WEP Warwick Evans Publishing

International Journal of Natural Resources and Environmental Studies

ISSN: 3006-2012 (Print), ISSN: 3006-0834 (Online) | Volume 3, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijnres.v3n1.07
Journal homepage: https://wepub.org/index.php/IJNRES/index

Urban Green Space and Human Health: an Environmental Justice Perspective

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ABSTRACT

Urban green spaces have been shown to provide many of the environmental and social benefits associated with improving the quality of life of residents. However, urban population growth combined with densifying urban planning policies, such development may lead to an unequal distribution of green spaces in cities. As a result, access to green space is increasingly recognized as an environmental justice issue. Based on the Science Citation Index (SCI) core collection database, this paper focuses on the recent research progress of environmental justice research in urban parks and green spaces. This literature documents access to urban parks across socioeconomic and ethnic groups, the extensive benefits of parks for public health and sustainability. The increasing supply of urban green space in many areas of the United States, while emphasizing its diversity and inclusiveness in use, will help alleviate the injustice of urban green space. However, adding too many new urban green spaces and increasing residents' access to parks may lead to green gentrification. In Europe, research is already exploring models of public participation that can promote spatial justice in cities. In China, research on environmental justice in urban green spaces is just emerging and has the potential to be linked to future research on green gentrification, multi-objective use of urban infrastructure, public participation, big data analysis, and community programming.

KEYWORDS

Urban green space; Human health; Environmental justice; Ecosystem services; Gentrification.

1. INTRODUCTION

Urban green spaces are the fundamental element of cities and provide a wide range of ecosystem services that can help fight many urban diseases and improve the lives of city dwellers and especially public health. Green spaces benefit urban social health by providing opportunities for physical activity, improving mental health and well-being, and reducing stress. Urban green spaces also provide support for human well-being, sustainability and resilience for cities and residents. Such green spaces are diverse, varying in size, vegetation cover, species richness, environmental quality, public transportation accessibility, facilities and services. And among the various open spaces of the city, the urban park system represents a network of public green spaces for active and passive recreation managed by park agencies.Most studies have concluded that green space is not always equitably distributed in cities. People's access is often highly stratified by income, racial characteristics, age, gender, disability, lack of political power, and other axes of difference[1, 2]. In this situation, the inequitable accessibility of urban green spaces has been recognized as an environmental justice issue and its importance to public health has been recognized.

Environmental justice issues are prevalent in cities around the world, both in developed and developing countries, and the distribution of green space in favor of advantaged groups is relatively common. This inequity is not only reflected in the difference in accessibility of different groups to the park green space, but also in the difference in the area and facilities of the park green space enjoyed by different groups. Environmental equity in park green spaces is relatively less of a problem in domestic cities, such as Shanghai, Guangzhou, and Wuhan, where the government's leading role in urban planning has played a large role in the equitable distribution of public resources. However, the overall level of park green space services is low, the per capita park green space resources need to be improved, and there are still differences in the distribution of park green space resources among different groups, with more distribution among those with higher socioeconomic status and low-end practitioners, the elderly and youth belonging to disadvantaged groups.

In this paper, we first review the academic research on urban green space and public health and point out the many studies that demonstrate the importance of green space for the health and well-being of residents. Second, we review research on environmental justice and urban park accessibility. And then comparing domestic and international studies, it is found that the studies on the justice of urban green space distribution in European and American countries generally reflect the obvious variability of green space distribution among different ethnic groups and different income classes.

2. METHOD

Based on the literature database of the core collection database of Science Citation Index (SCI), this study aims at the justice of urban green space. By using the content analysis method and scient metric tools such as CiteSpace, the scientific atlas analysis of the retrieval results is carried out. Data collection was December 2022. In the core collection of SCI, the limited search keyword is "Environmental Justice", the literature type is "Journal", the language is English, the time span is 2012 - 2022, and the search results are 847; After adding the search qualifier "Green Space" the search results were reduced to 46.

