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Geographic distribution of the Ciclovía and Recreovía Programs by neighborhood SES in Bogotá: How unequal is the geographic access assessed via distance-based measures?

Abstract

Ciclovía, also known as Open Streets initiatives in other countries, are city streets that are closed to motorized traffic and opened during certain times to residents for engaging in physical activity (PA). These initiatives are viewed by policy makers and health and community advocates as being beneficial to social, environmental, and community health. This study explores the geographic distribution of Ciclovía and Recreovía and the differences in geographic access assessed via distance-based measures, based on the socioeconomic status (SES) of the area. Results from this study show that the median distance to the Ciclovía according to SES ranges from 2,930 meters for SES 1 (most disadvantaged) to 482 meters for SES 6 (wealthiest). The median distance to the Recreovía sites ranges from 5,173 meters for SES 1 to 3,869 meters for SES 6. This study found revealing urban inequities in the distribution of Ciclovía whereas there was less inequalities within the Recreovía sites. This study shows that urban interventions are needed to promote recreational activity and reduce health disparities in under resourced, low SES areas.

1. Introduction

Community-based programs are feasible, cost beneficial and effective methods to easily integrate the practice of physical activity (PA) into daily life while increasing physical, social and mental health benefits.¹⁻⁴ A community-based program called *Ciclovía*, which reserves car free streets to allow exclusive access for pedestrians, cyclists, skaters, and others forms of active recreation, was developed in Bogotá Colombia in 1974.⁵ The current coverage involves a distance of 127.69 kilometers (79.3 Miles) of major avenues, these streets are closed every Sunday and holidays from 7 AM to 2 PM.⁶ This program has a 44-year history and approximately 600,000 to 1,400,000 users participate every Sunday and holiday.⁶ *Ciclovía* programs also known as “open streets” in the United States, are expanding rapidly worldwide and are found in at least 20 countries in North, Central, and South America.⁷⁻¹⁶

29 *1.1. The Ciclovía and Recreovía Program and urban developments in Bogotá*

30 The Ciclovía initiative emerged in Bogotá in December 1974 within a context of explosive urban
31 growth which started to take place in the 1950's in the majority of large Latin American cities.¹⁷
32 Due to lack of a long-term urban planning strategy, more than 50% of the neighborhoods in
33 Bogotá have low availability of green areas and public recreational spaces.¹⁸ According to the
34 Mayor's Office of Bogotá, the average green area per inhabitant is 6.6 m², ranging from 1.9 m² in
35 one of the lowest income neighborhoods in the city to 14.8 m² in a middle-high income
36 neighborhood district.¹⁹ Consequently, the Ciclovía Program in Bogotá could serve as a response
37 to the deficits in the availability of public parks and other recreational spaces.^{17,19} From 1974 to
38 1994, a total of 21 km of Ciclovía were built in middle-to-high socioeconomic neighborhoods.²⁰
39 Further history on the Ciclovía and Recreovía programs can be found elsewhere.⁵ One of the
40 reasons why the program was predominately in high-to-middle income areas was due to the
41 availability of high quality and paved roads, thus making it easier to implement the program. By
42 the year 2000, the Ciclovía Program expanded to 120 km, covering middle-to-low SES
43 neighborhoods and reducing the urban inequity in its geographic distribution.²¹

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45 Ciclovía's sister program known as "Recreovía" began on April 16, 1995 as a community based
46 PA program offering aerobic and dance classes in specific sites throughout the city, in order to add
47 value to the Ciclovía users and improve their quality of life. The first physical activity point was
48 the centrally located National Park (Pictured on Figure 5), which offers a large space and amenities
49 for the implementation of the activities. The physical activity classes offered by the Recreovía
50 program are informed by current scientific guidelines and delivered by highly qualified teachers.
51 Recreovía takes place in 44 sites throughout the city, located along the Ciclovía, where free of
52 charge aerobic and dance classes continued to be offered to the population.^{22,23} Twenty-eight of
53 these points offer classes during the same times that the Ciclovía takes place. The remaining points
54 offer classes during selected one or two days of the week. Sarmiento et al. found this program to
55 be especially effective for women who are less likely to meet the PA recommendations during
56 their leisure time.²² This study found that the percentage of women was higher in parks with
57 Recreovía, compared to parks without Recreovía. The prevalence of physical activity during
58 leisure time among women in Bogotá is only 23.8%, compared to 28.2 among men. A recent paper
59 evaluating the Recreovía program found that multi-sectoral strategies to promote active recreation

and PA in public spaces such as Recreovia are crucial to building a "culture of health". According to their findings, the Recreovia program has undergone adaptation processes to address the challenges that threatened their continuation and growth, in this sense being flexible and adaptable has been crucial to its survival.²⁴

A survey of 67 Ciclovías in Latin America characterized their overall distribution among the studied countries. The study showed that 53.7% of the Ciclovias included low-income areas, 89.3% connected different income areas, and 61.2% included routes in areas with a predominance of minority populations (ethnic groups, internally displaced populations, other minorities).²⁵ However, the particular distribution of Ciclovía in Bogota does not correspond to this type of distribution based on prior research and the results from the current study.

