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Research Paper

Characteristics of urban parks and their relation to user well-being

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ABSTRACT

Urban green spaces have been associated with the well-being of urban citizens. However, there is limited evidence documenting those characteristics that green spaces must have to provide real benefits. We evaluated perceived characteristics of green spaces and environmental components of urban parks as public urban green spaces, relating them to the well-being of their visitors. We surveyed users of nine parks in México City looking for usage patterns and their effect on citizen well-being. Results show a close relationship between patterns of visitor use and urban parks components such as distance, tree abundance, safeness, playground qualities and cleanliness. Variables explaining the well-being provided by the park to the visitors are trustworthy neighbors, trustworthy visitors and share it with well-known people. This implies that the perception of the park affects their use and provides different attributes on the users' well-being. Therefore, to increase visitor well-being, it is important to enhance characteristics that favor social interaction. These results can be useful for strategies in urban parks management.

1. Introduction

Urban green spaces are associated with the sustainability of cities due to the wide range of ecosystem services they provide, such as carbon capture, reduction of air pollution, biodiversity maintenance, aquifer recharging, and climate regulation (Jenerette et al., 2011). However, the relationship between urban nature and human well-being usually goes unnoticed, especially in cities were planners are more attached to economic growth than social interactions. At the individual level, the lack of contact with natural spaces is evident in an increase in the incidence of mental and physical illnesses (Van Den Berg et al., 2015). In addition, the use of green areas offers sun exposure, which has important medical implications such as calcium fixation through the synthesis of vitamin D (Walch et al., 2005). This, in turn, has consequences for emotional mood, circadian cycle regulation (activity and sleep patterns) and even neurological health (Heerwagen, 2009). Similarly, living in places with walkable parks can positively influence the longevity of adults living in cities, regardless of their age, sex, marital status, and socioeconomic status (Takano, Nakamura, & Watanabe, 2002). This relationship is mediated by the use of urban green spaces as a driving area for physical activity (Richardson, Pearce, Mitchell, & Kingham, 2013). Finally, psychological benefits caused by the use of green areas have been demonstrated, described as "the intangible benefits associated with relaxation, calmness, the creation of a balanced feeling, reduction of anxiety, tension, depression, fatigue, and vigor" (Lafortezza, Carrus, Sanesi, & Davies, 2009).

The appropriation of public spaces can lead to a greater degree of social cohesion through the promotion of attachment, residential satisfaction, as well as the increase of social contact (de Haan & Zoomers, 2005). Therefore, urban green spaces, when acting as places to rest and to interact with others, promote high-quality social relationships.

Despite these advantages, the simple presence of nature in parks is not automatically beneficial or attractive to the population. There is evidence that these sites must have particular characteristics that vary according to the context of every community in order to offer real benefits (McCormack, Rock, Toohey, & Hignell, 2010; Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013). In cities, the design and characteristics of green spaces facilitate (or hinder) their use (Gatersleben & Andrews, 2013; Pazhouhanfar & Mustafa Kamal, 2014). If quality of the green areas is important for these sites to offer real benefits, the characteristics of the urban parks are a keystone feature to consider. For example, park size and park accessibility are directly related to park use and to the increase in people's physical activity (Giles-Corti et al., 2005).

If the green areas are able to affect human well-being, then management strategies of these spaces may affect differentially the quality of life for people. Therefore, understanding the characteristics of the urban parks as promoters of well-being becomes relevant as they can change their perception and use. In this sense, this study analyses the relationship between the perceived spatial (size, number, and distance to the park), infrastructure and environmental components of three size-categories of urban parks in Mexico City and their use. We analyze the use of these spaces for promoting well-being, considering the relationship with three dimensions: health, community, and satisfaction

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Table 1
Size and location of the urban parks studied.

Size category (ha)	Urban park	Location in Mexico City		m^2	ha
		District	Neighborhood		
Small (< 1)	Playground Chicoasen	Tlalpan	Heroes de Padierna	3119	0.31
	Oasis Park	Xochimilco	Amp. Tepepan	4430	4.43
	Garden of Art	A. Obregon	San Angel	9030	9.03
Medium (1.1–4.5)	Masayoshi Ohira Park	Coyoacan	Country Club	10,988	1.09
	Cri-Cri Park	Iztapalapa	S. C. Meyehualco	32,070	3.20
	Lincoln Park	M. Hidalgo	Polanco	44,497	4.44
Large (> 4.6)	Deer's Park	B. Juarez	Portales Norte	82,036	8.20
	Mexico Park	Cuahutemoc	Hipodromo Condesa	88,000	8.80
	Sprouting Fountains Park	Tlalpan	Fuentes Brotantes	100,000	10.0

with life. These dimensions may underlie the mechanisms that mediate the relationship between green areas and well-being. Mechanisms include recovery from stress and attention fatigue, encouragement of physical activity, and facilitation of social contact. The relationship between these variables will help to elucidate the contribution of the characteristics of urban green areas to human well-being.