3. URBAN GREEN SPACE AND ENVIRONMENTAL JUSTICE

3.1. The public health benefits of urban green space

Urban ecosystem services were first considered as goods and services derived from biophysical processes that benefit human well-being and support social functions, and the concept quickly spread from research to policy [3]. The Ecosystem Assessment (2005) popularized the concept with the classification of provisioning, regulating, cultural and support services. Urban green spaces provide ecosystem services that not only support the ecological integrity of cities, but also protect the public health of urban populations. Green space filters air, removes pollution, attenuates noise, reduces temperature, infiltrates rainwater, and recharges groundwater; in addition, it provides food[4, 5]. For example, trees in urban areas can reduce air pollution by absorbing certain air pollutants from the atmosphere[6]. Green cover and urban forests can also help reduce the risk of disease among urban residents by providing shade and cooling areas to regulate temperature [7, 8].

As vital publicly funded components of the urban fabric, parks offer tangible benefits to urban communities in terms of both public health and sustainability. With regards to public health, these urban oases serve as havens where residents can immerse themselves in nature and engage in physical activities, thereby promoting wellness and vitality among the populace.[9-11]. For seniors, residing in proximity to a park is correlated with more frequent visits to these green spaces and a more favorable perception of their overall health. As for young people, their interactions with nature are replete with numerous benefits, encompassing not only physical and mental health improvements but also advancements in personal well-being, cognitive functioning, and social-emotional

development.[9]. The public health benefits of urban parks hold particular significance for minority communities, as they are disproportionately affected by higher rates of obesity among young individuals and people of color compared to their white counterparts in the United States. These green spaces offer a crucial respite for these populations, promoting physical activity, stress reduction, and overall wellness[12].

3.2. Environmental justice and access to urban green space

Environmental justice emerged as a normative concept and a social movement in the US in the 1970s[13]. According to a report on Environmental Justice and Race Equity in the EU, environmental justice is described as “equal access to a clean environment and equal protection from possible environmental harm irrespective of race, income, class or any other differentiating feature of socio-economic status”[14]. Recent research has focused on the spatial distribution of environmental amenities across income and ethnicity, particularly with respect to parks[15].

A large number of researches on the justice of urban green space distribution have used the accessibility of green space. Its physical distance and time of access, as a quantitative criterion. Such studies usually contain two aspects. On the one hand, determine the threshold of accessibility (usually standardized indicators about urban green space spatial planning, such as per capita green space area, service radius of different types of urban green space, etc.) to detect whether the spatial allocation of green space within the study area reaches this threshold; on the other hand, superimpose the urban green space accessibility indicators on the sociological attributes of the population on different spatial units, calculate the differences of green space accessibility among different communities, and through GIS spatial analysis techniques and spatial econometric analysis methods are used to analyze the relationship between the spatial layout of urban green spaces and the spatial clustering of social groups, so as to determine whether there is spatial differentiation in the spatial distribution.

In terms of exclusivity, many of the early parks were exclusive, preventing the general public from using them through high admission prices or other requirements (such as dress code), such as the Derby Arboretum in England, which charged admission when it was built and opened to the public in 1840 and was free only on Sundays, so that the working class could use it for free only on their days off and constituted exclusivity at other times. At present, the majority of parks in China's cities are free of entrance fees, and only a small number of parks charge admission fees. Among the parks that charge entrance fees, the price of admission is higher for historical parks and some special parks with restricted environmental capacity, mainly for better conservation. Many of the free parks also have fences, mainly for the purpose of better park management, not for setting exclusivity. In addition, certain ecological and social benefits of parks are not unavailable due to the inaccessibility of people, such as park green spaces that purify the air, reduce the urban heat island effect, protect biodiversity, and reduce crime rates, all of which have a certain radiation range that benefits the surrounding population.

