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ORIGINAL ARTICLE

The association of recreational space with youth smoking in low-socioeconomic status neighborhoods in Santiago, Chile

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Abstract
Objectives This study examines the relationship of neighborhood recreational space with youth smoking in mid- to low-income areas in the capital of Chile, Santiago.
Methods A unique data set of adolescents ($n = 779$, mean age = 14, 51 % male) provided home addresses of study participants which were geocoded and mapped. Satellite maps of neighborhoods were used to identify open spaces for recreational use (e.g., soccer fields and plazas). Thiessen polygons were generated to associate study participants with the nearest available open space using ArcGIS. Regression models, with smoking as a dependent variable, were estimated in which age, sex, family socioeconomic status, peer substance usage, neighborhood crime, and accessibility of open space were covariates.
Results The results show that residential proximity to recreational space was significantly and inversely associated with tobacco consumption among female, but not male, adolescents. Age and neighborhood crime were both positively associated with tobacco consumption among both male and female adolescents.
Conclusions This study suggests that recreational spaces in proximity to residences may have a positive impact on reducing adolescents' inclination to consume tobacco. The relationship of the accessibility to such spaces with smoking appears to vary by adolescents' sex.

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Introduction

The growing prevalence of youth smoking has been a significant issue in Latin America (Inter-American Drug Abuse Control Commission 2010; United Nations Drug Control Program and Inter-American Drug Abuse Control Commission 2009/10). Particularly in Chile, adolescents have one of the higher rates of smoking in Latin America (United Nations Drug Control Program and Inter-American Drug Abuse Control Commission 2009/10) with nearly 70 % of youth having tried smoking before the age of 15 years (Caris et al. 2003; Pan American Health Organization 2007). The percentage of secondary school students who consume tobacco (past month) in Chile was about four times higher than in the United States (World Health Organization 2005). Adolescent smoking is a universal public health priority given the morbidity and mortality associated with smoking and the high likelihood that cigarette use that may transition into other drug use (Adhikari et al. 2008; Caris et al. 2009).

Much research on cigarette use among youth has focused on individual, family, peer, and school influences (Alexander et al. 2001; Bryant et al. 2000; Doherty and Allen 1994; Fergusson et al. 1995; Komro et al. 2003), while fewer studies have investigated the relationship of neighborhood characteristics with the use of cigarettes (Delva et al. 2006; Diez Roux et al. 2003). Even among research that has examined the link between neighborhood environments and smoking, the measures for neighborhood characteristics are often limited to three dimensions:

neighborhood poverty level, the racial, ethnic or immigrant composition of neighborhoods, and the social disorganization of residential areas (Kandula et al. 2009; Kleinschmidt et al. 1995; Reijneveld 1998; Xue et al. 2007). The physical environment of the neighborhood (e.g., the amount of traffic, waste, smells, vegetation, and pavement conditions) has been more recently considered to be a potential contributor to cigarette smoking, both among adults and among adolescents (Crum et al. 1996; Ellaway and Macintyre 2009; Miles 2006; van Lenthe and Mackenbach 2006). In addition, researchers have recently found that the spatial proximity of certain types of neighborhood spaces, or the density of such spaces may be associated with individual tobacco consumption. For example, an individuals' proximity to tobacco retailers (e.g., convenience stores, gas stations) has been found to be positively associated with the likelihood of smoking (Pearce et al. 2009). The density of tobacco retailers surrounding schools has been found to be related to cigarette access and smoking behaviors among underaged students who smoked (Leatherdale and Strath 2007).

The purpose of this study was to examine whether a potentially beneficial type of neighborhood space (e.g., green space, recreational space) could be related to a health-related behavior (i.e., tobacco consumption) while controlling for other neighborhood characteristics (e.g., poverty, crime), as well as individual demographic characteristics. In particular, this study examined the relationship of recreational spaces (i.e., plazas and soccer fields) with youth tobacco consumption, hypothesizing that the availability and accessibility of those spaces was associated with decreases in youth smoking. In addition, we examined the validity of the assumption that environmental factors may affect the smoking behavior of the population to an identical degree. We hypothesized that the relationship between accessibility of neighborhood environmental resources and smoking behaviors could differ by gender (Waldron 1991; Wallace et al. 2003).

