

Engaging Citizen Scientists to Build Healthy Park Environments in Colombia

Abstract

Colombia's Recreovía program offers community-based free physical activity (PA) classes in parks. We evaluated built and social environmental factors influencing Recreovía local park environments, and facilitated a consensus-building and advocacy process among community members, policymakers and academic researchers aimed at improving uptake and impact of the Recreovía program. We used a mixed-methods approach, with individual and contextual PA measurements and a resident-enabled participatory approach (the *Our Voice* citizen science engagement model). Recreovía participants were likely to be women meeting PA recommendations, and highly satisfied with the Recreovía classes. Reported facilitators of the Recreovía included its role in enhancing social and individual well-being through PA classes. Reported barriers to usage were related to park maintenance, cleanliness, and safety. The *Our Voice* process elicited community reflection, empowerment, advocacy and action. *Our Voice* facilitated the interplay among stakeholders and community members to optimize the Recreovía program as a facilitator of active living, and to make park environments more welcoming.

Key Words

Parks; citizen science; physical activity; community-based participatory research

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1 **Introduction**

2 It is vital to evaluate and scale up interventions that have the potential to promote active
3 and healthy living (Sallis et al., 2016). Physical inactivity increases the global prevalence of
4 non-communicable diseases (NCDs) such as heart disease, stroke, diabetes, depression, and
5 eight types of cancers (US Department of Health and Human Services, 2018). Nearly a
6 quarter of the world's adult population is physically inactive, with even higher rates found
7 among women (WHO, 2018). Latin America and the Caribbean have the highest levels of
8 insufficient activity among women (>40%) (Guthold et al., 2018) highlighting a trend
9 related to economic development (WHO, 2018). In fact, the greatest burden of NCDs
10 occurs among women from low- and middle-income countries (Guthold et al., 2018).

11 Utilizing public spaces--particularly parks--has emerged as a potentially low-cost and
12 widely accessible approach to promoting physical activity (PA) and healthy living (Arena
13 et al., 2017; Díaz del Castillo et al., 2017). Latin America has numerous park-based health
14 promotion programs (Díaz del Castillo et al., 2017; Hoehner et al., 2013). These feature
15 regular free programming, including music-accompanied gymnastics, tropical rumba, and
16 similar classes in park and plaza public spaces (Gaffney et al., 2019; Cohen et al., 2017;
17 Rios et al., 2017). Previous studies in Brazil and Colombia reported that women are the
18 main users of park-based PA classes, and that people visiting parks with such programs are
19 more likely to engage in moderate-to-vigorous PA (MVPA) compared to people visiting
20 parks without formal PA programming (Sarmiento et al., 2017; Torres et al., 2013).

21 Beyond their potential use for physical activity promotion and programming, the
22 neighborhood-level availability of public parks has been associated with higher leisure
23 time PA (Zhang & Li, 2017), lower incidence of chronic diseases (Besenyi et al., 2014),
24 and higher levels of mental health (Wood, 2017). Additionally, benefits of activity-friendly
25 environments can extend beyond individual-level impacts, increasing community-wide
26 wellbeing by positively impacting neighborhood social cohesion and social capital (Atkins
27 et al., 2018; Díaz del Castillo et al., 2017; Torres et al., 2013). Understood in this light,
28 these types of community-based programs can be seen as opportunities for social
29 integration, especially for marginalized populations (Plane & Klodawsky, 2013), and also
30 contribute to decreasing gender disparities in physical activity (Torres et al., 2016).

1 Previous research has shown that deterrents to park use can include lack of safety and
2 inadequate facilities (Douglas et al., 2018; Rachele et al., 2016). These effects are not
3 distributed equally across socioeconomic groups, as low-income populations generally have
4 poorer access to safe, high-quality parks (Douglas et al., 2018; Rigolon, 2017).
5 Additionally, the determinants of physical activity in parks typically include the interactive
6 effects of individual characteristics, social and physical environments, and policies (Sallis
7 et al., 2006; Sawyer et al., 2017).

8 The municipal government of Bogotá, Colombia offers free PA classes in urban public
9 parks through a broader set of initiatives called “Recreovía” (Díaz del Castillo et al., 2017).
10 Designed in 1995 to promote PA at a community level, the Recreovía program has
11 undergone rapid scale-up in Bogotá (Abolghasem et al., 2018; Rios et al., 2017). By 2018,
12 more than 1.2 million people had participated in 10,894 activities across both weekends and
13 weekdays (IDRD, 2019). Recreovía goals include increasing park use and promoting
14 healthy lifestyle habits (Rios et al., 2017). In Colombia’s current post-conflict era, the
15 Recreovía program also seeks to build social capital and decrease inequalities in the
16 availability of recreational spaces (Rios et al., 2017).

17 Despite broad uptake, there is notable variability in Recreovía participation (Torres et al.,
18 2016). To better understand characteristics and interactions between built and social
19 environmental factors that support communities’ regular PA, and ultimately inform
20 effective PA policies, we applied a mixed methods design through a sequential explanatory
21 approach (Pluye & Hong, 2014). As the framework for our study we followed the *Our*
22 *Voice* “by the people” citizen science model. *Our Voice* uses accessible technologies to
23 engage community members in data collection and analysis, offering a channel for
24 providing feedback on existing programs and empowering residents to promote data-driven
25 changes in the local built and social environments (King, Winter, Chrisinger, Hua, &
26 Banchoff, 2019). While the model has been applied in a variety of contexts, previous to this
27 study it had not been employed for systematic evaluation of parks and programs like
28 Recreovía (Buman et al., 2013; Chrisinger et al., 2018; King et al., 2019; King, et al., 2016;
29 Rosas et al., 2016).

