



Neighborhood and family perceived environments associated with children's physical activity and body mass index



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ABSTRACT

Background. A growing body of research has been examining neighborhood environment related to children's physical activity and obesity. However, there is still not enough evidence from Latin America.

Objective. To investigate the association of neighborhood and family perceived environments, use of and distance to public open spaces with leisure-time physical activity (LTPA) and body mass index (BMI) in Argentinean school-aged children.

Methods. School-based, cross-sectional study with 1777 children (9 to 11 years) and their parents, in Cordoba city during 2011. Children were asked about LTPA and family perceived environment. Parents were asked about neighborhood perceived environment, children's use of public open spaces and distance. Weight and height were measured for BMI. We modeled children's LTPA and BMI z-score with structural equation models with latent variables for built, social and safety neighborhood environments.

Results. Parents' perceived neighborhood environment was not related with children's LTPA and BMI. Children's perceived autonomy and family environment were positively associated with LTPA. Use of unstructured open spaces and, indirectly, the distance to these, was associated with LTPA among girls. Greater distance to parks reduced their use by children.

Conclusions. Policies to increase children's LTPA should include access to better public open spaces, increasing options for activity. A family approach should be incorporated, reinforcing its role for healthy development.

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Introduction

Over the past few decades, Latin America has been profoundly affected by globalization, urbanization, economic changes and epidemiological transition. These processes have interacted in multiple complex ways producing significant changes in community socio-environmental characteristics and population health patterns, including those related with physical activity (PA) and obesity (Uauy et al., 2008).

A growing number of studies are examining features of the built and social neighborhood environments related with children's PA. Although

studies are often difficult to compare because of the varying built and social environmental and PA measures used, there is consistent evidence that better access to physical activity resources (Ding et al., 2011) and a more supportive family environment (Edwardson & Gorely, 2010) are associated with higher children's PA. However, there are still questions about the association with other features of the social environment, such as perceived safety (Ding et al., 2011).

Public health research and action need to be based on evidence from research on community environment and its association with health-related behaviors. However, much of the evidence currently available was generated in Europe, North America and Oceania, and the context-specific nature of these findings limits their application in Latin America (Fermino et al., 2013; Arango et al., 2013). Fortunately, in recent years, Brazil and Colombia have advanced in this field, not only in research, but also in the implementation of policies, but there is still not enough scientific information on policies in other Latin American countries.

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In 2001, Argentina joined the Healthy Municipalities and Communities initiative, a Latin American strategy encouraged by the World Health Organization and the Pan-American Health Organization, aimed at promoting participatory health. This involves supporting local government in establishing healthy public policies and promoting active community participation, supportive environments, and healthy lifestyles (Pan American Health Organization, 2005). Joining the initiative was an important step for Argentina toward considering the environment where people live as a significant factor in people's health. However, most actions so far have focused only on individual-based approaches, especially diet and PA, and strategies to create supportive environments for health are infrequent (Anon., 2008). One reason may be the lack of evidence on which community socio-environmental characteristics have most influence on Argentines' health-related behaviors, which would help in advocating for supportive environments.

Studies about leisure-time PA and neighborhood environment in Latin America have mainly focused on the built environment (Arango et al., 2013; Bauman et al., 2012) and have been conducted among adults (Bauman et al., 2012). It has been acknowledged that perceptions related to the environment and their association with PA are expected to differ according to age (Bauman et al., 2012). Moreover, it is reasonable to expect that parents' perceptions about the environment play a role in children's leisure-time PA, though findings are inconsistent on this topic (Ding et al., 2011). Evidence suggests that parental warmth and involvement, emotional support, appropriate granting of autonomy, and clear, bidirectional communication are positively associated with more healthy behaviors in children and adolescents (Newman et al., 2008). Supportive and encouraging attitudes from parents seem to be important influences on 6–11 year-old children being physically active (Edwardson & Gorely, 2010).

