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Common ground: Eight factors that influence walking and biking to school

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ABSTRACT

The primary goals of Safe Routes to School (SRTS) programs are to increase the number and safety of children walking, biking or using other forms of active travel to school (ATS). This study reviewed quantitative and qualitative research and identified eight common factors that influenced the choice of ATS: distance to school, parental fear of traffic and crime, family schedule constraints and values, neighborhood and family resources and culture, weather, and school characteristics. Suggestions were made as to how these barriers and facilitators of ATS could be integrated into the decision to fund local SRTS programs and to improve their effectiveness.

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1. Introduction

Walking, biking and other forms of active travel to school (ATS) are a convenient way for children to improve their health and reduce their environmental impact. Regular ATS is associated with increased levels of physical activity, which helps prevent chronic diseases related to inactivity, such as obesity and type II diabetes (Fulton et al., 2005; Heelan et al., 2005; Saksvig et al., 2007; Sirard et al., 2005b). To the extent that walk and bike trips offset automobile trips to school, ATS also mitigates air, noise, and other forms of automobile pollution (EPA, 2003). Despite these potential personal and societal benefits, rates of ATS in the U.S. have declined, from 47.7 percent in 1969 to 12.7 percent in 2009, while rates of students being driven to school in the family car have increased in mirrored proportions (McDonald et al., 2011). This trend is believed to have contributed to the childhood obesity epidemic and increased traffic congestion during the school commute (Hubsmith, 2006). The federal Safe Routes to School (SRTS) program seeks to reverse these trends.

Established in 2005 under SAFETEA-LU, the SRTS program is a national effort to enable and encourage children to safely walk and bike to school. The Federal Highway Administration (FHWA) allocates SRTS funds to all 50 States and the District of Columbia. State Departments of Transportation (DOTs) award funds to SRTS program proposals submitted by local agencies such as municipalities, school districts, or non-profit organizations. SRTS programs are designed to increase the numbers and safety of children walking and biking to school through some combination of the five Es: engineering, enforcement, education, encouragement, and evaluation. Each state must allocate 70 to 90 percent of its FHWA SRTS funds to infrastructure; the remainder must be spent on non-infrastructure activities (Hubsmith, 2006).

Most State DOTs receive SRTS proposals that far exceed their available funding. As of December 2011, state DOTs have announced nearly $691.3 million in awards for SRTS programs. This represents only 39 percent of the approximately $2 billion in SRTS funding requested through grant applications (National Center for Safe Routes to School (NCSRTS), 2011).

To best allocate scarce SRTS resources, state SRTS coordinators need tools to select proposals with the greatest potential for success. Successful SRTS programs will increase the safety and/or number of children walking or biking to school and result in corollary benefits such as improved health, reduced congestion, and better air quality. The greatest number of children can be expected to safely walk or bike to school where few barriers and many facilitators to ATS exist. Therefore, SRTS funding will be most efficiently spent at locations where few barriers and several facilitators to ATS already exist and only minor modifications are necessary to create a completely supportive pedestrian and bicycle environment. Knowledge of common barriers and facilitators of ATS would thus help state SRTS coordinators to identify existing conditions that affect rates of ATS for each SRTS grant application, as well as opportunities for removing barriers and establishing facilitators.

This study identifies common barriers and facilitators that influence the household decision to use active transportation to school. Numerous studies have investigated correlates of active travel to school and several review articles have summarized the findings of past research (Davison, et al., 2008; Sirard and Slater, 2008; Faulkner et al., 2009; Pont et al., 2009; Stewart, 2011). This

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article contributes to the knowledge base by employing the results of both correlational and qualitative research to develop a short list of common factors that influence the commute mode to school decision. This list captures a range of contextual factors that directly or indirectly affect that decision. It also serves as a guide for SRTS practitioners to assess the relevance of each factor within individual states, regions, or school-based communities and to help steer SRTS program design accordingly.

2. Methods

Two bodies of research were reviewed to identify common factors that act as barriers or facilitators to ATS. The first was correlational studies of ATS. Correlational factors were derived from a previous systematic literature review (Stewart, 2011). This literature review of 42 studies identified independent variables that had been tested for a significant association with ATS among children aged 18 or younger. The independent variables were organized into groups that measured similar phenomena. The number of significant and non-significant relationships within each correlate group is presented as an estimate of the importance of the relationship between each correlate group and ATS.