1 In a context of growing interest in socioecological models to better target interventions
2 aimed at health equity and behavior change (Blacksher & Lovasi, 2012), participatory
3 strategies have become a basis for promoting a culture of active living, prompting citizens
4 to serve as powerful agents of change (Arena et al., 2017; Bauman et al., 2012; Koorts et
5 al., 2018; Sallis et al., 2006). *Our Voice* applies the socioecological framework and draws
6 from empowerment theory and social cognitive theory to engage residents as behavioral
7 scientists in understanding and affecting the factors that influence their behaviors. *Our*
8 *Voice* targets individuals, social environments, physical environments, and policies to
9 achieve behavioral changes for health promotion. It encourages people to gain confidence
10 and skills to improve their quality of life through strengthening their self-efficacy to change
11 relevant health-promoting behaviors and environments (Glanz & Rimer, 2005; Hinckson et
12 al., 2017).

13 The specific aims of this study were to 1) evaluate built and social environmental factors
14 influencing Recreovía local park environments; 2) identify perceived factors that influence
15 participants' access to and engagement in Recreovía; and 3) facilitate a consensus-building
16 and advocacy process among community members, policymakers and academic researchers
17 aimed at improving uptake and impact of the Recreovía program.

18 **Methods**

19 Study Setting

20 This study was conducted in Bogotá, Colombia, a city with 7.2 million inhabitants
21 (Departamento Administrativo Nacional de Estadística, 2019). Currently, Bogotá has 5,112
22 parks (Instituto Distrital de Recreación y Deporte, n.d.). Recreovía primarily takes place in
23 low-to-middle-income neighborhoods (Díaz del Castillo et al., 2017; Instituto Distrital de
24 Recreación, 2019). It offers free classes daily, for 2 to 3 hours on weekday mornings and/or
25 evenings, and 3 to 6 hours on Sundays and holidays. In 2018, the Bogotá Recreovía
26 program had 70 physical activity instructors with an annual budget of US\$1.3 million
27 (personal communication with Recreovía Program Coordinator, September 2018).

Study design based on the *Our Voice* citizen science model

Our Voice in the Recreovía employed an explanatory sequential design (Pluye & Hong, 2014) to account for multiple-level device-based and reported data through observation and participatory approaches integrating quantitative and qualitative methods. First, we performed direct observations to characterize the parks in relation to park occupancy, physical activity levels and contextual features. Then, we implemented the *Our Voice* model to engage community members in data collection and analysis, and advance data-driven changes to promote environmental changes with policymakers. *Our Voice* in the Recreovía is part of the global *Our Voice* Citizen Science for Health Equity Research Initiative, and is a socioecological model that uses accessible technology and participatory qualitative and quantitative methodologies (King et al., 2016; Sheats et al., 2017). The entrée into this process is the Stanford Discovery Tool, a mobile data-gathering application (app) that allows residents to document neighborhood features through geocoded photographs, audio narratives, and GPS-tracked walking routes (Buman et al., 2013; King et al., 2016). The tool has been culturally adapted and translated for use in Colombia (Zieff et al., 2018). Through a facilitated process, the citizen scientists then use their data to promote changes in local built and social environments that can generate positive health-related impacts. The study included four phases: 1) planning and recruitment; 2) data collection; 3) data analysis and consensus-building; and 4) data harmonization and ripple effects capture.

Planning & Recruitment

We selected two public parks in urban areas based on official Recreovía attendance reports. Among parks with Recreovía programs, Santa Isabel park represented the lowest 10% in attendance rates, while San Andrés represented the upper 10% (personal communication with Recreovía Program Coordinator, September 2018).

In October 2017, participants in Recreovía PA classes at both parks were invited to engage in the *Our Voice* process as citizen scientists. The study was advertised via verbal announcements during and after the classes with the support of the PA instructors. Individuals 18 years of age and older were eligible to participate. Subsequently, among

1 eligible participants we selected self-identified 25% “community leaders” and 75% “non-
2 community leaders” for the final sample. We approached community leaders from pre-
3 existing elderly groups, Community Action Boards, and other neighborhood groups.
4 Recruitment was stated as completed upon reaching saturation in the discussions with
5 citizen scientists about positive and negative environmental features from each park. All
6 participants read and signed a university-approved informed consent form.

7 Data Collection and Analysis

8 *Community Walks and Survey*

9 Between October and December 2017, the research team trained citizen scientists to use the
10 Discovery Tool on mobile phones supplied by the project staff. Per the standard *Our Voice*
11 Discovery Tool protocol (Buman et al., 2013), citizen scientists took photographs and
12 recorded audio narratives describing environmental features that negatively and positively
13 impacted their experience related to engaging in PA in the park. Anonymous, de-identified
14 Discovery Tool data were then uploaded to a secure server at Stanford University.

15 Participants then completed a brief two-part survey. Sociodemographic variables assessed
16 included participant age, gender, education, and household socioeconomic status. The
17 survey also addressed participation in and satisfaction with the Recreovia program, general
18 perceptions of the park, and perceived levels of community cohesion and empowerment
19 among neighborhood residents. Community perceptions were evaluated using five-point
20 Likert scales from the standard *Our Voice* protocol (King et al., 2016).

