low accessibility).

We specifically asked people who stated they did not use UGS pre-COVID or used them rarely to provide a reason behind their choice. Respondents reported three main reasons: 1) safety (26.7%), 2) UGS close to them are small (24.9%), and 3) distance to UGS (18.8%).

After the Healthy Distance Program began, the number of people who reported using UGS decreased by 33.2%, with women reporting a greater decrease in use than men. For the COVID period, respondents who reported using the UGS closest to home more frequently increased...
Furthermore, 24.7% of respondents indicated that their opinion of the judged for going outside during this time, and 11.5% cited distance. contracting or spreading the disease, 19.5% of people expressed feeling importance of UGS changed after the stay-at-home order, with 98.8% considered UGS more important after COVID-19 began.

### Perceived UGS quality

The three quality characteristics of UGS that were given the highest importance rank were cleanliness and maintenance (M = 4.5, S.D. = 1.03), tranquility (M = 4.42, S.D. = 1.009) and good lighting (M = 4.35, S.D. = 1.03). On the other hand, the three green space characteristics that were given the lowest overall rating were the presence of local markets (M = 1.8, S.D. = 1.4), organization of cultural events (M = 2.9, S.D. = 1.5), and the existence of facilities for children to play (M = 3.7, S.D. = 1.4). The overall importance of security-related features was ranked higher by women. Compared with 55.4% of men, 68% of women gave good lighting the highest grade of importance, and 48.6% of women (vs. 38.7% of men) gave police presence the highest score (5).

We categorized the final quality scores into the following five groups: 1) 0–10, neighborhoods with very poor UGS quality (6.5%); 2) 10.5–20, neighborhoods with poor UGS quality (25.8%); 3) 20.5–30, neighborhoods with fair UGS quality (38.2%); 4) 30.5–40 (23.9%), neighborhoods with very good UGS quality; and 5) neighborhoods with excellent UGS quality (5.6%). The greatest number of respondents (747) indicated living in a neighborhood with fair UGS quality (Group 3). However, 127 respondents reported living in a neighborhood with UGS of very poor quality. The majority of people living in neighborhoods with very poor UGS quality belonged to Iztapalapa (16%), Gustavo A. Madero (19%), and Cuauhtémoc (10%).

### Distance to UGS

Concerning the walking time needed to reach the closest UGS from home, the descriptive results show that roughly 70% of respondents live within a 10 min walk from a green space, 15.5% of respondents can access a green space after walking 11–20 min, and 6.4% have to walk from 21 to 30 min to reach the closest green area. Notably, 133 (6.8%) participants indicated having to walk over 30 min to reach the nearest green space. Almost half of the people in this last group came from only three municipalities: Tlalpan (17%), Iztapalapa (15%), and Álvaro Obregón (11%). Of the group which specified having to walk more than 30 min to arrive at any green space, 13.4% also reported that their closest UGS was of very poor quality.

### SWB

The distribution of SWB pre-COVID and COVID is shown in Fig. 1. SWB pre-COVID shows an asymmetric distribution, where most responses are above the median. This asymmetry is less pronounced in SWB during COVID, showcasing the decline in subjective well-being scores for the COVID period.

The internal consistency of the WEMWBS was tested for both periods, pre- and COVID, through the Cronbach’s alpha reliability coefficient. WEMWBS demonstrated strong internal consistency and a high Cronbach’s alpha of 0.881 for the pre-COVID period and 0.909 for the COVID period.

### Differences in SWB during COVID according to UGS use

A one-way ANOVA was conducted to determine if SWB during the COVID period was different for people who used UGS (n = 1148) and those who did not (n = 808). The results for the ANOVA analysis indicate a statistically significant difference between groups [F (1,953) = 18.14, p < 0.0001]. In addition, when breaking down respondents by groups according to the frequency of UGS use into often (n = 1066), sometimes (n = 80), and no use (n = 808), the results also revealed a statically significant difference in SWB COVID between these three groups [F (1,953) = 10.31, p < 0.0001]. Using Eta-squared, 1.05% of the total variance is accounted for by the frequency of UGS use during COVID.

Moreover, a Tukey post-hoc test revealed that SWB during the COVID period was statistically significantly higher for respondents who used UGS often compared to those who did not use UGS, the control group (1.74 ± 0.39, p = 0.000). However, there were no statistically
significant differences between respondents who use UGS sometimes and those who did not use UGS (0.54 ± 0.97, p = 0.84), or respondents who used UGS often and those who used UGS sometimes (1.20 ± 0.96, p = 0.42).

