



Where Latin Americans are physically active, and why does it matter? Findings from the IPEN-adult study in Bogota, Colombia; Cuernavaca, Mexico; and Curitiba, Brazil



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ABSTRACT

Latin America (LA) has a unique structural, political, cultural and social environment. This study aimed to identify the places where Latin American adults are physically active; and to determine the association of using public- and restricted-access places with physical activity (PA). We used data from the International PA Environment Network study in Bogota, Colombia (n = 1000, accelerometry = 249); Cuernavaca, Mexico (n = 677, accelerometry = 652); and Curitiba, Brazil (n = 697, accelerometry = 331) (2010–2011). Walking and moderate-to-vigorous PA for leisure were measured with the International Physical Activity Questionnaire. Overall PA and PA within 10-minute bouts were measured with accelerometers. Participants reported use of public- and restricted-access places for PA. Mixed-effects regression models were used to determine the association of using public- and restricted-access places with PA. The streets were the most frequently-reported place for PA, and walking was the most common PA in the studied places. 'Informal', non-exercise-or-sports places (e.g., shopping malls) ranked high for use for PA in Bogota and Cuernavaca. In Curitiba, use of 'formal' places for sports/exercise (e.g., gyms) was more prevalent. Using public-access places was directly related to walking for leisure in all cities, and to additional PA outcomes in Bogota and Cuernavaca. In Cuernavaca and Curitiba, using restricted-access places was also associated with PA. Our study highlights the importance of public-access places for PA in LA. In some contexts, places for social interaction may be as important for PA as places for exercise/sport. Strategies increasing the availability, accessibility and quality of these places may effectively promote PA in LA.

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1. Introduction

Physical activity (PA) has been described as “the best buy in public health” (Morris, 1994). Physically active people live longer, and are at lower risk of obesity, cardiovascular diseases, diabetes, and some cancers (Lee et al., 2012). In spite of these benefits, about a third of the population worldwide is inactive, and as many deaths per year are attributed to physical inactivity as to tobacco use (Hallal et al., 2012; Jha and Peto, 2014).

Substantial evidence demonstrates the influence of the physical environment on PA (Sallis et al., 2009, 2016; Mayne et al., 2015; Bancroft et al., 2015). The relation between PA and place seems obvious: PA occurs in specific places (Sallis et al., 2006). Based on this premise, an

effective strategy to promote PA in cities should be to promote the use, and improve the quality availability of places commonly used for PA by residents. Numerous studies from high-income countries (HIC) have identified ‘formal’ places for PA, and have demonstrated a positive relation between their use, availability and quality with population PA levels (Cohen et al., 2007; Ranchod et al., 2014; Sallis et al., 2012; Kaczynski et al., 2014; Eriksson et al., 2012). These ‘formal places for PA’ include parks, recreation centers, gyms, trails and schools; and all are places or facilities for exercise or sports – the most traditionally studied types of PA. In fact, PA “for leisure” and “for exercise or sport” are terms that are commonly used interchangeably, although it is quite possible to be physically active for leisure, without practicing sports or exercising (e.g., dancing, or walking with friends).

Latin America (LA) has a unique structural, political, cultural and social environment (Salvo et al., 2014a). It is the most urbanized region in

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the world (80% of Latin Americans live in cities) (United Nations, 2012), and has rising prevalences of obesity and chronic diseases, paired with persistently high levels of undernutrition and infectious diseases (Rivera et al., 2014; Barreto et al., 2012; Popkin et al., 2012; Collaboration NRF, 2016). LA cities are characterized by high population density, disorganized transit systems, congestion, pollution, rising crime rates, and pronounced income inequality (United Nations, 2012; Barreto et al., 2012; Becerra et al., 2013; Hardoy et al., 2013; Knox and McCarthy, 2012; Briceno-Leon, 2005). The region has a strong cultural identity (Bakewell, 2004). Latin Americans have a strong collectivistic identity, being very social, community- and family-centered people (Bakewell, 2004; Alegria et al., 2004; Ramírez-Esparza et al., 2009; Schreier et al., 2010; Leng and Botelho, 2010). LA cities tend to have a vibrant street life, with many public places for social interaction (Briceno-Leon, 2005; Crowley, 1995; Ford, 1996; Low and Smith, 2013).