Physical inactivity is strongly associated with chronic non-communicable diseases, which contribute to 3.2 million deaths each year globally and cause 69.3 million deaths and disability-adjusted life years (DALYs).²⁶ Given that physical inactivity is a leading global risk factor for death, widespread promotion and delivery of PA programs should be a public health priority. Guthold et al. estimate that more than a quarter of adults in the world do not meet PA recommendations for health,²⁷ which suggests that community-based PA programs such as Ciclovía and Recreovia can play an important role in PA promotion.²² Furthermore, Colombian women from low SES populations are more at risk for physical inactivity, which supports the relevance and need for this study.²⁸

The purpose of this study is to use distanced based indicators in order to describe the geographic distribution of the Ciclovía and Recreovia programs according to the socioeconomic status of Bogotá's neighborhoods. *Ciclovía* is currently the largest PA program in the world,²³ but inequities in their access remain. A study carried out using data from 2009 found that the Ciclorutas (bicycle lanes) and the Ciclovía recreational program do not offer equal geographic access for all SES, especially for the lower SES. This is despite the fact that most of the users of the programs are from low and middle income SES. They concluded at the time that marginal route extensions, that is the expansion of Ciclovía, can improve equity in geographic access.²⁹ The program has been shown to increase social capital,³⁰ PA levels,³¹⁻³² bicycle use during the

week for transportation,^{33,34} and demonstrated to be a cost beneficial program.³⁵ However it is also essential to explore distribution of the Ciclovía and understand the inequities of geographic proximity to these recreational activities.

2. Methods

A spatial epidemiological study was undertaken using secondary data obtained through Geographic Information Systems. This data was provided by the Cadastre Office of Bogotá which collected this information in 2015.³⁶

Blocks were defined as the urban space delimited by streets. For the purpose of this study, only residential blocks were included in the analysis. The total number of blocks in Bogotá is 45,053 and, in this analysis, we used all 33,405 residential and mixed-use blocks, representing 74% of the city. Residential blocks are usually between 100 and 150 meters in length and are used exclusively for residential purposes according to the urban planning department. The block includes two sidewalks facing each other.³⁷ The 2015 Ciclovía distribution and the Recreovia points were obtained from the Institute for Sports and Recreation.^{38,39}

Blocks were classified in six categories of socio-economic status (SES), from SES 1 (lowest) to SES 6 (highest). These categories were pre-established by Cadastre for determining the price of public utilities and taxes which uses physical attributes of the surrounding environments (i.e., road and pedestrian infrastructure) and housing (i.e., construction types and materials).⁴⁰ This socio-economic stratification system was implemented in Colombia in the 1980's in order to classify areas of similar economic characteristics using a scale from 1 to 6, with 1 being the most disadvantaged and 6 the wealthiest. The system became a law in 1994, providing a framework for granting subsidies in public utilities to the poorest residents. 68 % of Bogotá's residents live in strata 2 and 3.⁴¹ The poorest population is concentrated in the periphery with mostly hilly terrain in the south and south-west of city in informal dwellings.¹⁹ The social stratification system was originally intended to benefit those with lower incomes, however it has become a system that divides by creating stigma and discrimination among the citizens.⁴²

Statistical Analysis

The shortest distance from the centroid of each of the residential blocks to the closest access point to the Ciclovía and Recreovía site was calculated using Network analyst (ArcGIS 10.3). An access point was defined as any point along the linear layer for the Ciclovía. We used the “Make Closest Facility Layer” tool of the Network Analyst extension to calculate the distance between the centroid of a block to the closest point of geographic access to a Ciclovía and to a Recreovía site. This procedure was made in Cartesian coordinate space (X,Y). For this we calculated the Manhattan distance, which considers road network to calculate the shortest distance between the origin and destination points.⁴⁷ We used the street network grid data of Bogotá from 2016, available from IDECA (Center for Spatial Data Infrastructure for Bogotá),⁴¹ and the Ciclovía’s official data from the Institute of Sports and Recreation.^{42,43} The result of the Make Closest Facility analysis produced a network of lines that connect each block’s centroid with the closest point of the Ciclovía based upon the shortest distance following the street network grid, using meters as the distance unit.⁴⁰ We conducted a Kruskal-Wallis equality of populations rank test to determine statistically significant differences in the distances between the different categories of SES.