Another aspect that needs to be further investigated is whether leisure-time PA and/or community socio-environmental characteristics have some influence in children's body mass index (BMI) (Pate et al., 2013; Safran et al., 2011). Systematic reviews tend to report weak to modest relationships between school-aged children's PA and overweight/obesity, with many risk estimates being non-significant (Pate et al., 2013; Safran et al., 2011; Janssen & LeBlanc, 2010; Wilks et al., 2011).

The purpose of this study was thus to investigate the association of neighborhood and family perceived environments with leisure-time PA and overweight/obesity in Argentinean school-aged children. We hypothesized that: (a) a negative parental perception of the built, social and safety attributes of the neighborhood would be negatively associated with children's use of parks and unstructured open spaces and their leisure-time PA; (b) children's perception of autonomy and family environment would be positively associated with the use of these spaces and leisure-time PA; and (c) children's leisure-time PA would correlate negatively with their overweight/obesity status.

Methods

Design, population and sample

A cross-sectional study was carried out in a population of 4th to 6th grade children – ages 9 to 11 years – of municipal primary schools in Cordoba city, which is the capital of Cordoba province, located in the center of Argentina and its second largest city, with 1.3 million inhabitants in an area of 576 km². It has a centralized urban distribution characterized by wide urban fragmentation with the highest proportion of poor people located in the outskirts of the city.

The study was conducted between September and December 2011. All the municipal primary schools are in the outskirts of the city, in medium to low socioeconomic neighborhoods (e.g., 6 to 28% of heads of household have completed high school) (Population census of Cordoba, 2008). The children were thus mostly from families with these socioeconomic characteristics.

Considering a population of 4820 children enrolled from 4th to 6th grade in city municipal schools, an expected prevalence of 50% (due to multiple

outcomes with heterogeneous expected prevalence), a sampling error of 3.5 percentage points, confidence interval of 95%, and a design effect of 2.0, a sample size of 1349 students was estimated for this survey. The sample was increased 15% (n = 1552) to enable control for confounding factors in association analyses and then 50% (n = 2328) due to refusals and missing.

For the sampling process, all municipal primary schools existing in 2011 (n = 37) were stratified into two groups: those with more than 75% of parents with at least elementary education completed (n = 20) and those below this cut-off (n = 17). 10 schools were randomly selected from the first group and nine from the second. The sample included all fourth to sixth-grade students and their primary adult caregivers (usually mothers). The 19 schools selected yielded a potential pool of 2424 students.

Parents were called to the school for a meeting with the research team, given an explanation of the study, and then written informed consent was obtained from those who agreed to participate and let their children participate. If parents did not attend the meeting, they were sent a note explaining the study, the informed consent and the questionnaire to be completed. Children were also asked to assent to participate, regardless of their parents' consent.

When both agreed to participate, parents completed a self-administered questionnaire after the meeting or at home. Children also completed a self-administered questionnaire that was read aloud by a member of the research team in the classroom, so that everybody completed it at the same time. Meanwhile, children who had no signed consent or did not assent to participate continued with school tasks assigned by the teacher.

Measures

Neighborhood and family perceived environments. Parents' gave information about the availability of different recreational sites in the neighborhood where the children lived, the distance from their homes in blocks – as distance is usually reported in Argentina, corresponding to approximately 100 m – and the frequency with which children used them for PA (never, once a month or less, once every other week, and once per week or more). For this analysis, we focused on distance to and frequency of use of parks and unstructured open spaces, such as streets, cul-de-sacs, and open land.

In addition, parents' perception of barriers to children's PA in their neighborhood of residence was examined through a Neighborhood Environment for Physical Activity Survey, cross-culturally adapted from the "Active Where?" Survey of the Robert Wood Johnson Foundation's Active Living Research (Anon.). Ten barriers were considered: (1) availability of places to be active in, (2) activity options, (3) equipment availability, (4) adult supervision, (5) general neighborhood safety, (6) traffic safety, (7) lighting, (8) presence of other children, (9) presence of other people, and (10) children's feelings. A four-point scale assessed each question: strongly disagree, somewhat disagree, somewhat agree, and strongly agree. Three latent variables were generated from these items to represent parents' perceived built and social environments and safety for PA of the neighborhood (see Supplementary Tables 1 and 2).