Given the characteristics of LA cities and people, it is possible that the places where Latin Americans are physically active are not limited to those most commonly studied in HIC, usually 'formal' places for PA centered on sports and exercise. The purpose of this study was to identify where Latin American adults are physically active, using data from Bogota, Colombia; Cuernavaca, Mexico; and Curitiba, Brazil. We also examined the relation of using public- and restricted-access places with self-reported leisure-time PA, and with overall accelerometer-based PA outcomes. We hypothesized that public-access places play a stronger role than restricted-access places for PA in LA.

2. Methods

2.1. Study sites

This analysis used data from the three participating LA sites of the International PA Environment Network (IPEN) adult study: Bogota, Colombia; Cuernavaca, Mexico; and Curitiba, Brazil; collected between 2010 and 2011. All sites are in Upper Middle-Income Countries (World Bank Group, 2012). Bogotá is Colombia's capital with over seven million inhabitants. When data collection took place (2010–2011), Bogotá had a Human Development Index (HDI) of 0.719 (HDI is a "summary measure of average achievement in key dimensions of human development," ranging from 0 to 1, with 1 representing the highest achievement in human development (Anand, 1994)), and a Gini coefficient of 54.2 (the Gini coefficient is a measure of inequality, with 0 representing complete equality, and 1 representing complete inequality (World Bank Group, 2012)). Cuernavaca is a centrally-located city of 365,000 inhabitants in the state of Morelos, Mexico. At time of data collection, it had a HDI of 0.775 and a Gini coefficient of 48.1 (World Bank Group, 2012). Curitiba is the capital city of the southern Brazilian state of Parana, with 1,760,000 inhabitants, a HDI of 0.73, and a Gini coefficient of 53.1 at time of data collection (World Bank Group, 2012).

2.2. Study design and sampling

IPEN was a cross-sectional study examining the associations between built environment features and PA among adults, using standardized protocols and measures from 17 cities in 12 countries. IPEN used a stratified, multistage, clustered sampling design. Neighborhoods constituted the primary sampling unit, and were stratified by walkability (high/low) and socioeconomic status (high/low). Participating sites identified the smallest administrative unit for geographically representing a neighborhood (equivalent to a US Census Tract). Neighborhoods from each stratum (high/low walkability \times socioeconomic status) were randomly selected, followed by a random selection of households. One adult (18–70 years) per household was eligible for participation. Participating sites were required to collect self-reported PA and perceived environment data from at least 500 participants, and objectively-measured data (accelerometry) from at least 250 participants.

During recruitment, respondents from the selected households were invited to partake in the full study (accelerometer + survey). If they preferred, participants could opt out from the accelerometer portion of the study, and remain as survey-only participants. Study sites continued standardized recruitment activities, balancing the full study sample and the accelerometry sub-sample by strata, until the minimum sample sizes were fulfilled. Study procedures for the three LA sites were adapted for in-person recruitment and data collection (Salvo et al., 2014a). Further details on IPEN's sampling and data collection procedures are available elsewhere (Salvo et al., 2014a,b, 2015; Kerr et al., 2013; Reis et al., 2013; Lemoine et al., 2016). The studies were approved by the Institutional Review Boards of the Universidad de los Andes (IPEN-Colombia), the National Institute of Public Health of Mexico (IPEN-Mexico), and the Pontifical Catholic University of Parana (IPEN-Brazil).

2.3. Physical activity

2.3.1. Leisure-time PA

Leisure-time PA was self-reported, using the long version of the International PA Questionnaire (IPAQ) (Craig et al., 2003). IPAQ was adapted for use in LA, with a script for interviewer-based administration, and culturally-appropriate language modifications and examples for each country (Salvo et al., 2014a; Hallal et al., 2010). IPAQ was administered to the full sample ($n \geq 500$ per country). Minutes per week of walking for leisure and moderate- to vigorous-intensity PA (MVPA) for leisure (excluding walking) were derived. Because these variables were highly positively skewed, and to contextualize the study within the frame of international PA recommendations for adults (150 min per week of MVPA) (WHO, 2010), dichotomous variables for achieving at least 150 min per week of walking for leisure, and of leisure-time MVPA, were computed.

2.3.2. Objectively-measured PA

Accelerometer-based PA data were collected for at least 250 participants per study site. The three LA sites used Actigraph GT3X accelerometers, initialized to collect data at 60-second epochs. Participants were instructed to wear the accelerometer for seven days during waking hours, and were instructed on correct accelerometer use. Further details on accelerometry field procedures for IPEN are available elsewhere (Salvo et al., 2014a,b, 2015; Kerr et al., 2013). For wear-time validation, a minimum of five days with at least 10 h of wear time were required. Accelerometry data were scored using Freedson cut-points for adults (Freedson et al., 1998). Dichotomous variables for achieving at least 150 min per week of overall accelerometer-based MVPA, and of accelerometer-based MVPA within bouts, were derived. Bouts were defined as having a continuous duration of at least 10 min, with MVPA in at least 80% of the total bout duration (i.e., 20% of the bout can correspond to naturally occurring breaks below the MVPA threshold), and with individual breaks having a maximum duration of 2 min. This definition of PA-bouts has been previously described (Salvo et al., 2015).