1.1. But, what is well-being?

The concept of well-being has been associated with numerous personal aspirations that change according to cultural and historical context. However, based on our review of conceptualizations, this paper proposes that well-being can be described as "a state of the human being that arises when good health is maintained (physical and mental), social relationships of trust and cooperation are established, and individuals and groups can act to pursue their goals so that they are satisfied with their lives". For this work the key components of people's well-being are: 1) health (physical and mental), 2) social relationships of trust and cooperation, and 3) satisfaction with life. These three dimensions of well-being can be affected by the presence and quality of the green areas, which lead us to the following hypotheses:

1) There is a differential well-being between people who live close to a park and those who do not.
2) There is a relationship between the components of urban parks (spatial, infrastructure and environmental), their pattern of use, and the well-being of their users.

2. Methods

2.1. Study site

The metropolitan area of Mexico City hosts close to 21 million inhabitants and is expected to have more than 24 million inhabitants by 2035 (United Nations, 2018). This number is more than three times higher than 50 years ago when the city had almost 7 million people (Secretaría de Industria y Comercio Dirección General de Estadísica, 1970). The fast growth has generated an intense process of urbanization that has physically and socially transformed the city, and in the process, urban green spaces have been relegated.

In addition, the model of urban development used by government has favored infrastructure (housing and roads) in green spaces. For example, between 2013 and 2016 close to 10,144 trees in public areas were cut down for public and private infrastructure (Ayala & Moysen, 2016).

A second factor threating green spaces in Mexico City is the overestimation of urban greenery. For example, in 2009 the Environmental and Land Planning Agency (PAOT) concluded that inhabitants of Mexico City have 14.4 m^2 of green space *per capita* (per person) (PAOT, 2010). This falls above international guidelines that request a minimum of 9 m^2 *per* inhabitant. However, this calculus considers green space to be "*any surface covered with vegetation*", including categories such as private gardens, green roofs, planters and ridges (PAOT, 2010). Defining green space in this way without considering other attributes such as size, accessibility, or distance, homogenizes the information. When spatial heterogeneity in the distribution of green spaces is not considered, the daily experience of citizens in many areas is poorly characterized. Public green spaces in Mexico City are insufficient and unequally distributed among municipalities favoring those higher income regions (Álvarez, 2012). Recent neighborhood improvement policies are not enough to reduce patterns of social segregation or to address stronger neighborhood problems such as insecurity. On the contrary, the selective improvement of parts of the city is encouraged (Delgadillo Polanco, 2012), widening the gap between citizens living in different parts of the city.

For this study, we examined nine urban parks in Mexico City equally distributed into three size categories: small, < 1 ha; medium, 1.1–4.5 ha; and large, > 4.6 ha, based on the classification of Ballester-Olmos and Morata (2001). The selection of each park was made randomly from a pool of 1353 facilities in the city, using stratified sampling, which aims to represent each size category (Table 1). The park characteristics are shown in Table 2 and the Supplementary 1 shows a picture of each of the parks.

2.2. Evaluation of the use of green areas as a promoter of well-being among its visitors

The survey to evaluate park visitor's perceptions of spatial,

Table 2
Variables that integrate the three components evaluated of the nine urban parks studied.

Component	Variable
Spatial	Size
	Distance
	Accessibility
Infrastructure/Services	Walking trails
	Illumination
	Graffiti
	Exercise equipment
	Playground equipment
	Cleanliness
	Seats
	Safety
Environmental	Abundance of trees
	Height of trees
	Greenness of landscape
	Birds song
	Biodiversity
	Naturalness degree
	Noxious fauna

infrastructure/services, environmental components (Table 2) and well-being can be found in Supplementary 2. This survey requested information about 1) personal information (age, sex, and living area), 2) park usage, (frequency and duration of visits), and 3) park conditions (spatial, environment and infrastructure). In the last section of the survey, the respondents were asked to estimate their general state of well-being through self-perceived physical and mental health status, level of activity, trust in their neighbors and in the people attending the park and satisfaction with life. All responses were answered on a scale from 0 to 10, being 10 the highest possible value.

The sample of the participants was limited to adults (≥18 years old). The subjects were invited to participate in a person-to-person survey while they spent leisure time in different places. Following the recommendation of Chiesura (2004), to encourage participation we gave a childrens book to study participants. This was not conditioned on any type of response (Chiesura, 2004). Surveys in all the sites visited were collected Monday to Friday from 4 to 7 pm, because preliminary data suggested that these were peak-visiting hours.

This survey allowed each person to rate well-being in their own terms, using personal criteria and aspirations matching their needs. The choice of this method was based on the concept that well-being should always be considered complex and subjective since it is a unique experience of each subject and only the subject is able to report it (Rojas, 2014). Therefore, we used a scale that represents the well-being that people experience. In this study, the information was obtained from a general question such as: "Recently, from 0 to 10, how happy are you with your life?". The temporary dimension was necessary to generate a global analysis of their situation at a specific time. To answer this question, the interviewee made an excerpt of their wellness experiences.

2.3. Statistical analyses

To compare the perceived characteristics and the time of visit across size categories, we used nonparametric Kruskall-Wallis test followed by Dunn's test corrected for multiple comparisons as reported elsewhere (Diaz et al., 2018). We compared the proportion of users according to urban parks size with Chi-square test, and adjusted cumulative Gaussian curves for the number of visits per month to test whether the visitors from each size category differed in their frequency of use of the facilities.