21 *Physical activity levels: individual and park level*

22 ***Individual-level physical activity and anthropometric measurement***

23 In order to assess objectively the PA levels of participants, we used the Actigraph GT3X
24 and GT3X+ Accelerometer (ActiGraph LLC, Pensacola, FL, USA), initialized to collect
25 data at 60-second epochs. Participants were asked to wear the accelerometer 24 hours per
26 day for 7 days using an elasticized belt around the waist at the right mid-axillary line. For
27 wear-time validation, a minimum of five days with at least 10 hours of wear during the
28 awake time was required (Salvo et al., 2014). Accelerometry data were scored using
29 Freedson cut-points for adults (Freedson, Melanson, & Sirard, 1998). The cut-off point

1 used with the accelerometer data was an average MVPA per day of more than 22 min,
2 equivalent to meeting the weekly PA recommendation of ≥ 150 min/week. These analyses
3 were conducted with R 3.3.2 (Core Team, Austria, 2009).

4 Anthropometric data (i.e., body weight and height) were measured by trained researchers
5 using a portable Tanita SC-240 Body Composition Analyzer (Tanita, Arlington Heights,
6 IL, USA), and a portable Seca 213 stadiometer (Seca, Hamburg, Germany).

7 ***Parks Characteristics and Physical Activity levels***

8 To characterize the park in relation to park occupancy and MVPA, we used the System for
9 Observing Play and Recreation in Communities (SOPARC). SOPARC is an observational
10 method developed to assess the number of park users by gender and age group, and their
11 physical activity levels (McKenzie et al., 2006). It consists of systematic micro-scans of
12 selected target areas over a specified period of time. The method has been adapted
13 previously for application in Colombia (reliability $>80\%$) (Santos et al., 2016). Data were
14 collected by five trained observers under the supervision of two field coordinators.

15 Commensurate with SOPARC methodology, parks were divided into target areas according
16 to characteristics that facilitate the practice of PA (e.g., courts, parking lots, fields,
17 walking/running tracks, exercise areas, and open areas). Santa Isabel included 42 target
18 areas and San Andrés included 25 target areas. Observations were made according to
19 Recreovía schedules of each park. In Santa Isabel, park observations were made during
20 three Sundays between March and May 2017. In San Andrés, park observations were made
21 during three weekdays between May and July 2017. On each observation day in the
22 Recreovía target areas, three 20-minute observation periods were conducted. In Santa
23 Isabel, observations were made at 9:00 am, 10:00 am, and 11:00 am. In San Andrés,
24 observations were made at 7:00 am, 8:00 am and 9:00 am. Total park users and their mean
25 characteristics were calculated for each park on a daily basis. Observed user characteristics
26 included gender, age group, and current physical activity level.

27 To systematically assess the contextual characteristics of both parks we used the Physical
28 Activity Resource Assessment (PARA) instrument (Lee et al., 2005). Through PARA we
29 evaluated the quality of parks by qualifying their conditions into five domains (i.e., features

for PA practice, amenities, incivilities, services and accessibility) with scores ranging 0 to 4 (Sarmiento et al., 2017). The quality score was computed as the sum of the items.

We used descriptive statistics to analyze park and users' characteristics. Statistical significance was tested among categorical variables using a chi-square test (X^2), and among continuous variables using a *t*-test. All analyses were performed using SAS 9.4 (SAS, Cary, NC, 2007).

Data Analysis by the Citizen Scientists

Discovery Tool data preparation

After the Discovery Tool data were collected by the citizen scientists, the research team prepared documents with verbatim transcriptions of each participant's audio narratives paired with their respective photographs. Each participant received printed copies of their own data.

Community Meetings to discuss the environmental data

All citizen scientists who participated in data collection were invited and encouraged to participate in community meetings organized by the research team. During March 2018, an anthropologist facilitated six one-hour community meetings (two in Santa Isabel Park and four in San Andrés Park), which were attended by a total of 24 citizen scientists (50%). Participants collectively reviewed their photos and audio transcripts and identified relevant issues to address in each park. Lawyers from the research team provided advocacy training on how to use participatory mechanisms described in the Colombia Constitution. All participants received a snack and sweatband in gratitude for their participation, as well as their anthropometric and accelerometer results with recommendations to improve health.

Following each community meeting, the research team organized the categories identified into clusters based on the themes that emerged during the citizen scientist discussions. Saturation was reached when the themes reflected similar information for each park regarding perceived enablers and barriers to practicing physical activity.

Community meeting with local policymakers for empowerment and change

In April 2018, four citizen scientists (Santa Isabel=1, San Andrés=3, [8,3%]) and three local policymakers attended a community meeting at the Institute of Sports and Recreation. The citizen scientists presented their findings and recommendations across the two sites using the visual, narrative, and map data drawn from the Discovery Tool.

Members of the research team entered field notes from all community meetings into Excel (Microsoft Corporation, 2016) and thematically analyzed them by constructing narrative matrices. Themes included notions about healthy habits and healthy environments; personal experiences practicing PA; perceptions about the environment where they practice PA; and ideas about how to promote PA. Participants quotes were translated from Spanish to English by members of the research team for dissemination purposes.

Data harmonization

In order to inform policies aimed at increasing park usage for the promotion of PA, and identify facilitators of and barriers to Recreovía participation, the research team harmonized the following data: surveys about park features, MVPA levels measured by accelerometry, SOPARC measurements, and the themes that emerged from the community meetings.