2.4. Places for physical activity

The three IPEN-LA sites developed and implemented a set of standardized questions, added to the core IPEN study survey, to assess the use of a set of 'formal' (locations designed for exercise or sport practice) and 'informal' places (locations not officially designated for exercise or sport) that were hypothesized to be relevant for PA in LA cities (Salvo et al., 2014a). For the three cities, these places included: parks, plazas (public squares), cycling or walking paths, informal outdoor courts (undeveloped land), streets (includes sidewalks), private courts or sports facilities, private gyms, home, and school or university campuses. During the instrument development process, additional places were determined to be relevant to some cities, but not others. The following places were only included in some sites: outdoor green spaces, shopping malls,

bars and nightclubs, and museums in Bogota and Cuernavaca; public recreation centers in Cuernavaca and Curitiba; *Ciclovias* (Open Street programs) in Bogota; and churches, Ruas da Cidadania (“citizenship streets” - decentralized administrative units) and Academia ao Ar Livre locations (public “city gym” program) in Curitiba. Participants were asked if during the past 7 days they had been physically active in each place. In all countries, the following examples of “being physical activity” were provided: “walking, bicycling or engaging in moderate or vigorous physical activities” (this section was administered after IPAQ, which provided more detailed definitions and examples of MVPA). If participants reported using a given place for PA, they were then asked which type of PA they did (open answer). The development of this set of standardized questions resulted from: a) iterative discussion sessions among the investigative teams of each country; b) obtaining and incorporating feedback from experienced field data collectors of each country; and c) pilot testing the in-person administration of this set of questions about places for PA in Latin America as part of the 2-week training period for data collectors. Wording structure, answer options, scripts for in-person administration, and item ordering were standardized across countries. Further information on the instrument development and data collection procedures is available elsewhere (Salvo et al., 2014a).

2.4.1. Public- versus restricted-access places for PA

The places for PA were categorized as being open- or restricted-access. “Public-access places” were defined as being open to the public, with no fee, cost, membership or affiliation required (e.g., parks, plazas – i.e., public squares – or shopping malls). “Restricted-access places” included those not open to the public without a fee, associated cost, membership, or affiliation required, such as private gyms, a school or university campus, or a bar or nightclub. Dichotomous variables for “use of any public-access place for PA” and “use of any restricted-access place for PA” were derived. ‘Home’ was not included in the “restricted-access places for PA” variable, since gaining access to one’s own home does not suppose any challenge, restriction, cost or membership.

2.5. Analysis

All statistical analyses were conducted by study site. To identify the places where Latin Americans are physically active, the prevalence of reported-use for PA of each studied place was calculated. Next, places were ranked based on their prevalence of use.

Mixed-effects regression models with a logit link function were used to estimate the effect of using public- and restricted-access places on achieving 150 weekly minutes or more of walking for leisure, MVPA for leisure, overall accelerometer-based MVPA, and accelerometer-based MVPA within bouts. The use of home for PA was included as an independent variable in the models. The random portion of the models included the neighborhood-clustering variable, while the fixed portion of the models included the independent variables of study (use of public-access places, use of restricted-access places, and use of home for PA), as well as individual-level covariates for adjustment, including sex, age, educational attainment and motor-vehicle ownership. All analyses were conducted using SAS 9.3 (SAS Institute, Inc., Cary, NC).

3. Results

3.1. Sample characteristics

Full data were available for 1000 adults in Bogota, Colombia (accelerometer subsample = 249), 677 in Cuernavaca, Mexico (accelerometer = 652), and 697 in Curitiba, Brazil (accelerometer = 331). The sociodemographic characteristics of the three study samples are shown in Table 1. All three samples had slightly higher participation of females versus males (percent female was: Curitiba = 52.9%, Cuernavaca = 55.4% and Bogota = 63.7%), and were well balanced with respect

to age. A third of the participants from Curitiba had a lower educational attainment than high school, followed by those from Bogota (36.5%), and Cuernavaca (43.6%). Motor-vehicle ownership was highest in Curitiba (78.6%), followed by Cuernavaca (54.8%), and Bogota (38.5%).

