

## Association between Neighborhood Parks and Leisure-time Physical Activity among Adult Mexican Women

### Asociación entre parques de barrio y actividad física recreativa en mujeres mexicanas adultas

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**Abstract:** Although an extensive literature in developed countries suggests that elements of the urban built environment stimulate physical activity with beneficial health effects, information about this link in developing countries is still scarce. This study examines whether women's leisure-time physical activity (LTPA) is associated with neighborhood socioeconomic status, presence of public parks, and sociodemographic and health characteristics of women living in a mid-size Mexican city. A multilevel logistic regression analysis was performed to test the association among a sample of adult women (N=1,285) in Hermosillo, Mexico. The analysis links two measures of LTPA to several metrics on park accessibility and neighborhood socioeconomic status. Twenty-two percent of women engaged in neighborhood-based physical activity (NPA), while 29% engaged in overall physical activity (OPA). After adjusting by neighborhood socioeconomic status and individual-level variables, parks density, park-to-people ratio, combined parks' service areas, or distance to the nearest park were not related with NPA and OPA. Neighborhood socioeconomic status was the only contextual variable with a significant influence on women's NPA (AOR 1.05; 95% CI 0.99-1.10) and OPA (AOR=1.06; 95% CI 1.01, 1.12). After controlling for neighborhood-level variables, women's age and education were also statistically associated with physical activity. Based on the indicators used in this study, findings do not support a connection between the presence of parks and women's physical activity in Hermosillo's neighborhoods.

**Keywords:** Leisure-time physical activity, neighbourhood parks, women.

**Resumen.** Aunque numerosos estudios en países desarrollados sugieren que algunos elementos del ambiente urbano construido estimulan la actividad física, con efectos benéficos sobre la salud, el estudio de esta relación sigue siendo escasa en países en desarrollo. Este estudio examina la asociación entre la actividad física recreativa (AFR), y el estatus socioeconómico del barrio, la presencia de parques públicos, y las características sociodemográficas y de salud de mujeres residentes de una ciudad mexicana de tamaño medio. El análisis usa una regresión logística multinivel para probar esta relación en una muestra de mujeres adultas (n=1,285) en Hermosillo, México. El análisis relaciona dos medidas de AFR con indicadores de accesibilidad a parques y el estatus socioeconómico del barrio. Veintidós por ciento de las mujeres realizaron actividad física en su barrio (NPA), mientras que 29% realizó actividad física general (OPA). Después de controlar el estatus socioeconómico del barrio y variables individuales, la densidad de parques, la razón parque-individuo, la suma de las áreas de servicio de los parques, y la distancia al parque más cercano, no estuvieron asociados con NPA y OPA. El estatus socioeconómico del barrio fue la única variable a nivel contextual asociada con NPA (AOR 1.05; 95% CI 0.99-1.10) y OPA (AOR=1.06; 95% CI 1.01, 1.12). Luego de controlar las variables de contexto, la edad y la educación de las mujeres estuvieron asociadas con la AFR. Conforme a los indicadores utilizados, los resultados no confirman una asociación entre la presencia de parques de barrio y AFR entre mujeres residentes de Hermosillo.

**Palabras claves:** Actividad física recreativa, parques de barrio, mujeres.

### Introduction

The burgeoning body of research on the nexus between leisure-time physical activity (LTPA) and wellbeing has increased the attention to the significant disparities in access to active living environments encountered by multiple subpopulations and geographies

(Salvo et al., 2017; Schipperijn et al., 2017). This perspective emphasizes the need to understand why some persons do not engage in sufficient physical activity and may not be getting all the physiological and psychological health benefits associated with an active lifestyle (Bermejo, Almagro, & Rebollo, 2017; Blanco, Soto, Benitez, Mondaca, & Jurado, 2019; Casper, Harrolle, & Kelley, 2013). It also underscores the importance of approaches using a multilevel perspective amidst the growing evidence that engagement in

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physical activity is influenced by the interaction and intersection of individual, societal, and built environment factors (Carlson et al., 2012; Jáuregui et al., 2017; Mitáš et al., 2019; Salvo et al., 2017; Schulz et al., 2013; Talavera & Saldaña, 2020)

As described by Henderson and Gibson (2013) in their integrative review, most women are likely to believe that LTPA is right for them, yet many are not able to be physically active on a regular basis. Research examining the role of gender on sport, fitness, exercise and other forms of free-time physical activity has consistently shown that women face more constraints than men on their access to leisure opportunities and resources (Blanco et al., 2019; Evenson, Williamson, Han, McKenzie, & Cohen, 2019). Although everyone is affected by the lack of facilities and limited opportunities due to daily life pressures, many women face a range of constraints resulting from perceptual and structural factors associated with their gender. Expectations and needs of the family, economic barriers, significant life changes, and safety concerns are among the major actors limiting the involvement of the female population in physical activity in general, but particularly of poor and minority women (Lara-Valencia & García-Pérez, 2020; Ross & Searle, 2019; Wright Wendel, Zarger, & Mihelcic, 2012).