The main exclusion of parks is currently reflected in the fact that due to the uneven distribution of parks in the city, especially the uneven distribution of high-quality parks, visitors are not able to reach the parks easily, spending a lot of time costs in the process and constituting an implicit exclusion. New York City did not operate a bus line to Central Park during the first 30 years of its construction, so that the general public could not reach it conveniently and was thus excluded from being a user. In terms of competition, the uneven distribution of parks in the city, with some areas experiencing a shortage of parkland per capita due to a lack of parkland and dense population, has led to increased competition. For example, the difference between the lowest (4.29 m2/person) and highest (46.13 m2/person) per capita park green space in Beijing's administrative districts in 2018 was more than 10 times, and nearly four times from the citywide average (16.30 m2/person). In addition, the quality of parks is not evenly distributed, and there are gaps in the cost of construction and the level of maintenance and management, leading visitors to gather in parks of good quality and increasing

competitiveness. Overall, the uneven distribution of parkland in the city, especially the uneven distribution of high-quality parkland, is the main cause of exclusivity and competitiveness, thus affecting the public product attributes of parks. This problem is then similar to the situation faced by other basic public goods, which are caused by the low level of supply and uneven supply, which is contrary to social equity, especially the distributional equity in environmental equity.

3.3. Green gentrification

Current research underscores the inseparable link between exposure to green spaces and improved physical and mental health outcomes. Recognizing this, cities frequently incorporate the health benefits of green spaces into their planning strategies, seamlessly integrating new green areas into redevelopment initiatives and the very fabric of urban planning. This approach underscores the vital role that nature plays in fostering resilient and healthy urban environments. However, it is imperative to acknowledge that in certain instances, the introduction of new environmental resources, such as parks or other green spaces, can inadvertently contribute to the phenomenon of gentrification, colloquially termed 'green gentrification.' This process often leads to the displacement of long-time residents, particularly those from marginalized communities, as the desirability of these areas increases and property values soar. As a result, there is a "pitfall" in the construction of urban green space: increased public green space can promote urban public health, improve the urban environment, and alleviate urban equity and justice issues, but the ensuing green gentrification inadvertently denies disadvantaged groups the right to easily access green space, thereby exacerbating the injustice of urban space, or creating additional pressures due to the changing social environment of the region, leading to increased health inequalities. The study by Curran et al. takes the "Just Green Enough" project in Brooklyn, New York, as an example, and attempts to avoid the social injustice of large-scale urban regeneration through small and micro-community participation in regeneration projects to improve the green space environment as a way to alleviate the negative impacts of green gentrification.

With the accelerating urbanization process in China, a large number of urban renewal projects with urban green space construction as the landscape catalyst have emerged in urban construction, and the ecological gentrification phenomenon brought about by the production of these urban green spaces and the ensuing social injustice problems are worthy of in-depth exploration in future research.

4. INFLUENCING FACTORS AND MEASUREMENTS OF URBAN GREEN SPACE EQUITY

4.1. Influencing factors

4.1.1. Spatial environmental factors of park green space

To illuminate the multifaceted nature of access to urban green spaces, I delved into the equity mapping literature, focusing on three pivotal parameters: park proximity, acreage, and quality. By examining data pertaining to these metrics, we can gain insights into pivotal questions that shape our understanding of accessibility. Firstly, how close is the nearest park to a given location? (Proximity). Secondly, how many parks or acres of green spaces are within a reasonable reach? (Acreage). Lastly, what is the quality and level of maintenance of these parks within proximity? (Quality). These inquiries are crucial in assessing and enhancing equitable access to urban green spaces.