3.2. Physical activity levels

Adults from Bogota had the highest percentage of achieving at least 150 weekly minutes of overall accelerometer-based MVPA (Bogota = 79.1%, vs. Cuernavaca = 56.4%, and Curitiba = 54.7%) and bout-specific accelerometer-based MVPA (Bogota = 29.3%, vs. Cuernavaca = 13.3% and Curitiba = 14.5%) (Table 1). Bogota and Cuernavaca had a similar prevalence of achieving at least 150 weekly minutes of both self-reported (IPAQ-based) walking for leisure (Bogota = 12.9%; Cuernavaca = 14.2%), and MVPA for leisure (Bogota = 21.6%; Cuernavaca = 20.4%). In Curitiba, more adults achieved 150 min or more per week of walking for leisure (17.7%) than of MVPA for leisure (12.6%).

3.3. Where and how are Latin Americans physically active?

Rankings and prevalence of use of places for PA by site are presented in Table 2. In all cities, the most common place for PA was the streets (public-access), and the second place was at home. In Bogota and Cuernavaca, the third most common place for being physically active was shopping malls (public-access). Parks (public-access) were also ranked among the leading places for PA in all cities: third in Curitiba, fourth in Bogota and fifth in Cuernavaca. In all sites, the top-ranking places for PA were predominantly occupied by public-access places.

In spite of the considerable consistency of high-ranking places for PA across sites, the actual prevalence estimates varied markedly by city. For instance, streets ranked first in all sites, yet the prevalence for use for PA was 32.3% in Cuernavaca, 49.2% in Curitiba, and 93.2% in Bogota ($\chi^2 = 805.3$, $p < 0.0001$). Prevalence of use of all places for PA were

Table 1
Sociodemographic characteristics and physical activity levels among adults from Bogota, Colombia; Cuernavaca, Mexico; and Curitiba, Brazil (2010–2011).

Sample Characteristics	Bogota, Colombia % (n)	Cuernavaca, Mexico % (n)	Curitiba, Brazil % (n)
Full sample	100 (1000)	100 (677)	100 (697)
Accelerometer subsample	24.9 (249)	96.3 (652)	47.5 (331)
Gender			
Male	36.3 (363)	44.6 (302)	47.1 (328)
Female	63.7 (637)	55.4 (375)	52.9 (369)
Age			
18–34 years	36.5 (365)	31.0 (210)	36.9 (257)
35–49 years	31.0 (310)	39.0 (264)	33.4 (233)
50–70 years	32.5 (325)	30.0 (203)	29.7 (207)
Education			
Less than high school	36.5 (365)	43.6 (295)	33.3 (232)
More than high school	63.5 (635)	56.4 (382)	66.7 (465)
Motor vehicle ownership			
No motor vehicles in household	61.5 (615)	45.2 (306)	21.4 (149)
≥ 1 Motor vehicle in household	38.5 (385)	54.8 (371)	78.6 (547)
Physical activity (≥ 150 min per week)			
Walking for leisure - IPAQ ^f	12.9 (129)	14.2 (96)	17.7 (123)
MVPA ^a for leisure - IPAQ ^f	21.6 (216)	20.4 (138)	12.6 (88)
Overall MVPA ^a (accelerometer)	79.1 (197)	56.4 (382)	54.7 (181)
MVPA within bouts ^b (accelerometer)	29.3 (73)	13.3 (90)	14.5 (48)

^a International Physical Activity Questionnaire – Long Version.

^b Moderate- to vigorous-intensity physical activity.

^c Bouts are defined as having at least 10 min in duration, with at least 80% of the total bout duration consisting of MVPA, and no single break under the MVPA threshold lasting more than 10 min.

Table 2
Most frequently reported places for physical activity (PA) among adults from Bogota, Colombia; Cuernavaca, Mexico; and Curitiba, Brazil (2010–2011).