A latent variable representing the children's perceived autonomy and family environment was generated using the autonomy, parent relations and home life, and financial resources domains of the KIDSCREEN-52, Argentinean version (Berra et al., 2009). Children were asked fourteen 5-point scale questions and the KIDSCREEN-52 protocol was used to define the values for each domain (see Supplementary Tables 1 and 2).

Children's leisure-time physical activity. Children were asked about the frequency and duration of moderate and vigorous leisure-time PA, using the PA section of the 2006 Spanish version of the "Health Behavior in School-aged Children" survey questionnaire (Booth et al., 2001). Examples of PA within each level of intensity were provided to make the differences between them clear. Children were asked about weekly frequency (never, once a week, two to three days a week, four to six days a week, and every day) and daily duration (none, less than half an hour, half an hour, one hour, and more than one hour) in each intensity. The leisure-time PA in each intensity was determined separately, combining the frequency and duration in a discrete score ranging from 0 (lowest leisure-time PA) to 4.

Body mass index z-score. Trained staff measured weight and height with a digital scale and a portable height rod. Children wore light clothes, without sweaters, jackets or shoes, during the procedure. Body mass index (BMI) was defined as weight in kilograms divided by the square of height in meters, and z-scores were calculated according to the WHO 2006 standards (WHO Multicentre Growth Reference Study Group, 2006) using WHO AnthroPlus software.

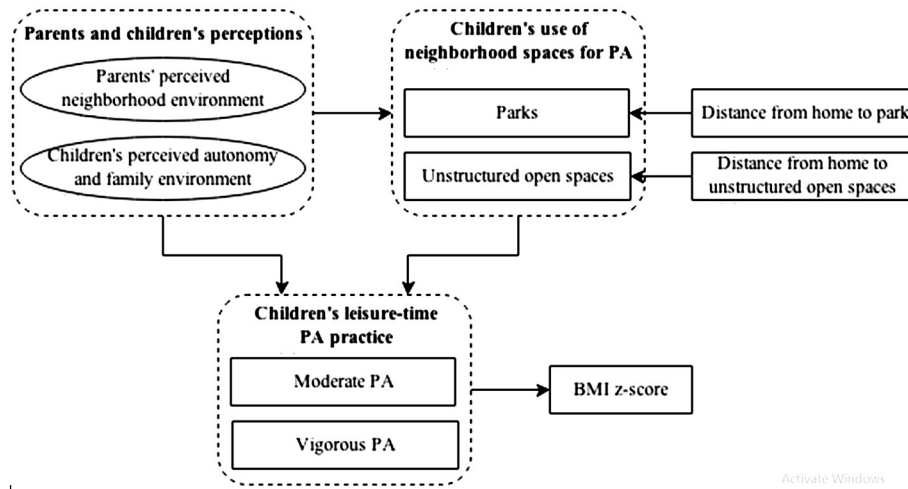


Fig. 1. Hypothesized relationships tested through the model. Covariance between use of parks and of open unstructured spaces and between moderate and vigorous leisure-time PA were considered. Children's school grade and mother's educational level were used as adjustment factors between moderate and vigorous leisure-time PA and BMI z-score. Notes: PA = physical activity; BMI = body mass index.

Supplementary Table 1 presents all the variables used in the analysis, as well as the questions or protocols and answer options used to obtain them.

Statistical analysis

All analyses were stratified by gender. Descriptive statistics included frequencies, means (\bar{x}), and standard deviation (s). Chi-square test and Student t-test for independent samples were used to compare differences between genders. Normal distribution and equality of variances assumptions were evaluated through histogram visualization and Levene's test, respectively.

Structural equation modeling was carried out to determine associations between perceived environmental attributes, use of neighborhood spaces for PA, moderate and vigorous PA, and BMI z-score. Analyses were performed using R, version 3.1.1, and the *lavaan* package. Parameters were estimated by the full information maximum likelihood method and results were presented as standardized regression coefficients (b). All statistical tests were two-tailed and a 5% significance level was adopted.