Although mainstream research on leisure and women is shedding light on emerging and critical issues, including the role of leisure as a vehicle of resistance and empowerment, there is still a significant need for integrative studies on the complex interaction between individual (e.g., schooling) and contextual factors (e.g., features of neighborhoods) underpinning women's participation in LTPA (Day, 2006; Monforte & Colomer, 2019). This need is particularly significant in the global south, where the field is in the early stages of development and systematic knowledge on motivation, patterns, barriers, and enabling factors of physical activity is very uncommon (Salvo, Reis, Sarmiento, & Pratt, 2014). In the context of Latin America, in particular, women have been identified as a subpopulation experiencing low participation in sports and exercise activities, a major factor in the increasing risk of non-communicable diseases and premature death, yet studies on LTPA participation and other aspects of the leisure experience are still limited (Mitáš et al., 2019; Wright Wendel et al., 2012).

In Mexico, for instance, a 2019 study based on a representative sample reported that the week previous to the survey, 47.0% of Mexican men aged 18 and over

were engaged in some type of LTPA (e.g., playing soccer, baseball, walking, etc.), while the percentage of active women was 37.7% (INEGI, 2020). Most Mexican reported exercising and practicing a sport in open and public spaces (INEGI, 2020; Salvo et al., 2017). Among women, LTPA increased with education, showing the highest prevalence in younger women (18 to 24 years). Another study showed that participation in LTPA is negatively correlated with work-related transportation time, and it is less prevalent among working women (Rodríguez Guajardo, Salazar Cantú, & Cruz Ramos, 2013)

Mexico's female population is also disproportionately affected by overweight and obesity. According to data from the 2018 Mexican National Survey on Health and Nutrition (ENSANUT), 40.2% of Mexican adult women are obese, while obesity affects only 30.5% of men (INSP, SS, & INEGI, 2018). Obesity especially targets poor women in urban areas, where the prevalence of obesity is approximately 17% higher than in rural communities (Shamah-Levy et al., 2019). The effect of overweight and obesity is significant, as 10.3% of Mexican adult women have diabetes compared with 8.4% of adult men (Shamah-Levy et al., 2019). The findings of several studies agree that, aside from biological factors, obesity rates reflects the limited availability of affordable, healthy food in neighborhoods, along with urban conditions that discourage physical activity (Henderson & Gibson, 2013; Johnson-Lawrence, Schulz, Zenk, Israel, & Rowe, 2015; Schulz et al., 2013). Thus, in addition to income and education, inadequate access to a healthy living environment are features of urban places, but especially of residential areas, that could be key to explain the prevalence of chronic diseases among Mexican women.

Studies also suggest that parks' density and proximity in residential areas improve residents' tendencies to engage in various forms of physical activity and healthier lifestyles (Elshahat, O'Rourke, & Adlakha, 2020; Jáuregui, Salvo, Medina, Barquera, & Hammond, 2020). In particular, the availability of parks and other green spaces in neighborhoods has been positively associated with the frequency of brisk walking (Nagel, Carlson, Bosworth, & Michael, 2008), spontaneous free play among residents (Ziviani et al., 2008), and recreational walking (Sugiyama et al., 2013). These studies propose that the distance to the nearest park is inversely correlated with the frequency of visitation, and that individuals living within walking distance from a park have a better chance to engage in leisure physical activity.

Some of these studies, however, observe that although parks' availability and accessibility are enablers of LTPA, their influence varies across demographic groups, urban contexts, cultural practices, and physical activity domains (Elshahat et al., 2020; Evenson et al., 2019; Kaczynski et al., 2014; Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013; Stewart, Moudon, Littman, Seto, & Saelens, 2018). The understanding of this variation is critical in the planning and implementation of actions to promote active lifestyles among local populations. To date, only a handful of studies have examined the influence of neighborhoods parks in the levels of people' physical activity in Latin America. The regional specificities of the culture, urbanization, and social dynamic of Latin American cities warrant research to understand the role of parks on LTPA.

In this study, we examine the association of the presence of neighborhood public parks, neighborhood socio-economic status, and women characteristics with their propensity to engage in LTPA. Understanding women's physical activity patterns and their correlates in urban neighborhoods of developing nations like Mexico is needed to expand the existing knowledge of the determinants of physical activity beyond female populations in North America and Europe. As suggested by Stodolska (2000), although commonalities across populations are expected, the exploration of different experiences and their contextualization within the realities of the global south could contribute to the expansion of theory applicable to human leisure in general.