Methods

Data

Original data are from a National Institute on Drug Abuse-funded study of 1,108 community dwelling adolescents (mean age = 14 years, 51 % male), mostly from '*comunas*' (equivalent to city districts, boroughs or municipalities in the United States) of mid- to low-socioeconomic status in Santiago, Chile. Between 2007 and 2010 we conducted a 2 h interviewer-administered survey with youth participants that included extensive questions about substance using behaviors as well as information about individual, familial, and neighborhood characteristics. Residential street addresses of all respondents were recorded at each interview. A team of research assistants spent extensive time mapping the addresses in order to locate the respondents on a map, using Geographic Information System (GIS) software. The geocoding took over a year and a half due to the large number of addresses, and the necessity of travel to Chile to confirm the accuracy of *comuna* boundaries in reference to printed maps available from various municipalities. The location of each study participant was then linked to the collected survey data. The analyses were done using respondents' actual addresses, however, only statistical summaries, and no identifying location information, are presented in this manuscript to protect the privacy of the study participants.

Study area and study sample

The geocoding of individual addresses showed that the study participants were from more than 20 *comunas* in Santiago, Chile. However, the majority of respondents (80 %) were concentrated in the southeast of central Santiago, within four *comunas*—San Ramón, La Granja, La Florida, and La Pintana and therefore the focus of the analyses was on these *comunas*. Furthermore, within the four *comunas*, we limited the study area to near central Santiago because these neighborhoods share similar characteristics of urban environments. The outer parts of the chosen study area (e.g., the eastern part of La Florida *comuna* and the southern part of La Pintana *comuna*) include vast open green spaces with little urban development. In order to focus urban spaces, the area of interest for the present study, analyses were limited to the area in the red box shown in Fig. 1.

Accordingly, we selected participants whose residential addresses belong to the study area. For the geographical and statistical analyses, we used the survey data from the residents in this area ($n = 779$).

Neighborhood recreational spaces

This study identified neighborhood recreational spaces as plazas and soccer fields within walking distance from the residential locations of the youth. Recreational spaces at a neighborhood level carry particular significance in terms of outdoor recreational opportunities because schools in Chile typically close after school hours; schools do not provide recreational spaces other than their designated times for physical education or school-sponsored activities. As alternatives, this study identified plazas and soccer fields as primary neighborhood recreational spaces. Plazas and public soccer fields are common forms of recreational spaces in many areas of Santiago. In the local context,

