

Neighborhood Design and Children's Outdoor Play: Evidence from Northern California

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Abstract

Today's children are spending less of their free time outdoors in the neighborhood, with negative consequences for health. Neighborhood design has attracted attention for both its contribution to the problem and its potential as a solution. However, relatively few studies have examined the causal relationship between neighborhood design and children's outdoor play. This study uses data from a 2003 survey of a random sample of households from eight Northern California neighborhoods. Using a quasi-longitudinal design, we apply ordered probit models to examine the effect of neighborhood characteristics on children's outdoor play while controlling for neighborhood preferences. The results provide support for a causal relationship between neighborhood design and outdoor play and point to cul-de-sacs, larger front yards, lower crime, and increased interaction among neighbors as key characteristics that influence outdoor play by increasing parents' perceptions of safety.

Keywords: neighborhood design, built environment, outdoor play, youth, adolescents

Introduction

As a physical and social environment, neighborhoods influence the things children do, can do, like to do, and are able to do (Berg and Medrich 1980, 321).

In the past, children spent much of their free time outdoors in the neighborhood. In his seminal study from the 1980s, Robin Moore described a rich array of outdoor activities in which children engaged, usually involving friends and imagination (Moore 1986). These activities took place in both formal, managed, official places within the neighborhood, including schools, parks, and playgrounds, as well as informal, unmanaged, and unofficial spaces. In the latter category, neighborhood streets have served as an important site for children's play throughout history and around the world (Jacobs 1961; Gans 1962; Opie and Opie 1969; Lynch 1977; Tranter and Doyle 1996).

However, today's children are spending more of their free time indoors and more of their outdoor time in scheduled activities (Valentine and McKendrick 1997; Karsten and van Vliet-- 2006). The potential implications of the decline in outdoor play are numerous. Public health officials are especially concerned, given the link between time spent outdoors and levels of physical activity (Sallis, Prochaska and Taylor 2000; Ferreira et al. 2006). Declining physical activity levels are contributing to a rise in obesity rates in children, as well as obesity-related conditions such as diabetes and cardio-vascular disease (Koplan, Liverman and Kraak 2005).

Although the reasons for the decline in outdoor play are as numerous as the implications, neighborhood design has attracted attention as a contributing factor (Koplan, Liverman and Kraak 2005). While conditions such as wide streets, lack of sidewalks, and inadequate parks within the neighborhood might discourage outdoor play, the high-speed, high-traffic arterials that bound the typical suburban subdivision and separate it from the surrounding community might also be a problem, especially for children old enough to walk or bike on their own but too young to drive. The physical design of the neighborhood might also influence outdoor play through its impact on the social environment of the neighborhood, including the extent and nature of street life as well as the social connections between neighbors. Of course, if neighborhood design is a part of the problem, then a new approach to neighborhood design might also be a part of the solution.

The potential of this approach depends on two underlying questions. First, what neighborhood qualities are associated with greater outdoor play? Second, is there a causal relationship between these qualities and outdoor play? To address these questions, we first review existing evidence and then present results from a study of eight neighborhoods in Northern California.

Literature Review

Evidence on the influence of neighborhood characteristics on children's outdoor play is relatively limited. Studies of children's outdoor play in the neighborhood are more often qualitative than quantitative and tend to examine social factors rather

than physical characteristics of the neighborhood. The physical activity literature, based in the health behavior field, includes many rigorous quantitative studies on factors influencing children's physical activity, including a growing subset that examines neighborhood characteristics, but few of these studies focus on physical activity within the neighborhood. In addition, some forms of physical activity are not play (e.g., biking to school), and some forms of play do not involve much physical activity (e.g., playing house). Nevertheless, these studies together provide important insights into neighborhood characteristics that may influence children's outdoor play.

