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Parent safety perceptions of child walking routes

Cody Evers[a,*], Shawn Boles[a,1], Deb Johnson-Shelton[a,1], Marc Schlossberg[b,2], David Richey[c,3]

[a] Oregon Research Institute, 1715 Franklin Blvd., Eugene, OR 97403, USA
[b] University of Oregon, 147B Hendricks Hall, 1209 University of Oregon, Eugene, OR 97403, USA
[c] Lane Council of Governments, 859 Willamette Street, Suite 500, Eugene, OR 97401, USA

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ABSTRACT

Walking rates to school remain low for U.S. children in large part due to parent concern for child safety. Little research exists that identifies which features of streets and intersection lead parents to feel that walking is unsafe for their children. In this study, parent volunteers conducted an audit of streets and intersections leading to seven elementary schools in a suburban school district. Parents were most likely to feel concern about streets that lacked sidewalks or had sidewalks with obstructions. Wheelchair-accessible routes were seen as appropriate for walking children. Parents expressed concern over safety at intersections, particularly those involving large streets; traffic controls did not mollify their concern. These results support the use of appropriate behavior models for assessing walking choices, highlight the importance of well-maintained sidewalks and age-appropriate crossings for young families, and demonstrate the importance of including the public in street audits.

1. Introduction

Childhood obesity in the U.S. is rising at the same time that opportunities for physical activity are decreasing (Dollman et al., 2005). Active transportation (e.g., walking, biking) to school can provide children opportunities for more daily physical activity, which can, in turn, help reduce childhood obesity and obesity-related morbidity (Handy et al., 2002; Lee and Zhu, 2008). Children who walk to school are more physically active than those who are driven (Cooper et al., 2003), and such activity creates additional opportunities for socialization, outdoor play, and exercise (Sallis et al., 2004). Unsupervised play also results in better cognition skills (Hüttenmoser, 1995). Currently as few as 15% of the U.S. student population arrive or depart school by foot or bike, in sharp contrast to some 60% of students just one-half century ago (see Fig. 1; McDonald, 2007; McDonald et al., 2011). Declines in walking have been greatest among elementary-aged children (distance adjusted decrease from 40.7% in 1969 to 13.1% in 2009) and for children who live within one mile of their school (85.9% in 1969 to less than 50% in 2009) (ibid).

For children, the decision to walk is strongly tied to parent concerns over safety (Carver et al., 2010; Kerr et al., 2006; Moore et al., 2010). Concerned parents are less likely to let their children walk to and/or from school (Carver et al., 2010; Kerr et al., 2006; McMillan, 2007), particularly when their child is young (Timperio, 2004). Parents point to traffic danger as a primary source of their concerns (Carver et al., 2008b; Kerr et al., 2006; Martin and Carlson, 2005). To address this issue, policy makers and transportation planners have championed changes to infrastructure that reduce the danger of traffic to people walking. The literature is equivocal as to whether such changes lead more children to walk to or from school (e.g., Boarnet et al., 2003; Staunton et al., 2003).

What is frequently lacking in both policy discussion and research is a mechanism for describing how environmental cues are interpreted. This is especially true with children, whose decisions are constrained to a large degree by their parents. In this capacity, McMillan (2005) described parents as gatekeepers. She wrote:

> Given particular elements of urban form, a parent forms opinions about the ability of the physical environment to support different modes of travel for their child's trip to school, and these opinions dictate the decision of how the child gets to school. (p. 449)

* Corresponding author. Present address: Oregon Research Institute, 1776 Millrace Drive, Eugene, OR 97403, USA. Tel.: +1 541 484 2123; fax: +1 541 484 1108.
E-mail addresses: codye@ori.org (C. Evers), shawn@ori.org (S. Boles), debj@ori.org (D. Johnson-Shelton), schlossb@uoregon.edu (M. Schlossberg), drichey@lcog.org (D. Richey).
[1] Present address: Oregon Research Institute, 1776 Millrace Drive, Eugene, OR 97403, USA.
[2] Tel.: +1 541 346 2046.
[3] Tel.: +1 541 682 4283.