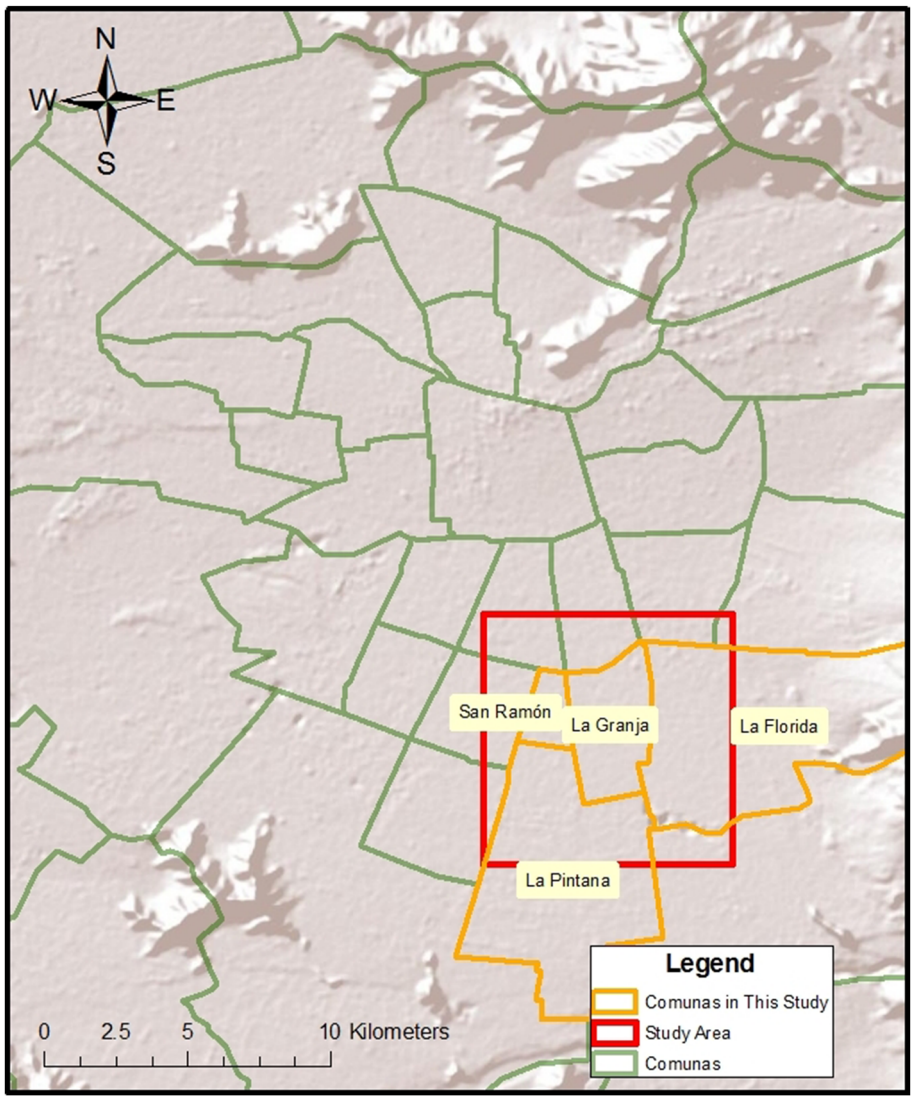

Fig. 1 Study area in Santiago, Chile. The area marked by the *red square* presents the study area

plazas refer to open spaces that are generally located in the center of the communities. The common amenities of plazas comprise trees, green area, and benches. Soccer fields are also frequently observed neighborhood resources that vary in size and location within the communities. We identified the locations of these recreational spaces using satellite photography from a variety of sources as well as extensive consultation with Chilean members of our study team who are familiar with the studied neighborhoods at a street level.

We examined the distribution of recreational spaces using the spatial autocorrelation tool in ArcGIS, and the result (Moran's $I = 0.24$, p value <0.01) indicated that the locations of those spaces were not evenly distributed. Values in the Moran's I index range from -1 (indicating perfect dispersion) to $+1$ (perfect correlation), and the value can be transformed to a Z-score for statistical hypothesis testing. Visual examination of our GIS data indicated that the northwest of San Ramón *comuna*, the northeast and south of La Granja *comuna*, and the west of La Florida *comuna* seemed to have relatively fewer recreational spaces when compared to other parts of the study area.

In order to associate study participants with the nearest recreational open space, we used an ArcGIS algorithm to create Thiessen polygons, a technique which is commonly employed in the geography literature (Brabyn and Skelly 2002; Twigg 1990). Broadly speaking, Thiessen polygons may be seen as a way of estimating the size of a catchment area or area of influence of a particular geographic feature. Figure 2 shows the Thiessen polygons created around each open recreational spot. Each Thiessen polygon represents the area of a surrounding neighborhood which is closest to a given recreational spot. Figure 2 also visually confirms the result of the autocorrelation analysis that the recreational spaces were not evenly distributed.