Evidence of the influence of parks and playgrounds on neighborhood activity is compelling though sometimes mixed. Several studies show that access to parks, schools, and other public recreational facilities is positively associated with physical activity (Mota et al. 2005; Davison and Lawson 2006), although one study found that park space mattered for boys but not for girls (Roemmich et al. 2007). On the other hand, an older study of 11- to 12-year-olds in Oakland, California found that children "make do" in the absence of parks and were not always attracted to "managed" spaces like playgrounds when they were available (Berg and Medrich 1980). Similarly, a more recent study found no link between outdoor play and provision of outdoor facilities: "children are no more likely to play outdoors, or play further away from home, if there are adequate opportunities provided within their neighborhood" (Valentine and McKendrick 1997, 219).

The evidence is stronger with respect to the association between street design and neighborhood activity. Street design appears to influence behavior directly as well as indirectly through its impact on traffic levels. Higher levels of traffic are associated with less street play, and vice versa (Eubank-Ahrens 1987; Hillman and Adams 1992; Tranter and Pawson 2001; Huttenmoser 2003). Several studies have found an association between traffic and physical activity as a whole (de Vries et al. 2007), or walking and cycling in particular (Carver et al. 2005). Traffic density and speed, as well as having roads to cross, have been shown to have a negative association with physical activity, while sidewalks and controlled intersections have been shown to have a positive association (Davison and Lawson 2006). Pedestrian and bicycle infrastructure seems to matter (Kerr et al. 2006), although at least one study concluded that sidewalks do not (Mota et al. 2005). Other studies point to the importance of parental perceptions of traffic levels and road safety in explaining neighborhood activity, particularly walking and cycling (Timperio et al. 2004; Carver et al. 2005; Carver, Timperio, and Crawford 2008).

The social environment of the street, which may be shaped by the built environment, also appears to influence outdoor play. For example, studies show that the presence of other children playing and relationships among neighbors are associated with levels of street play (Valentine 1997). As was true for road safety, parental perceptions of the social environment may be critical. Indeed, while many studies find that neighborhood crime influences physical activity (Davison and Lawson 2006), others note that it is the parental perception of neighborhood safety that is most important: neighborhood quality predicts physical activity only to the extent that parents perceive the neighborhood to be unsafe (Beets and Foley

2008). Parental fears may relate both to "stranger danger," i.e., the fear of child snatching, as well as traffic dangers (Carver, Timperio and Crawford 2008). Not surprisingly, inner-city parents tend to be more concerned than suburban parents (Weir, Etelson and Brand 2006). Parents' views may be more important than the child's view in predicting neighborhood activity (Carver, Timperio and Crawford 2008).

However, the effectiveness of neighborhood design as a strategy for increasing physical activity in children depends on a causal relationship with outdoor play (Transportation Research Board and Institute of Medicine 2005). Documenting associations between neighborhood design and children's outdoor play meets one criterion for establishing causality, but the criteria of non-spuriousness and time precedence must also be addressed (Singleton and Straits 2005). It is possible that any observed associations between neighborhood design and children's outdoor play are explained by "self-selection," the selection of a residential location with built environment characteristics that are consistent with an individual's behavioral predispositions (Cao, Mokhtarian and Handy, forthcoming). For example, parents who want their children to play outdoors may choose to live in neighborhoods conducive to children's outdoor play (*and* encourage them to do so), in which case the preference rather than the neighborhood design is the causal factor. Indeed, one study shows that parents' attitudes toward outdoor play, as well as the suitability of the local environment for outdoor play, was an important consideration in the decision to stay in the city or move to the suburb (Karsten and van Vliet--2006). To the extent that self-selection occurs, policies aimed at changing the neighborhood environment will not have the desired effect on children's outdoor play unless preferences are also aligned with the changes. To eliminate the rival hypothesis that self-selection explains the observed association, researchers must control for preferences and attitudes related to residential choice and children's outdoor play. Ideally, longitudinal designs would be used to also address time order and provide further evidence of causality (Ferreira et al. 2006; Carver, Timperio and Crawford 2008).