Park proximity refers to the measurement of the distance between a geographic unit and its nearest park, disregarding the park's size or the amenities it offers. Numerous studies have scrutinized this aspect, investigating whether the distances separating various geographic units from their closest park or playground correlate with demographic variables. Such analyses aim to uncover potential disparities in access to green spaces across different populations.[16, 17], and difference in land value

between parcels within and beyond a quarter mile of a park [15, 18]. Proximity primarily encapsulates the feasibility of traversing to a park on foot. Meanwhile, park acreage metrics meticulously quantify the quantity or extent of parks and recreational facilities situated within a defined geographic area (e.g., a neighborhood) or within a specified distance from that area. The equity mapping literature has extensively delved into metrics such as the count of parks within a neighborhood, the total acreage of parks within a neighborhood, and the acreage of parks per resident or per child within a neighborhood, highlighting the importance of these factors in ensuring equitable access to green spaces.[19, 20]. In particular, the metric of park acres per resident or per child serves as an indicator of potential congestion issues within parks[21]. Park quality, on the other hand, encompasses a broad spectrum of metrics that reflect the amenities available, the level of maintenance, and the safety from crime, all of which can significantly influence the frequency of park visitation.[10]. Studies examining park amenities have comprehensively addressed various aspects, including the number and diversity of recreational facilities present within parks, such as playgrounds, sport facilities, trails, and more. Additionally, these investigations have delved into tree canopy coverage and park aesthetics, recognizing their vital role in enhancing the overall attractiveness and usability of green spaces.[22].

The CPAT (Community Park Assessment Tool) is a recently devised comprehensive framework in Kansas City, Missouri, that meticulously evaluates the pivotal attributes of park environments. It encompasses a wide range of factors, from park amenities and facilities to the overall number of quality indicators that may foster active utilization of these spaces. Furthermore, the CPAT incorporates an assessment of the immediate vicinity surrounding the park perimeter, taking into account specific characteristics such as neighborhood amenities (e.g., sidewalks) and potential quality concerns (e.g., traffic), thereby providing a holistic view of the park environment and its surroundings[23]. The CPAT was collaboratively crafted by a diverse group of stakeholders, including researchers, parks and recreation professionals, community leaders, and local residents. This collaborative effort aimed to ensure that the tool would be user-friendly and accessible to a broad spectrum of individuals interested in assessing and improving their local park environments. By involving various perspectives and expertise, the CPAT was designed to cater to the needs and interests of a wide array of potential users.

4.1.2. User factors of park green space

In recent years, foreign research has begun to turn to the environmental inequity of differences in recreationists' ability to use. First, race. The persistence of discrimination against people of color in the United States and elsewhere has driven research on park accessibility, such as the finding that low-income communities of color have lower park service than whites and wealthy populations[24]. Second, age. Hung et al. found from a study of the limitations and benefits of urban park use among older adults in Hong Kong that the main factors that prevented older adults from visiting parks regularly were health reasons, being too busy, and poor park management, and that respondents perceived different health conditions, social and psychological benefits from park use[25]. Third, income. Public space, including green space, is one of the fundamental elements of urban formation, and investment in it benefits the entire urban population, especially low-income residents who rely on public green space for most of their leisure and recreational activities[26]. One study found that low-income residents are more dependent on free green space than middle- and upper-income residents[27], and that adults living below the poverty line are three times less likely to be physically active than higher-income adults. Park distribution is inequitable across socioeconomic status, with residential areas with an absolute number of private properties having higher park areas, lower congestion, and better park services[28]; Fourth, gender. For example, men use green space significantly more frequently than women, but excluding sports fields, there is no significant difference in the use of other green space by men and women[29].

4.2. Metrics and measurement methods

4.2.1. Park green space provision index

The most common measure of environmental equity in urban green spaces at domestic and international level is accessibility, which can be divided into objective (transport accessibility) and subjective (psychological accessibility) levels, and the current research mainly focuses on the objective level[30]. Research on park accessibility has advanced dramatically in the past five years, mainly due to advances in geospatial science and technology, and an increasing number of studies using GIS methods[24], such as the minimum proximity method, the attractiveness index method, and the travel cost or cost method (travel cost method). Sister et al. proposed that park service area analysis can help identify areas with higher park demand, applying the Los Angeles metropolitan area as a case study, using Tyson polygons to calculate the service area of each park and calculate its potential crowding or pressure, providing a practical method for studying existing inequity measures of park accessibility[21]. A practical approach to study existing inequity measures of park accessibility. The service radius is related to the size of the park, the quality of the green space, the surrounding environment, and other factors, and is a complex shape with changing edges influenced by many factors.