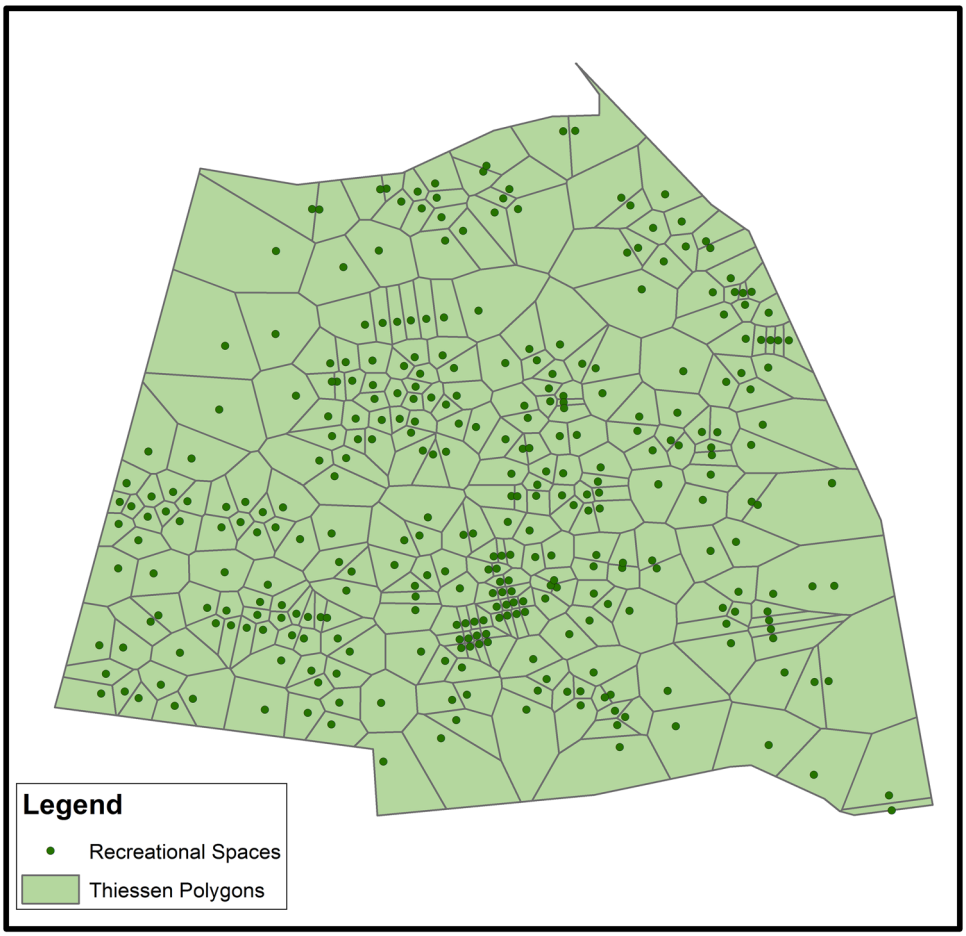

Fig. 2 Thiessen polygons by the locations of recreational spaces in the Santiago study area, Chile, 2011

We scaled the area of the Thiessen polygons into five groups using the Natural Breaks classification methodology based on the Jenks' Natural Breaks algorithm (ESRI Support). Thiessen polygons with larger areas represented locations in which a particular plaza or soccer field served a larger number of people while Thiessen polygons with smaller areas represented locations where a plaza or soccer field served fewer people. Therefore, the inverse of the size of the Thiessen polygon was used as a measure of open space availability. As a result, a higher score represented a higher availability of recreational spaces while a lower score represented a lower availability of such spaces. On the map, the areas of smaller polygons contained more closely located recreational spaces; adolescents living in smaller polygons had better geographical accessibility to recreational spaces.

Measures

Operational definitions

Outcome variable Adolescents' cigarette use was measured by the product of the answers to two questions about cigarette use in the past month: the average number of cigarettes that youth had smoked on a daily basis, and the average number of days that youth had smoked in the past 30 days. The outcome of this multiplication reflected the total number of cigarettes consumed in the past month by that adolescent. Subsequently we recoded this score into number of packs of cigarettes given that the common number of cigarettes per pack is 20 in Chile.

Predictors In this study, the primary predictors of interest were respondents' gender and the availability of recreational space. Other covariates were included to test if these factors could potentially confound the association between the outcome and the primary predictors of interest. Age, socioeconomic status, peer substance use, and neighborhood crime were included since these factors have been known to influence smoking patterns, and may be correlated with neighborhood effects (Kobus 2003; Lau et al. 1990; Stead et al. 2001).

Age was measured in years. Sex consisted of the categories 'male' and 'female'. Socioeconomic status was measured using the Graffar scale, a scale developed to assess socioeconomic status in developing countries (Graffar 1956), and one that has been frequently used in research in Chile (Alvarez et al. 1985; Gahagan et al. 2009).

On the Graffar, a higher score indicates a lower socioeconomic status. The variable for peer substance use was created as a composite score based on the questions regarding peer substance (e.g., cigarette, alcohol, marijuana, cocaine) use; higher scores represented a higher number of friends using substances (Cronbach's $\alpha = 0.87$). The variable for neighborhood crime was a composite score that reflected study participants' perception of neighborhood crime. The questions were taken from the "Neighborhood safety" section in the *National Survey of American Life: Adolescent Questionnaire* prepared by the Program for Research on Black Americans at the University of Michigan (2001). The questions included: "How often are there problems with muggings, burglaries, assaults or anything else like that in your neighborhood?"; "How much of a problem is the selling and use of drugs in your neighborhood?"; and "How often have you seen people selling illegal drugs in your neighborhood?" A composite score was created by adding the responses to all three questions with higher scores indicating that adolescents perceive more crime in the neighborhood (Cronbach's $\alpha = 0.71$).