6.7. Association between the use of UGS with respondents’ SWB

Results for the multilevel mixed-effects linear regression models of SWB pre-and pos-COVID are shown in Table 3 and reveal that the effect of using UGS (often) on respondents’ SWB was positive and significant for Models 1, 2, and 3 in both periods. Meanwhile, the relationship between SWB and UGS use (sometimes) was non-significant or weak during both periods, indicating that only regular use of these spaces is linked to a higher SWB.

When all other variables were held constant, the results indicate that being a woman was moderately negatively associated with SWB during the COVID period (–0.9 Model 2 and –0.8 Model 3). The negative association was not observed for the pre-COVID period. During both periods, age had a significant positive relationship with SWB for Models 2 and 3. While the employment status of both groups of unemployed people (those who are and those who are not looking for a job) had a significant negative association with SWB during the COVID period, this relationship was only prominent for the unemployed group looking for a job in the pre-COVID period (–1.8 Model 2 and -1.7 Model 3). Our results also show a positive association between high-income and SWB for both periods. This relationship did not hold for middle-income in the COVID period. Even so, mid-income was positively associated to SWB in the pre-COVID period (1.4 Model 2 and 1.22 Model 3).

The results for municipal level variables indicate a robust positive relationship between the perceived neighborhood’s UGS quality and SWB during both periods. As we hypothesized, higher perceived quality of UGS at the municipal level is associated with better SWB outcomes. On the other hand, the time needed to reach the closest UGS had no significant association to SWB for the COVID period and only had a significant negative association for the low access group in the pre-COVID period (–1.30).

Finally, the analysis for the sustained or increased SWB COVID included the 1954 respondents in the sixteen different municipalities of Mexico City (see Table 4). When testing if maintaining or increasing SWB during the COVID period was associated with UGS use, this association proved to be positive in the odds ratios (1.48 for Model 1, 1.47 for Model 2, and 1.46 for Model 3). As hypothesized, UGS use during the pandemic is related to either sustaining or increasing SWB during COVID.
The positive association between UGS use and SWB did not hold for respondents and urban green spaces (UGS) use for the pre- and COVID periods, online survey applied to adults living in Mexico City (n = 1954) from May 26 to June 15, 2020.

7. Discussion

The results of this exploratory study shed light on the value of UGS during a time of crisis. Similar to evidence from other cities around the world, our results suggest that regular exposure to UGS (once or more than once a week) has a positive association with SWB outcomes not only in the pandemic context but also under more normal conditions (Hedblom et al., 2019; Venter et al., 2020). UGS use decline could have detrimental implications for residents’ physical and mental health, particularly for populations living in underserved and densely populated areas. Consequently, public awareness campaigns that encourage UGS use, following social distancing guidelines, are needed to sustain the population’s SWB while containing the spread of the pandemic (Cole et al., 2020).

Notably, among the individual-level factors that were examined, age had a positive association with SWB. Results from an online survey aimed at evaluating SWB factors during the pandemic in Spain also indicate that people in older age groups had better SWB outcomes than those in younger age groups.

Our findings suggest that regular exposure to UGS (once or more than once a week) has a positive association with SWB outcomes not only in the pandemic context but also under more normal conditions. Despite the inclination of respondents to overestimate their positive feelings of remembered experiences (Diener et al., 2010), including the assessment of SWB pre-COVID allowed us to observe that there is a positive tendency regarding its association to UGS use. Additional studies on the association of SWB with UGS use are needed outside of the pandemic context to obtain a more in-depth understanding of this relationship. Nonetheless, our results demonstrate that encouraging UGS use when the level of collective stress has increased could counteract the adverse effects of a pandemic on mental health, leading to a healthier population (Slater et al., 2020).
those in younger age groups (Gonzalez-Sanguardino et al., 2020). The difference in outcomes can be partially explained because young people’s economic stability, such as employment rates, is predominantly affected during an economic crisis, such as the one resulting from the COVID-19 pandemic (Shanahan et al., 2020). Additional studies have shown that young people have experienced more severe lifestyle disruptions since the pandemic began, increasing their level of stress and sense of hopelessness (Shanahan et al., 2020). Increasing UGS use amongst younger age groups is therefore critical.

While some studies have found a positive relationship between well-being and distance to the nearest UGS (McCormack et al., 2010; Paquet et al., 2013), others, including this study, find no significant association between distance to the nearest UGS and SWB during the pre-COVID or COVID periods (Hillsdon et al., 2006; Hobbs et al., 2017; Sugiyama et al., 2013), except for the low access group during the pre-COVID period. This finding contradicts our initial hypothesis that the time needed to reach the nearest UGS would significantly correlate with SWB at the municipal level. Even so, almost one-fifth of respondents who stopped using UGS during the COVID period cited distance as the main impediment. Although distance may not be directly associated with SWB, it could be a critical factor in predicting UGS use. Evidence about the factors that influence UGS use is inconclusive and more studies on that matter are needed (Wan and Shen, 2015).