Observed variables were recoded to maintain a positive association with the latent variables (e.g., higher value for better environmental perception). Confirmatory factorial analysis was carried out to determine whether the hypothesized sets of observed variables shared common variance-covariance characteristics and to define the theoretical constructs (latent variables). Supplementary Table 2 presents the coefficients derived from the measurement model.

Fig. 1 shows the hypothesized relationships tested and a reduced representation of the structural model. Covariance between use of parks and of open unstructured spaces and between moderate and vigorous leisure-time PA was also considered. Finally, children's school grades and mother's educational level were considered as adjustment factors between moderate and vigorous leisure-time PA and BMI z-score.

The following parameters were used to evaluate the overall model fit: Chi-squared test, Root Mean Square of Approximation (with its 90% confidence interval), Standardized Root Mean Square Residual, Comparative Fit Index, Tucker-Lewis Index, Goodness of Fit Index, and Adjusted Goodness of Fit Index. Values of <0.08 for Root Mean Square of Approximation, <0.05 for Standardized Root Mean Square Residual, and >0.90 for Comparative Fit Index, Tucker-Lewis Index, Goodness of Fit Index, and Adjusted Goodness of Fit Index were considered as acceptable adjustments (Kline, 2011).

Results

The final sample consisted of 1777 children. They were evenly distributed throughout school grades and there were more boys (53%) than girls. Most mothers (62%) had only completed elementary school. Boys used parks and unstructured open spaces for PA more frequently, but girls had higher vigorous leisure-time PA (Table 1).

Figs. 2 and 3 present the final models for girls and boys, respectively, and the fitting indices indicating that both models fit the data (see

Supplementary Table 2 for results of the measurement model). For both genders, the use of parks for PA showed negative association with distance from home (girls: $b = -0.11$, $p = 0.01$; boys:

Table 1
Characteristics of the sample. Cordoba city, Argentina, 2011.

Characteristics	Total (n = 1777)	Girls (n = 843)	Boys (n = 934)	p
<i>School grade (n, %)</i>				
4 th	591 (33)	307 (33)	284 (34)	0.54
5 th	624 (35)	321 (35)	303 (36)	
6 th	558 (32)	304 (32)	254 (30)	
<i>Mother's educational level (n, %)</i>				
None	162 (11)	90 (12)	72 (10)	0.02
Elementary school	885 (62)	472 (63)	413 (50)	
Middle or high school	319 (22)	142 (19)	177 (25)	
College or higher	73 (5)	42 (6)	31 (5)	
Distance to park (no of blocks) (\bar{x} , s)	4 (5)	5 (5)	4 (5)	0.17
<i>Park use for PA (n, %)</i>				
Never	264 (22)	148 (24)	116 (21)	<0.001
Once a month or less	218 (18)	132 (21)	86 (15)	
Once every other week	185 (16)	115 (18)	70 (13)	
Once a week or more	522 (44)	234 (37)	288 (51)	
Distance to UOS (no of blocks) (\bar{x} , s)	2 (2)	2 (2)	2 (2)	0.78
<i>UOS use for PA (n, %)</i>				
Never	619 (60)	368 (69)	251 (51)	<0.001
Once a month or less	63 (6)	29 (5)	34 (7)	
Once every other week	63 (6)	34 (6)	29 (6)	
Once a week or more	287 (28)	107 (20)	180 (36)	
<i>Moderate leisure-time PA (n, %)</i>				
0	110 (7)	56 (8)	54 (7)	0.12
1	217 (14)	108 (15)	109 (13)	
2	271 (18)	108 (15)	163 (20)	
3	332 (21)	162 (22)	170 (20)	
4	627 (40)	292 (40)	335 (40)	
<i>Vigorous leisure-time PA (n, %)</i>				
0	184 (12)	70 (10)	114 (14)	<0.001
1	255 (16)	91 (13)	164 (20)	
2	146 (9)	58 (8)	88 (11)	
3	400 (26)	177 (24)	223 (27)	
4	570 (37)	327 (45)	243 (28)	
Body mass index z-score (\bar{x} , s)	0.7 (1.3)	0.6 (1.2)	0.7 (1.3)	0.09

Notes: UOS = unstructured open spaces. PA = physical activity. Categories of PA: 0 = none; 1 = very low (<60 min/week); 2 = low (60–119 min/week), 3 = medium (120–299 min/week), 4 = high (300 min/week or more). P-values refer to Chi-square test (for categorical variables) and Student's t-test for independent samples (for continuous variables).