Ranking ^a (1 = most prevalent)	Bogota, Colombia		Cuernavaca, Mexico		Curitiba, Brazil	
	Places for PA	%	Places for PA	%	Places for PA	%
1	Streets ^a	93.2	Streets ^a	32.3	Streets ^a	49.2
2	Home	92.6	Home	19.4	Home	41.1
3	Shopping malls ^a	53.6	Shopping malls ^a	9.2	Parks ^a	37.4
4	Parks ^a	38.3	Outdoor/Informal courts ^a	8.7	Cycling paths ^a	22.9
5	Outside/open green spaces ^a	24.2	Parks ^a	7.8	Private gyms ^{b*}	22.2
6	Outdoor/Informal courts ^a	17.7	Outside/open green spaces ^a	7.4	Plazas ^a	22.1
7	Plazas ^a	16.5	Plazas ^a	5.0	Outdoor/Informal courts ^a	19.5
8	School/University ^b	16.0	Cycling paths	4.1	Academia ao Ar Livre ^a	12.3
9	Bars & Nightclubs ^b	12.9	Public recreation centers ^a	4.0	Private sports facilities ^b	10.5
10	Cycling paths ^a	10.8	Private gyms ^b	3.9	School/University ^b	8.6
11	Ciclovía ^a	7.5	Bars & nightclubs ^b	2.6	Church ^b	5.6
12	Private sports facilities ^b	5.1	School/University ^b	2.0	Rua da cidadania ^a	4.6
13	Private gyms ^b	4.6	Private sports facilities ^b	1.5	Recreation Center ^a	1.3
14	Museums ^b	1.8				
	Use of any (≥1) public-access place for PA	100.0		42.2		74.6
	Use of any (≥1) restricted-access place for PA	64.3		10.4		48.6
	Use of any (≥1) place for PA (public-access, restricted-access or home)	100.0		53.9		87.7

NOTE: 'Home' = own home.

^a Open-access place: no cost, membership or affiliation required for access and use.

^b Restricted-access place: cost, membership of affiliation required for access and use. Excludes home.

* Only places with a prevalence of use for physical activity ≥1% are reported.

consistently lower in Cuernavaca (streets and home were the only places with prevalence of use >10%), and higher in Bogota.

In all cities, walking was the most frequently reported PA for all studied places except home (most frequent PA: household chores), informal outdoor places used as courts and private sports facilities (soccer), private gyms (strength training), and bars and nightclubs (dancing).

3.4. Use of 'formal' versus 'informal' places for PA in Latin America

'Informal', non-exercise/sport places for PA, were more commonly reported in Bogota and Cuernavaca than in Curitiba (Table 2). In addition to shopping malls (ranked third in Bogota and Cuernavaca), informal courts (undeveloped land-parcels) ranked fourth in Cuernavaca, and sixth in Bogota. More adults from Bogota reported being physically active in bars and nightclubs (ranking = 9, prevalence = 12.9%) than at private gyms (ranking = 13, 4.6%). In Curitiba, 'formal' exercise/sport places for PA were more often reported (cycling/walking paths, ranking = 4, prevalence = 22.9%; private gyms, ranking = 5, prevalence = 22.2%).

3.5. Overall use of open- and restricted-access places for PA

In Cuernavaca, 42.2% reported using any open-access place (e.g., streets, parks, shopping malls) for being physically activity during the past 7 days, while 10.4% used restricted-access places (e.g., gyms, schools). In Curitiba, 74.6% used any public-access place for PA during past 7 days, and 48.6% used restricted-access places. In Bogota, 100% used any public-access place for PA, and 64.3% did so for restricted-access places.

3.6. Association of use of public- and restricted-access places with PA

Results from the fully-adjusted regression models are presented in Table 3. The models also include the independent effect of using one's own home for PA on the studied PA outcomes. Given the high prevalence of reported use of streets for PA in Bogota (93.2%), yielding no variability in the 'public-access places' variable for this site, and the fact that streets were also the most frequently reported place for PA in Cuernavaca and Curitiba, 'use of streets for PA' was included as a separate

independent variable in the models. Therefore, the 'public-access places' variable in the models represents all studied public-access places but streets.

Table 3

Association of use of public- and restricted-access places with physical activity outcomes among adults from Cuernavaca, Mexico; Bogota, Colombia; and Curitiba, Brazil (2010–2011).