Previous studies in Latin American cities, including Mexico City, have suggested that UGS quality is strongly associated with SWB, with residents preferring to use green areas that have ample vegetation, numerous benches, and that are clean and well maintained (Ayal-Azcarra et al., 2019; Reyes Pácke and Figueroa Aldunce, 2010). This is partially consistent with our results. On average, respondents reported that they value cleanliness and maintenance, tranquility, and good lighting most highly among the elements related to UGS quality. Interestingly, cleanliness, maintenance, and good lighting are often associated with safety (Mayen Huerta et al., 2021; Sugiyama et al., 2015), which seems to be a priority for UGS use in Mexico. Meanwhile, police presence was ranked sixth in order of importance. This can be explained by the lack of trust in the police among citizens of Mexico, as police are often perceived as a threat or corrupt, especially among young people and indigenous groups (Blanco, 2013; Mayen Huerta et al., 2021).

Our results indicate that neighborhoods with UGS that are perceived to be of greater quality have a more positive relationship with SWB than those of lower perceived quality (Feng and Astell-Burt, 2017). Evidence from the last decade also points out that well-being has a stronger association with UGS quality rather than walking distance (Bell et al., 2014; Francis et al., 2012; Giles-Corti et al., 2005; McCormack et al., 2010; Paquet et al., 2013; Wolch et al., 2014). For instance, a multilevel analysis by Van Dillen et al. (2012) that focuses on Dutch neighborhoods concludes that well-being is more strongly and positively correlated with the quality of UGS than with the distance to reach them. Some researchers have even suggested that it is more effective to incorporate higher quality features in existing UGS rather than increasing their number to improve well-being outcomes across vulnerable groups in a

| UGS use during COVID               | Model 1 | Model 2 | Model 3 |
|-----------------------------------|---------|---------|---------|
| stopped using UGS                 |         |         |         |
| kept or started using UGS         | 1       | (1.23–1.78)*** | (1.22–1.76)*** | (1.21–1.76)*** |
| Gender                            |         |         |         |
| Male                              | 1       |         |         |
| Female                            | 0.828   | (0.69–1.00) ** | 0.831   | (0.69–1.00) ** |
| Age group                         |         |         |         |
| 18–34                             | 1       |         |         |
| 35–44                             | 0.945   | (0.71–1.26) | 0.940   | (0.70–1.26) |
| 45–54                             | 1.189   | (0.88–1.60) | 1.192   | (0.88–1.60) |
| 55–64                             | 1.473   | (1.10–1.97) *** | 1.488   | (1.11–1.99) *** |
| 65+                               | 1.578   | (1.18–2.12) *** | 1.573   | (1.17–2.11) *** |
| Employment status                 |         |         |         |
| Employed                          | 1       |         |         |
| unemployed (not looking)          | 0.783   | (0.62–0.98) ** | 0.783   | (0.62–0.98) ** |
| unemployed (looking)              | 0.810   | (0.60–1.10) | 0.809   | (0.58–1.09) |
| Income                            |         |         |         |
| Low-income                        | 1       |         |         |
| Middle-income                     | 0.812   | (0.63–1.04) | 0.806   | (0.63–1.04) ** |
| High-income                       | 0.924   | (0.73–1.16) | 0.914   | (0.72–1.16) |
| Municipal level factors           |         |         |         |
| UGS quality                       |         |         |         |
| Very poor quality                 | 1       |         |         |
| Poor quality                      | 0.998   | (0.67–1.48) |         |         |
| Fair quality                      | 1.115   | (0.76–1.64) |         |         |
| Good quality                      | 1.098   | (0.73–1.64) |         |         |
| Excellent quality                 | 1.319   | (0.78–2.22) |         |         |
| Time to closest UGS (min)         |         |         |         |
| 0 to 10                           | 1       |         |         |
| 11 to 20                          | 1.119   | (0.87–1.44) |         |         |
| 21+                               | 1.047   | (0.80–1.37) |         |         |

Note: significance levels ***p < 0.01, **p < 0.05, *p < 0.1.
Model 1: unadjusted.
Model 2: model 1 adjusted for respondents’ gender, age group, and employment status.
Model 3: model 2 adjusted for municipal characteristics.
McKelvey & Zavoina’s R-squared, Model 1: 0.011 (p = 0.000).
McKelvey & Zavoina’s R-squared, Model 2: 0.035 (p = 0.000).
McKelvey & Zavoina’s R-squared, Model 3: 0.037 (p = 0.000).
given city (Rigolon and Németh, 2016; Sugiyama et al., 2015). Nonetheless, it is worth noting that in our study, UGS perceived quality was not significantly associated with sustained or increased SWB during COVID, indicating that UGS quality may not be an important predictor to maintaining or increasing people’s SWB during a pandemic. The latter suggests that UGS use is more important.