Just a handful of studies have used longitudinal methods to examine causal relationships between neighborhood characteristics and neighborhood activity for children, though with mixed success. In Leiden, Western Netherlands, streets and playgrounds were altered in the 1980s to make the environment more attractive to children (van Andel 1984/85). Children's behavior was observed before, during and after the alterations, and children were interviewed. Children liked the improvements, but the observations did not show a "spectacular" change in their activities. The authors concluded that "to give truly alternative possibilities for play, the environment would have to change in a more fundamental way." More recently, seven Home Zone projects in the UK, designed to improve the neighborhood street environment to better accommodate children's play, were evaluated (Gill 2006). The evaluations showed that traffic speeds and volumes declined and found some evidence that accidents and crashes declined. Of the seven sites, five showed a positive impact on play opportunities and independent mobility. However, these evaluations relied on retrospective reporting of changes

in traffic conditions and children's play by local officials and apparently did not follow a rigorous research design.

Methods

This study uses both cross-sectional and quasi-longitudinal designs to test the association between the built and social environments of neighborhoods and children's outdoor play within the neighborhood, while controlling for preferences and attitudes. The quasi-longitudinal design uses a sample of recent movers and parental-report measures of changes in neighborhood-based outdoor play from before to after the move; a sample of residents not recently moving serve as a control group by reporting change in outdoor play from one year ago.¹

Sample

The data used in this study came from a self-administered 12-page survey mailed in two rounds in the fall of 2003 to residents of eight neighborhoods in Northern California. The neighborhoods were selected to vary systematically on neighborhood type, size of the metropolitan area, and region of the state, and to control for socio-economic status. Neighborhood type was differentiated as "traditional" for areas built mostly in the pre-World War II era (between 28 and 68 percent of the homes in these four neighborhoods were built before 1949, according to data from the 2000 U.S. Census), and "suburban" for areas built more recently (in these four neighborhoods, between 0.4 and 5 percent of homes were built before 1949). The two neighborhood types offer significantly different built environment characteristics (Figure 1; see also Table 2, below), although the differences between neighborhoods of the same type are also sometimes significant (Handy et al. 2004). In this analysis, we focus on the effect of specific neighborhood characteristics rather than using the more coarse designation of neighborhood type.

¹ The survey instrument and procedure were approved by the Institutional Review Board of the University of California Davis.

Figure 1. Comparison of traditional and suburban neighborhoods (Sacramento)



For each neighborhood, we purchased two databases of residents from a commercial provider, New Neighbors Contact Service (www.nncs.com): a database of "movers" and a database of "nonmovers." The "movers" included all current residents of the neighborhood who had moved within the previous year. From this database, we drew a random sample of 500 residents for each of the eight neighborhoods. The database of "nonmovers" consisted of a random sample of 500 residents not included in the "movers" list for each neighborhood. The result is a disproportionate sample stratified by neighborhood and mover/nonmover status. For sampling purposes, neighborhood boundaries were defined based on natural boundaries, manmade boundaries such as major arterial streets, census tracts, and planning areas, and were set large enough so as to achieve an initial sample size of 500 movers.

The original database consisted of 8,000 addresses, only 6,746 of which turned out to be valid. The response rate is 24.7 percent based on the valid addresses only. This rate is considered quite good for a survey of this length, since the response rate for a survey administered to the general population is typically 10-40 percent (Sommer and Sommer 1997). A comparison of sample characteristics to population characteristics, based on the 2000 U.S. Census (Table 1), shows that survey respondents tend to be older than residents of their neighborhood as a whole, and that for most neighborhoods, the percent of households with children is lower for the sample. In addition, median household income for survey respondents was higher than the census median for all but one neighborhood, a typical result for voluntary self-administered surveys. However, since the focus of our study is on explaining children's outdoor play as a function of other variables rather than on describing the simple univariate distribution of physical exercise per se, these differences are not expected to materially affect the results (Babbie 1998). Although the overall sample size for the survey was 1,682, the sample used in the analyses presented here includes only households with children under the age of 16, resulting in respective sample sizes for the cross-sectional and quasi-longitudinal models, described below, of 308 and 272. In the subsamples, respondents are younger, households are larger, and incomes are higher on average than in the full sample.