Second, qualitative research that explored reasons why parents or children did or did not use ATS was reviewed. This research was used to identify common factors that parents and children consider when choosing a commute mode to school and provide a framework for better understanding the numerous correlates of ATS and their complex relationships. A literature review identified publications that presented parent- or child-reported factors that influenced their use of ATS. PubMed, ScienceDirect, the National Transportation Library, and Active Living Research databases were searched using relevant keywords for articles published between 1997, the year of the first U.S. SRTS program, and 2010 (Hubsmith, 2006). Articles were included if they published self-reported barriers to ATS based on findings from surveys or interviews that allowed for open-ended responses to the question, "What prevents or helps you or your child walk or bike to school?" From this research, themes that repeatedly emerged were recorded as common factors.

Correlate groups that comprised common barriers and facilitators of ATS were organized according to the social ecological model. The model helped identify multiple levels of influence on behaviors, including individual, social, organizational, community, physical environment, and policy (Sallis et al., 2008). It was applied to contextualize where the common barriers/facilitators are located within these multiple levels of influence.

3. Literature review

3.1. Quantitative literature

Correlates of ATS were derived from a previously published literature review (Stewart, 2011). The review covered 42 articles and identified 480 variables that had been tested for a statistically significant association with ATS. It organized the variables into 32 correlate groups that measured similar phenomena hypothesized to influence the use of ATS. In the present study, these 32 correlate groups were classified into 12 predominant domains of influence within the social ecological model. Table 1 lists the 32 correlate groups and summarizes the number of significant or not significant associations with ATS.

Table 1
Correlate groups, organized by their predominant domain within the social ecological model (adapted from Stewart, 2011).

Social ecological domain	Correlate group	Number of variables associated with ATS	
		Significant	Not significant
Natural environment	Weather	1	2
Built environment	Barriers along route	4	8
	Distance	21	1
	Land use mix	7	12
	Pedestrian infrastructure	12	13
	Population density	6	3
	Street connectivity	5	7
	Urbanization	6	4
	Walkability	3	0
School characteristics	School conditions	5	1
Family/school location	Region (U.S.)	1	2
Family neighborhood SES*	SES (neighborhood)	1	2
Family demographics	Household size	0	1
	Siblings	3	4
Family SES	Foreign	2	5
	Income	8	9
	Number of adults in household	2	6
	Race	7	13
Family characteristics	Child independence	1	7
	Schedule constraints	8	12
	Transportation options	11	16
Parent SES	Education	3	7
	Employment	3	7
Family attitudes	ATS attitude	6	1
	Auto attitude	2	1
	PA** Attitude	8	32
Parental perceptions	Crime concerns	1	7
	General safety concerns	4	14
	Neighborhood aesthetics	5	5
	Traffic concerns	4	8
Child demographics	Child age	17	9
	Child gender	13	9

* SES: Socio-economic Status.
** Physical activity.

3.2. Qualitative literature

Five articles met the inclusion criteria for parent- and child-reported barriers to ATS (Ahlport et al., 2008; Faulkner et al., 2010; Greves et al., 2007; McDonald and Aalborg, 2009; Orsini and O'Brien, 2006). Faulkner et al. (2010) used semi-structured interviews of 20 parents who drove their children to school and 17 parents whose children walked to school. The parents were drawn from elementary schools in the Greater Toronto Area that varied on neighborhood socio-economic status (SES) and street network type. Interviews were framed using the theory of behavioral economics. Faulkner et al. found that although the mode choice for travel to and from school was a habitual behavior, much thought went into the initial decision to select a mode. In making the choice, the first issue parents considered was their child's ability to travel alone to school based on his or her capabilities to safely navigate traffic and social interactions. This determined if a walk or bike to school alone mode was even an option. From the range of possible travel modes, parents generally chose what they perceived to be the easiest and most convenient. Convenience was based on travel time or distance as well as the ease of dropping the child off at school on the way to work or to wherever other family members needed to go. The chosen mode was reinforced by experiences during the commute until a habitual mode formed. The actual ease of getting a child to school

on time was the primary reinforcing experience. Health benefits were sometimes identified as a reinforcing factor. Some parents of children that attended high-SES schools walked to school as part of an overall healthy lifestyle, but most parents did not perceive the walk to school as a significant opportunity for physical activity. Traffic noise and volume were also found to make the walk trip to school unpleasant for some children, providing negative reinforcement for the walk mode choice. Travel mode habits were sometimes interrupted by weather. Children who usually walked were sometimes driven in bad weather, while children who regularly drove sometimes walked in pleasant weather. Occasionally snow contributed to the convenience of walking because parents found it quicker to walk to school than to shovel out the driveway.