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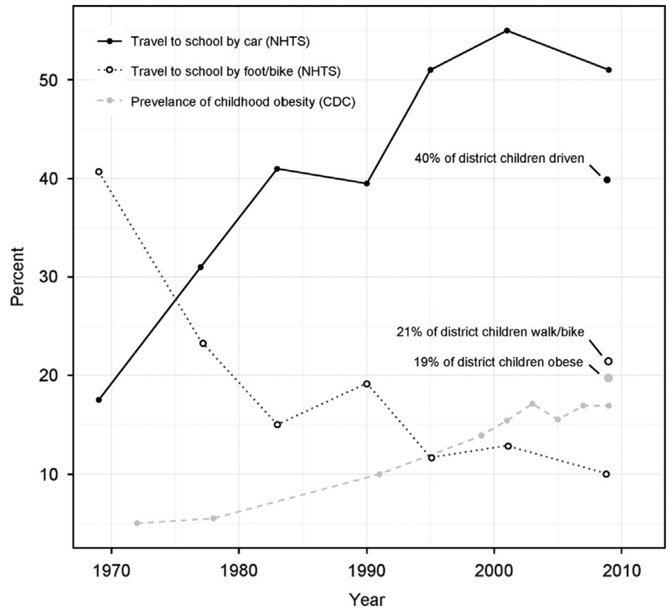

Fig. 1. National changes in how elementary-aged children arrive at school alongside prevalence of childhood obesity. Similar rates found within participating school district, shown at right. Transport data from U.S. Department of Transportation, National Highway Traffic Safety Administration data, adapted from *American Journal of Preventive Medicine*, 32:(6), N. C. McDonald, Active transportation to school: Trends among U.S. school children, 1969–2001, 509–516, copyright 2007, with permission from Elsevier. NHTS 2009 values from McDonald et al. (2011). U.S. school travel, 2009: an assessment of trends. *American Journal of Preventive Medicine, 41,* 146–151. Childhood obesity data adapted from Ogden and Carroll (2010). Prevalence of obesity among children and adolescents: United States, trends 1963–1965 through 2007–2008. Atlanta: Centers for Disease Control and Prevention. National Center for Health Statistics, 201(0).

Surprisingly little is known about which features of streets networks mediate parent concern. This paper contributes to the child pedestrian safety literature in two ways. First, our study focuses on the specific microvariables found in streetscapes[4] (e.g., trees, sidewalk width, curb cuts, uninterrupted sidewalk path) and their association with parent ratings for child pedestrian safety. Second, our data are derived from direct parent observations of the entire street network serving a suburban school district. The combination of these approaches allowed us to analyze which features of the street environment had the strongest association with parent ratings of safety or concern for child pedestrians. Clarifying this relationship can provide a more specific framework for promoting street designs that facilitate changes in child walking behavior.

2. Research approach and data collection

Data were obtained as part of the Community and Schools Together (CAST) project, a 5-year childhood obesity tracking project that employed multiple community-based participatory research methods to examine environmental influences on the prevalence of overweight and obesity in a sample of elementary-aged children from a Eugene, Oregon, suburban school district. The data were acquired on location by parent participants using mobile GIS technology to conduct a comprehensive inventory of street, sidewalk, and crossing features, and to rate their comfort and concern if an unaccompanied child were to walk along the assessed street. The protocol and informed consent procedures for this study were approved by the Institutional Review Board of Oregon Research Institute.

2.1. Study sample

The school district serves approximately 6000 students, 3000 of whom are located in seven elementary (K–5) schools. Compared to the state of Oregon, the school district has a larger percentage of students eligible for free and reduced lunch (41.5% state vs. 46.8% district), a smaller percentage of students with English as a Second Language (ESL) (10.3% state vs. 2.2% district), and a slightly smaller percentage of Hispanic students (17.2% state vs. 13.9% district) (Oregon Department of Education, 2007). Data previously collected from the school district during the 2008–2009 school year (n=2316) indicated that 19% of children were obese;[5] the percent of obese children varied among the seven schools from 13% to 28% (Moreno et al., 2013). Four of the seven schools had children who were more obese than the national average for elementary students of 18.8% (Ogden and Carroll, 2010). A random survey of parents of CAST students in 2009 (n=409) indicated that 41% drove their child to and/or from school.