Table 1. Sample vs. population characteristics

	Traditional				Suburban			
	Mountain View	SR Junior College	MD Central	SC Midtown	Sunnyvale	SR Rincon Valley	MD Suburban	SC Natomas
Population Characteristics ¹								
Population	5,493	9,886	13,295	7,259	14,973	13,617	19,045	13,295
Average age	36.1	36.3	36.5	42.7	35.9	38.3	38.1	31.7
Average HH size	2.08	2.21	2.46	1.79	2.66	2.48	2.51	2.57
Percent of HHs w/kids	19.3	20.3	32.9	12.4	35.3	35.4	34.2	41.7
Percent home owners	34.3	31.2	58.8	34.3	53.2	63.5	61.4	55.2
Median HH income (k\$)	74.3	40.2	42.5	43.8	88.4	49.6	40.2	46.2
Full Sample Characteristics								
Number	228	215	184	271	217	165	220	182
Average age	43.3	47.0	51.3	43.4	47.1	54.7	53.2	45.6
Average HH size	2.08	2.03	2.13	1.78	2.58	2.19	2.41	2.35
Percent of HHs w/kids	21.1	18.6	21.7	8.9	42.4	24.8	25.5	31.9
Percent home owners	51.1	57.8	75.6	47.0	61.1	68.7	81.0	82.4
Median HH income (k\$)	98.7	55.5	45.5	64.2	95.0	49.5	55.5	55.3
Subsample Characteristics								
Number	44	31	31	22	75	33	50	47
Average age	40.8	39.0	38.2	43.2	41.0	42.0	42.5	40.7
Average HH size	3.73	3.58	4.06	3.55	3.76	3.67	4.16	3.87
Percent of HHs w/kids	100	100	100	100	100	100	100	100
Percent home owners	59.1	64.5	54.8	77.3	64.5	57.6	78.0	68.1
Median HH income (k\$)	104.2	73.0	63.4	86.8	99.3	53.7	65.0	62.6

Notes: SR = Santa Rosa, MD = Modesto, SC = Sacramento, HH = household

¹Source: 2000 U.S. Census

Measures

The dependent variables used here are frequency of children's outdoor play (COP) within the neighborhood and changes in children's outdoor play within the neighborhood, as reported by parents. In the survey, respondents were asked to report: "If you live with children under the age of 16, how many days in the last

seven days did they play outdoors somewhere in your neighborhood (besides your backyard)?" Note that the question is not child-specific and thus may be influenced by the number of children in the household. For the analysis, we group responses into never (zero days in last seven days), low (one to two days), medium (three to five days), and high (six to seven days), and use these categories as a general indicator of frequency of outdoor play for children in the household. We also asked respondents to indicate the change in their COP compared to the frequency of COP just before the move (for the movers) or from one year ago (for the nonmovers), on a five-point scale from "much less often now" to "much more often now." This question produces an indicator of the direction and general magnitude of change rather than a measure of the actual change. By design, these variables focus on play rather than physical activity and on the public spaces of the neighborhood rather than the private spaces of backyards. They are intended as general indicators of COP rather than accurate measures of the amount of COP.

The explanatory variables were grouped into three categories, as follows:

Socio-demographics: Socio-demographic measures include respondent's education, household income, the type of housing unit (whether an apartment or not), the number of children in the household, and the presence of children of different ages. Some changeable socio-demographics such as household size, presence of children, and income were measured currently as well as before moving for movers and from one year ago for non-movers. The quasi-longitudinal analysis included changes in these variables as predictors of change in COP.