We used multivariate analysis to evaluate the association among the three components for the urban parks. The spatial, infrastructure/services, and environmental factors that clustered each size category of urban parks were defined based on a Principal Component Analysis (PCA) as reported elsewhere (Aguirre-Benítez et al., 2017).

To examine the linear relationship between two sets of variables we used Canonical Correlation Analysis (CCA). CCA is a multivariate technique useful for finding how the X variables (independent or predictive variables) predict the outcome or dependent variables (Y variables); in our case, components vs. the pattern of use, the pattern of use vs. well-being, and components vs. well-being. The goal of CCA is finding linear combinations of the X and Y variables that best express the correlations between the two sets. The linear combinations are called the canonical variables and the correlations between pairs of canonical variables are called canonical correlations (Afifi, May, & Clark, 2011). From the same method, we constructed CCA models in a two-way process: the first step included all the pre-defined variables for each set of X and Y outcomes, from which only those with standardized coefficients ≥ 0.10 were selected (Supplementary Figs. 2, 3A and 4). For the second step, the final model was constructed and the correlations visualized in a conceptual model (Supplementary Figs. 2, 3B and 5).

Multivariate analyses were performed on SAS University Edition (SAS Institute, USA), whereas univariate analysis and graphs were done in Prism 7 (GraphPad Inc. Software, USA). In all cases, we defined statistical significance as $p < 0.05$.

Table 3
Comparison of the perceived characteristics of three size categories of urban parks studied.

Components	*Size category of urban parks			p value
	Small (n = 61)	Medium (n = 120)	Large (n = 157)	
Spatial				
Area	3.05 ± 2.04^{c}	6.69 ± 2.61^{b}	7.91 ± 1.81^{a}	< 0.0001
Distance	3.16 ± 3.29^{b}	5.72 ± 3.86^{a}	5.05 ± 3.87^{a}	0.0001
Accessibility	0.85 ± 0.51^{b}	1.59 ± 1.90^{a}	1.70 ± 1.66^{a}	0.0020
Infrastructure and services (per 1000 m^2)				
Walking trails	7.50 ± 1.42^{b}	8.82 ± 1.13^{a}	7.87 ± 2.07^{b}	< 0.0001
Illumination	4.09 ± 1.80^{b}	6.80 ± 2.95^{a}	6.92 ± 2.60^{a}	< 0.0001
Graffiti	4.27 ± 2.65^{a}	2.01 ± 2.65^{b}	1.71 ± 2.73^{b}	< 0.0001
Exercise eqpt.	6.04 ± 3.13^{a}	5.11 ± 3.38^{b}	6.22 ± 2.83^{a,b}	0.0107
Playground eqpt.	6.34 ± 1.77^{b}	7.44 ± 2.04^{a}	7.00 ± 2.91^{a,b}	0.0176
Quality of eqpt.	6.18 ± 2.53^{b}	8.36 ± 1.53^{a}	6.99 ± 2.83^{a,b}	< 0.0001
Cleanliness	5.22 ± 2.34^{b}	7.40 ± 2.92^{a}	7.07 ± 2.62^{a}	< 0.0001
Seats	6.04 ± 1.45^{b}	7.38 ± 1.58^{a}	7.15 ± 2.92^{a}	0.0008
Safety	5.08 ± 1.67^{c}	7.80 ± 2.45^{a}	6.72 ± 2.54^{b}	< 0.0001
Environmental				
Tress abundance	6.50 ± 1.71^{c}	8.22 ± 2.27^{b}	9.19 ± 1.25^{a}	< 0.0001
Height of trees	7.14 ± 1.84^{c}	8.90 ± 1.25^{b}	9.32 ± 1.03^{a}	< 0.0001
Greenness	6.44 ± 1.67^{c}	7.84 ± 2.14^{b}	9.01 ± 1.43^{a}	< 0.0001
Naturalness degree	5.00 ± 2.02^{c}	7.48 ± 2.00^{b}	8.30 ± 1.59^{a}	< 0.0001
Biodiversity	4.24 ± 2.50^{b}	6.87 ± 2.31^{a}	7.43 ± 2.12^{a}	< 0.0001
Birds song	6.01 ± 2.41^{b}	8.31 ± 1.38^{a}	7.96 ± 2.35^{a}	< 0.0001
Noxious fauna (rats)	0.09 ± 0.56^{b}	0.36 ± 1.51^{b}	3.08 ± 3.96^{a}	< 0.0001

* Small, < 1 ha; medium, 1.1–4.5 ha; and large, > 4.6 ha.

3. Results

3.1. Comparison and multivariate integration of the perceived characteristics of urban parks

Visitors rated small-sized parks with the lowest score for the perceived area (3.05 ± 2.04) according to a 0–10 score in the spatial component. This contrasted significantly with the scores of larger urban parks. In comparison with visitors of small-sized urban parks, users from medium and large facilities reported a significantly higher mean number of urban parks that were accessible to their homes (1.59 ± 1.90 and 1.7 ± 1.66, respectively). Regardless of the size of the urban park, between 21.3 and 32.5% of the users had no access to a green area from a walkable distance from their homes. However, 43.3–78.6% of the visitors reported the accessibility to 1 or 2 urban parks near their homes. Finally, when contrasted to medium and large parks, the users of small-sized parks indicated a closer distance to an urban park (Table 3).