	Bogota, Colombia ^a	Cuernavaca, Mexico	Curitiba, Brazil
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Use of public-access places (excluding streets) for PA			
Self-reported PA (IPAQ)			
Leisure-time walking	3.6 (1.7, 7.6)*	4.9 (2.5, 9.5)*	1.9 (1.1, 3.3)*
Leisure-time MVPA	4.1 (2.3, 7.5)*	5.2 (3.9, 6.9)*	1.4 (0.9, 2.6)
Accelerometer-based PA			
Overall MVPA	1.9 (1.0, 3.8)*	1.3 (1.1, 2.0)*	1.2 (0.8, 2.0)
MVPA within bouts	0.6 (0.3, 1.3)	3.6 (2.0, 6.5)*	1.9 (0.9, 4.1)
Use of streets for PA			
Self-reported PA (IPAQ)			
Leisure-time walking	1.5 (0.6, 4.1)	2.9 (1.4, 6.2)*	2.6 (1.5, 4.3)*
Leisure-time MVPA	0.8 (0.4, 1.5)	1.6 (0.9, 2.8)	1.0 (0.6, 1.5)
Accelerometer-based PA			
Overall MVPA	3.3 (1.2, 11.9)*	1.4 (0.9, 2.0)	0.9 (0.5, 1.4)
MVPA within bouts	0.8 (0.6, 1.9)	2.0 (1.0, 3.8)*	0.9 (0.3, 1.8)
Use of restricted-access places for PA			
Self-reported PA (IPAQ)			
Leisure-time walking	1.1 (0.7, 1.8)	2.5 (1.1, 5.7)*	0.6 (0.3, 1.3)
Leisure-time MVPA	1.3 (0.9, 1.8)	8.1 (3.2, 20.0)*	9.0 (4.7, 17.4)*
Accelerometer-based PA			
Overall MVPA	0.6 (0.3, 1.3)	0.8 (0.5, 1.6)	1.0 (0.6, 2.0)
MVPA within bouts	0.9 (0.5, 1.8)	1.9 (1.0, 3.7)*	1.3 (0.6, 3.0)
Use of home for PA			
Self-reported PA (IPAQ)			
Leisure-time walking	2.2 (0.8, 5.8)	0.9 (0.5, 1.9)	1.6 (0.8, 3.3)
Leisure-time MVPA	1.4 (0.8, 2.7)	1.8 (0.9, 5.1)	0.3 (0.2, 0.5)*
Accelerometer-based PA			
Overall MVPA	0.8 (0.1, 9.4)	1.1 (0.7, 1.7)	0.6 (0.3, 1.1)
MVPA within bouts	0.7 (0.4, 1.5)	1.0 (0.6, 1.7)	0.6 (0.3, 1.5)

NOTE: Reported Odds Ratios are adjusted for all other independent variables (e.g., OR for effect of "use of public-access places" is adjusted for use of streets, use of restricted-access places, and use of home for PA). All models are also adjusted for the neighborhood-clustering variable, sex, age, educational attainment and motor vehicle ownership.

* p < 0.05.

3.6.1. Associations of use of streets and other public-access places with PA

The use of public-access places (variable excluding streets) was significantly associated with at least one PA outcome in all countries (Table 3). In Cuernavaca, those reporting using open-access places for PA during the past 7 days had significantly higher odds of achieving 150 min per week or more of all PA outcomes of study: leisure-time walking (OR: 4.9, 95% CI: 2.5–9.5), leisure-time MVPA (OR: 5.2, 95% CI: 3.9–6.9), overall accelerometer-based MVPA (OR: 1.3, 95% CI: 1.1–2.0), and accelerometer-based MVPA 10-minute bouts (OR: 3.6, 95% CI: 2.0–6.5). In Bogota, the use of public-access places for PA was significantly related to three of the four outcomes of study: achieving 150 min or more per week of leisure-time walking (OR: 3.6, 95% CI: 1.7–7.6), leisure-time MVPA (OR: 4.1, 95% CI: 2.3–7.5), and overall accelerometer-based MVPA (OR: 1.9, 95% CI: 1.0–3.8). In Curitiba, only leisure-time walking was significantly and positively related to the use of public-access places (excluding streets) for PA (OR: 1.9, 95% CI: 1.1–3.3). Using streets for PA was independently significantly associated with at least one PA outcome in all sites. In Bogota it was positively related to overall accelerometer-based MVPA (OR: 3.3, 95% CI: 1.2–11.9); in Cuernavaca to leisure-time walking (OR: 2.9, 95% CI: 1.4–6.2) and accelerometer-based MVPA within bouts (OR: 2.0, 95% CI: 1.0–3.8); and in Curitiba to leisure-time walking (OR: 2.6, 95% CI: 1.5–4.3).

3.6.2. Associations of use of restricted-access places with PA

In Bogota, use of restricted-access places had no significant effect on any of the PA outcomes of study. In contrast, in Cuernavaca, a direct significant association was observed for: leisure-time walking (OR: 2.5, 95% CI: 1.1–5.7), leisure-time MVPA (OR: 8.1, 95% CI: 3.2–20.0), and accelerometer-based MVPA within 10-minute bouts (OR: 1.9, 95% CI: 1.0–3.7), but not to overall accelerometer-based MVPA. In Curitiba, using restricted-access places for PA was significantly associated with leisure-time MVPA (OR: 9.0, 95% CI: 4.7–17.4).