## Materials and Methods

### *Sampling and data collection*

The present analysis relies primarily on data from a survey conducted in 2005 among adult women living in the City of Hermosillo, Mexico. As the political and administrative center of the northern state of Sonora, provision of public services in Hermosillo is above average relative to Mexican standards. Hermosillo had almost 642,000 residents in 2005 and only 2.3 percent of the housing units in the city lacked running water and 2.7 percent sewage connection (INEGI, 2005b). According to the Hermosillo' planning authority, the city was divided in about 358 residential neighborhoods and subdivisions called *colonias* (IMPLAN, 2014). The survey was part of a larger study examining several health outcomes that used a multistage systematic sampling procedure to obtain a neighborhood level

sample of women aged 25-54 residents of Hermosillo (García-Pérez, Harlow, Erdmann, & Denman, 2010). Firstly, a sample of 29 census enumeration districts was randomly selected from a universe of 234 predominantly residential districts ( $\geq 50$  inhabitants) in Hermosillo. Secondly, ten urban blocks were randomly selected within each district and dwellings with each block were surveyed sequentially until approximately 45 eligible women were interviewed within each selected district. Thirdly, a short household screening questionnaire was applied to identify women aged 25-54 years old who were living in the house at the moment of the survey. In households with more than one eligible woman, one woman was randomly selected for the interview. A total of 1,420 eligible women were identified through this procedure, of whom 1,307 were interviewed (92%), 49 (3.4%) declined to participate, and 64 (4.5%) could not be contacted. Respondents who did not answer the questions about LTPA were excluded from this analysis, as well as those individuals who lived in neighborhoods with less than five informants selected by the sampling procedure ( $n=21$ ). Thus, our final study population includes  $n=1,285$  women in household and urban blocks dispersed in 44 «colonias» or neighborhoods. The interviews were conducted by nurses working for the state health department and trained by the principal investigator in the survey's methodology and the application of the survey's questionnaire. The study was approved by the Ethics Committee of the University of Michigan, El Colegio de Sonora and El Colegio de la Frontera Norte. Participants were informed of the nature of the study and provided written informed consent.

### *Leisure-time physical activity measures*

Leisure-time physical activity was measured using questions extracted from the sports/exercise domain of the Kaiser Physical Activity Survey (Baecke, Burema, & Frijters, 1982). The tool assesses LTPA using a 12-month timeframe focusing on a large spectrum of women's health outcomes (Ainsworth, Sternfeld, Richardson, & Jackson, 2000; Dugan, Bromberger, Segawa, Avery, & Sternfeld, 2015; Lambiase & Thurston, 2013). In addition of questions about morbidities such as urinary incontinence, pelvic pain and peri-menopause symptoms, women participating in the survey were asked the following question: During the past year, did you play a sport or exercise? Those participants responding affirmatively were asked to report the most common activity performed and respond to two

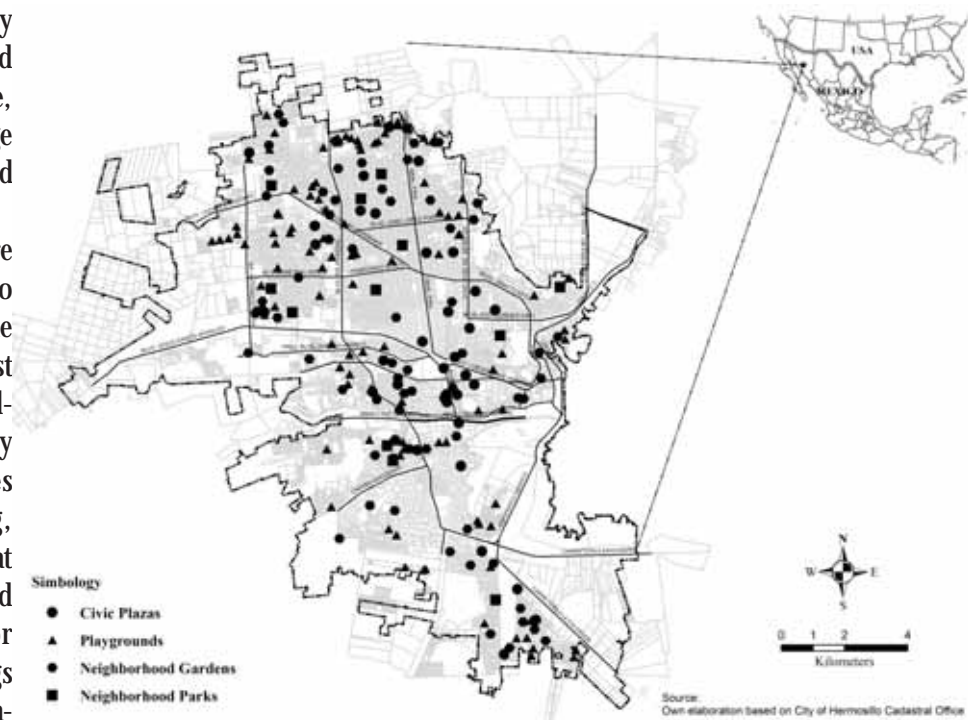
questions about the activity duration (hours/week) and its relative intensity (none, small, moderate, or large increase in heart rate and breathing).