Based on a score from 0 to 10, users rated their perceived acceptance in quality and quality (lowest to highest) of the available infrastructure/services component of the parks. The results showed that, among users, the perception of such characteristics varied according to the size category of urban parks (Table 3). Users of medium and large urban parks scored the illumination, cleanliness, seats, and the safety with higher values (range 6.80–7.80). In contrast, except for graffiti (4.27 ± 2.65) and exercise equipment (6.04 ± 3.13), users of small-sized urban parks rated these places with the lowest scores for all other characteristics of the infrastructure/services component (range 4.09–7.50).

Users of large urban parks rated with the highest scores the abundance and height of trees, the greenness of landscape, and the

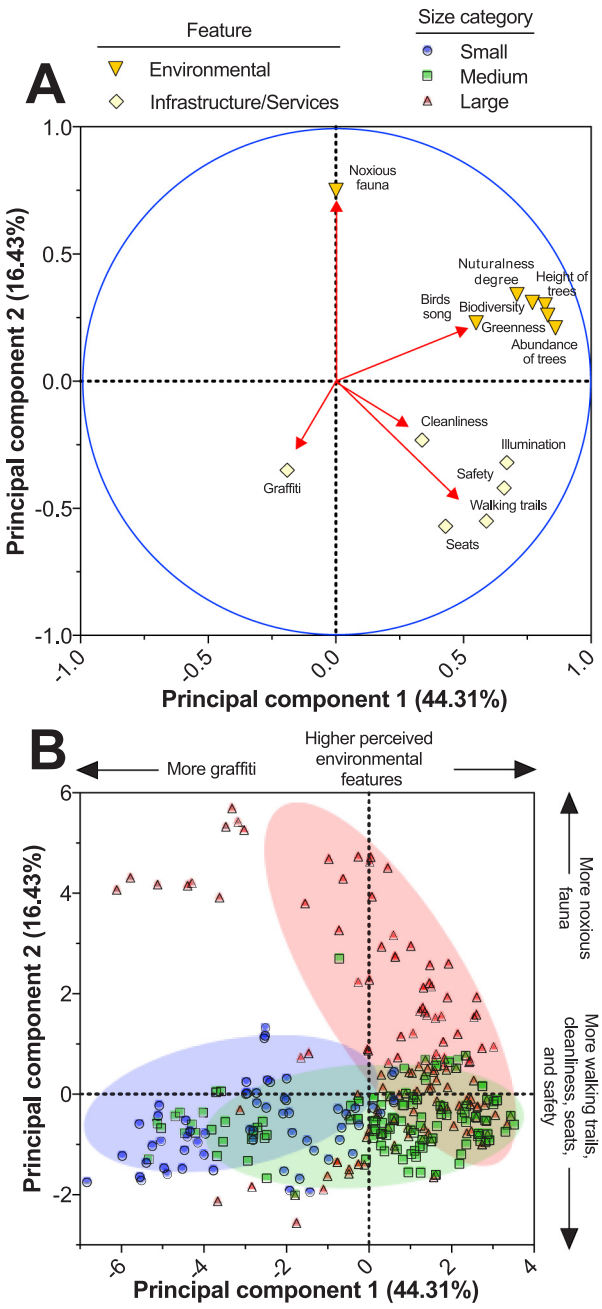

Fig. 1. Patterns of association of the infrastructure and environmental components of three size-categories of urban parks. A) Outcomes loadings for the two principal components that explained 60.74% of the total variation, and B) Individual scores for the small, medium, and large parks according to PC axis 1 and 2. Note that the main perceived features that separated large and small urban parks were a larger size, a higher number of trees, a higher greenness, higher biodiversity, a better illumination, higher cleanliness. To define groups, 95% confidence prediction ellipses were drawn.

naturalness degree of the parks (range 8.30–9.32) in the environmental component. Users of small parks gave them with low values for biodiversity (4.24 ± 2.50) and birds song (6.01 ± 2.41) in comparison to larger parks. Finally, users of large-sized parks scored them significantly higher for noxious fauna (rats, 3.08 ± 3.96) in comparison to the other two categories (Table 3).

The main characteristics of urban parks separated into environmental or infrastructure features according to the two first main axes of the principal component analysis (PCA), which explained in