Preferences for neighborhood characteristics: To measure preferences for neighborhood characteristics, respondents were asked to rate the importance of 34 neighborhood characteristics when they were looking for a new place to live (for the movers) or if they were going to be looking for a new place to live (for the non-movers), on a four-point scale from "not at all important" (1) to "extremely important" (4). For this analysis, we used a subset of 12 characteristics that are conducive to COP (Table 2). These items are used to control for self-selection, i.e., the possibility that parents who want their children to engage in outdoor play consciously choose to live in neighborhoods that are conducive to COP. Note that some characteristics are clearly measures of the built environment (e.g., large front yards), while some are descriptors of the social environment (e.g., interaction among neighbors), which may be influenced by the built environment (e.g., a cul-de-sac). The item for "safe neighborhood for children to play" likely comprises both built and social environment aspects. In the quasi-longitudinal analysis of change in COP, preferences were assumed to be unchanged.

Perceptions of neighborhood characteristics: To measure perceptions of the neighborhood environment, respondents were asked to indicate how true the same 34 characteristics are for their current and (for movers) previous neighborhoods, on a four-point scale from "not at all true" (1) to "entirely true" (4). Again, the subset of characteristics that are conducive to COP and that represent the built and social environments are used here (Table 2), with the exception that the perception of "safe neighborhood for children to play" was not included directly in the models

because it is endogenous to other attributes that were included (see Table 5 and the "Discussion" section). These items are used as perceived measures of the environment. In addition, terms for the interactions between age of children and all preferences and perceived neighborhood characteristics were tested in the model to account for the possibility that these factors matter more for children of certain ages; different age ranges were tested in the modeling process. The quasi-longitudinal model for change in COP uses measures of changes in the neighborhood environment as explanatory variables. For the sample of movers only, changes in the neighborhood environment were measured by taking the difference between perceived characteristics of the current and previous neighborhoods; the neighborhood environment was assumed unchanged for the sample of non-movers.

Table 2. Preferences for and perceptions of neighborhood characteristics (n=334)

Characteristic	Mean Preference ¹	Mean Perception ²	Mean Perception Traditional ²	Mean Perception Suburban ²
<i>Built Environment</i>				
Amenities (e.g. pool, community center) nearby	2.37	2.86	2.89	2.73*
High level of upkeep in neighborhood	3.31	3.09	3.16	3.03*
Large back yards	2.96	2.65	2.56	2.46*
Large front yards	2.48	2.44	2.27	2.38*
Living unit on cul-de-sac rather than thru street	2.20	1.92	1.43	2.05*
Low level of car traffic on neighborhood streets	3.24	2.66	2.51	2.67*
Parks and open spaces nearby	3.22	3.54	3.49	3.45
Sidewalks throughout the neighborhood	3.09	3.57	3.57	3.58
<i>Social Environment</i>				
Lots of interaction among neighbors	2.82	2.66	2.71	2.43*
Lots of people out and about in the neighborhood	2.79	2.95	3.07	2.72*
Low crime rate within neighborhood	3.75	3.18	3.08	3.21*
<i>Composite Environment</i>				
Safe neighborhood for children to play	3.74	3.21	3.05	3.16*

¹ How important statement is in choice of neighborhood, on a scale from 1 (not at all important) to 4 (extremely important).

² How true statement is for neighborhood, on a scale from 1 (not at all true) to 4 (entirely true).

*Differences between Traditional and Suburban significant at the 0.05 level.

Analysis

The purpose of both the cross-sectional and quasi-longitudinal analyses was to test the association between the dependent variable (COP) and characteristics of neighborhood design, while controlling for neighborhood preferences and socio-demographic characteristics. If neighborhood design characteristics are significant after controlling for these factors in the cross-sectional model, two criteria for causality are supported: association and non-spuriousness. If neighborhood design characteristics are significant after controlling for these factors in the quasi-longitudinal model, the third criterion for causality, time precedence, is also supported. Although the quasi-longitudinal model is a stronger test of causality than the cross-sectional model, we include the latter here as a comparison for cross-sectional studies that do not control for attitudes and preferences.