These responses were used to construct two outcome variables at the individual level. The first variable is neighborhood-based physical activity (NPA), which includes activities like walking, jogging, and running that are likely to be conducted in a variety of outdoor neighborhood settings such as parks, streets, plazas and other open spaces close to home.

Women's responses were dichotomized as active if they walked or ran (yes = 0) versus not active if they answered negatively or performed activities other than walking or running (no = 1). Overall leisure-time physical activity (OPA) was also measured as a binary variable, where a woman was categorized as active (yes = 0) if during the last 12 months she regularly practiced an organized sport, such as yoga, dancing, boxing, or cycling requiring more specialized settings plus running, jogging or walking; or as inactive (no = 1) if she responded negatively. Because the inclusion of activities requiring more specialized settings, such as gyms, this measurement was expected to be less sensitive to the presence of parks in the neighborhood.

### ***Neighborhood Built Environmental and Socioeconomic Variables***

A database containing information on the geographic location, area, type, and other characteristics of green areas was created with information provided by Hermosillo's Cadastral Office and Parks Department (see figure 1). A total of 499 green areas, including parks, gardens, playgrounds, plazas, and street medians of all sizes, were inventoried and integrated into a geographical information system (GIS). Because this study focuses on public parks that can be used for walking, jogging or running, green spaces with an area below 1,120 m<sup>2</sup> were excluded from the analysis, a criterion suggested by Mexican guidelines and applied in similar studies conducted in other Latin America cities (Parra,



Gómez, Fleischer, & Pinzón, 2010; SEDESOL, 1999). Also excluded was land designated as green areas — such as street medians— but not equipped for passive or active recreation. Applying these criteria, 222 public parks within Hermosillo were identified and verified through in situ audits and remote analysis using Google Earth imagery. The majority of the facilities identified were classified as playgrounds (n=109, 49.1% of the total), gardens (n=67, 30.2%), and plazas (n=34, 15.3%) and parks (n=12, 5.4%). In terms of size, most of the facilities tend to be near the lower limit of the recommended area by the Mexican government within each category. Average size ranged from 1,770 m<sup>2</sup> (playgrounds) to 17,400 m<sup>2</sup> (neighborhood parks).

Four different objective measures of park availability and accessibility were derived using as point of reference the urban block where women in the survey had their place of residence. Availability was measured through a simple tally of the number of parks within each neighborhood but also by calculating the ratio of parks to people residing within each neighborhood. Accessibility is a distance-based metric. It was determined by calculating the Euclidian distance between the survey respondents' residential block and the centroid of the polygon representing the nearest park, regardless of its location within or outside the neighborhood. To test the potential influence of distance, three proximity classes were used: <350 m, 350–750 m, and >750 m. The lower (350 m) and upper distances (750 m) of the three proximity classes corresponds to the service areas recommended by the Mexican

government for the different type of neighborhood public parks (SEDESOL, 1999). Accessibility was also measured as the ratio resulting from dividing the aggregated area of the 750 m concentric radii around each park overlapping the neighborhood's territory, divided by the neighborhood's total land area. The formula used is:

$$A = \frac{\sum_{i=1}^n x_i}{b} = \frac{x_1 + x_2 + \dots + x_n}{b}$$

Where A is the ratio of the sum of all the park concentric circles overlapping the neighborhood's extent, x is the park service area (m<sup>2</sup>) overlapping the neighborhood, and b is the area (m<sup>2</sup>) of the neighborhood. The inclusion of these two last indicators compensates for the edge effect, a common problem of studies using the so-called container approach (Talen, 1997).

Neighborhoods' socio-economic status was measured using principal-component analysis to construct a socio-economic status index (SESi). This index combines data from the 2005 Population Count on characteristics and services connected to dwellings as well as on household ownership of durable goods such as a television, computer, and refrigerator. This type of index provides a reasonable proxy of poverty/affluence in countries where data on income or expenditure is not reliable or existent (Filmer & Pritchett, 2001). In general, a high SESi score reflects a neighborhood with a higher proportion of people with relatively higher income and households with a relatively high number of assets. In contrast, a low SESi score indicates a neighborhood with a high proportion of people with lower income and households with fewer assets. Detailed information about the construction of the index has been published elsewhere (Lara-Valencia & García-Pérez, 2015)

### ***Individual measures***

The analysis also includes a number of individual-level covariates to control for the influence of anthropometric and socio-demographic factors, including age, education, marital status, occupational status, migratory status, parity, pregnancy status, body mass index and diabetes. Age was assessed as an interval variable, while education was measured as a dichotomous variable (at least a year of high school as cut-point). Other individual covariates were the number of children and women's occupational status the week before the survey (employed or seeking employment versus others). Bodyweight in kilograms was assessed with a digital scale by nurses at the end of the interview (Tanita