As far as differences between municipalities, we found that Iztapa-lapa, where some of the poorest segments of the population are concentrated, has on average the lowest scores for UGS quality, as well as the lowest SWB scores. In contrast, Benito Juarez, which has the lowest poverty concentration levels, good infrastructure, and education levels, has the highest scores for UGS quality (CONEVAL, 2019). This stratification pattern reinforces marginalization (Haq, 2011) and possibly has impacted health outcomes during the pandemic.

8. Strengths and limitations

The present study has three main strengths. First, to the best of our knowledge, this is the first study to examine the association between the frequency of UGS use and SWB during the lockdown period associated with the COVID-19 pandemic in Latin America. Second, we included variables at the individual and municipal levels in our model. Doing so made it possible to adjust the associations between individual-level variables and SWB outcomes for characteristics at the municipal level. Third, because we asked respondents about their behavior and feelings toward UGS before the pandemic, we could examine the direction (positive) of the association between UGS use and SWB pre-COVID, even if the intensity of the association had some margin of error due to its retrospective nature (Kahneman et al., 2006).

As far as limitations, we acknowledge that the use of internet-based data collection tools can be biased against marginalized population groups since this method excludes residents who do not have internet access at home. We also recognize that there may be a selection bias, with people more interested in the subject of UGS participating more actively. Additionally, older adults, who are often less technologically savvy, are also underrepresented in our survey. Nonetheless, given the unusual circumstances in which we conducted this study, we concluded that an online survey was the safest and most reliable method. It could present relevant and timely insights about UGS use and its association with SWB for large population segments. Additionally, online surveys diminish respondents’ self-consciousness, as they do not interact with the interviewer, who may unintentionally bias their opinion (Salazar, 1990).

Moreover, due to ongoing concerns about safety issues in Mexico City, we recognize that it is challenging to ask respondents for more specific information, such as their exact age, income, or the neighborhood where they live, which would add more depth to the analysis. We tried to mitigate this fear by asking for non-identifiable information; nonetheless, we understand that the inclusion of sociodemographic questions limited participation in this study.

Finally, we realize that the measures for quality and distance we used are based on perceptions, not objective criteria, which might influence the study results due to respondent bias. However, perceptions can also provide important information, as they are more frequently connected to behavioral changes than objective characteristics (Maas et al., 2008). Further studies contrasting our results with objective measures of distance and quality features are needed to examine whether respondents’ perceptions align with objective data. Lastly, it is important to note that as this is a cross-sectional study, it is not possible to derive causality. Other factors beyond UGS have clearly impacted SWB during the pandemic; nonetheless, UGS use appears to play an essential role in mitigating some of the mental health consequences of COVID-19.

9. Conclusions

The impact of UGS on the quality of urban life is a vital issue that has implications for urban planning, policymaking, and public health. In recent months, during which individuals’ mental health has deteriorated due to the COVID-19 pandemic, UGS have also become relevant as a resilience tool. Therefore, it is critical to understand the relationship between UGS use and SWB to better design future measures to tackle the negative consequences of a pandemic and build healthier cities.

This cross-sectional study found evidence to support the theory that frequent UGS use is associated with better SWB outcomes in Mexico City, with positive associations observed across all municipalities of the city for both the pre-and COVID periods. The study’s findings suggest that frequent use of UGS can be considered a path to promote public health and increase self-reported SWB, particularly during a pandemic. These results also support the theory that the quality of UGS acts as a correlate of SWB.

Our results also indicate that, in the event of a future pandemic, it is essential to keep UGS open as they provide valuable support for maintaining or increasing self-reported SWB. Furthermore, authorities in Mexico City should consider encouraging regular UGS use, once or more than once a week, as a policy tool not only to counteract the adverse effects that lockdown measures have on people’s mental health but as an overall measure to improve SWB.

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Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Psychology Health and Applied Sciences Human Ethics Sub-Committee of the University of Melbourne (Ethics ID, 2056618, approved May 8, 2020).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2021.102606.

Annex 1
Short version of the Warwick-Edinburgh Mental Well-Being Scale

| Statement                                      |
|-----------------------------------------------|
| 1 I’ve been feeling optimistic about the future |
| 2 I’ve been feeling useful                      |
| 3 I’ve been feeling relaxed                    |

(continued on next page)
### Annex 1 (continued)

| Statement |
|-----------|
| 4 | I’ve been dealing with problems well |
| 5 | I’ve been thinking clearly |
| 6 | I’ve been feeling close to other people |
| 7 | I’ve been able to make up my mind about things |

Source: [https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/](https://warwick.ac.uk/fac/sci/med/research/platform/wemwbs/)
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