Ordered probit techniques were used to estimate both the cross-sectional and quasi-longitudinal models. This technique is appropriate for an ordinal-dependent variable, and the model structure is parsimonious. The central equation of the model can be interpreted as representing a continuous underlying latent variable, in this case representing the propensity for COP for the cross-sectional model, and the propensity to change COP for the quasi-longitudinal model. We used Limdep 8.0 to estimate both models. In determining which variables to include in the models, we generally used a 5 percent level of significance. We present only the final models with insignificant variables excluded.

Results

Frequency of Children's Outdoor Play

The average frequency of children playing outside was 3.02 days in the last seven days. Twenty-two percent of households reported that their children did not play outside in the previous week. The differences in outdoor play frequency between traditional and suburban neighborhoods were not significant.

In the cross-sectional model for children's outdoor play, parents' education, household income, housing unit type, and renter status were not significant, though the work status of the parent and the number of children in the household were (Table 3). The last association may be partly explained by our use of a family-level measure of children's play. Preferences for two neighborhood characteristics were also significant: cul-de-sacs and large backyards, with positive coefficients. These results suggest that parents who prefer an environment conducive to children's play may be inclined to allow or encourage their children to play outdoors. After accounting for these variables, perceptions of three neighborhood characteristics were significant, all with positive coefficients: cul-de-sac interacted with the presence of children ages 6 to 12 years, parks and open space nearby, and interactions among neighbors. The first two characteristics are elements of the built environment, while the last may be influenced by the built environment.

Table 3. Cross-sectional model for children's outdoor play frequency (ordered probit)

Variables	Unstandardized Coefficients	Standardized Coefficients*	p-value
Constant	-1.563	0.826	0.001
Sociodemographics			
Parent is worker	0.311	0.109	0.078
Number of children under 16 in the household	0.167	0.140	0.029
Neighborhood preferences			
Preference for cul-de-sacs	0.298	0.144	0.025
Preference for large backyard	0.167	0.147	0.022
Perceived neighborhood characteristics			
Perception of cul-de-sac X presence of children 6 to 12	0.427	0.158	0.015
Perception of interaction among neighbors	0.170	0.158	0.012
Perception of park and open space nearby	0.196	0.134	0.035
Threshold parameter - 1	0.837	0.837	0.000
Threshold parameter - 2	1.674	1.674	0.000
N	308		
Log-likelihood at constant and threshold parameters	-424.85		
Log-likelihood at convergence	-402.09		
χ^2	45.5		0.000

* The model was re-estimated after standardizing all explanatory variables except the constant and threshold parameters; the dependent variable was not standardized.

Change in Children's Outdoor Play

Over half (52.7 percent) of parents reported no change in the frequency with which their children play outdoors from before the move or from one year ago, with 15.7 percent reporting a decline and 31.5 percent reporting an increase. Households with children ages 12 to 16 years were more likely to report no change in children's outdoor play than households with younger children. Households with children ages 5 to 12 were more likely to report an increase in children's outdoor play than households with older children. The differences were not significant between families currently living in suburban and traditional neighborhoods.

In the model for change in COP (Table 4), the change in number of children ages 12 years and under in the household was significant and positive, suggesting that an increase in children was associated with less of a decline or more of an increase in COP; this association may be partly explained by our use of a family-level measure of children's play. Preference for a safe neighborhood for kids to play was also significant and positive, an intuitive result that suggests a self-selection effect. After accounting for these variables, changes in four perceived neighborhood characteristics also had a positive impact on COP: cul-de-sac interacted with presence of children ages 6 to 12 years, large front yards, low crime, and

interaction among neighbors. These characteristics reflect aspects of the built environment as well as aspects of the social environment.