Ahlport et al. (2008) used the socio-ecological and political economy of health frameworks to analyze responses from semi-structured focus groups with 37 parent and child pairs (11 non-ATS and 26 ATS users) who lived within walking or bicycling distance (1.5 mile) of four elementary schools in Central North Carolina. Households considered personal safety concerns such as fears of abduction, collisions, bullies, and immature judgment. Because of these concerns, older siblings that attended the same school and could walk with a younger child facilitated ATS, while younger siblings that could not keep up or siblings that attended different schools acted as barriers. Inflexible work schedules acted as barriers, especially in the mornings, while flexible work schedules acted as facilitators. ATS was found to require a high level of energy, strength, motivation, and commitment to the health benefits of exercise and quality time outdoors. Environmental barriers to ATS included distance, weather, lack of sidewalks, and traffic. School-based barriers included early start times that would mean less sleep if children were to spend the extra time to walk to school. Early start times also meant that children would be walking in the dark part of the year, contributing to safety concerns. Limited storage for jackets and bike helmets were also a school-based barrier, as well as safety concerns due to unorganized pick-up and drop-off zones and a lack of crossing guards. School policies such as designated walker/rider programs, grade minimums for walking or bicycling, rules against riding push scooters to and from school, and policies requiring bicyclists and walkers to wait to be dismissed until after the car riders leave were also identified as barriers.

Greves et al. (2007) used the socio-ecological model to identify barriers to walking to school from focus groups with 53 immigrant parents and grandparents of elementary school-aged children from low-income neighborhoods in Seattle. Barriers were classified as fears, feasibility, and norms. Interpersonal fears included fears of abduction, bullying, homeless people, and gangs. Parents and guardians often did not know or trust their neighbors due to language differences. Traffic fears included heavy traffic, unsafe street crossings, and a lack of crossing guards or walking paths. Feasibility fears were divided between distance, lack of time, and weather. Many children did not live near their school or found the route to be too difficult. Time constraints came in the form of both parents working, too many kids to walk together, a greater convenience in dropping children off while driving to work, child care logistics before and after school, and choosing a school further away based on a more convenient pick-up time. Weather barriers included rain, cold, and darkness, especially in winter months. Finally, guardians identified a normative barrier in that there was no necessity to walk and their children were not accustomed to it.

McDonald and Aalborg (2009) conducted a telephone interview of 403 parents of children aged 10 to 14 in Bay Area locations with walkable built environments, defined as the presence of gridded streets, sidewalks, and flat topography. Households were within 2 mile of school. Researchers asked parents who drove their children to school why they did so. Responses fell into two categories: convenience and safety. Convenience responses included the perception that the school was too far away. Also, driving was considered faster or more convenient; it let children sleep later; it ensured the child arrived on time; and it allowed the parent to drop the child off on the way to work or on the way to drop off others. The availability of carpools and the lack of bus service also influenced convenience responses. Safety responses included stranger danger, the child being too young, or traffic concerns. Two additional unclassified responses were that driving was the child's preference and allowed the parent to spend time with the child.

Orsini and O'Brien, 2006 used mixed methods to understand why six 16- and 17-year olds cycled to school in Vancouver, British Columbia. They found that cycling provided independence, was faster and more fun than other modes of travel, and contributed to fitness. These teenagers began cycling independently between the ages of 4 and 12. They were motivated to do so from older role models and continued to do so in part because of encouragement from role models.

The five qualitative articles examined various populations using various methods. Nonetheless, six recurring themes emerged from these studies as factors that influenced the decision to use ATS (Appendix 1):

distance to school,
parent's fear of traffic and crime,
schedule constraints,
values,
weather, and
school characteristics and policies.

Worth noting is that distance, schedules, and values arose in all five articles, whereas fear of traffic and crime was not reported as an influence among teenage cyclists (Orsini and O'Brien, 2006) and only three of the articles mentioned weather and school characteristics or policies (Faulkner et al., 2010; Ahlport et al., 2008; Greves et al., 2007). Barriers and facilitators reported among households from different cultures, built environments and SES stratifications were similar (Faulkner et al., 2010; Greves et al., 2007). The six common factors reported by parents and/or children in qualitative studies were used as a framework to understand how the 32 correlate groups of ATS influenced the family decision for children to walk or bike to school and to classify them into common factors that influence ATS.