2.2. Study area

The school district covers 31 square miles of the northwest quarter of Eugene, Oregon, a city with a population of 150,000, and extends into surrounding rural lands (Fig. 2). Most students (93%) live within the 13.5 square miles of the school district that intersect with the

[4] The United States term ‘sidewalk’ is synonymous with the United Kingdom term ‘pavement’. Further, in this paper ‘street’ encompasses not only the roadbed itself, but also sidewalk(s) and planting strip between the sidewalk and the road if such exist.

[5] Excess weight among children in the United States is defined in relation to the 2000 CDC sex-specific BMI-for-age growth charts (see Ogden and Carroll, 2010). A child is obese if their Body Mass Index exceeds the age and sex specific 95th percentile.

Fig. 2. Parents from seven elementary schools (black squares) surveyed 73% of streets (bolded) and 82% of intersections for child walking safety using handheld GIS devices. The surveyed area covered the urban zone of a suburban school district in Eugene, Oregon. More than 90% of the district's elementary-aged students (approximately 3000) live in the surveyed area, 25% within 1/2 mile walking distance to their school.

city's urban growth boundary (UGB). We excluded areas of the school district elementary school catchment areas not within the UGB from the study area since (a) all of the district elementary schools were located within the UGB portion of the district, and (b) walking and biking are ultimately limited by the distance a child lives from school.

2.3. Data collection

Street audits were completed by parents in the school district using the Complete Streets Assessment Tool (CSAT; Schlossberg and Brehm, 2009). The CSAT survey approach was designed to (a) gather fine-grain data relevant to walking and biking and (b) develop and mobilize knowledgeable community members in the nomenclature of built environments (Schlossberg and Brehm, 2009). The CSAT survey is built upon ArcPad software by Environmental Systems Resource Institute (ESRI, 2009). ArcPad is intended for professional survey and inventory tasks, but Schlossberg and Brehm (2009) modified it for use by lay assessors using a handheld personal data assistant (PDA) with specialized software. The software displays maps of specific audit areas and allows users to select geographic features (e.g., street segments, intersection points) and record observations for those features by answering a series of questions using buttons, check-boxes, radio buttons, drop-down lists, and an onscreen keyboard. The software stores survey results as attributes of the assessed feature.

The CSAT survey was composed of various modules, each of which is related to a specific user of the street environment: walkers, bikers, and transit users. For each user group, the surveyor recorded various objective observations of streetscape attributes (e.g., number of lanes, width of sidewalk) and followed with a summary assessment of the overall perceived safety and comfort. Tables 1 and 2 give the attributes of both street segments and intersections in the walking module used by CAST parent observers. Parents were asked to report

Table 1
Questions from Parent-Led Street Audit.

	Street attribute survey question	Attribute	Response values
C.	Would feel safe letting child walk unaccompanied?	safeTravel	1=Disagree 2=Neutral/agree
1.	How many traffic lanes (both ways)?	streetLanes	0=2 lanes[a] 1=GT 3 lanes
2.	Road has center turning lane?	streetCTurnLane	0=No[a] 1=Yes
3.	Road has paved/planted median strip?	streetMedian	0=No[a] 1=Yes
4.	Street has trees?	streetTrees	0=No 1=Yes[a]
5.	Ends in cul-de-sac?	streetCulDeSac	0=No 1=Yes[a]
6.	Most likely place to walk?	travelPath	1=Sidewalk[a] 2=Side of road 3=On the road
7.	Entire segment wheelchair traversable?	pathWcAccess	0=No 1=Yes[a]
8.	Is the walking path wide enough?	pathWide	0=LT 5ft 1=GTE 5ft[a]
9.	Is the path surface free of tripping hazards?	pathSmooth	0=No 1=Yes[a]
10.	Are there obstructions in the path?	pathObstructed	0=No[a] 1=Yes
11.	Driveways or entrances create hazard?	pathAutoConflict	0=No[a] 1=Yes

[a] Value used as the reference in the logistic model.