Table 4. Quasi-longitudinal model for changes in children's play (ordered probit)

Variables	Unstandardized Coefficients	Standardized Coefficients*	p-value
Constant	0.844	1.990	0.009
Sociodemographics			
Change in number of children (≤ 12) in the household	0.402	0.234	0.001
Neighborhood preferences			
Preference for safe neighborhood for kids to play	0.314	0.147	0.028
Perceived neighborhood characteristics			
Change in cul-de-sac X presence of children 6 to 12	0.212	0.170	0.014
Change in large front yards	0.208	0.200	0.005
Change in low crime	0.361	0.290	0.002
Change in interaction among neighbors	0.205	0.189	0.008
Threshold parameter - 1	0.764	0.764	0.000
Threshold parameter - 2	2.526	2.526	0.000
Threshold parameter - 3	3.444	3.444	0.000
N	272		
Log-likelihood at constant and threshold parameters	-343.1		
Log-likelihood at convergence	-305.2		
χ^2	75.7		0.000

* The model was re-estimated after standardizing all explanatory variables except the constant and threshold parameters; the dependent variable was not standardized.

Discussion

Both the model for frequency of children's outdoor play and the model for change in children's outdoor play support the hypothesis that neighborhood design has a causal effect on children's outdoor play. The model for change in COP provides especially strong support for causality by addressing all three criteria: association, non-spuriousness, and time order. In both models, perceived characteristics of the neighborhood are significant after accounting for socio-demographic characteristics and neighborhood preferences, a control for the self-selection effect. Note that neighborhood preferences are also significant, suggesting that both a self-selection effect and a direct causal effect of the built environment may occur. It is particularly noteworthy that both the preferences for and perceptions of cul-de-sacs are significant in the cross-sectional model. One implication is that COP could potentially be increased through strengthening parents' preferences for supportive built environments, as well as through making built environments themselves more supportive.

One perceived neighborhood characteristic was significant in both models: cul-de-sac in both cases interacted with age of children. This result points to cul-de-sacs

as an important predictor of outdoor play, at least for children between the ages of 6 and 12 years. The significance of cul-de-sacs for children in this age range is consistent both with previous findings that age moderates the effect of the environment on children's play (Holt et al. 2008) and with previous findings that children living on through streets have fewer opportunities for outdoor play than children living on cul-de-sacs (Veitch et al. 2006). The cross-sectional model shows that having parks and open space nearby are important predictors of children's COP, consistent with some prior research (e.g. Mota et al. 2005; Davison and Lawson 2006). The quasi-longitudinal model points to larger front yards, lower crime, and increased interaction among neighbors as predictors of increased COP. These results echo recent work that points to the important role of parental perceptions of neighborhood safety (Beets and Foley 2008). Indeed, in an ordinary least squares (OLS) regression model estimated with our data, perceptions of low crime and interaction among neighbors, along with low traffic, are statistically significant predictors of perceptions of "safe neighborhood for children to play," with p-values less than 0.05 (Table 5); cul-de-sacs and large front yards are significant at the 0.12 level. In other words, all of the environmental variables that predict COP are related to parental perceptions of safety.

Table 5. Model for perception of "safe neighborhood for kids to play" (OLS regression)

	Coefficients	t	p-value
Constant	0.413	1.728	0.085
High level of upkeep in neighborhood	0.053	1.094	0.275
Large back yards	0.030	0.731	0.465
Large front yards	0.070	1.554	0.121
Living unit on cul-de-sac rather than through street	0.042	1.567	0.118
Lots of interaction among neighbors	0.120	2.953	0.003
Lots of people out and about within the neighborhood	0.016	0.339	0.735
Low crime rate within neighborhood	0.486	10.056	0.000
Low level of car traffic on neighborhood streets	0.079	2.161	0.032
Parks and open spaces nearby	0.033	0.666	0.506
Pool or community center nearby	0.019	0.612	0.541
Sidewalks throughout the neighborhood	0.008	-0.178	0.859

Adjusted R-square = 0.50; N=286

These results present something of a dilemma for city planners. The new urbanism movement, which has been widely influential in the planning field, aims for communities that support more street life, whether walking, playing, or interacting with neighbors, but promotes smaller front yards and discourages cul-de-sacs, among other features, as a way of achieving this aim. Although some evidence supports new urbanist principles as a strategy for promoting physical activity among adults, particularly walking as a mode of transportation, our results suggest that children may benefit from a more conventional approach—or at least that parents feel more comfortable letting their children play outdoors in a more typical

suburban environment (with cul-de-sacs and large front yards), whether or not they are actually safer. Our findings may add fuel to the debate within the planning field over the use of cul-de-sacs in residential neighborhoods (e.g., Southworth and Ben-Joseph 2004).