3.6.3. Associations of use of home for PA

In Bogota and Cuernavaca, using one's home for PA was not significantly associated with any studied PA outcome. In Curitiba, being physically active at home was inversely associated with leisure-time MVPA (OR: 0.3, 95% CI: 0.2–0.5).

4. Discussion

This study identified the places where Latin Americans from three cities are physically active, and confirmed that 'informal' places which are not primarily for exercise and sport are important contributors to PA in some Latin American cities. Consistent with other international studies, the streets emerged as the most common place for PA. However, our results highlight the important role of a wider variety of public-access places for PA among Latin Americans.

Some of our results were generalizable across the cities. Walking, playing soccer and dancing were consistently reported as the most common types of PA in the studied places. The streets, a "city's largest public space," (Paley et al., 2012) was the number-one place for PA in LA. The use of restricted-access places for PA was consistently lower than public-access places, and was only significantly associated with PA in Cuernavaca and Curitiba. Using the streets and other public-access places was significantly associated with objectively-derived PA in Cuernavaca and Bogota, but not in Curitiba. Across all sites, using public-access places for PA significantly increased the odds of meeting PA recommendations with walking for leisure. This is an important finding since, although walking emerged as the most common PA among Latin Americans, consistent with reports from other HIC (Berrigan et al., 2012; Powell et al., 2003; Australian Bureau of Statistics, 2011), in LA most walking is necessity-driven (transport-based) rather than choice-driven (leisure-based) (Salvo et al., 2014a). Promoting leisure-PA is critical in LA, where, as economies continue to grow, more people will afford private motorized vehicles, possibly resulting in less

necessity-driven PA (i.e., walking for transport). Walking is a familiar, easy activity for most adults to engage in, and is clearly feasible for increasing population PA (Powell et al., 2003; Siegel et al., 1995). Thus, increasing the availability, equitable access, and quality of places where people are likely to walk for leisure represents an opportunity for effectively increasing and sustaining population PA. Pending confirmation from longitudinal studies, our results suggest that the best investment of resources for this purpose in LA lies in publicly accessible places, and particularly the streets. This is also supported by the success of initiatives involving the repurposing of public spaces for PA in LA (e.g., Ciclovias – Open Street programs), which have been heavily driven by the need for improving social equity and augmenting social cohesion (Pratt et al., 2016; Sarmiento et al., 2017-in this issue).

Our findings accentuate the importance of local context and culture. Cuernavaca and Bogota are cities that grew mostly unplanned (Czerny, 2011; Berney, 2008; Aguilar, 1999; Cohen, 2004). At time of data collection, both had high levels of perceived insecurity from crime due to sociopolitical conflict and drug-related violence (Berney, 2008; DANE, 2012; INEGI, 2013). In these contexts, shopping malls have become alternatives to public spaces for all socioeconomic strata, providing safe, aesthetically pleasing environments for walking and socialization (Briceno-Leon, 2005; Jáuregui et al., 2016). The concept of *mall walking* (i.e., walking for exercise in shopping malls – an increasingly common occurrence in some HIC (Farren et al., 2015)), is practically nonexistent in Latin America. Therefore, the high prevalence of use of places like shopping malls or bars and nightclubs for PA suggests that social interaction is an important motivator for PA in Bogota and Cuernavaca (e.g., walking with friends while window-shopping, or dancing for fun) (Leyden, 2003; Sarmiento et al., 2010). On the other hand, Curitiba is a relatively rich city for LA. It is modern and clean, and is known as the "greenest city in LA" (Joss, 2010). Curitiba is one of the few LA cities with planned and controlled city growth (Joss, 2010; Carvalho et al., 2012). Culturally, Brazilians have a strong affinity for personal fitness (Hino et al., 2011). These factors may help explain the preference of adults from Curitiba for 'formal' sports and exercise-based places for PA, including the higher use of certain restricted-access places such as gyms and private sports facilities. Our results are consistent with other studies in Curitiba, which have found the availability of restricted-access places (gyms) to be more strongly associated with leisure-time PA than that of public-access places (parks and plazas) (Hino et al., 2011). Shopping malls were not included as a studied 'place for PA' in Curitiba's survey, as it was determined as not being culturally-relevant during the instrument development and testing process. Confirmatory studies are needed to verify that these type of 'informal' places are in fact not important locations for PA in Curitiba. Likewise, reporting home-based PA in Curitiba was inversely related to leisure-time MVPA. Further studies are needed to elucidate this finding. Perhaps in Curitiba, people who perceive being active at home don't choose to be active elsewhere, paired with the fact that the intensity and/or duration of their home-based PA may not sufficiently contribute to their overall MVPA.