3. Results

Tables 1 and 2 show the results for the Ciclovía and Recreovía analysis respectively. The 39.9% of 33,405 residential blocks belonged to SES 2 (33.9%) and only 2.7% to SES 5 and 2.1% to SES 6. The overall median distance from block centroids to the closest Ciclovía was 1,848 meters (see Table 1). The median distance to the Ciclovía according to SES ranges from 2,938 meters for SES 1 (most disadvantaged), 2,349 meters for SES 2, 1,306 meters for SES 3, 784 meters for SES 4, 716 meters for SES 5, and 482 meters for SES 6 (wealthiest) (Table 1). These variations were statistically significant ($p < 0.001$). This is over a six-fold difference in distance to Ciclovía from the lowest to highest SES group. Of the total blocks, 71% were over 1000m from the closest geographic access point to the Ciclovía corridor. For SES 1, 96.4% of the blocks were greater than 1000m. For SES 6, only 12.5% of the blocks were over 1000m.

Table 2 shows the overall median distance from block centroids to the closest Recreovía point which was 2,125 meters. The median distance to the Recreovía sites according to SES ranges

from 5,173 meters for SES 1 (most disadvantaged), 2,117 meters for SES 2, 1632 meters for SES 3, 1,800 meters for SES 4, 3,041 meters for SES 5, and 3,869 meters for SES 6 (wealthiest). These differences were statistically significant ($p < 0.001$).

Figure 1, shows a graphic representation of the distribution of Ciclovía and Recreovía by neighborhood SES. The map shows a greater distribution of Ciclovía in blocks of higher SES, those in dark blue and blue, compared to the areas in dark red and red. Figure 1, also shows a somewhat more equal distribution of Recreovía points by SES, compared to Ciclovía. Similarly, as argued before, we can observe in the map that the distribution of Recreovía sites and Ciclovía are not reaching neighborhoods of low SES where there is also a deficit of the distribution of public parks.

Fig. 1 Distribution of Recreovía Sites and Ciclovía in Bogotá by neighborhood SES

Figures 2-4, include pictures of the Ciclovía program in Bogotá, taken during a typical Sunday in 2018, in different socio-economic strata neighborhoods in Bogotá. Figure 5 includes a picture from the Recreovía program taken during a regular Sunday at the National Park, the oldest Recreovía point in the city.

171 **Fig. 2** Ciclovía in an avenue surrounded by SES 4 neighborhoods

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185 **Fig. 3** Ciclovía in an avenue surrounded by SES 3 neighborhoods

199 **Fig. 4** Ciclovía in an SES 2 neighborhood

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Fig. 5 Recreovia Site from SES 4

4. Discussion

This study suggests that there are inequalities in the geographic distribution of Ciclovía in terms of distance-based measures, while the disparity appears to be lower for Recreovia sites. This study extends the current state of research on Ciclovía and Recreovia programs in Bogotá by examining the geographic distribution and differences in proximity according to the socioeconomic status of the neighborhoods.⁴⁰ It is important to acknowledge that the distribution of geographic access to Ciclovía by socioeconomic status is likely a context-specific matter, and the current analysis for Bogotá cannot be used as evidence to inform action in other settings. However, it can be used as a process to generate equivalent indicators in cities with Ciclovías across the globe.

This study found that SES groups 1, 2 and 3 had a farther distance to travel to the Ciclovía than did SES 4, 5 and 6, with SES group 1 having a six-fold difference compared to the highest SES. These results confirm our hypothesis of the unequal geographic accessibility of the Ciclovía for low SES neighborhoods in Bogotá Colombia assessed via distance-based measures, which was also confirmed when exploring access to Bogotá's public network of bicycle paths.⁴⁰

Furthermore, Figure 1 reveals that Ciclovía is scarcely found in SES 1 neighborhoods and there are fewer Ciclovías in SES 2 and 3 neighborhoods. Conversely, neighborhoods in SES 4 have to travel on average 1,023 meters, and SES 5 and 6 have less than 1,000m to travel to geographically access the closest Ciclovía. Our results support the findings by Teunissen et al., in regards to the unequal geographic access of the program Ciclovía for the lower SES groups using data from 2009.²⁹

Though still unequally distributed, the Recreovia program is more geographically accessible to lower SES neighborhoods (Figure 1). As demonstrated by Sarmiento et al.²⁴ the Recreovia program has great potential for increasing PA levels particularly among women, who are at higher risk of being sedentary. The fact that geographic access to Recreovia is better for low-income neighborhoods compared to the Ciclovía might be partially explained by the role of disparities in already existing infrastructure (e.g. street quality, street design, street lighting) which contributes to differential access to Ciclovía routes. For instance, Open Streets initiatives use existing infrastructure, impacting where the route will be located, while Recreovia uses parks and other open spaces, also existing, but more adaptable to the current conditions of the neighborhood income.