Results

Characteristics of parks and target areas

Both public parks were located in middle-income localities. However, Santa Isabel had higher monetary poverty and homicide rates than San Andrés (Bogotá Cómo Vamos, 2017). Santa Isabel Park is smaller (22,521 m²) than San Andrés Park (68.695 m²), but the Recreovía area of Santa Isabel was larger than the Recreovía area of San Andrés. Although both parks are public, Santa Isabel Park is crossed by streets and San Andrés Park is enclosed with a fence and has specific access hours. San Andrés Park had higher quality scores in features, amenities, safety, and services compared to Santa Isabel Park (Table1).

[Insert - Table 1. Characteristics of parks, features of the parks and sociodemographic characteristics of citizen scientists– here]

Park users and activities observed

We observed 3769 park users, 22.7% of whom were observed in Santa Isabel and 77.3% in San Andrés. Across both sites, most observed park users were women (64.9%) and adults (79.7%). However, in San Andrés, the percentage of older adults (51.2%) was higher than in Santa Isabel (10.4%). The percentage of users engaging in MVPA across both sites was virtually equal for men (84.8%) and women (86.3%).

Characteristics of citizen scientists

Table 1 shows the characteristics of citizen scientists who participated in the *Our Voice* process. A total of 48 citizen scientists were enrolled in the study (Santa Isabel=17, San Andrés= 31), but for one participant, Discovery Tool data were not properly recorded. Citizen scientists were mostly women, and on average were 50 (SD=15) years old, with more than a high school education, and from middle-income households. Citizen scientists in general had perceptions of good-to-excellent health status, reported spending an average of 135 minutes/ per day (SD=53.5) in the Recreovía, and described their main reason for participating as “health” (94%). Reflecting the high PA levels of users of the Recreovía, most citizen scientists from both parks met PA recommendations and in general had perceptions of good-to-excellent health status, although 50% of the citizen scientists were overweight or obese. Overall, citizen scientists were highly satisfied with the Recreovía classes and reported that these classes increased the friendliness of the parks. However, citizen scientists from Santa Isabel were less satisfied with the cleanliness of the exercise class areas compared to San Andrés.

Citizen scientists from both parks reported perceiving that in their communities, people support each other and that working together could strengthen their possible influence on the decision-making process.

Discovery Tool data and community meetings

Perceived enablers and barriers to practicing physical activity in parks

Overall, 299 photos and 297 audio narratives were recorded by 47 citizen scientists. Of these, 24 participated in the community meetings to review, analyze and discuss the Discovery Tool

1 data. As assets in both parks, citizen scientists highlighted the encouragement of PA through
2 the Recreovía program; availability of outdoor fitness equipment; maintenance of green
3 areas, and the diversity and maintenance of courts. They reported that their neighborhood
4 parks are inclusive spaces offering a range of facilities adequate for diverse age and gender
5 groups.

6 Regarding barriers to park usage, Santa Isabel's residents were particularly attentive to
7 safety and cleanliness concerns. They identified as top concerns poor management of
8 garbage (including animal waste), lack of safety, and limited interactions among neighbors.
9 They suggested that this was due to the presence of a homeless population, poor
10 community recycling practices, and the use of the park for the sale and consumption of
11 illegal drugs. Conversely, San Andrés residents expressed that safety and cleanliness were
12 not challenges as their park is enclosed, has private security, prohibits pets, and is
13 administered by the mayor's office. The only expressed sporadic concerns about the San
14 Andrés park were over the lack of maintenance of courts, trails, and green areas, and
15 limited night-time lighting. Other concerns from participants of both parks included
16 occasional problems with the sound quality of the music accompanying the PA classes and
17 the irregularities of the court surfaces for the PA classes.

18 Citizen scientists' experiences accessing and engaging with PA classes in parks

19 During the community meetings, citizen scientists also noted the co-benefits of community-
20 based PA programs, which went beyond PA promotion to include increasing self-
21 confidence, social capital, mental health and civic engagement. Citizen scientists revealed
22 that experiencing such outcomes supports their regular PA practice.

23 One older adult said that PA helps them to maintain their vitality and self-confidence.

24 *I thank the doctor who told me to come here to walk, because otherwise I would*
25 *be in a wheelchair (...) from the age of 40 I have exercised; I do not like pills.*
26 *When I feel pain in my joints I go out and I heal myself with exercise. (Santa*
27 *Isabel).*

28 Another participant mentioned that Recreovía park use amounts to taking care of mental
29 health and building bonds with neighbors.

1 *I come to the park to walk or do physical activity and I disconnect; I have fun,*
2 *and I'm happy. And I'm with friends, sharing, having a good time (Santa Isabel).*

3 A third citizen scientist noted the importance of supporting the District's efforts to create
4 programs that benefit public health.

5 *These spaces allow people to exercise without costs (...). I think it's very good*
6 *that the government cares about this. It's a good policy; so, we should come and*
7 *take advantage of it (San Andrés).*

8 *Building consensus to advocate for healthier environments*

9 During the community meeting with local policymakers, citizen scientists praised the high
10 quality of the Recreovía program and the expertise of the PA instructors as critical in
11 meeting their communities' needs for healthy and active living. The dialogue among users
12 of both parks also elicited a proposal to create specific Recreovía hours for the elderly.

13 Policymakers, in turn, stressed the value of receiving data-driven feedback from the
14 community, as this afforded them the opportunity to clarify information about district-level
15 accountability for the Recreovía program and general park maintenance. At the conclusion
16 of the meetings, policymakers committed to bringing the community's concerns to the
17 proper administrative offices.