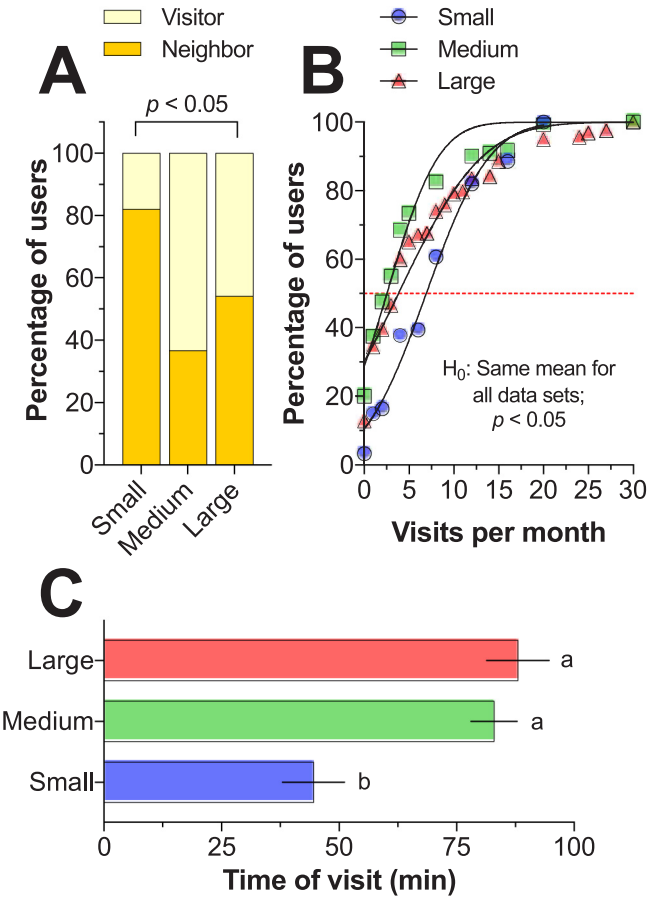

Fig. 2. A) Comparison of the percentage of users (neighbor or visitor) who attend the different sizes of parks; B) Comparison of the visits per month of the users from the three size categories of urban parks; and C) Comparison of the time of permanence of the users from the different sizes of parks. In B, a non-linear Gaussian fit was adjusted to the data to compare with an extra sum-of-squares F test whether the visitors from all size categories had the same mean of visits per month.

conjunction 60.74% of the total variation (Fig. 1A). The separation was due to the higher scores that users assigned to medium and large urban parks; therefore, PC1 defined the separation mainly based on the environmental component, whereas PC2 segregated medium and large urban parks based on perceived infrastructure (Fig. 1B). The presence of more noxious fauna in large urban parks and the higher score for graffiti in small-sized parks contributed to separate parks.

3.2. Patterns of use by size

In small parks, 82% of the interviewed persons lived in the neighborhood around the park. Such trend contrasted significantly with the 37% and 54% of neighbors that visited medium and large parks. In these two categories, there were more visitors from different neighborhoods (Fig. 2A). Users of small-sized parks visited them more frequently (6.93 ± 5.53 visits per month), compared to users of medium or large urban parks (2.54 ± 4.50 and 3.83 ± 7.33 visits per month, respectively [Fig. 2B]). Users in small urban parks spent significantly less time during a visit (44.5 ± 51.6 min per visit) in comparison to the larger parks in which users spent between 82.9 and 88.0 min on average (Fig. 2C).