Data analysis

Ordinary least squares (OLS) regression analyses were performed to assess the associations between adolescents' smoking, age, sex, socioeconomic status (SES), peer usage, and accessibility to recreational space. Thus, our model was:

$$\begin{aligned}\text{Packs smoked} = {} & \beta_0 + \beta_1 \text{ age} + \beta_2 \text{ sex} + \beta_3 \text{ ses} \\ & + \beta_4 \text{ peer usage} \\ & + \beta_5 \text{ perception of neighborhood crime} \\ & + \beta_6 \text{ accessibility of recreational space} \\ & + \beta_7 \text{ sex} \times \text{accessibility of recreational space}\end{aligned}$$

A potential moderation effect by adolescents' sex was investigated using an interaction term in order to test the gender difference in utilizing neighborhood recreational resources. Second, separate OLS regression models were estimated for males and females in which age, SES, peer usage, and accessibility to recreational space, perception of neighborhood crime were covariates.

Results

In the sample, 169 adolescents (21.7 %) reported they had smoked at least one cigarette during the last 30 days. The proportion of smokers was slightly higher among females (23 %) than males (20 %). Six to seven percent of both female and male adolescents had smoked a considerable amount, more than three packs during the last 30 days (i.e., more than two cigarettes per day). On average, females and males showed very similar characteristics in terms of their age, peer substance use, access to recreational spaces, and perception of neighborhood crime, except that peer substance use among females appeared slightly higher than that among males. Descriptive information for the study sample is provided in Table 1.

Table 2 presents the results of the regression analyses. The analysis with the total sample found that a 1-year increase in age was associated with 10 % increase in the number of packs of cigarettes smoked during the last month. Better accessibility to recreational space showed a statistically significant association with adolescents smoking less. Higher socioeconomic status, experiencing higher levels of peer substance use and neighborhood crime were associated with an increase in the number of packs of cigarettes smoked ($\beta = 0.011$, $\beta = 0.024$, $\beta = 0.039$, respectively). Additionally, the association between accessibility to recreational space and smoking was significantly moderated by sex controlling for age, SES, peer usage, and neighborhood crime.

Subsequently, we ran OLS regressions for males and females separately in order to examine and more clearly present the varying impact of the accessibility to recreational spaces on smoking. The adjustment resulted in different outcomes for each gender. Better accessibility to neighborhood recreational spaces was a statistically significantly factor for a reduced amount of smoking among female adolescents ($\beta = -0.143$, standard error $= 0.044$), while it was not a statistically significant factor among male adolescents ($\beta = -0.010$, standard error $= 0.037$). For females, all the other covariates were significant factors for smoking. A year increase in age was associated with a 9 % increase in the number of packs of cigarettes smoked in the last month. Higher family income was associated with increased likelihood of adolescents smoking in the past month. Peer usage and perceptions of neighborhood crime also showed positive associations with girls' smoking. For males, only age and neighborhood crime remained significant for smoking. A year increase in age was associated with an 11.1 % increase in the number of packs of cigarettes smoked in the last month. Higher perceptions of neighborhood crime were also associated with higher levels of smoking. In sum, age and neighborhood crime were the common contributing factors for tobacco consumption for adolescent females and males.

Discussion

Summary

In four *comunas* in Santiago, Chile, accessibility to recreational spaces was significantly and inversely associated

Table 1 Descriptive statistics of the sample ($n = 779$) from the Santiago study data (2007–2010), Chile

	Total ($n = 779$)		Female ($n = 376$)		Male ($n = 403$)	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Outcome variable						
Smoking (scored)	0.5 (1.0)	0–4	0.5 (1.1)	0–4	0.4 (1.0)	0–4
Predictors						
Age	14.4 (1.4)	11.9–17.8	14.4 (1.4)	11.9–17.7	14.3 (1.4)	11.9–17.8
SES[a]	34.2 (6.7)	19–58	34.1 (6.7)	19–58	34.2 (6.8)	21–53
Recreational space[b]	3.4 (1.3)	1–5	3.5 (1.2)	1–5	3.3 (1.4)	1–5
Peer use[c]	14.8 (5.5)	8–36	15.2 (5.6)	9–36	14.4 (5.4)	8–35
Crime[d]	9.0 (3.4)	0–15	9.0 (3.5)	0–15	9.0 (3.3)	0–15