2001W-B Ultimate Body Fat Scale) with participants wearing light clothing and no shoes. Height was measured using a dressmaker's measuring tape and recorded to the nearest half centimeter. BMI was then calculated as weight-for-height (kg/m<sup>2</sup>). Diabetes was assessed using a combination of two measurements: the response to the question «Have you ever been told by a doctor that you have diabetes», and/or the outcome of a blood glucose test (García-Pérez, Harlow, & Denman, 2018). For the test, we used the Accu-Chek Active System (Roche) to carry out a casual blood glucose test at the time of the interview. Any value greater than or equal to 200 mg/dL at any time of the day was considered abnormal (Rojas de P, Molina, & Rodríguez, 2012). Using a finger stick, 1-µL capillary blood samples were drawn into a test strip and this strip was then inserted into the Accu-Chek Active Blood Glucose Meter. In this study, 5.9% of participants had been diagnosed with diabetes, whereas 1.0% had an abnormal casual blood glucose test. Participants were provided with a copy of the glucose test and were alerted if their results were abnormal.

### ***Analysis***

We used SAS GLIMIX (SAS version 9.3) to compute a two-level multiple logistic regression. The influence of neighborhood-level variables on LTPA while controlling for individual-level variables was assessed. Random-effect log-linear models with a random intercept for each neighborhood were used to obtain odds ratios of the association between LTPA and parks' availability and accessibility (Raudenbush & Bryk, 2002; Sundquist & Yang, 2007). Using this approach, a set of three models was examined. The first model examines the relationship of parks' availability and accessibility measures on the estimates of the two outcomes of physical activity (NPA and OPA) across neighborhoods. A second model examines the association of parks' availability and accessibility covariates plus the influence of neighborhood socio-economic status on NPA and OPA. These two models allowed the exploration of the influence of neighborhood's built environment and social characteristics separately. Finally, all the individual-level and neighborhood-level variables were combined into a single model. In the final analysis, we decided to drop marital status, occupation, number of children, pregnancy, BMI and diabetes, because some of these individual variables were highly correlated and did not show an association with women's leisure-time physical activity. The models' coefficients provide estimates of

the relationships of the individual- and neighborhood-level variables to the study's measures of LTPA. As explained above, both NPA and OPA are assessed as dichotomous outcomes. Since the reference outcome was women's not engaging in physical activity, the coefficients estimated through these models indicate women's likelihood of being physically active. Odds ratios and 95% confidence intervals are reported for all the effect estimates.

## Results

Table 1 shows the descriptive statistics of individual-level and neighborhood-level variables used in the analysis. In total, 21.9% of participants engaged in neighborhood-based physical activity (NPA) during the 12 months prior to the survey, while 28.9% were physically active in general (OPA). Women in the sample averaged 38.5 years of age, while the number of years they had been living in Hermosillo was almost 31 years, a period suggesting long-term exposure to and familiarity with the city. Almost 60% of the respondents stayed at home, and the rest were employed or seeking employment.

Table 1. Outcome and covariates means and variability (n=1,285)

	n (%)	Mean	Std. Dev.	Range
<b>Individual-level outcomes (n=1285)</b>				
Neighborhood based leisure-time physical activity (NPA)	282 (21.9)			
Overall leisure-time physical activity (OPA)	372 (28.9)			
<b>Individual-level Covariates</b>				
Age groups				
25-34 years	475 (37.0)			
35-44 years	456 (35.5)			
45-54 years	354 (27.5)			
Education				
<High school	867 (67.5)			
≥High school	417 (32.5)			
Missing	1			
Marital status				
Married/Living as married	1016 (79.1)			
Other	269 (20.9)			
Occupation				
Employed/Self-employed/looking for a job	506 (39.4)			
Other	779 (60.6)			
Pregnant during the last 12 months (n=1,283)	8.0			
Number of children (n=1,284)		2.8	1.6	0-13
Body mass index (kg/m <sup>2</sup> ) (n=1,268)		29.4	5.9	15.7-57.7
Diabetes	89 (6.9)			
Native of Hermosillo	755 (58.8)			
Missing	1			
<b>Neighborhood-level covariates (n=44)</b>				
Socioeconomic status index (SESI)		0.4	3.6	-13.5-6.1
Number of parks in the neighborhood		0.8	1.6	0-7
Park-to-people ratio (m <sup>2</sup> of park per resident)		0.3	1.1	0-13.4
Distance to nearest park from residence (meters)		477.5	284.8	55.1-1219.5
Number of overlapping 750 m park's service areas		7.1	6.4	0-24

About a third of women completed at least one year of high school and 79.1% declared being married/living as married and having an average of 2.8 children. About 8% of the respondents were pregnant during the 12 months before the survey. The respondents' average BMI was 29.4 kg/m<sup>2</sup>, a level indicative of overweight and borderline obesity. According to the definition used

in this analysis, 6.8% of the participants had diabetes.