3.3. Pattern of use of urban parks and their association with the components

As depicted in Fig. 3A, there were nine characteristics included in

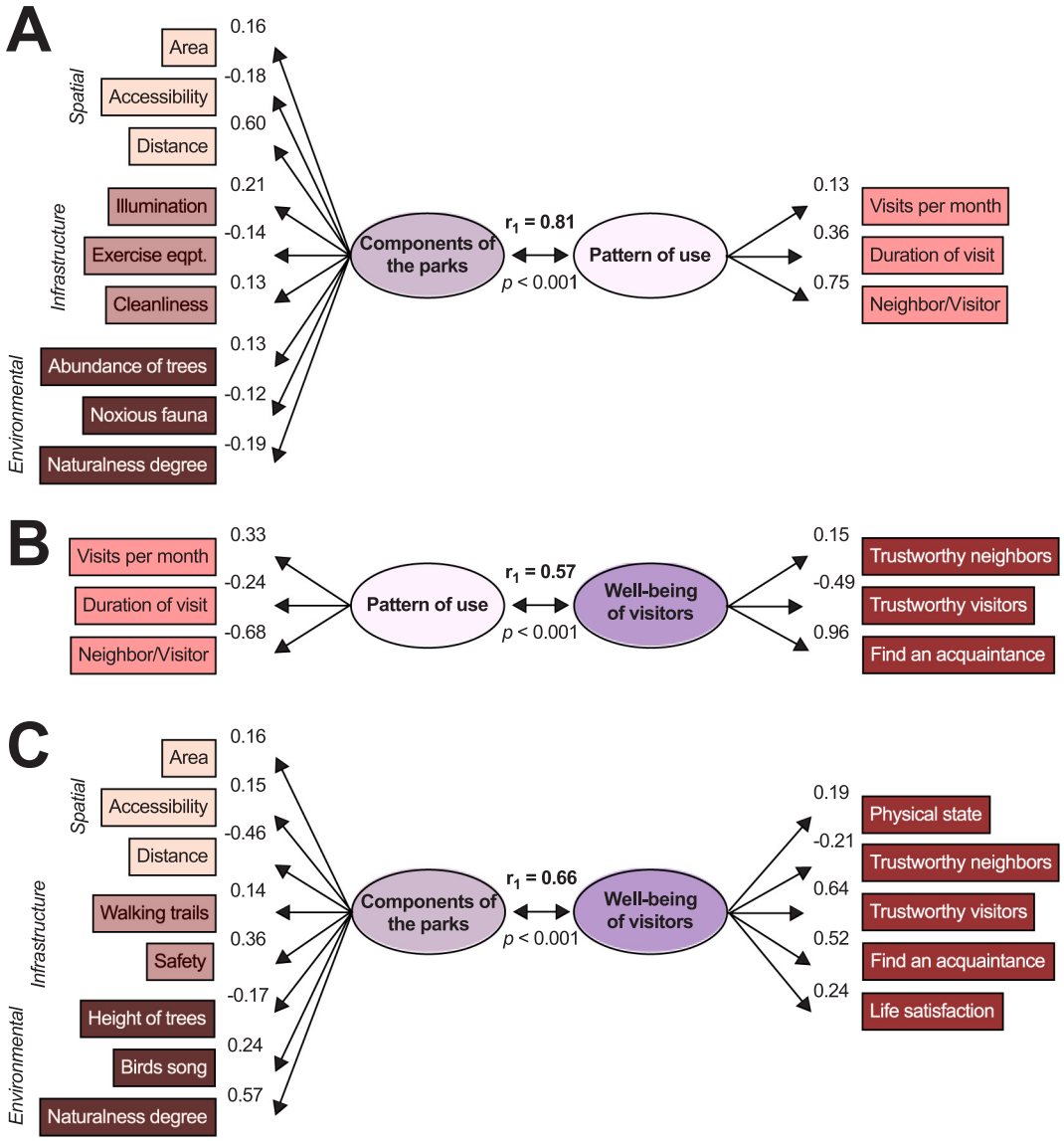

Fig. 3. A) A conceptual model of the canonical correlation analysis for urban park's components and the pattern of use, and B) Conceptual model of the canonical correlation analysis for urban park's components and the well-being of the users. Included are the value of the first canonical correlation and the values of the significant standardized coefficients.

the final model, which contributed differentially (negatively and positively) among park components. The accessibility and the distance to the urban parks, the illumination of the facilities, and the naturalness (lack of nature) degree were the main determinants for the components due to high values of standardized coefficients (−0.18, 0.60, 0.21, and −0.19, respectively). The duration of a visit, and whether the user was a neighbor or a visitor largely determined (0.36 and 0.75, respectively) the canonical variate based on the dependent set of variables (pattern of use). As shown in Fig. 3A, users who report a lower number of accessible urban parks, walk a greater distance to visit an urban park, and perceived better illumination, a cleaner space, low values of noxious fauna, and more nature (naturalness degree) tend to use more frequently the parks. They also expend more time during a visit and use the urban parks which are in a different neighborhood from the one their houses are located.

Specific scores for both canonical variates are shown in Supp. Fig. 2. Clustered groups of users mainly from small-sized parks are distributed within the negative scores; thereby confirming their lower perceived values of the park's components and a distinct pattern of use. In contrast, users from larger parks tend to score higher and positively in both outcomes. This indicates both a better perception of the components of the parks and the increased use of parks.

3.4. Description of well-being of users of urban parks

Only 4 out of 7 outcomes that we used to assess the well-being of the visitors differed significantly across the three categories of urban parks (Table 4). Persons interviewed in small-sized installations showed a higher value of self-reported mental state (9.31 ± 0.69) or a higher trust in neighbors (6.93 ± 1.30) when contrasted to visitors of large-sized urban parks. The visitors of large facilities had significantly higher scores of trust in visitors and likelihood to find an acquaintance, when compared to the users of small parks. Interestingly, regardless of the size category, the users reported high and consistent values of self-reported physical state (range 8.22–8.31) and life satisfaction (range 8.38–8.70).

Table 4
Comparison of self-reported users well-being of three size categories of urban parks studied.

Well-being	*Size category of urban parks			*p* value
	Small (n = 61)	Medium (n = 120)	Large (n = 157)	
Self-reported physical state	8.31 ± 0.96	8.25 ± 0.96	8.22 ± 1.49	0.8832
Self-reported mental state	9.31 ± 0.69[a]	8.60 ± 1.21[b]	8.79 ± 1.20[b]	0.0004
Self-reported level of physical activity	7.54 ± 1.71	7.28 ± 1.50	7.01 ± 1.88	0.1079
Trustworthy in neighbors	6.93 ± 1.30[a]	6.19 ± 2.45[a,b]	5.99 ± 2.51[b]	0.0275
Trustworthy in visitors	3.98 ± 2.12[b]	6.70 ± 2.31[a]	6.26 ± 2.35[a]	< 0.0001
Likelihood to find an acquaintance	2.90 ± 2.37[b]	3.36 ± 3.65[b]	4.49 ± 3.62[a]	0.0022
Self-reported life satisfaction	8.70 ± 1.06	8.38 ± 1.37	8.61 ± 1.33	0.2071

* Small, < 1 ha; medium, 1.1–4.5 ha; and large, > 4.6 ha.

3.5. Multivariate association between the pattern of use or the components of the parks and the perceived well-being of the visitors

There was a high association between the pattern of use of parks and well-being of the visitors (Fig. 3B). For the independent variables, the number of visits per month and the origin of the user (neighbor or visitor) were the two main characteristics that defined the first canonical variate (pattern of use), though their coefficients were of opposite sign. For the dependent variables, there were only three characteristics included in the final model, of which the main determinants were trust in visitors (−049) and likelihood of finding an acquaintance (0.96). From the conceptual model, users who frequently visit the urban parks spent less time during the visit and are neighbors to the installations. They tend to show less trust in visitors but more trust in other neighbors and also have an increased likelihood of finding an acquaintance.