Table 2
Questions from Parent-Led Intersection Audit

	Intersection attribute survey question	Attribute	Response values
C.	Would feel safe letting child cross unaccompanied?	crossSafe	1=Disagree 2=Neutral/agree
1.	Type of traffic control?	trafficControl	1=Traffic light 2=Stop signs 3=Other 4=No controls[a]
2.	Size of intersecting roads?	intSize	1=Minor/minor 2=Minor/major 3=Major/major 4=Cul-de-sac[a]
3.	Are any corners 'bumped-out'?	bumpouts	1=None 2=Some 3=All[a]
4.	Any crossings lack curbcuts?	curbcuts	1=None[a] 2=Some 3=All
5.	Any crossings have medians?	medians	1=None 2=Some 3=All[a]
6.	Any crossings marked?	crosswalks	1=None 2=Some 3=All[a]

[a] Value used as the reference in the logistic model.

their agreement with the statement, “I would feel comfortable letting an unsupervised 8-year-old child travel along/across this street/intersection.” Parents responded along a 5-point Likert scale centered on neutral. Reponses in disagreement were coded 1; all other responses were coded 0.

Street surveys were conducted by parent teams in seven separate school-based workshops held between May and September of 2009. Each workshop lasted approximately four hours, and included a short training session, two hours of data collection, and a short period for group reflection. Participants included a core group of the project's Parent Advisory Council ($n=28$), who also trained other parents ($n=33$) recruited to the CSAT data collection effort. In total, 61 parents participated in data collection activities.

For each school, multiple audit areas of approximately 0.25 square miles were constructed that could be surveyed in about two hours. Depending on the school, there were from 14 to 35 audit areas within the UGB portion of each school catchment area. Fig. 2 displays the map of all surveyed areas associated with the seven elementary schools.

At the beginning of each workshop, conducted by bilingual trainers, teams of two parents (both English speaking or both Spanish speaking) were assigned up to three audit areas and supplied with two PDAs, one for assessment of intersections and one for assessment of street segments. These PDAs were preloaded with a training map of streets and intersections close to the school where the training was held, as well as the maps for the audit areas and online entry instructions in the language of the survey team. Teams practiced the assessment of features using the training map with the requirement that both surveyors agreed on the assessment of the street segment or intersection feature being assessed for all features in the test map area. This practice increased the likelihood of observer agreement for both intersection and segment ratings during audit surveys, although field checks were not conducted to make sure that there was agreement between other observers. Such field checks would have entailed two PDAs for each member of the observation team (to obtain independent ratings of both segments and intersections) and was not possible within the constraints of time available for the volunteer surveyors and the cost of added equipment.

At the conclusion of the assessment event, data from the individual PDAs was checked into a single geo-database using tools included in the ESRI ArcPad extension. For several of the workshops there were not enough teams to assess all of the relevant audit areas. Teams from earlier workshops were later recruited to complete the assessments of these areas. Team members were each given a $30 stipend per completed workshop.

Four months after completion of the last workshop, Parent Advisory Council members were asked to review and confirm the observer ratings of all audit areas. This exercise involved 12 parents who had participated in the assessment at six of the seven schools. Using maps of the perceived comfort and safety of streets and intersections for children, parents identified street segments and intersections where they disagreed with the ratings. Project staff also interviewed parents and recorded qualitative comments as to the accuracy of the collected data. Both the feedback collected on the maps and the verbal comments recorded during the workshop were used to verify, and in some cases, modify, the previously collected map data. The exercise resulted in changes to 17 of 1641 street segment ratings ($\sim$1%) and 29 of 1190 intersection ratings ($\sim$2%). Many of these modifications reflected road construction projects (e.g., adding sidewalks, crosswalks, signals) completed between the time of the original survey and the review. While not as stringent a procedure as calculation of interobserver agreement for observer pairs, the follow-up session did provide a mechanism for assessing the perceived accuracy of field ratings conducted by the observers.