Extensive variation in socio-economic status and park availability and accessibility were observed across neighborhoods. The average SESi was 0.44 (SD 3.61), with neighborhoods above the mean distributed almost randomly across the city. The average number of parks was 0.78 units (SD 1.57). Only 32% of the *colonias* had at least one park of minimally 1,200 m<sup>2</sup> in area. The park area per resident was estimated to be 0.34 m<sup>2</sup> per resident, which is considerably below the city target of 1.1 m<sup>2</sup> per inhabitant and the internationally accepted minimum of 9 m<sup>2</sup> per inhabitant (IMPLAN, 2014; Pafi, Siragusa, Ferri, & Halkia, 2016; SEDESOL, 2010).

Regarding accessibility to parks, the average distance to the nearest park was approximately 478 m (SD 285m) and the minimum distance was 56 m. Proximal overlapping service areas averaged 7.1 units. It is important to note that accessibility and availability to parks tend to be higher in neighborhoods located at the city's core than in the periphery and that poor neighborhoods are less likely to have access to public parks.

Table 2 shows characteristics of LTPA, women's self-reported heart rate and breathing variations while exercising, and frequency of LTPA participation (h/week). Walking was the most reported activity (71.7%), followed by aerobics or Pilates (10.6%) and biking (7.5%). Other activities reported less frequently were team sports participation (basketball, volleyball, racquetball, or soccer), running, dancing, swimming, kickboxing, etc. The choice of activity is correlated with the intensity of the physical exertion, as indicated by the fact that almost 80% of the women reported none-to-small variation in heartbeat or breathing during the activity. Regarding frequency, only a third of the women exercised two or more hours per week.

Table 2. Type of activity, changes in heartbeat and frequency of LTPA (n=372)

Leisure-time physical activities*	n (%)
Walking	277 (71.7)
Aerobics or Pilates	41 (10.6)
Cycling	29 (7.5)
Basketball, volleyball, racquetball, or soccer	8 (2.0)
Running/jogging	7 (1.8)
Dancing	5 (1.3)
Swimming	4 (1.0)
Abdominals	4 (1.0)
Yoga/tai-chi	3 (0.7)
Kickboxing	3 (0.7)
Weights or stationary bike	3 (0.7)
Gymnastic	2 (0.5)
<b>Relative increase in heartbeat and breathing</b>	
None-to-small	291 (79.7)
Moderate-to-vigorous	74 (20.3)
Missing	7
<b>Duration (hours per week)</b>	
Less than 1 hour	125 (34.4)
1 < 2 hours	118 (32.5)
≥ 2 hours	120 (33.1)
Missing	9

\*Some women reported more than one activity, therefore the count is higher than the sample size.

Table 3 presents coefficient estimates resulting from the multilevel analysis for NPA. Our results indicate no evidence that the number of parks, park-to-people ratio, frequency of combined service areas, or distance to the nearest park have any influence on physical activity among women aged 25 to 54 years old in Hermosillo (model 1). Only after adjusting by neighborhood socio-economic status, distance to the nearest park Model 2 showed some effect on NPA ( $p < 0.07$ ), but the regression indicated a similar non-significant association. Under this model, women residing between 350 to 750 meters from a park had an increase of 48% in the odds of walking and running relative to women living at more distant locations (95% CI 0.96, 2.30). On the other hand, SESi increased the odds of women's engagement in NPA by 8% (95% CI 1.02, 1.13) after controlling for park-related variables.

Table 3.  
Two-level odds ratios for neighborhood-based LTPA

Fixed Parameter	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
Constant	-1.3797	-1.5271	-1.7318
Park provision predictors			
Number of parks	1.00 (0.85, 1.17)	0.99 (0.87, 1.14)	1.00 (0.88, 1.14)
Combined service areas	0.99 (0.95, 1.02)	1.00 (0.96, 1.03)	1.00 (0.97, 1.03)
Park area per resident	0.92 (0.84, 1.02)	0.92 (0.84, 1.01)	0.93 (0.84, 1.01)
Distance to nearest park			
<350 m	1.28 (0.75, 2.20)	1.32 (0.80, 2.17)	1.35 (0.83, 2.19)
350-750 m	1.39 (0.88, 2.21)	1.48 (0.96, 2.30)	1.49 (0.97, 2.29)
> 750 m	1.0 Reference	1.0 Reference	1.0 Reference
Neighborhood SES			
SESi	na	1.08 (1.02, 1.13)	1.05 (0.99, 1.10)
Individual-level predictors			
Age group			
25-34 years			0.68 (0.48, 0.97)
35-44 years	na	na	1.0 Reference
45-54 years			1.47 (1.04, 2.08)
<High school	na	na	1.0 Reference
≥High school			1.76 (1.29, 2.40)
Random parameters			
Between-neighborhoods variation	0.15 (0.09) <sup>d</sup>	0.77 (0.07)	0.050 (0.06)