$b = -0.23, p < 0.001$). Among girls, the use of parks for PA was negatively associated with their parents' perceived safety ($b = -0.41, p = 0.05$), but positively associated with their parents' perceived social attributes of the neighborhood ($b = 0.25, p = 0.05$) and with girls' perceived autonomy and family environment ($b = 0.12, p = 0.03$). These associations were not significant among boys. On the other hand, the use of unstructured open spaces for PA by boys was negatively associated with their parents' perceived built environment ($b = -0.27, p = 0.05$), but positively associated with their parents' perceived safety ($b = 0.29, p = 0.05$). Among girls, the use of unstructured open spaces for PA showed negative associations with their distance from home ($b = -0.14, p < 0.001$).

Neither boys nor girls showed evidence of association between leisure-time PA and parents' perceived neighborhood attributes. In addition, leisure-time PA showed no association with the frequency of using parks for PA. However, the use of unstructured open spaces for PA, which was associated with their distance from home, showed positive association with vigorous leisure-time PA among girls ($b = 0.12, p = 0.01$). Therefore, living closer to unstructured open spaces increases vigorous leisure-time PA. Children's perceived autonomy and family environment showed a positive association with both moderate (girls: $b = 0.17, p < 0.001$; boys: $b = 0.19, p < 0.001$) and vigorous (girls: $b = 0.19, p < 0.001$; boys: $b = 0.23, p < 0.001$) leisure-time PA.

Finally, neither moderate nor vigorous leisure-time PA showed significant association with BMI, in both genders.

Discussion

This study provides new evidence about the interrelationships among parents' perceived neighborhood environment, children's perceived autonomy and family environment, use of spaces for PA, PA and BMI. In Argentina, this is the first study addressing this topic and one of the few studies in Latin America. We found evidence of associations of children's perceived autonomy and family environment with leisure-time PA. On the other hand, parents' perceived neighborhood environment was not related with children's leisure-time PA. Finally, there was no association between leisure-time PA and BMI z-score.

Parents' perception of the built, safety and social attributes of neighborhood was associated with their reports of children's use of parks and unstructured open spaces for PA. Studies conducted in different socio-economic areas of Melbourne, Australia, and in a low-income inner city of the United States (US) showed that parents' perception of neighborhood safety seems to be an especially important issue limiting outdoor activities at this age, and one of the main reasons for parents to restrict their children's outdoor activities (Weir et al., 2006; Veitch et al., 2006; Franzini et al., 2009). These results were also supported in a literature review made by Carver et al. (2008)

In the current study, safety perception affected girls' use of recreational facilities negatively but boys' use positively. Girls' parents seemed to give more importance to social environment for using parks, while boys' parents prioritized the safety environment for the use of unstructured