4. Common factors

Twenty-six of the correlate groups were found to support one or more of the six common factors that parents and/or children reported to influence their decision to walk or bike to school. The remaining six correlate groups were organized into two additional common factors: resources and culture. Resources included parental employment status and education, household income, car ownership, and neighborhood socio-economic status. Culture included foreign-born status, race/ethnicity, and regional location. These two factors were not explicitly reported by parents or children in qualitative studies but were, however, incorporated into the design of two such studies (Faulkner et al., 2010; Greves et al., 2007). This resulted in eight common factors that acted as barriers or facilitators to ATS (Table 2).

4.1. Distance to school

Distance to school was often reported by parents and children as a barrier, even among families that lived within walking distances

Table 2
Eight common factors that act as barriers or facilitators to ATS and the correlate groups that provide supporting evidence.

Correlate group	Social ecological domain	Eight common factors							
		Identified in qualitative literature, supported by quantitative literature						Quantitative literature only	
		Distance to school	Fear of traffic and crime	Schedule constraints	Values	Weather	School characteristics	Resources	Culture
Distance	Built environment	•							
Barriers along route	Built environment	•	•						
Land use mix	Built environment	•	•						
Pedestrian infrastructure	Built environment	•	•						
Population density	Built environment	•	•						
Street connectivity	Built environment	•	•						
Urbanization	Built environment	•	•						
Walkability	Built environment	•	•						
Crime concerns	Parental perceptions		•						
General safety concerns	Parental perceptions		•						
Neighborhood aesthetics	Parental perceptions		•						
Traffic concerns	Parental perceptions		•						
Child gender	Child demographics		•						
Child age	Child demographics		•	•					
Child independence	Family characteristics		•	•					
Household size	Family demographics		•	•					
Siblings	Family demographics		•	•					
Parents in household	Family SES		•	•					
Employment	Parent SES			•				•	
Schedule constraints	Family characteristics			•					
ATS attitude	Family attitudes				•				
Auto attitude	Family attitudes				•				
PA attitude	Family attitudes				•				
Weather	Natural environment					•			
School conditions	School characteristics						•		
Income	Family SES							•	
Transportation options	Family SES							•	
Neighborhood SES	Neighborhood SES							•	
Education	Parent SES							•	
Foreign	Family SES								•
Race	Family SES								•
Region (U.S.)	Family/school location								•

to school. It was also strongly and frequently associated with less walking and biking to school when tested in correlational research. Distance directly impacts the travel time each mode requires and parents often chose the mode of shortest duration (Faulkner et al., 2010). In a mode choice model based on a nationally representative sample, a one-minute increase in the time it took to walk to school led to a 0.2 percent decrease in the likelihood of a child walking to school (McDonald, 2008a). A strong negative relationship between distance to school and the probability of ATS was found for trips shorter than a mile; beyond 1 mile rates of ATS were consistently low (McDonald, 2007b). At distances greater than or equal to 2 mile, only 1.7 percent of K-8 graders walked or biked to school (McDonald et al., 2011).

Other built environment attributes which were significantly associated with ATS in correlational research likely also captured effects similar to those of distance. Children were more likely to walk or bike to school in mixed use, dense, urban, and highly connected neighborhoods—places where schools or other destinations were likely to be closer to children's homes. These findings might also reflect that walking and biking to school are part of a general habit of walking to other neighborhood destinations (Dollman and Lewis, 2007). Neighborhood walkability was also significantly associated with greater levels of walking and biking in all three studies testing its impact on ATS. When measured objectively, walkability was an aggregate of measures of residential density, retail floor area ratio, intersection density, and land use mix (Kerr et al., 2006). When measured subjectively, it likely reflected not only shorter distances to destinations, but also routes that were comfortable and safe from traffic and criminal dangers (Yang et al., 2008).