Most users of small-sized facilities showed high positive scores for the outcomes, whereas the visitors of medium and large urban parks tended to scatter through the axis of the canonical variates Supp. Fig. 3B. Therefore, there was a higher association in users from small-size with the pattern of use and their self-reported well-being.

Finally, the components of the urban parks were associated with the self-reported well-being of the visitors. The distance needed to reach the installation (−0.46), the perceived safety of the place (0.36), and the rated naturalness degree (0.57) contributed the most to the independent canonical variate (components of the parks). Trust in the visitors and the likelihood of finding an acquaintance (0.64 and 0.52) determined the dependent canonical variate (well-being of visitors, Fig. 3C). Results suggest that users who travel short distances to urban parks perceive higher safety within the facilities, rate them higher in naturalness degree of the installations, tend to have better social interactions, and have a higher value of self-reported physical state and life satisfaction. Users of the three size categories are broadly distributed; in consequence, the association between the components of the parks and the self-reported well-being does not vary with respect to the size category of the park Supplementary Fig. 5. The components of the parks separate better the scores of the self-reported well-being, thereby becoming best predictors of the benefits obtained from using such places.

4. Discussion

Our results show a clear relationship between the components of urban parks, their use and the well-being of people. However, the variables that shape the conceptual model change when considering different combinations of the relationship: 1) park components/use pattern, 2) use pattern/well-being and 3) park components/well-being. In all combinations of the relationship, the three spatial component variables (size, accessibility, and distance to the park) are important predictors of both: use of parks and self-reported well-being. This may occur because larger green areas can promote the coexistence of groups of people of different ages and interests, allowing several activities simultaneously; for example, sports, rest and play (Reyes & Figueroa, 2010). These activities promote interactions between different actors and can promote social cohesion in a community, which is related to human well-being (Peters, Elands, & Buijs, 2010).

Results also validate the idea of accessibility and distance to parks as crucial variables for their use and to obtain the benefits they offer. The organization English Nature indicates that citizens must have access to green areas at least 2 ha in size and less than 300 m from their homes (Handley et al., 2003). Among the benefits of green spaces, adults who live less than 100 m from a park perform physical activities more regularly than those who live beyond that distance (Bonnefoy, Braubach, Moissonnier, Monolbaev, & Röbbel, 2003). There is a large number of international studies that have validated this relationship (Bush et al., 2007; Cutts, Darby, Boone, & Brewis, 2009; Evans & Jones, 2011; Evenson, Wen, Hillier, & Cohen, 2013; Jackson, 2003; Sallis, Floyd, Rodriguez, & Saelens, 2012). Other authors indicate that people should live a maximum of 400 m (or 10 min walking) from a green area for that space to benefit the community, since most people are not willing to walk more than that distance (or time) (Barbosa et al., 2007). The benefits of these sites as health promoters vanish when the green areas are outside this range (Astell-Burt, Feng, & Kolt, 2013; Tzoulas et al., 2007; de Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003).

For both the infrastructure and the environmental component, the variables that stand out in the model change depending on whether the pattern of use or well-being is analyzed. The only variable that remains constant regardless of the relationship analyzed is the degree of naturalness. That relationship is even stronger in the prediction of well-being, likely because people believe that these sites are capable of providing greater psychological restoration (Carrus et al., 2013; Hipp, Gulwadi, Alves, & Sequeira, 2015).

Regarding the analysis of the components and the pattern of park use, infrastructure variables such as illumination, exercise equipment, and cleaning determine the possibility of these sites being visited. This is explained by the fact that the presence of exercise devices, as well as playgrounds, stimulate the attendance of different sectors (Crawford et al., 2008; Estabrooks, Lee, & Gyurcsik, 2003). These three variables, in turn, promote well-being in people, in whose model the main infrastructure variables that predict well-being were the presence of walking paths and the perception of safety. A park full of waste, poor lighting or lack of maintenance may be perceived as a location of crime, generating a sense of insecurity, regardless of any real relationship with the crime rate. This breaks the sense of security and community (Kaplan & Austin, 2004), affecting the interaction between individuals.

Outcomes were similar for the environmental components where the variables that predict the use and well-being in both models are different. For example, for pattern of use, the most important variables are the abundance of trees and the absence of noxious fauna (described later), while for the well-being case the crucial variables are the height of the trees and the song of the birds. One of the most recognized benefits of the presence of trees in green areas is their ability to provide shelter and shade. This is related to the height of the trees. The

abundance of trees can also reduce urban noise, helping to reduce the stress of city dwellers (Gidlöf-Gunnarsson & Öhrström, 2007; Öhrström, 2004). This relation becomes relevant in particularly noisy areas of cities, which is manifest in physiological issues like increased blood pressure, and cognitive issues like affected memory and hindered concentration and verbal communication (Martínez Sandoval, 2005). The presence of trees can replace vehicular noise with sounds associated with the fauna they harbor. This is a restorative factor for stressful events or mental fatigue (Dallimer et al., 2012; Hedblom, Heyman, Antonsson, & Gunnarsson, 2014; Mind, 2007). Natural sounds stimuli are an important part of human relationship with the environment and can have positive effects on our quality of life. Sounds such as birdsong have been associated with stress reduction, improved mood, and increased learning and concentration skills (Beatley & London, 2011). Recent studies have shown that humans who are in contact with sounds of birds have reported feelings of tranquility, peace, relaxation, happiness and even freedom (Ratcliffe, Gatersleben, & Sowden, 2013).