18 *Short-term outcomes and longer-term ripple effects of Our Voice in the Recreovía*

19 Several short-term effects were documented six months following the conclusion of the
20 *Our Voice* process. First, *Our Voice* contributed to strengthening and sustaining the
21 Recreovía program in Santa Isabel, where low attendance had previously led to a plan to
22 discontinue it. Now, in response to community interest and needs highlighted through the
23 *Our Voice* process, the site continues operating on weekends, and an additional site has
24 been developed nearby. Second, citizen scientists were empowered as advocates for the
25 Recreovía program. During a presentation at the National Seminar on Policies and
26 Programs to Promote Healthy Habits and Lifestyles held by the Ministry of Sports (Bogotá,
27 October, 2018), a citizen scientist from the Santa Isabel assessment presented on
28 Recreovía's community benefits, highlighting that the *Our Voice* approach helped to foster
29 dialogue and shared solution-building within communities and with policymakers. Third,

1 the relationships among community members, policymakers and academic researchers
2 aimed at advancing activity-promoting changes in the Recreovía program were
3 strengthened. Specifically, the coordinator of the Recreovía program became involved in an
4 ongoing Recreovía evaluation project, which has resulted in the scheduling of monthly
5 meetings and further steps to clarify the impacts of the program. In addition, before
6 implementing new Recreovía hubs in underserved areas, the research team was called in to
7 conduct a formal impact evaluation, and the coordinator presented results from research
8 papers and policy briefs about Recreovía to the director of the Institute and at an
9 international scientific congress. The data-driven decision-making process to open new
10 hubs reflects policymakers' engagement with the research activities and the *Our Voice*
11 process (personal communication with coordinator, January 2019).

12 Six months after implementation, we observed project ripple effects related to local
13 capacity building. The director of the Ministry of Sports' Healthy Habits and Lifestyles
14 Program invited the research team to present the results of *Our Voice* in the Recreovía and
15 train the program's municipal-level instructors on *Our Voice* methodology during the
16 National Seminar (Bogotá, October, 2018). In total, 250 instructors participated in the
17 training, which included virtual and in-person sessions, and featured a citizen scientist who
18 shared her experience about *Our Voice* in the Recreovía. During the same month, the
19 researchers were also invited to share the *Our Voice* research experience and results at the
20 International Physical Activity Seminar organized by Bogotá's Institute of Sports and
21 Recreation.

22 **Discussion**

23 The *Our Voice* in the Recreovía study, the first of its kind in a middle-income Latin
24 American city, discovered relevant factors supporting regular community-based PA
25 practice related to the interaction between individual behaviors and healthy environments.
26 Quantitative measurements regarding characteristics of parks showed that San Andres Park
27 had better quality than Santa Isabel park. The *Our Voice* approach helped researchers and
28 decision makers to understand that beyond characteristics of the parks, Recreovía users
29 highlighted broad factors supporting their PA engagement. Over the course of the project,
30 citizen scientists expressed high satisfaction with the Recreovía program, and reported that

1 it improved the friendliness of the environment of both parks. They elucidated program co-
2 benefits that extended to fostering self-confidence, social capital, mental health, and civic
3 engagement. At the same time, they reported that the main barriers to use were related to
4 park maintenance, cleanliness, and safety. The opportunity for residents of two different
5 communities to listen to each other and engage in dialogue with local policymakers allowed
6 all actors to understand the complex array of individual, social, and political factors that
7 support regular physical activity. Documentation of short-term outcomes and longer-term
8 ripple effects showed that both citizen scientists and policymakers can effectively engage
9 with research activities in order to improve their environments, and enhance existing
10 programs. In study follow-up, local and national policymakers have acknowledged the
11 potential of the *Our Voice* process to strengthen community-based PA programs and to
12 build local capacity for health-promoting change.

13 The results of *Our Voice* in the Recreovía are consistent with previous studies using the
14 *Our Voice* approach, in which citizen scientists identified and advocated for improving
15 aspects of their neighborhoods that can support healthy living. Building on this
16 foundational research, *Our Voice* in the Recreovía contributes to understanding the impacts
17 and promise of park-based programs by assessing a program with 1.2 million participants,
18 mainly benefiting women, embedded in social policy for NCD prevention and PA
19 promotion. *Our Voice* in the Recreovía may also serve as a model for direct resident
20 engagement in building and strengthening a range of park-based community programs to
21 promote healthy living. In fact, worldwide, similar Recreovía-type programs seeking to
22 increase levels of PA and decrease health inequalities by reaching low-income women exist
23 in countries like Argentina, Brazil, Chile, Cuba, Ecuador, Guatemala, Mexico, the U.S., and
24 Australia (Díaz del Castillo et al., 2017).

25 While citizen scientists described adequate facilities in both parks (i.e., recreation courts,
26 activities, outdoor fitness equipment), there was a big usage gap between the two that can
27 be explained at least in part by environmental factors. Public parks were positively
28 described as inclusive spaces with the potential to enhance social capital, self-care and civic
29 engagement. On the other hand, concerns about safety hindered the use of the parks for
30 physical activity. This is consistent with previous studies about lack of safety as an

environmental deterrent for PA practice in public spaces (Francis et al., 2012; Rachele et al., 2016; Sawyer et al., 2017). However, *Our Voice* in the Recreovía provided more nuanced insights into how engaging residents and policymakers can create a synergy of bottom-up and top-down efforts to address safety concerns and encourage active living.

This study's findings helped to clarify the varying levels of success of Recreovía programming across sites. *Our Voice* in the Recreovía proved to be a multilevel, multisectoral community-based participatory experience that drew on local knowledge to leverage PA champions and advocate for a sustained park-based PA program.