4.2. *Parental fear of traffic and crime*

Parental fear of traffic and crime was frequently reported by parents (Dellinger and Staunton, 2002; Martin and Carlson, 2005; McDonald and Aalborg, 2009) and were evident in numerous correlates of walking and biking to school. National statistics justify traffic safety concerns. Although child pedestrian and bicyclist traffic collision fatality rates have declined from 1987 to 2009 (Centers for Disease Control and Prevention, 2008; National Highway Traffic Safety Administration (NHTSA), 2011), the reason behind the decline may be lower exposure, not increased safety (Centers for Disease Control and Prevention, 2008). Bicycling and walking were the two highest risk commute modes to and from school when analyzed on the basis of exposure (Transportation Research Board (TRB), 2002).

On the other hand, crime concerns may be based more on social norms than actual risk. The rate of violent crime against 12- to 19-year olds declined between 1973 and 2005 to 44 cases per 100,000 children (U.S. Department of Justice, 2006). Kidnapping makes up only two percent of violent crimes against youth and only four percent of all kidnappings occur around schools (Finklehor and Ormrod, 2000). Yet parents often feared the worse, even if they knew the odds of abduction were slim (Ahlport et al., 2008). These fears have likely been fed by media reports of kidnappings (Greves et al., 2007). Parents and guardians also mentioned fears of exposure to other interpersonal risks, such as bullying, gang activity, or homelessness. These fears, however, were secondary to abduction or violence (Ahlport et al., 2008; Greves et al., 2007). Regardless of actual risks, letting a child travel alone is often stigmatized as an indicator of neglectful or irresponsible parenthood (Greves et al., 2007; O'Brien et al., 2000).

Built environment factors likely contributed to parental fears of traffic and criminal danger. The lack of pedestrian and bicycle support facilities (including sidewalks, bike paths, walking trails, street trees, lighting, and windows facing the street), the lack of street network connectivity (which limits the option of walking along streets that carry less traffic), and various barriers along the route (such as major streets and railroads) were sometimes associated with lower use of ATS (Bringolf-Isler et al., 2008; Kweon et al., 2007; Fulton et al., 2005; Kerr et al., 2006; McMillan, 2007; Mota et al., 2007; Saksvig et al., 2007; Schlossberg et al., 2006; Timperio et al., 2006).

Parental fears might also explain the correlational findings that females were less likely to walk or bike to school than males. Girls tend to be more protected from the outside world than boys:

they spend less time in the public urban setting, are more likely to be supervised, and have a more restricted home range (O'Brien et al., 2000; Valentine, 1997). The only time girls were found to be more likely to walk to school than boys was when they were accompanied by their mothers (Yarlagadda and Srinivasan, 2008) and the odds that girls walked less than boys was moderated by a caregiver's own walking behavior, (McMillan, 2005), suggesting that when girls walk to school, they are usually accompanied. Interestingly, gender was never reported as a barrier in the qualitative research on ATS.

Young children may be especially vulnerable to traffic and criminal dangers due to their developing physical, cognitive and psychosocial abilities. Experts advise that most children are not ready to begin walking alone until age 10 (National Center for Safe Routes to School (NCSRTS), 2008). Parents often cited age 12, or when U.S. children enter the seventh grade, as the age when their child would be allowed to walk or bike to school independently (Faulkner et al., 2010). This meant that through elementary school, most children's non-motorized transportation options would be limited to walking with an adult and therefore their mode of travel to school would be dependent on adult schedule constraints and travel preferences. Children in middle school might have a greater range of non-motorized travel modes, but middle schools often have larger enrollments and attendance areas, suggesting that many students at this age live far from their school and may not easily walk the distance (Fulton et al., 2005). The issue is exacerbated for high school students because these schools are even further consolidated and motorized transportation options increase as students and peers obtain driver's licenses, enabling teens to drive solo or to carpool to school (McDonald, 2007b). Cross-sectional studies captured the generally positive association between age and walking and biking to school, which was tempered by the tendency for older students to live further from their schools and have more motorized travel options. A significant negative correlation between age and ATS was found in studies that included older students, aged nine to 18 (Pabayo and Gauvin, 2008; Tudor-Locke et al., 2003; Fulton et al., 2005; Evenson et al., 2003; Schofield et al., 2005), while studies that showed a significant positive relationship focused on younger students, aged five to 14 (Merom et al., 2006; McDonald, 2008a; Bringolf-Isler et al., 2008; Timperio et al., 2006; Kweon et al., 2007; Martin et al., 2007). Expectedly, children with a greater level of independence were more likely to walk or bike to school (Merom et al., 2006) and younger children were more likely to walk with their mother, while older children were more likely to walk alone (Yarlagadda and Srinivasan, 2008). Children with more siblings were sometimes more likely to walk or bike to school (Kweon et al., 2007; McDonald, 2008a; McMillan, 2007), likely because older children could chaperone younger children when their schools were along a similar route.