4.2.2. Park green space provision and demand integrated indicators

Integrating both supply and demand perspectives has become a trend in parkland environmental equity studies. Urban planners should consider building new parks where demand far outweighs park supply, rather than just considering whether there are many parks around, because residents with high population density may be suffering from a lack of park services despite having many parks around[31]. Taleai et al. proposed an integrated spatial equity evaluation method to measure the equilibrium between the demand generated by the population in a residential area and the supply of urban services at different spatial scales[32]; Chen et al. proposed a model method to evaluate the equity of park location distribution using accessibility, park service coverage, service overlap, and park area per capita[33]; Tan et al. used park area ratio, park area per capita, park area served per capita, park service area, and number of people per unit of park area in the park supply index[28]. Laszkiewicz et al. applied an econometric model to study the impact of green space on residence time from an environmental equity perspective, combining data from 860 local residents' quality of residence questionnaires and objective measures of urban green space proximity. It is proposed that if the effect of green space availability on residence time is negative among those residents who do not have an easy life, while the relationship is positive or neutral for those with high socioeconomic status, we can assume an environmental inequity [34]. In Germany, in order to clarify whether the distribution between urban green space and population is unequal, further analyses were conducted based on user preferences, taking into account demographics and immigration status, and applying methods such as GIS, differentiation indices and cluster analysis to calculate and analyze public land use and social statistics obtained at the sub-regional level[35].

5. STRATEGIES TO ALLEVIATE THE ENVIRONMENTAL INJUSTICE

5.1. Improving public health

To reduce public health risk exposure through urban green space, we should consider the actual effects of urban green space distribution pattern, landscape level, and plant structure on cooling, dust retention, and air purification to maximize the health benefits. For example, in order to reduce the exposure to high temperature and to make use of the effectiveness of vegetation in urban cooling, the most effective strategy to maximize the cooling effect should be proposed, taking into account the downwind cooling effect of parks, the effect of street length, width, height and orientation on shading and wind flow patterns. In addition, attention should be paid to whether urban green space may have

negative impacts and increase health exposure risks. A narrow space enclosed by urban roads and buildings on both sides of the city is a space where air pollution is progressively increased by increasing traffic emissions and insufficient natural ventilation. Blindly increasing urban greenery without considering all the conditions of the environment may defeat the purpose of health promotion (Figure 1).

Fig. 1 People active in the green space (Photo credit: Self-drawn by the author)

5.2. Improve the equal distribution of urban green space

In terms of green space scale levels and morphology, Tan et al. studied the distribution of different classes of parks in Singapore and showed that focusing on smaller-scale neighborhood community parks would help enable equitable access to urban green space for all social classes and races. Ngom's research pointed out that a linear structure of green space can play a greater role in improving the equity of regional green space distribution. In the US, practical projects have begun to explore the equitable demand for urban green space into the consideration system while making multi-objective use of urban infrastructure to mitigate the inequitable supply of urban green space. This multi-objective use includes greening remaining urban land, repurposing obsolete or underutilized transportation infrastructure, and combining urban gray water infrastructure with green infrastructure.

As with other basic public goods, it is difficult to achieve absolute parity in parkland due to the population distribution, urban development process, and geographical factors. Different historical periods have different perceptions of parkland, resulting in different quotas, construction purposes and costs, and different population densities, development intensities, and investment in parkland in different areas during the same period, all of which will result in different parkland areas, landscape quality, and service facilities, and affect the fair distribution of parkland. To address this problem, different policies should be implemented in different areas. For the old city with limited green space increment, we should adopt the way of "inserting green in the seams", and build "pocket parks" or even "one-meter gardens" with the purpose of increasing the amount of three-dimensional green space. We should pay attention to systematic construction, adopt a distributed green space structure, and disperse different functions among these micro parks and green spaces in clusters to improve the efficiency of use; upgrade existing parks and green spaces, improve landscape quality and supporting facilities, and supplement the quantity with quality; advocate three-dimensional greening and rooftop greening as a supplement to park green spaces, and improve the green coverage and green view rate. For new urban areas with a green center structure, we should increase the number of corner parks and street parks, improve the quality of existing green spaces, and build a greenway system to improve the "green outlook".