As a way out of this dilemma, planners in the U.S. might do well to consider efforts in Europe to remake the street as a play environment for children, as it once was. The concept of the *Woonerf*, developed in the Netherlands in the late 1960s, gives priority to pedestrians over motorists and creates shared street spaces (Ewing 1999). Similarly, the Home Zone concept is being promoted in the UK as "a group of residential streets designed so that the street space is available for social uses such as children's play, while car access is also allowed" (Gill 2006). In the U.S., the *Woonerf* concept inspired the development of traffic calming programs, which proliferated in the face of growing traffic and are now common throughout the U.S. These programs help to create play-friendly streets in areas with gridded street networks. However, they often focus largely on speed bumps and other traffic-slowing devices, in contrast to the more holistic European programs that aim to create shared spaces. Programs to retrofit cul-de-sacs with pedestrian "cut-through" paths could also help to facilitate both outdoor play and active travel in more post-war U.S. suburbs. Communities like Davis, California and Portland, Oregon have taken advantage of turn-over in residential properties to purchase land or acquire easements for such paths. Although there is no "silver bullet" that will stem the decline in outdoor play among children, this study adds to the growing evidence that neighborhood design matters and that strategies like these can make a difference.

Although our study offers new support for a causal relationship between the built environment and children's play in the neighborhood, our methodology has several notable limitations. The measures of children's outdoor play are not child-specific and thus are influenced by the number of children in the household; we have partly addressed this limitation by including the number of children in the models. The measures depend on parental report of children's outdoor play, both currently and retrospectively, and they have not been validity tested. What qualified as "outdoor play within the neighborhood" was not defined for parents, and respondents may have interpreted this activity differently. The measures focus on outdoor play in the public space of the neighborhood, thereby omitting outdoor play in private backyards and physical activity in the neighborhood that is not play. The study did not include measures of total physical activity and thus does not account for the possibility that outdoor play replaces other forms of physical activity for children, a question of particular interest to the public health field. Because the primary purpose of the overall study was to examine the relationship between neighborhood design and travel behavior (see Handy, Cao and Mokhtarian 2005; 2006), the survey did not include measures of parental attitudes towards COP and other potentially important factors. Finally, the study is not a true longitudinal design, and thus is subject to memory lapses and biases.

Most of these limitations, particularly those related to the measure of current outdoor play, can be easily remedied in future studies. Survey questions can be

designed to measure outdoor play for each child separately, and their scope can be adjusted to include backyard play and/or active travel. Validity and reliability testing of these measures would enhance the credibility of the analysis. Attitudes towards children's physical activity and outdoor play can be included in the survey. Objective measures of street design and access to parks and other potential play spaces could be used instead of or in addition to perceptual measures and would enable an exploration of the relationship between the two. Models should test potential interaction effects between neighborhood characteristics and gender as well as gender and age together, given prior evidence that these characteristics moderate the effect of the built environment on physical activity. However, to provide a more conclusive test of causality, true longitudinal designs must be implemented. One approach is to measure changes in children's outdoor play for families that move from one neighborhood to another, employing before and after surveys rather than the retrospective survey used here. The other approach is to measure outdoor play before and after a change in the neighborhood environment, such as the implementation of a traffic calming program or the opening of a new playground. Both types of studies present practical challenges that few researchers have so far been able to overcome. Nonetheless, the results of the present study and others provide strong enough support for causality to encourage these more ambitious efforts.

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