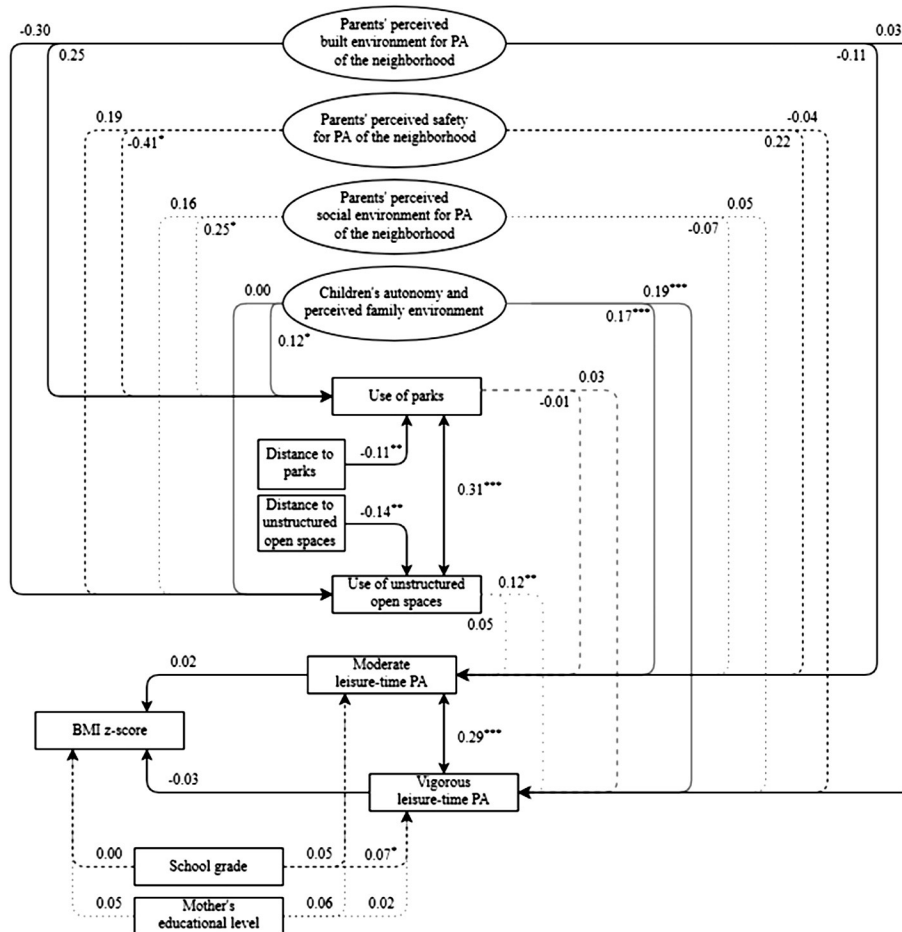


Fig. 2. Final model of association between perceived environment, use of neighborhood spaces for PA, leisure-time PA practice, and BMI z-score in girls. Cordoba city, Argentina, 2011. Notes: Different line patterns were used to help identifying the exposures. * = p -value ≤ 0.05 ; ** = p -value ≤ 0.01 ; *** = p -value ≤ 0.001 . PA = physical activity. BMI = body mass index. Chi-squared test = 398.03, p -value < 0.001 ; Root Mean Square of Approximation = 0.04, 90% Confidence Interval: 0.03–0.04; Standardized Root Mean Square Residual = 0.04; Comparative Fit Index = 0.92; Tucker–Lewis Index = 0.90; Goodness of Fit Index = 1.00; Adjusted Goodness of Fit Index = 0.99.

open spaces. The negative associations found between parents' perception of built environment and the use of unstructured open spaces in boys, and between safety environment and the use of parks in girls, were contradictory.

Another finding was that greater distances from home to parks were associated with reduced use by boys and girls. Previous research in three different US cities showed that living closer to large public parks and public open spaces – especially within walking or cycling distance – increased the likelihood of using these sites (Grow et al., 2008).

Of all the associations tested in both models, only the use of unstructured open spaces and, indirectly, the distance to these spaces, were associated with vigorous leisure-time PA, and these only in girls. The lack of consistency in the association between parental environment perceptions and children's PA agrees with a systematic review conducted by Ding et al. (2011), which found inconsistent relationships between perceived environment measures and children's reported PA. It should be noted that most studies in Ding's review were from North America, Europe, Australia and New Zealand. It could be argued that, in this specific population, parents' perception has little influence on children's PA because the neighborhood is the only or most accessible place where children can do PA (Lavin Fueyo & Berra, 2015), regardless of its built, social or safety conditions. Besides, open spaces that have no or poor PA infrastructure, whether parks or unstructured, may make a reduced contribution to leisure-time PA, even if the children spend a lot of time there. The children might also be doing PA outside the neighborhood or within their own homes. We also need to consider a possible discrepancy between parental reporting of environmental factors and children's

reporting of their leisure-time PA, and also measurement bias regarding children's reporting of PA.