This study had several limitations. The cross sectional design precluded determining causality. There were wide differences in prevalence of use of places for PA across sites, in spite of matched rankings and similar prevalence of leisure PA. The observed differences suggest that some cultures disproportionately over-report (Colombians) or under-report (Mexicans) their use of places for PA. In Bogota, the high proportion of reported PA in the streets may be due to their high levels of transport-based PA (90%) (Salvo et al., 2014a), and is likely reflective of short PA bouts (<10 min). This is supported by the significant association in Bogota between the use of streets and overall accelerometer-based MVPA, but not with bout-specific accelerometer-based MVPA. In Cuernavaca, the low reported-use of places for PA may be due to the fact that in Mexico the term "physical activity" is not usually understood as including 'transport-based PA' – this was a common clarification that data collectors had to make when administering the transport-based PA section of IPAQ in Cuernavaca. The responses

regarding the use of places for PA in Cuernavaca possibly mainly reflect leisure-PA. This is supported by the fact that 90% of adults from Cuernavaca report walking at least 10 min per week for transportation (Salvo et al., 2014a), yet only a third report using the streets for PA. Because of these wide differences in prevalence, we used rankings to compare the use of places for PA across sites. To confirm that our survey adequately ranked people based on their use of places for PA, we ran correlation tests between the reported use of each studied place, and each PA outcome of study (continuous format, minutes per week). For the majority of places studied, the Spearman correlation coefficients were moderate-to high (rho range: 0.2–0.9) (data not shown). Notably, ‘home’ was among the few place-variables with weaker correlation coefficients (rho < 0.15), suggesting that Latin Americans overestimate the intensity and/or duration of their household chores, which is consistent with other reports (Hallal et al., 2010). The use of composite variables grouping all public-access places other than streets, and all restricted-access places, may have limited our ability to determine the specific place-based drivers of PA behaviors in these settings. We chose this approach because the distinction between public- and restricted-access places makes conceptual sense, and when trying to model every place as an independent variable, the models had severe collinearity issues. Finally, the study sites are not necessarily representative of other cities in each country, although they do share common cultural values of their countries and of the LA region at large. Because of its size, Bogota is likely more comparable to other large Latin American cities such as Sao Paulo or Mexico City, than to other Colombian cities. Cuernavaca has been described as a standard small- to medium-sized Mexican city (Salvo et al., 2014b, 2015), but is not necessarily representative of larger Mexican cities like Mexico City, Monterrey or Guadalajara. Curitiba is an atypical Brazilian and Latin American city: it is modern, well-organized, and has abundant greenery.

Our study also has strengths. It is the first to use comparable measures, data collection protocols and analytic procedures to estimate the use of contextually-relevant places for PA among Latin Americans, and their relation with PA outcomes. We used state-of-the-art assessment methods, including robust sample sizes for accelerometer-based PA. We included both self-reported measures of leisure-time PA, capturing specific behaviors, as well as accelerometer-based PA measures, capturing total raw movement through acceleration. While accelerometer-based PA assessment provides an objective measure of total daily movement, measuring specific PA behaviors is important for understanding why people are active. By examining the associations between the use of different types of places with these complementary measures of PA, we were able to attain a deeper understanding of the potential place-based factors that influence PA in LA.

5. Conclusion

The use of public-access places was associated with PA outcomes among Latin Americans. Latin Americans tend to use a wider range of places for PA than those commonly studied in HIC. This raises the important question of how to measure PA in these settings, as well as their physical and contextual features for optimizing their use for PA. Research instruments and protocols for assessing leisure-PA in streets, shopping malls, undeveloped land, and other public-access places in the context of PA and LA are needed. The high use of informal public-access places for PA suggest that perhaps we need to redefine the concept of “public spaces for PA” based on the local context and culture. In some countries, places that facilitate social interaction and improve social equity may matter as much or more for PA than places that promote exercise and sport. Policies increasing the availability, equitable access and quality of these places may represent an effective strategy to increase PA in LA.

Conflict of interest statement

All authors declare that there are no conflicts of interest.

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