Strengths and Limitations

Our Voice in Recreovía had three main strengths. First, at the methodological level, we combined quantitative, qualitative and technology-based methods. Second, at the policy level, we were able to stimulate productive data-driven dialogue among community members and policy makers in a variety of contexts (e.g., meetings, policy seminars). Third, through ongoing contact with program coordinators, we have been able to track longer-term ripple effects, such as using citizen scientist data to leverage the maintenance and opening of new Recreovía sites.

This study has limitations that should be considered. First, citizen scientists were recruited during their participation in the Recreovía; therefore, we did not recruit general park users who were not also Recreovía participants. This might have created a complacency bias among citizen scientists, regarding acceptance of the program. In addition, as the *Our Voice* process includes several phases, the number of citizen scientists participating in each phase of the process diminished over time. Despite this attrition, participants were able to reach consensus around the central ideas and activities, underscoring that a relatively small number of engaged residents can enact positive change. Second, while the project enjoyed the engagement of key local stakeholders (e.g., the coordinators of the Recreovía program and the National Healthy Habits and Lifestyles program), the community meetings had relatively low policymaker participation. Finally, project ripple effects were evaluated over a relatively limited time frame (i.e., 11 months). Fortunately, the commitment to nurture the

relationships formed during this initial period will allow further documentation of potential ripple effects.

Conclusions

This study underscores the importance of mixed-methods approach to understand factors supporting community-based PA behaviors. As such, relevant identified factors influencing the use of the Recreovía program include its role in enhancing social and individual well-being. Recreovía improves the friendliness of the park environment; additionally, it fosters self-confidence, social capital, mental health and civic engagement. The *Our Voice* process elicited community reflection, dialogue, empowerment, advocacy and action. The process allowed residents to reflect on outcomes of their PA practice while systematically collecting and discussing data of direct relevance to their local community. This gave them an evidence-based “voice” to advance pragmatic solutions that promote active living in their local community. *Our Voice* facilitated the interplay among researchers, citizen scientists, and policymakers to optimize community programs. Combining quantitative and qualitative methods, this study provides an adaptable framework for using technology-driven participatory design to evaluate park-based as well as other types of interventions.

References

- Abolghasem, S., Solano, F., Bedoya, C. D., Navas, L. P., Ríos, A. P., Pinzón, E. A., ... Sarmiento, O. L. (2018). A robust DEA-centric location-based decision support system for expanding Recreovía hubs in the city of Bogotá (Colombia). *International Transactions in Operational Research*, 00, 1–31. <https://doi.org/10.1111/itor.12573>
- Arena, R., Bond, S., O'Neill, R., Laddu, D. R., Hills, A. P., Lavie, C. J., & McNeil, A. (2017). Public Park Spaces as a Platform to Promote Healthy Living: Introducing a HealthPark Concept. *Progress in Cardiovascular Diseases*, 60(1), 152–158. <https://doi.org/10.1016/j.pcad.2017.05.010>
- Atkins, R., Deatrick, J. A., Bowman, C., Bolick, A., McCurry, I., & Lipman, T. H. (2018). University – Community Partnerships Using a Participatory Action Research Model to Evaluate the Impact of Dance for Health. *Behavioral Sciences*, 8(113). <https://doi.org/10.3390/bs8120113>
- Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, 380(9838), 258–271. [https://doi.org/10.1016/S0140-6736\(12\)60735-1](https://doi.org/10.1016/S0140-6736(12)60735-1)
- Besenyi, G. M., Kaczynski, A. T., Stanis, S. A. W., Bergstrom, R. D., Lightner, J. S., &

- Hipp, J. A. (2014). Planning for health: A community-based spatial analysis of park availability and chronic disease across the lifespan. *Health and Place*, 27, 102–105. <https://doi.org/10.1016/j.healthplace.2014.02.005>
- Blacksher, E., & Lovasi, G. S. (2012). Place-focused physical activity research, human agency, and social justice in public health: Taking agency seriously in studies of the built environment. *Health and Place*, 18(2), 172–179. <https://doi.org/10.1016/j.healthplace.2011.08.019>
- Bogotá Cómo Vamos. (2017). *Informe de Calidad de Vida en Bogotá 2017*. Bogotá. <https://doi.org/2539-4681>
- Buman, M. P., Winter, S. J., Sheats, J. L., Hekler, E. B., Otten, J. J., Grieco, L. A., & King, A. C. (2013). The Stanford Healthy Neighborhood Discovery Tool. *American Journal of Preventive Medicine*, 44(4), e41–e47. <https://doi.org/10.1016/j.amepre.2012.11.028>
- Chrisinger, B. W., Ramos, A., Shaykis, F., Martinez, T., Banchoff, A. W., Winter, S. J., & King, A. C. (2018). Leveraging Citizen Science for Healthier Food Environments: A Pilot Study to Evaluate Corner Stores in Camden, New Jersey. *Frontiers in Public Health*, 6(March), 89. <https://doi.org/10.3389/fpubh.2018.00089>
- Departamento Administrativo Nacional de Estadística. (n.d.). Proyecciones de Población.
- Díaz del Castillo, A., González, S. A., Ríos, A. P., Páez, D. C., Torres, A., Díaz, M. P., ... Sarmiento, O. L. (2017). Start small, dream big: Experiences of physical activity in public spaces in Colombia. *Preventive Medicine*, 103, S41–S50. <https://doi.org/10.1016/j.ypmed.2016.08.028>
- Douglas, J. A., Briones, M. D., Bauer, E. Z., Trujillo, M., Lopez, M., & Subica, A. M. (2018). Social and environmental determinants of physical activity in urban parks: Testing a neighborhood disorder model. *Preventive Medicine*, 109, 119–124. <https://doi.org/10.1016/j.ypmed.2018.01.013>
- Francis, J., Giles-Corti, B., Wood, L., & Knuiman, M. (2012). Creating sense of community: The role of public space. *Journal of Environmental Psychology*, 32(4), 401–409. <https://doi.org/10.1016/j.jenvp.2012.07.002>
- Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the computer science and applications, Inc. accelerometer. *Med Sci Sports Exerc.*, 30(5), 777–781.
- Gaffney, L. K., Lozano, O. D., Almanza, A., Ruiz, N., Mantero, A., & Stoutenberg, M. (2019). The Implementation of a National Physical Activity Intervention in Colombia. *Journal of Physical Activity and Health*, 1–7. <https://doi.org/10.1123/jpah.2018-0183>
- Glanz, K., & Rimer, B. (2005). *Theory at a Glance. A guide for Health Promotion Practice*. National Cancer Institute (Second, Vol. 83). U.S. Department of Health and Human Services. National Institutes of Health. <https://doi.org/10.1111/j.1360-0443.1989.tb03059.x>
- Guthold, R., Stevens, G. a, Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants, (18). [https://doi.org/10.1016/S2214-109X\(18\)30357-7](https://doi.org/10.1016/S2214-109X(18)30357-7)
- Han, B., Cohen, D. A., Derosé, K. P., Li, J., & Williamson, S. (2018). Violent Crime and