In the present study, perceived autonomy and family environment were positively associated with the use of parks in girls and with moderate and vigorous leisure-time PA in both genders. Other studies using the same instrument to measure autonomy and family environment in children have also found associations between this variable and frequency of PA (Olaya et al., 2015) and with meeting the PA international recommendations (Breslin et al., 2012). They have also observed that children with higher moderate and vigorous PA had positive parent-child relationships (Pinquart, 2014) and higher parental support. (Edwardson & Gorely, 2010; Langer et al., 2014) A better perception of children's autonomy and family environment, which includes family relationships and financial capacity, may be associated with greater opportunities for leisure time activities (KIDSCREEN Group Europe, 2006). Self-determination theory explains possible mechanisms associating children's perceptions with moderate and vigorous PA (Teixeira et al., 2012), suggesting that individuals guide their behavior based on opportunities to satisfy their psychological needs, especially those present in their environment (Ryan & Deci, 2000). In addition, children have a higher sense of autonomy when parents support their autonomy, expanding their intrinsic motivation (Ryan & Deci, 2000). These associations may be reinforced by children who practice PA out of their homes having a higher sense of autonomy as they learn how to make decisions, solve problems, practice self-control, follow rules, regulate emotions and develop and maintain peer relationships (Mullan & Edwards, 2014).