Figure 1 also shows that along with a lower number of Ciclovía and Recreovia sites, areas of low SES also have a deficit of public parks, further highlighting the inequity of recreational opportunities for the population of Bogotá who are under resourced. The percentage of the population of Bogotá from SES 1 (10.4%) and SES 2 (41.3%) was 51.7% as of 2014.

Unequal distribution is a problem because Ciclovía and Recreovia are public health initiatives that encourage leisure time PA, and lower SES groups have been associated with higher levels of

physical inactivity.⁴⁸ According to the National Nutrition Survey of Colombia conducted in 2015, the prevalence of having met leisure time PA among adults was positively associated with income.²⁶ Likewise a research study in Brazil found an association between low socioeconomic status and a lack of leisure time PA.⁴⁹ Despite this inequity, the mission and goal of the Recreovia and the Ciclovía programs is to reduce the unequal access to recreational activities and to benefit the community as a whole.^{50,51}

Unfortunately, other public health programs offered in Bogotá, such as the Cicloruta, are also not in close proximity to lower SES neighborhoods.⁴⁰ However, geographic access includes more than proximity as some studies have found that proximity alone does not guarantee access or use of a particular resource, such as a public bicycle share program⁵² and trail network accessibility.⁵³

Our study uses simple statistics (mean/median/range) to determine differences in the proximity to a large scale, urban community program for health promotion, while controlling for the slope of the terrain. Our study design of measuring and comparing the distance from the centroid of each block within all city neighborhoods classified by SES, to a geographic access point of a Ciclovía or Recreovia site can be easily adopted and replicated by other cities around the world. This type of data could be useful for public health policy, research, and programs for promoting health and reducing inequities and disparities, while at the same time creating a repository of comparable data. At the local level, this can have immense impact, by pointing out priority areas of expansion and investment, towards a more equitable Ciclovía/Recreovia and community-based public health system in cities.

This study has several limitations that should be noted. Primarily, Ciclovía and Recreovia initiatives were not designed as an intervention study and there are limitations associated with this uncontrolled evaluation. Residential block centroids were used to obtain the distance between the center of the block and the closest geographic access to the Ciclovía or Recreovia site, rather than measuring individual addresses, which would have provided more accurate distance information. This study did not consider other forms of geographic access, such as road connectivity, public transit availability, and quality of the roads. Furthermore, economic access

should also be considered when analyzing and interpreting levels of social equity and disparity. For example, it should be taken into account if the individuals can afford the time or resources for transportation to gain access to these programs. Therefore, access should be assessed in a variety of forms in order to address health disparities and promote health equity. This study measured access specifically related to geographic access using only distance-based measures. However, access as a broader construct includes aspects such as cultural/acceptability access, and availability of destinations (density & count-based measures) among others. Despite these limitations, results of this study highlight the need to expand and refine the measurement of PA to include the possibility of identifying how environmental factors outside the neighborhood may also have an influence on patterns of PA.

In Bogotá, inequalities in the quality and availability of recreational resources have been previously acknowledged.²⁹ The Sports and Recreation Institute from Bogota which manages the Ciclovía and Recreovía programs aims to work with residents to increase participation of all residents from the City. Improving geographic access to Ciclovía and Recreovía programs has shown to be a promising strategy to promote park use and PA.^{28,37} Expansion of these programs in low-SES areas can target vulnerable groups, particularly those who are less likely to meet PA recommendations during their leisure time. The provision of a cost-free community program may be an effective approach and a good investment for the health of low-SES populations. According to the government plan from the City Major, the goal is to make of Bogota the world capital of the bicycle.⁵⁴ He pledged to increase and improve bicycle infrastructure in Bogota, but unfortunately progress in the last three and half years has been slow.⁵⁵ There is also not a specific plan to increase equity for all regardless of socio economic strata, which is a serious problem as reported in this study and elsewhere.

Planning and implementation of complex initiatives like Ciclovía and Recreovía must involve input from a combination of local communities, policy makers, practitioners, advocacy groups, researchers, local businesses, and stakeholders from the transportation, planning and public health sectors. It is important to identify goals (e.g., increased PA, recreation, awareness of bicycling infrastructure, increased spending)²⁴ and measure success to ensure long-term sustainability of these initiatives. In addition, in unequal societies such as Colombia in which

there are remarkable democratic deficits, the participation in advocacy processes is determined by the socioeconomic hierarchy.⁵⁶ This should be examined in futures studies in the area of urban health.

5. Conclusion

Worldwide, interest in Ciclovía initiatives continues to grow and this study serves as a source of PA and community connectivity. Findings have high relevance for Bogotá and for other cities from developing countries, where community initiatives to promote PA at the population level can result in substantial public health benefits. However, an effort must be made to eliminate issues of disparity by having programs like the Ciclovía and Recreovía reach areas of low SES.

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