2.4. Analysis methods

The geographic data were flattened into tables containing a list of all street segments or intersections in the surveyed area with results for each survey question listed in columns. We removed streets and intersections that fell outside the study area audit zones. Those streets and intersections within the study area that were not surveyed were assigned an NA value (not available).

Given the focus of the paper, we predicted the perception of an *unsafe* segment or intersection from the street and intersection features respectively. Both full and reduced logistic regression models were created for street segments and intersections, using either the original survey data or data reflecting parental adjustments. Results reported are based on the adjusted data.

Tables 1 and 2 show the predictors for full street segment and intersection models, together with their reference coding for the analyses. The full model created for the street segments data predicted the perception of lack of safety (*safeTravel*) using all 11 of the street segment features measured (Table 1) while the full model for intersections predicted the lack of safety in crossing an intersection (*crossSafe*) from all six intersection features (Table 2). The full models were reduced using a fast backward step-down procedure (Harrell, 2001). In the case of street segments, the reduced model contained five of the original predictors while the intersection model was reduced to a single predictor.

3. Results

Parent teams surveyed 73% of all street segments in the study audit zones, as measured by distance, and 82% of the intersections. Those streets and intersections not surveyed were omitted because they (a) were outside the UGB, (b) lacked students, (c) were part of a gated community, or (d) were otherwise not accessible (e.g., highways, beltways). Tables 3 and 4 show the distribution of responses for each question for the street segments and intersections surveyed by parents.

The final model predicting perceived lack of safety for street segments encompassed five predictors and performed well ($R^2=0.632$, Concordance=0.938). The odds ratios for the five variables included in the final street segment model are shown in Table 5. All were significant predictors of whether or not a street was perceived as unsafe. The two strongest predictors of an unsafe street segment were the absence of an off-street path accessible for wheelchairs (OR=9.53; 95% CI: 5.63, 16.14; $p<0.0001$) and the requirement of walking in the roadbed (OR=6.91; 95% CI: 3.94, 12.13; $p<0.0001$). The absence of street trees predicted that streets were perceived as unsafe (OR=1.88; 95% CI: 1.25, 2.83; $p<0.003$).

Two of the four measures of sidewalk condition were associated with general perceived safety. Walking paths with poor surfaces that create tripping hazards were more likely to be seen as unsafe than paths with walking surfaces in good repair (OR=2.67; 95% CI: 1.68, 2.45; $p<0.0001$). Paths obstructed by plants, poles, or other permanent fixtures were more likely to be felt unsafe than paths free of such obstacles (OR=1.91; 95% CI: 1.20, 3.04; $p<0.0006$). Segments that were seen as wheelchair accessible were often those same segments that ranked well with regard to the surface condition, width, and obstructions.

Table 3
Summary of Parent Responses from Street Audit.

	Street attribute	N	%		Street attribute	N	%
C.	Feel safe child walking			6.	Most likely place to walk		
	-Disagree	294	18		-Sidewalk[a]	1116	68
	-Neutral/agree	1347	82		-Side of road	200	12
					-On road	318	19
1.	Street lanes			7.	Traversable by wheelchair		
	-Two lanes[a]	1560	98		-Yes[a]	1182	72
	-More than two lanes	39	2		-No	468	28
2.	Center turning lane			8.	Path width		
	-Yes	150	9		-5ft wide or wider[a]	1039	63
	-No[a]	1489	91		-Less than 5ft	599	37
3.	Paved/planted median			9.	Free of tripping hazards		
	-Yes[a]	86	5		-Yes[a]	1294	79
	-No	1559	95		-No	353	21
4.	Street trees			10.	Path obstructed		
	-Yes[a]	903	55		-Yes	327	20
	-No	731	45		-No[a]	1308	80
5.	Ends in cul-de-sac			11.	Driveways cross path		
	-Yes[a]	252	15		-Yes	468	28
	-No	1397	85		-No[a]	1177	72

[a] Value used as the reference in the logistic model.