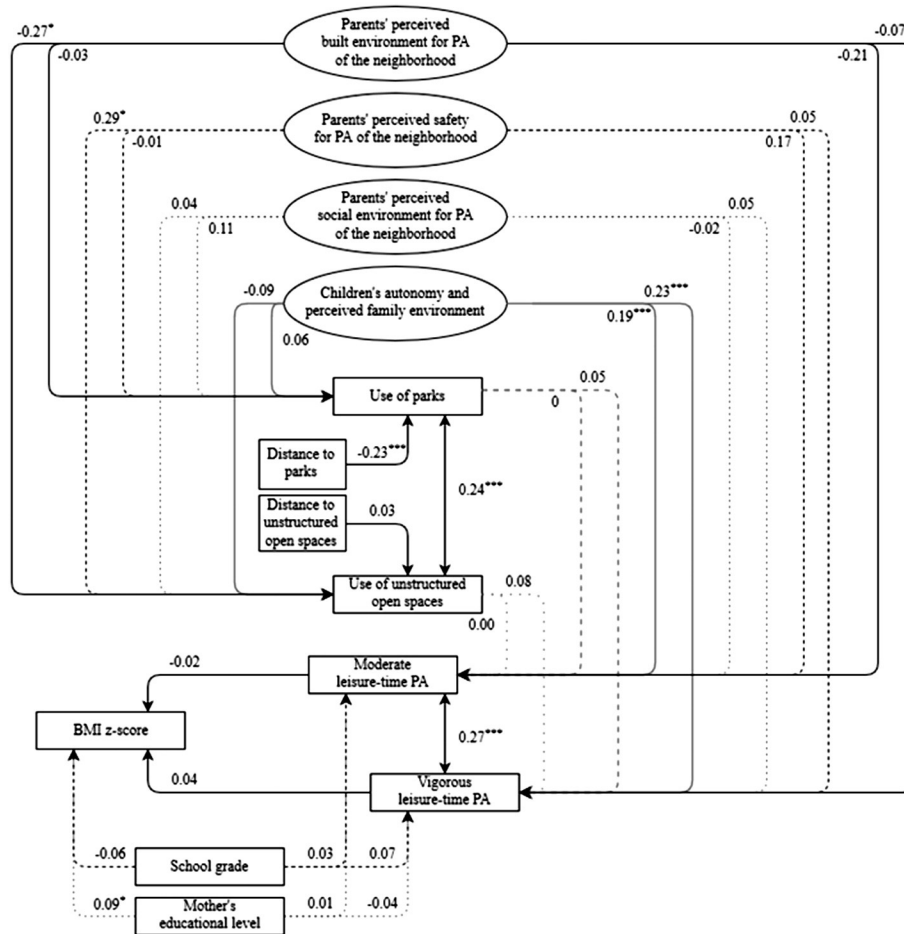


Fig. 3. Final model of association between perceived environment, use of neighborhood spaces for PA, leisure-time PA practice, and BMI z-score in boys. Cordoba city, Argentina, 2011. Notes: Different line patterns were used to help identifying the exposures. * = p-value ≤ 0.05; ** = p-value ≤ 0.01; *** = p-value ≤ 0.001. PA = physical activity. BMI = body mass index. Chi-squared test = 402.88, p-value < 0.001; Root Mean Square of Approximation = 0.04, 90% Confidence Interval: 0.04–0.05; Standardized Root Mean Square Residual = 0.05; Comparative Fit Index = 0.91; Tucker-Lewis Index = 0.89; Goodness of Fit Index = 1.00; Adjusted Goodness of Fit Index = 0.99.

Our findings are strongly gender-related. Boys doing more PA than girls has been widely documented, and also girls and boys using different places for PA (Floyd et al., 2011). In our current study, these differences affected mostly girls, who seem to have fewer opportunities for PA in the neighborhood. We also found that parental neighborhood perception differs between boys and girls, with boys conditioned by the safety and built environment perception and girls by the social environment. These findings support the idea that boys and girls are given disparate roles in the family and in society, resulting in different functions, behaviors and preferences that, in the end, determine health inequities between genders. Therefore, gender differences must be considered when designing policies to increase PA among children, both environmentally and individually.

Neither moderate nor vigorous leisure-time PA showed significant associations with the BMI z-score in this population. This confirms the complex and inconsistent relation between PA and body weight-related variables in young people, shown in several systematic reviews (Pate et al., 2013; Safron et al., 2011; Janssen & LeBlanc, 2010; Wilks et al., 2011). Reasons for these inconsistent findings need to be further explored. Nevertheless, some methodological limitations may contribute to this inconsistency in our study. There may be measurement bias regarding self-reported PA, because children, especially those who are overweight, may report more than their actual PA (McMurray et al., 2008). In addition, we investigated only one PA domain, leisure time. However, PA itself may have a small or even non-significant contribution to overweight/obesity in children. Nevertheless, this does not reduce the importance of promoting and supporting PA for children, because PA is known to be associated with numerous short- and long-term physical, mental and social health benefits (Janssen & LeBlanc, 2010). Furthermore, studies indicate that more active children report a better quality of life than their less active peers, although this relation is not sufficiently established for this age group (Sánchez-López et al., 2009; Rodríguez-Hernández et al., 2011).

Finally, besides the limitations already presented, the cross-sectional design of this study does not allow us to draw cause-and-effect conclusions. PA might be both a causal and a consequential factor of obesity in children. Moreover, neither diet nor sedentary behaviors were included in the model, but they did not show significant association with PA and BMI in this population (data not shown). Although the model was well fitted, it may not be unique and there may be other reasonable models for the same dataset.

Conclusion

The present study contributes to growing evidence on the role of neighborhood and family environment in children's PA. Parents' perceived neighborhood environment showed an association with the use of public recreational spaces for PA, even though their perception or even children's use of these spaces showed no direct association with leisure-time PA. On the other hand, children's perceived autonomy and family environment were consistently associated with both use of recreational places and leisure-time PA.

Given that public open spaces are those most common for children's physical activities (Grow et al., 2008; Lavin Fueyo & Berra, 2015), these results have important implications: policies and interventions to increase PA during childhood must take into consideration other than purely individual factors. Creating a supportive built environment, with access to better public, and even private, open spaces, in order to increase the options for PA is probably the most evident way. However, especially for children, it seems important to incorporate a family approach, in which improvement of the built and social environment must be accompanied by strategies to modify parents' perceived neighborhood environment and to reinforce the importance of children's autonomy and family environment for healthy development.

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.ypmed.2015.11.005>.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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