<sup>a</sup>Adjusted for built environment variables  
<sup>b</sup>Adjusted for built environment and neighborhood deprivation variables  
<sup>c</sup>Adjusted for built environment, neighborhood deprivation, age and educational attainment  
<sup>d</sup>Statistically significant at 0.05 level

Table 4.  
Two-level odds ratios for overall LTPA

Fixed Parameter	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
Constant	-0.9405	-1.0945	-1.4445
Park provision predictors			
# Parks	1.02 (0.84, 1.23)	1.01 (0.86, 1.19)	1.01 (0.87, 1.18)
Combined service area	0.98 (0.94, 1.02)	0.99 (0.95, 1.03)	0.99 (0.96, 1.03)
Park area per resident	0.94 (0.85, 1.03)	0.94 (0.86, 1.02)	0.94 (0.86, 1.02)
Distance to nearest park			
<350 m	1.20 (0.68, 2.11)	1.23 (0.72, 2.09)	1.22 (0.73, 2.05)
350-750 m	1.29 (0.81, 2.07)	1.35 (0.86, 2.12)	1.36 (0.87, 2.11)
> 750 m	1.0 Reference	1.0 Reference	1.0 Reference
Neighborhood SES			
SESi	na	1.09 (1.03, 1.15)	1.06 (1.01, 1.12)
Individual-level predictors			
Age group			
25-34 years			0.84 (0.61, 1.14)
35-44 years	na	na	1.0 reference
45-54 years			1.44 (1.02, 2.04)
< High school	na	na	1.0 Reference
≥High school			1.68 (1.26, 2.24)
Random parameters			
Between-neighborhood variation	0.31 (0.12) <sup>d</sup>	0.21 (0.10) <sup>d</sup>	0.17 (0.93) <sup>d</sup>

<sup>a</sup>Adjusted for built environment variables  
<sup>b</sup>Adjusted for built environment and neighborhood deprivation variables  
<sup>c</sup>Adjusted for built environment, neighborhood deprivation, age and educational attainment  
<sup>d</sup>Statistically significant at 0.05 level

As can be observed in model 3, a positive association was found between SESi and NPA, but the regression

showed a non-significant association (AOR=1.05; 0.99-1.10), after adjusting by individual-level (age and education) and park-related variables. At the individual level, age and education were associated with NPA; thus, older women were significantly more likely than younger women to have walked or jogged, and more educated women were more likely to engage in this activity than less educated (model 3).

Table 4 estimates the influence of neighborhood and individual-level variables on OPA. Similar patterns in the association between neighborhood-level variables in OPA were observed. Model 3 seems consistent with the SESi in increasing the odds of women's engagement in OPA by 6% (95% CI 1.01, 1.12) after controlling by park-related variables and women's age and education. All the relationships between OPA and individual covariates were in the expected direction and were statistically significant.

## Discussion

This study investigated the influence of objectively measured dimensions of park provision, neighborhood socio-economic status and individual characteristics related to LTPA in a large representative sample of women aged 25 to 54 years, living in Hermosillo. Detected physical activity levels were consistent with other studies reporting that participation of Mexican women in LTPA is generally low (INEGI, 2005a, 2020; Mitáš et al., 2019; Rodríguez Guajardo et al., 2013). Prevalence rates were estimated at 21.9% for NPA and 28.9% for OPA. Walking was the most important type of NPA (71%) undertaken by women in Hermosillo, followed distantly by running and cycling. These results are consistent with the findings of other studies in Latin America (Guimarães et al., 2019; Salvo et al., 2017). These activities are performed at a very low pace and for a short time, so most women did not report a significant change in heartbeat and breathing as a result of the exertion (79.7%), and only one third exercised more than two hours per week. This is clearly below the recommended international guideline of at least 150-300 minutes of moderate-intensity aerobic physical activity; or at least 75-150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week, for substantial health benefits» (WHO, 2020).

Women aged 25 to 34 years were less likely to engage in LTPA, an outcome also observed in other

studies (Hernandez et al., 2003; INEGI, 2020). It is possible that the lower prevalence of LTPA among younger adult women is partially due to greater familial responsibilities and work, while older women might be more inclined to exercise due to health concerns and lower family obligations. In fact, an exploratory study among adult women in Hermosillo found that older women are more likely to use the neighborhood's streets to walk, attend a Zumba class at the neighborhood park, and experience more freedom to engage in leisurely activities than younger women (García-Pérez & Lara-Valencia, 2016). In contrast, as reported elsewhere, younger women are more likely to describe themselves as individuals with limited leisure time due to work and/or family responsibilities (INEGI, 2020; Valenzuela & Meléndez, 2019). Having high school or higher education was independently associated with an increase in both women's NPA and OPA. Similar findings have been reported elsewhere (INEGI, 2020; Mitáš et al., 2019; Ross & Searle, 2019).