Table 4
Summary of Parent Responses from Intersection Audit

	Intersection attribute	N	%		Intersection attribute	N	%
C.	Feel safe child crossing			4.	Crossings lack curbcuts		
	-Disagree	191	16		-All	846	72
	-Neutral/agree	988	83		-Some	178	15
					-None[a]	147	13
1.	Traffic control device			5.	Crossings have medians		
	-Traffic light	16	1		-All[a]	10	1
	-Stop sign	287	26		-Some	25	2
	-Other	59	5		-None	1076	92
	-No controls[a]	761	68				
2.	Size of intersecting roads			6.	Crossings marked		
	-Major/major	29	2		-All[a]	24	2
	-Minor/major	221	19		-Some	42	4
	-Minor/minor	712	60		-None	1094	94
	-Cul-de-sac[a]	228	19				
3.	Corners with bump-outs						
	-All[a]	10	1				
	-Some	48	4				
	-None	1076	92				

[a] Value used as the reference in the logistic model.

Table 5
Significant Associations Between Perceived Safety and Street and Intersection Attributes

Attribute	Odds ratio		Lower	Upper	p-value
Street[a]					
4. Street trees	No: Yes[c]	1.88	1.25	2.83	0.002
6. Most likely place to walk	Side: Sidewalk[c]	6.09	3.32	11.19	< 0.001
	Road: Sidewalk[c]	6.91	3.94	12.13	
7. Traversable by wheelchair	No: Yes[c]	9.53	5.63	16.14	< 0.001
9. Free of tripping hazards	No: Yes[c]	2.67	1.68	4.25	< 0.001
10. Path obstructed	Yes: No[c]	1.91	1.20	3.04	0.003
Intersection[b]					
2. Size of intersecting roads	Major/Major: Cul-de-sac[c]	22.10	7.32	66.72	< 0.001
	Major/Minor: Cul-de-sac[c]	26.07	11.10	61.24	
	Minor/Minor: Cul-de-sac[c]	4.39	1.88	10.21	

[a] Nonsignificant street attributes: 1. Street lanes, 2. Center turning lane, 3. Paved/planted median, 5. Ends in cul-de-sac, 8. Path width, 11. Driveways cross path.
[b] Nonsignificant intersection attributes: 1. Street lanes, 3. Crossings have medians, 5. Ends in cul-de-sac, 8. Path width.
[c] Value used as the reference in the logistic model.

There was no difference in the odds that a street was seen as unsafe between street segments where children were more likely to walk along the side of the street and those segments where children were forced to walk in the street—both were equally likely to be seen as unsafe compared to streets with sidewalks.

With respect to street intersections, the reduced model was weaker than the street model (R^2=0.204, Concordance=0.740) and contained only one predictor: the size of the intersection. When compared to crossing a cul-de-sac (the reference level for intersection size), crossing an intersection involving two major roads (more than 2 lanes) or a major and a minor road (2 lanes) was perceived as very unsafe (OR=22.10; 95% CI: 7.32, 66.72; $p<0.0001$ for the former and OR=26.07; 95% CI: 11.10, 61.24; $p<0.0001$ for the latter). Crossing an intersection of two minor streets was also perceived as unsafe, but to a lesser degree (OR=4.39; 95% CI: 1.88, 10.21; $p<0.0001$).

4. Discussion

This study focused on identifying features of the walking environment that influence parental concerns about their children walking to school alone. Since parents act as gatekeepers for their children's behavior, understanding parent perceptions of walking safety is important to developing effective interventions to increase child walking rates.

As other studies have noted (Boarnet et al., 2003; Retting et al., 2003), our results pointed to the presence or absence of sidewalks as one of the strongest influences on parent views of walking safety. However, it was not just the presence of a sidewalk which was important to parents but also its condition. Sidewalks with uneven surfaces, that were obstructed by utility poles or vegetation, or that lacked accessibility features such as curb cuts felt as unsafe as walking corridors that lacked a sidewalk entirely. Both obstacles and uneven surface may lead to erratic walking patterns, which may expose children to automobile traffic. Further, such conditions may contribute to a sense of poor upkeep, reinforcing the connection between disrepair and comfort (Kelly et al., 2007).