1 Park Use in Low-Income Urban Neighborhoods. *American Journal of Preventive*
2 *Medicine*, 54(3), 352–358. <https://doi.org/10.1016/j.amepre.2017.10.025>

3 Hinckson, E., Schneider, M., Winter, S. J., Stone, E., Puhan, M., Stathi, A., ... King, A. C.
4 (2017). Citizen science applied to building healthier community environments:
5 Advancing the field through shared construct and measurement development.
6 *International Journal of Behavioral Nutrition and Physical Activity*, 14(1), 1–14.
7 <https://doi.org/10.1186/s12966-017-0588-6>

8 Hoehner, C. M., Ribeiro, I. C., Parra, D. C., Reis, R. S., Azevedo, M. R., Hino, A. A., ...
9 Brownson, R. C. (2013). Physical activity interventions in Latin America: Expanding
10 and classifying the evidence. *American Journal of Preventive Medicine*, 44(3), e31–
11 e40. <https://doi.org/10.1016/j.amepre.2012.10.026>

12 Instituto Distrital de Recreación y Deporte. (n.d.). Sistema de Información Distrital de
13 Parques.

14 INSTITUTO DISTRITAL DE RECREACIÓN Y DEPORTE. (2019). Recreovia. Retrieved
15 May 16, 2019, from <https://www.idrd.gov.co/recreovia>

16 King, A. C., Winter, S. J., Chrisinger, B. W., Hua, J., & Banchoff, A. W. (2019).
17 Maximizing the promise of citizen science to advance health and prevent disease.
18 *Preventive Medicine*, 119(December 2018), 44–47.
19 <https://doi.org/S0091743518303955>

20 King, A. C., Winter, S. J., Rosas, L. G., & Buman, M. P. (2016). Leveraging Citizen
21 Science and Information Technology for Population Physical Activity Promotion.
22 *Transl J Am Coll Sports Med*. 2016 May 15;1(4):30-44., 1(4).

23 Koorts, H., Eakin, E., Estabrooks, P., Timperio, A., Salmon, J., & Bauman, A. (2018).
24 Implementation and scale up of population physical activity interventions for clinical
25 and community settings : the PRACTIS guide, 1–11. [https://doi.org/10.1186/s12966-](https://doi.org/10.1186/s12966-018-0678-0)
26 018-0678-0

27 Lee, R. E., Booth, K. M., Reese-Smith, J. Y., Regan, G., & Howard, H. H. (2005). The
28 Physical Activity Resource Assessment (PARA) instrument: Evaluating features,
29 amenities and incivilities of physical activity resources in urban neighborhoods.
30 *International Journal of Behavioral Nutrition and Physical Activity*, 2, 1–9.
31 <https://doi.org/10.1186/1479-5868-2-13>

32 McKenzie, T. L., Cohen, D. A., Sehgal, A., Williamson, S., & Golinelli, D. (2006). System
33 for Observing Play and Recreation in Communities (SOPARC): Reliability and
34 Feasibility Measures. *Journal of Physical Activity & Health*, 3 Suppl 1, S208–S222.

35 McNeill, L. H., Kreuter, M. W., & Subramanian, S. V. (2006). Social Environment and
36 Physical activity: A review of concepts and evidence. *Social Science and Medicine*,
37 63(4), 1011–1022. <https://doi.org/10.1016/j.socscimed.2006.03.012>

38 Plane, J., & Klodawsky, F. (2013). Neighbourhood amenities and health: Examining the
39 significance of a local park. *Social Science and Medicine*, 99, 1–8.