Our results show that not all fauna is well received by humans and may even be considered noxious. For example, the presence of pigeons, rats, mice, and even squirrels have been associated with the accumulation of garbage in the site as well as the transmission of diseases such as rabies (António, 2010). Similarly, the presence of dogs and cats without an owner can be perceived as a threat to humans (Gatersleben & Andrews, 2013) both for the diseases they can transmit and for the attacks they may initiate upon people and their pets. Our study provides evidence that all the mentioned variables can predict the use and well-being of the people who use the parks.

When analyzing well-being dimensions related to use pattern and the park components, the variables that best explain the model are from the social dimension (trust in neighbors, trust in visitors and probability of finding an acquaintance). There is evidence that social networks support well-being since they provide the basis for trust, cooperation, and social support by providing opportunities for socialization (Cattell, 2001; D. A. Cohen, Farley, & Mason, 2003; Ikeda & Kawachi, 2010). For example, people who report higher values of interpersonal trust and social relationships report better health (S. Cohen & Syme, 1985; Putnam, 2001), which is related to well-being.

Green areas play a fundamental role in the formation of a support network and the social cohesion of a community (Peters et al., 2010; Vargas-Chanes & Merino-Sanz, 2012) by facilitating socialization of different groups and improvement in the local economy (Li, Saphores, & Gillespie, 2015). The presence of public spaces and urban parks can stimulate contact and social interaction, at a basic level, by inducing people to leave their homes. Coexistence in public spaces encourages individuals to actively participate in society and generates feelings of acceptance that contribute to their perception of well-being (Putnam, 2001). Likewise, the appropriation of public spaces can lead to a greater degree of social cohesion by promoting attachment to these places, residential satisfaction, as well as the increase of social contact (de Haan & Zoomers, 2005).

However, the erosion of the social fabric in the absence of spaces for coexistence can rupture communities, fostering environments with high levels of insecurity (Bogar & Beyer, 2015; Wilkinson, 2011). Especially in low socioeconomic strata, the lack of quantity and quality of public spaces that allow socializing, encourages pressure and intensive use of these sites, increasing a sense of belonging and identification (Pérez, 2004). Social contact is one possible mechanism driving the relationship between green spaces and well-being. This implies that the ability of parks to stimulate social contact affects the well-being of people and generates an asymmetry between those who have access to them and those who do not.

4.1. Implications for Mexico City

Our results confirm a potential environmental injustice, since park neighbors obtain more benefits from them than those who do not have a green space near home. This situation is aggravated by the inequality in the spatial distribution of the parks, relative to regionally income (Alvarez, 2015).

People living close by parks also tend to have higher trust values in their neighbors. In a densely populated megacity with evident rupture of the social tissues, having access to safe and well-maintained green public spaces can tie communities together (Álvarez, 2012). Therefore, urban green spaces are a basic necessity for people to keep and improve their well-being and can even be part of the solution to decrease the deficiency in some areas of the city (Kuo & Sullivan, 2001).

4.2. Strengths, limitations, and perspectives

The research tries to understand well-being based on the urban park condition. However, it is also possible to consider this relationship from the opposite point of view, as the well-being of the people can predict the use of these spaces. In this sense, it would be important to compare our results with a study that analyzes the well-being of the people who visit these sites versus those people who do not.

Further studies should analyze the validity of these results for other types of users. Surveys to assess the environmental quality and infrastructure, as well as the self-reported well-being of the people, were carried out in the afternoons. However, based on previous unpublished studies we determined that in the morning (6 a.m.–8 a.m.), there is a second peak of activity. The community of users visiting these sites during this time may perceive the quality of the parks differently. Surveying user-groups at different times of day opens the opportunity to deepen the knowledge of this study. This is also true for seasons of the year. Although extreme temperatures do not mark the climate of Mexico City, the patterns found in this work could change throughout the year. As the vegetation changes color or dies back at the end of autumn and winter, the perception of these parks can be changed. Future research should focus on responding if the patterns presented relate to socioeconomic and socio-demographic factors such as educational level, socioeconomic stratum, geographical background or others.

5. Conclusions

- Well-being is different between people who live close to parks (that get more benefits, such as value nature more, tends to have greater confidence in their neighbors and report greater physical health and satisfaction with life) and those who are far away (that are not able to have constant visits).
- There is a relationship between the components of urban parks, their pattern of use, and the well-being of their users. Nevertheless, the components of the parks that predict their use differ from those components that predict well-being. Therefore, characteristics that increase park use are not necessarily related to the well-being of their users. The social dimension of well-being best explains the well-being of park visitors. For park attendees to report on well-being, it is important to reach beyond the characteristics that beautify parks and focus on those that favor social interaction.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2019.04.005.

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