Parents saw a well-designed sidewalk as a refuge for their children from surrounding traffic dangers. When an adequate sidewalk was present, characteristics of the street did not appear to have any impact on perceived safety. Likewise, parents reported feeling more comfort with safety on streets with street trees, a design element commonly used to separate pedestrian and auto traffic and add esthetic appeal to the streetscape. Other studies have also noted the influence of the attractiveness of neighborhood on walking behaviors (Giles-Corti & Donovan, 2002).

Parents in our study noted concern with the safety of their children crossing an intersection involving major streets (more than 2 lanes), but notably also described unease over children crossing intersections containing only minor streets (i.e. residential roads with 2 lanes). We did not find any indication that traffic lights, marked crosswalks, or bump-outs mediated parent concerns over child crossing safety, which we assume was the consequence of asking parents to assess the environment from the perspective of an unaccompanied 8-year-old child. Crossing intersections requires a fair degree of knowledge, practice, and self-control (all things that many children lack), and young children lack the cognitive ability to weigh distance, speed, and stopping ability of approaching vehicles (Ampofo-Boateng and Thompson, 1991; Schieber and Thompson, 1996). Aggregate spatial measures of walkability, such as intersection density, may not capture key barriers to walking, especially for younger children.

Finally, it is worth noting that data for this project were collected in an innovative manner—through the use of parent volunteers collecting objective and subjective data on almost every street and intersection throughout a school district and seven elementary schools using field-based GIS technology. Parental perceptions are typically not included in either street design or new pedestrian project development. This study indicates a consistent link between certain aspects of the walking environment and a perceived sense of danger to children from traffic.

It is important to note that parent views of neighborhood safety are also influenced by fear of crime and strangers (Carver et al., 2008a; Timperio, 2004). In our surveys, we did not ask parents to distinguish between concerns related to strangers or crime from that of traffic, and in some cases this may have influenced how parents reported street safety.

5. Conclusions

Transport policies have historically focused on maximizing the movement of people and goods, but in doing so have created many disadvantaged groups, including children, whose freedom to move around safely on their own has been severely constrained. The drop in fatality rates of children walking and biking in the U.S. over the last half century exactly mirrors the decline of children walking or biking (Jacobsen et al., 2009). Marginal improvement in fatality rates amongst children likely reflect advances in trauma care rather than any substantive reduction in traffic danger (Harris et al., 2002; Nathens et al., 2000).

Our streets fail to protect the most vulnerable from traffic dangers and parents have responded by restricting the freedom of their children (Carver et al., 2010), often by restricting their activity to a limited number of secure areas (e.g., the home, the backyard, the schoolyard), or by making parents feel the need to escort children when they travel outside of those areas—a task often accomplished by car. As Carver et al. (2008a) noted, this cycle contributes to a *social trap*; as parents drive their children to more places, they add to both the real and perceived sense of traffic danger on those same streets. These self-reinforced cycles, along with many others, have contributed to a more pervasive health risk: inactivity and obesity-related immobility.

Recommendations that emerge from this study include (1) city transportation engineering and planning, as well as local safe routes to school programs, should engage parents in neighborhood walkability assessments to focus pedestrian interventions appropriately, (2) studies examining the influence of the physical environment on physical activity and walking should use measures that are appropriate to explaining walking decisions, (3) school catchment area streets must have well-maintained sidewalks throughout the area as a minimum requirement to help parents feel safe about children walking to school, (4) street trees and other pedestrian amenities can be an important buffer between sidewalk and moving vehicle and provide an esthetic asset that enhances parental comfort about safety, and (5) crossing streets, especially large ones, is a critical safety barrier for parents. Intersection-specific interventions need to be tailored to the needs of elementary-aged youth.

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