We assumed that higher availability and accessibility of neighborhood parks would be positively associated with LTPA, and in particular, would stimulate neighborhood-based activities such as walking and running. Contrary to our hypothesis, we found that parks' presence and proximity seemed to contribute little to the level of women's LTPA. Our findings did not show that higher provision of parks was correlated with LTPA under any of the physical activity metrics scrutinized. One dimension showing some effect was the distance to the nearest park, but regression analysis revealed a non-significant association for both NPA and OPA. Other studies elsewhere had also reported no association between parks and LTPA in females. Recent analyses concluded that, although distance to parks is generally associated with increased activity, this link is more dependent on the type of parks (Bojorquez, Ojeda-Revah, & Diaz, 2018; Jáuregui et al., 2017; Salvo et al., 2017; Soltero, Scherezade, Pacheco, & Lee, 2015). Other built environment factors associated with park accessibility such as street connectivity, sidewalks, street lighting and perceived neighborhood safety and walkability may also influence women's NPA, as suggested by some studies (García-Pérez & Lara-Valencia, 2016; Joseph & Maddock, 2016). In Hermosillo's case, this lack of association could also be attributed to parks' limited attractiveness. Although Mexican standards prescribe the planting of trees and other vegetation in parks, it is common that green areas in Mexican cities are not well maintained, giving the

appearance of abandonment and disarray (Ojeda-Revah, Bojorquez, & Osuna, 2017). Other studies have also shown that people are more likely to visit and exercise in parks if they have the proper layout, and in general, are attractive (García-Pérez & Lara-Valencia, 2016; A. Jáuregui et al., 2017; Soltero et al., 2015). Due to lack of data, perceptions of park attractiveness, as well as the sense of neighborhood safety, were not explored in this analysis.

Besides, the neglect of gender-specific needs and values can also inhibit women's utilization of parks. In Hermosillo, parks' layouts and amenities favor male-oriented activities over those preferred by women. For example, some public spaces include soccer or baseball fields and rarely include formal pathways for walking and jogging, two of the most common activities reported by women participating in the survey. Many women in the sample were mothers with caregiving responsibilities, so it is plausible to assume that for some, it can be challenging to use parks with no access ramps for strollers or without spaces where they can exercise while supervising children. Therefore, it is likely that improperly equipped parks, unkempt or with no vegetation, could be another factor explaining women's inactivity.

The neighborhood SESi was significantly associated with being physically active. Other studies that have included neighborhood-level income measures in their analysis have also reported positive associations between higher levels of deprivation and higher rates of inactivity among women (Diez-Roux, Link, & Northridge, 2000; Nakamura, Teixeira, Hino, Kerr, & Kokubun, 2016). This is possibly the result of the clustering of households with similar income levels and its impact on the neighborhood's material and social characteristics. In Hermosillo, high SESi neighborhoods are often master-planned communities, in which provision of paved streets, sidewalks and lighting is standard. In contrast, low SESi neighborhoods are usually unplanned residential areas that frequently lack necessary urban infrastructure. Some of the high SESi neighborhoods were also designed as gated communities, where safety is marketed as the top amenity. Studies conducted in other contexts have reported that street safety, crime levels, and perceived insecurity also influence women's utilization of parks (Jáuregui et al., 2016). In fact, most Hermosillo residents characterize their city and street neighborhoods as insecure, with women having a more negative perception of security than men (García-Pérez & Lara-Valencia, 2016; INEGI, 2016). Indeed, urban violence



and crime have reached epidemic levels in Mexico in the last decade, especially in the northern region, where Hermosillo is a major urban center (INEGI, 2019).

### Limitations

This study has several limitations and strengths. As a cross-sectional analysis, this study is unable to identify any causal link between neighborhood features and LTPA. Also, the study relies on self-reported activity accounts during the past 12 months, a procedure that is subject to recall bias. Further, park features and women's perception of parks as safe or hazardous places were not examined. Studies concentrating on the qualitative dimensions of park usage and neighborhood's perceived safety should be prioritized in future research. Despite these limitations, our study is one of the few in Mexico using a multilevel approach to directly assess the social and built environmental correlates of LTPA based on a sizeable probabilistic survey and GIS data at the neighborhood level. It also contributes knowledge and creates opportunities for the expansion of leisure and women studies by extending research customarily conducted in developed nations to a city in a developing nation where studies of this kind are scarce and therefore urgently needed (A. Jáuregui et al., 2017; Salvo et al., 2014).

### Conclusions

This study found that LTPA among adult women was not associated with the availability and accessibility of public parks in the neighborhoods where they live. Although our results do not support the view that neighborhood public parks have a direct effect on the proclivity of residents to engage in physical activity, these results highlight the need for a more systematic analysis of other built environment elements, as they seem to be intervening in the connection between neighborhood parks and LTPA among women in Hermosillo, Mexico.

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