40 Pluye, P., & Hong, Q. N. (2014). Combining the Power of Stories and the Power of
41 Numbers: Mixed Methods Research and Mixed Studies Reviews. *Annual Review of*
42 *Public Health*, 35(1), 29–45. <https://doi.org/10.1146/annurev-publhealth-032013->

- Rachele, J. N., Ghani, F., Loh, V. H. Y., Brown, W. J., & Turrell, G. (2016). Associations between physical activity and the neighbourhood social environment: baseline results from the HABITAT multilevel study. *Preventive Medicine*, 93(2016), 219–225. <https://doi.org/10.1016/j.ypmed.2016.06.034>
- Rigolon, A. (2017). Parks and young people: An environmental justice study of park proximity, acreage, and quality in Denver, Colorado. *Landscape and Urban Planning*, 165(May), 73–83.
- Rios, A., Paez, D., Pinzón, E., Fermino, R., Sarmiento, O., Férmino, R., & Sarmiento, O. (2017). Logic model of the Recreovía: a community program to promote physical activity in Bogota. *Revista Brasileira de Atividade Física & Saúde*, 22(2), 206–211. <https://doi.org/10.12820/rbafs.v.22n2p206-211>
- Rosas, L. G., Salvo, D., Winter, S. J., Cortes, D., Rivera, J., Rodriguez, N. M., & King, A. C. (2016). Harnessing Technology and Citizen Science to Support Neighborhoods that Promote Active Living in Mexico. *Journal of Urban Health*, 93(6), 953–973. <https://doi.org/10.1007/s11524-016-0081-6>
- Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., ... Hallal, P. C. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet*, 388(10051), 1325–1336. [https://doi.org/10.1016/S0140-6736\(16\)30581-5](https://doi.org/10.1016/S0140-6736(16)30581-5)
- Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health*, 27(1), 297–322. <https://doi.org/10.1146/annurev.publhealth.27.021405.102100>
- Salvo, D., Reis, R. S., Sarmiento, O. L., & Pratt, M. (2014). Overcoming the challenges of conducting physical activity and built environment research in Latin America: IPEN Latin America. *Prev. Med.*, 69(1), S86–S92.
- Santos, M. P. M., Rech, C. R., Alberico, C. O., Fermino, R. C., Rios, A. P., David, J., ... Mota, J. (2016). Utility and Reliability of an App for the System for Observing Play and Recreation in Communities (iSOPARCÂ®). *Measurement in Physical Education and Exercise Science*, 20(2), 93–98. <https://doi.org/10.1080/1091367X.2015.1120733>
- Sarmiento, O. L., Rios, A. P., Paez, D. C., Quijano, K., & Fermino, R. C. (2017). The recreovía of bogotá, a community-based physical activity program to promote physical activity among women: Baseline results of the natural experiment al ritmo de las comunidades. *International Journal of Environmental Research and Public Health*, 14(6). <https://doi.org/10.3390/ijerph14060633>
- Sawyer, A. D. M., Jones, R., Ucci, M., Smith, L., Kearns, A., & Fisher, A. (2017). Cross-sectional interactions between quality of the physical and social environment and self-reported physical activity in adults living in income-deprived communities. *Plos One*, 12(12), e0188962. <https://doi.org/10.1371/journal.pone.0188962>
- Sheats, J. L., Winter, S. J., Romero, P. P., & King, A. C. (2017). FEAST: Empowering Community Residents to Use Technology to Assess and Advocate for Healthy Food Environments. *Journal of Urban Health*, 94(2), 180–189. <https://doi.org/10.1007/s11524-017-0141-6>

- 1 Torres, A., Díaz, M. P., Hayat, M. J., Lyn, R., Pratt, M., Salvo, D., & Sarmiento, O. L.
2 (2016). Assessing the effect of physical activity classes in public spaces on leisure-
3 time physical activity: “Al Ritmo de las Comunidades” A natural experiment in
4 Bogota, Colombia. *Preventive Medicine*.
- 5 Torres, A., Sarmiento, O. L., Stauber, C., & Zarama, R. (2013). The ciclovía and cicloruta
6 programs: Promising interventions to promote physical activity and social capital in
7 Bogotá, Colombia. *American Journal of Public Health*, 103(2), 23–31.
8 <https://doi.org/10.2105/AJPH.2012.301142>
- 9 US Department of Health and Human Services. (2018). 2018 Physical Activity Guidelines
10 Advisory Committee Scientific Report. To the Secretary of Health and Human
11 Service. <https://doi.org/10.1111/j.1753-4887.2008.00136.x>
- 12 Wood, L., Hooper, P., Foster, S., & Bull, F. (2017). Public green spaces and positive
13 mental health – investigating the relationship between access, quantity and types of
14 parks and mental wellbeing. *Health and Place*, 48(July), 63–71.
15 <https://doi.org/10.1016/j.healthplace.2017.09.002>
- 16 World Health Organization. (2018). *Global action plan on physical activity 2018–2030:*
17 *more active people for a healthier world*. Geneva: WHO.
- 18 Zhang, Y., & Li, F. (2017). The relationships between urban parks, residents’ physical
19 activity, and mental health benefits: A case study from Beijing, China. *Journal of*
20 *Environmental Management*, 190, 223–230.
21 <https://doi.org/10.1016/j.jenvman.2016.12.058>
- 22 Zieff, S. G., Musselman, E. A., Sarmiento, O. L., Gonzalez, S. A., Aguilar-Farias, N.,
23 Winter, S. J., ... King, A. C. (2018). Talking the Walk: Perceptions of Neighborhood
24 Characteristics from Users of Open Streets Programs in Latin America and the USA.
25 *Journal of Urban Health*, 95(6), 899–912. <https://doi.org/10.1007/s11524-018-0262-6>