Parent-reported concern of traffic or criminal danger was significantly associated with ATS less often than were age, gender, or most built environment pedestrian safety features. Because safety concerns are a common and recurring theme reported by both parents and children, it appears that some parents allow their children to walk or bike to school despite such fears; and that these fears persist as a child regularly walks or bikes to school. This situation may be more common among lower SES households that have few transportation options and live in deprived neighborhoods that tend to have greater crime and traffic risks (Zhu and Lee, 2008). This might explain the counter-intuitive finding that children who thought it was unsafe to play in their neighborhood were more likely to walk or bike to school (Fulton et al., 2005). Further research using objective measures of crime would help determine the extent to which ATS is based on actual criminal activity or perceptions of such activity.

4.3. Schedule constraints

Schedule constraints, such as after-school activities or rigid work schedules, were a common barrier to ATS reported by parents and children. These constraints, however, were only associated with lower ATS five of the 21 times they were tested (Kweon et al., 2007; Martin et al., 2007; Yarlagadda and Srinivasan, 2008). And three studies found greater schedule constraints were significantly associated with more ATS (Evenson et al., 2003; Martin et al., 2007; Merom et al., 2006). These mixed associations suggested that family schedules had an impact on travel to school modes and were dependent on specific circumstances, such as whether or not day care was available before or after school (Greves et al., 2007); whether the child could travel alone to school or had to be escorted (Faulkner et al., 2010); how a parent's work schedule aligns with a child's school schedule; and if there were other children in the family that traveled to different locations.

4.4. Values

Values that place less importance on walking and biking were associated with less walking and biking to school in six of the seven times they were tested. Attitudes that were supportive of physical activity in general were associated with ATS less frequently than attitudes toward walking and biking specifically. Attitudes toward general physical activity were significant in eight out of 40 tests. This could be because not all parents see the trip to school as an opportunity for physical activity (Faulkner et al., 2010). These attitudes likely influenced how parents arranged their schedules and responded to time constraints that precluded them from walking with their children to or from school. Parental values were also likely to impact other decisions that had a downstream effect on the ease of walking or biking to school, such as how close a family lived to their child's school or how many cars they owned (Black et al., 2001; Yang et al., 2008).

4.5. Weather

Weather was reported as both a barrier and a facilitator to walking to school by parents and children. This paradox was evident in findings from a national study where parents who reported adverse weather as a barrier to walking and biking to school, were *more* likely to have children that walked or biked to school (Martin and Carlson, 2005). This is probably related to situations where children who usually walk to school are often driven when the weather is bad. Three other cross-sectional studies in relatively warm climates found no association between weather and ATS (Kweon et al., 2007; Sirard et al., 2005a; Ziviani et al., 2004).

4.6. School characteristics

School characteristics can act as barriers to walking and biking. Policies that prohibit or limit walking and biking to school were reported as a barrier by parents in North Carolina (Ahlport et al., 2008) and were found to be significantly associated with less walking and biking in a national sample (Martin and Carlson, 2005). Attendance at traditional, neighborhood public schools (diGuiseppi et al., 1998; Merom et al., 2006; Yang et al., 2008) were associated with more walking and biking to school, which probably reflected shorter distances from residences to these types of schools. Parents and children reported chaotic drop-off and pick up areas as both a barrier (due to safety concerns) and facilitator (traffic can cause the walk to school to be quicker than the drive) (Ahlport et al., 2008). The latter part of this

phenomenon was captured in an urban London study that found a perceived parking problem at school to be associated with more walking and biking to school (Black et al., 2001). Classroom storage areas for clothes and bicycle helmets were also reported as a barrier to walking and biking to school, but were not tested in the correlational research reviewed here.