[a] Continuous scale, 15 (highest) to 58 (lowest) with low scores reflective of high socioeconomic status

[b] Scaled 1–5, higher numbers reflect better accessibility to recreational spaces

[c] Continuous scale, higher scores represent higher number of friends using drugs

[d] Continuous scale, higher scores represent more crime in the neighborhood

Table 2 Regression of youth smoking on accessibility to recreational space with an interaction term as well as several potential confounders using Santiago study data (2007–2010), Chile

Smoking	Total ($n = 779$)			Female ($n = 376$)			Male ($n = 403$)		
	Coefficients	SE	p-Value	Coefficients	SE	p-Value	Coefficients	SE	p-Value
Age	0.101	0.029	0.001	0.090	0.044	0.043	0.111	0.040	0.006
SES	−0.011	0.005	0.030	−0.020	0.008	0.014	−0.004	0.007	0.530
Rec space	−0.142	0.043	0.001	−0.143	0.044	0.001	−0.010	0.037	0.779
Peer use	0.024	0.007	0.002	0.032	0.011	0.005	0.018	0.010	0.080
Crime	0.039	0.010	0.001	0.034	0.015	0.033	0.044	0.015	0.004
Sex	−0.503	0.209	0.016						
Sex × rec space	0.135	0.057	0.019						

p-value considered significant at $p < 0.05$

with smoking for female adolescents controlling for age, SES, peer substance use, and perception of neighborhood crime. For male adolescents, their perception of neighborhood crime was found to be significantly associated with their smoking behavior. This study adds meaningful information to a suspected association between the neighborhood built environment and adolescents' decisions related to health. First, the results imply that recreational spaces in proximity to residences may have a positive impact on reducing adolescents' inclination to smoking. Second, the results suggest the possibility that the neighborhood environment influences residents to varying degrees; in this case, the impact of recreational spaces on smoking depended on adolescents' gender.

Limitations

Further research is needed to supplement the study findings due to the following limitations. One of the major limitations of the study is that we limited the definition of recreational spaces to soccer fields and plazas, and this excluded the possibilities for youth to be physically and socially active at other locations such as near their homes or at other sports facilities. Our model also did not reflect the possibilities that teenagers use more than one and not necessarily the nearest recreational spaces.

In addition, the concept of accessibility we used is somewhat constrained. According to Brabyn and Skelly's (2002) terms, we only took "locational" accessibility into account without obtaining a deeper understanding of "effective" accessibility to recreational spaces. In other words, we measured the accessibility of recreational space only based on the proximity to the nearest recreational space while leaving out the consideration of factors that could potentially facilitate or hinder the effective access to those recreational spaces. Other aspects of neighborhood dynamics (e.g., the degree of social cohesion, monitoring) and behavioral tendencies of the youth populations

(e.g., how likely and how easily they utilize these recreational spaces) could provide meaningful additions to future investigations.

Lastly, our primary data included little information that could guide the interpretation of the gender differences we identified. The interpretation could be enriched by obtaining qualitative insights on topics such as whether certain gender prefers to use specific types of recreational spaces, how they use the spaces, and how they perceive the benefits or downsides of those spaces. Future research would benefit from identifying if recreational spaces are perceived and used differently by male and female adolescents and if these spaces are associated with their smoking behaviors to a varying degree.

Implications

Growing evidence points to the significant influence of the neighborhood built environment on the health of individuals; for example, the amount of green spaces, available public parks, or spaces people can exercise have been identified as important factor for health outcomes such as obesity, smoking, or even mortality (Cohen et al. 2007; Coutts et al. 2010; de Vries et al. 2007; Madsen et al. 2013). These studies suggest that neighborhood-level interventions can be timely and effective to encourage positive habits such as physical activity and in turn to prevent illnesses. This study specifically suggests that communities with limited recreational space can consider developing such space as a neighborhood asset and as alternative recreational spaces/activities to youth smoking. For policy guidance, there is a need to investigate the extent to which improving the physical environments at the neighborhood level may serve to buffer youth smoking onset. Also, the pathways underlying the relationship between recreational spaces and youth smoking remain to be identified before developing such interventions.

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