5.3. Inclusive landscape design

In the context of urban green space utilization and its impact on diversity and tolerance, it is noteworthy that in Latin American countries, certain green spaces tend to be established predominantly in urban landscapes catering to the consumption patterns of the middle class. This process of spatial production, often driven by economic gain for capital or the assertion of political rights, can inadvertently isolate and hinder disadvantaged groups from accessing and enjoying these green spaces. Consequently, there is a need to address this disparity and ensure that urban green spaces are inclusive and accessible to all members of society.[29]. Multidimensional classification of parks in the context of specific social and natural environmental conditions, emphasizing the differences and diversity of different types of parks in terms of spatial distribution, spatial design, and built environment; the homeless people's right to legally live in urban green spaces should be recognized, and corresponding facilities and management regulations should be set up to enable this vulnerable group to retain their right to urban green spaces as their "last home"[36].

Park green space stands as a cornerstone of sustainable urban landscapes, contributing invaluable environmental, social, and economic benefits to urban areas[37]. As a form of public investment, it is imperative that urban parks are accessible and serve every community equitably, ensuring that all residents have the opportunity to enjoy the myriad advantages that these green spaces offer[15]. Parks play a vital role in the lives of individuals who may have limited mobility or access to private recreational spaces, such as youth, older adults, low-income populations, and minority groups. To ensure that these individuals can fully enjoy the benefits of green spaces, it is crucial to enhance the infrastructure of parks by implementing barrier-free access, clear signage, and adequate lighting systems. By doing so, we can create outdoor environments that are inclusive and suitable for all types of people, including the elderly, children, individuals with disabilities, and the general public. This approach fosters a sense of community and ensures that everyone has equal access to the many benefits that parks provide. Strengthen the installation of diverse sports and fitness spaces and facilities to encourage the public to participate in the green environment and engage in diverse health-promoting activities, such as walking, running, cycling, ball games, equipment sports, etc. (Figure 2).

Fig. 2 Public space promotes interaction among various groups of people (Photo credit: Self-drawn by the author)

6. CONCLUSION

In the fields of human environment and sociology, the discussion of "fairness" and "justice" in the distribution and use of urban green space is a lasting issue. Some practical projects have begun to explore the need for equity and justice in the use of urban infrastructure with multiple objectives, in order to alleviate the inequitable supply of urban green space. This multi-objective use includes such things as landscaping remaining urban areas, reusing displaced or underused transportation infrastructure, and combining urban gray water infrastructure with green infrastructure. Heckert et al. developed an equity assessment framework for green infrastructure construction projects in the Philadelphia water department in the United States. It aims to address issues related to the equitable distribution of urban green space, such as the allocation of funds for the project, the assessment of community priority construction levels, the selection of partners involved in construction and the type of construction. Wendel et al. evaluated the equity of urban green space and water landscape in Tampa (Florida, USA) in terms of accessibility, diversity and scale. Provides three development scenarios for integrated storm water management, where the development scenarios under different scenarios will achieve different levels of improvement in the urban green space and waterscape in terms of distributive justice, and then explores the relationship between environmental justice and urban water management. The research is focus on integrating social needs and environmental justice into urban green infrastructure planning to improve access and equity in the distribution of urban green spaces, ensuring benefits for all members of society, in order to improve the issue of justice in urban green space distribution.

CONFLICTS OF INTEREST

The authors declare no competing interests.

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