4.7. Resources

Resources in a family or community were frequently associated with ATS in correlational research. Many studies found that children from families with a greater income (McDonald, 2007a, 2008b; Ewing et al., 2004; McMillan, 2007; Pabayo and Gauvin, 2008; Tudor-Locke et al., 2003; Yang et al., 2008), more educated parents (Evenson et al., 2003; Martin et al., 2007; Mota et al., 2007), higher parent employment status (Black et al., 2001; Mota et al., 2007; Yeung et al., 2008), or a home in an area with a higher socioeconomic status (McDonald, 2008b) were less likely to walk or bike to school. A travel model using national data found that a 10% increase in household income led to a 2.6% decline in walking and a 2% increase in being driven to school (McDonald, 2008a). In qualitative research, parents did not identify financial resources as a barrier or facilitator. However, parents in higher SES neighborhoods reported using ATS as part of a healthy lifestyle, while parents in lower SES neighborhoods reported having little time to accompany children on the walk to school (Faulkner et al., 2010). Resources appear to be an external factor to the decision to walk or bike to school, which may be related to the availability of private automobile and schedule constraints.

4.8. Culture

Culture in this paper, refers to measures of foreign-born status, race/ethnicity, and regional location. Correlational results were mixed, perhaps due to the inconsistent and imprecise measures. One study reported significantly more ATS among children of foreign-born parents in the U.S. (McMillan, 2007); another reported significantly less ATS among children of foreign-born parents in Canada (Pabayo and Gauvin, 2008); and four more studies found no significant association between foreign-born parents, nationality, or language spoken at home and ATS (Bringolf-Isler et al., 2008; McDonald, 2007b; McMillan, 2006; Merom et al., 2006). Racial variations in walking to school appeared to be due to other factors. Two studies using data from separate nationally representative surveys initially found significant differences in rates of ATS by racial groups, but these differences lost significance after controlling for individual and neighborhood covariates such as distance to school, family income, and population density (McDonald, 2008b; Martin et al., 2007). Children living in the Southern U.S. were more likely to walk to school than children living in the Northeast, which could represent cultural norms but may also reflect other regional differences, such as climate and predominant urban development patterns (Martin et al., 2007). Like resources, culture was not directly reported as a barrier or facilitator to walking or biking to school by parents or guardians in the review of qualitative research. Immigrant parents and grandparents of diverse backgrounds reported similar barriers to walking and biking to school as households from predominant cultural backgrounds, although mistrust of neighbors was more pronounced amongst minority groups due to cultural isolation (Greves et al., 2007). Thus culture appears to moderate—or be moderated by—other factors that directly influence the decision to use ATS.

5. Discussion of implications for SRTS

The eight common factors that influenced walking and biking to school can be used by SRTS coordinators to select SRTS grant applications that have the greatest potential to increase the number of students safely walking and biking to school.

5.1. Distance to school

Children who live too far away from their school will simply not walk and bike unless absolutely necessary. To increase rates of safe walking and biking to a school, there must be a substantial number of students living within a reasonable walking/biking distance. One mile may be a reasonable threshold. At this distance, a model based on trips to school of 6508 children aged five to 13 in the U.S found that 19 percent of children were estimated to walk to school, but at a distance of 2 mile, the estimate dropped to five percent (McDonald, 2008a). Because distance has a direct impact on walking or biking to school, the number of students who live 1/4, 1/2, and 1 mile from school would provide the best estimate of potential active commuters, assuming children attended their neighborhood school. Data on children's home locations may be available from individual schools or school districts. It could also be collected through parent surveys available from the National Center for Safe Routes to School (NCSRTS) (2010a). Methods have also been developed to estimate this information using U.S. census data in a geographic information system (Falb et al., 2007). The numbers of students living near a school, along with data on rates of ATS to or from school would provide SRTS administrators with estimates of the number of students whose safety may be improved, and of the potential number of students who could switch to an active commute mode. These data would also be instrumental in supporting post-program evaluations. Any changes in ATS can only be understood in the context of how many students live within walking distance.

Different SRTS strategies might be necessary for schools with many students who live beyond an easy walking distance. A SRTS emphasis on biking, safe routes to bus stops or walking from bus stops to schools are examples of activities that can support safe active travel for children who live far from schools (Safe Routes to School National Partnership, 2007). However, the return on investments for these programs might be relatively low compared to programs geared toward children who live close to their school.

5.2. Parental fear of traffic and crime

With 70 to 90 percent of funding earmarked for engineering components, SRTS programs are best suited for building a safe pedestrian and bicycle environment for children. SRTS programs are needed most in areas where actual traffic dangers exist and children live close enough to school to be able to walk or bike. One study that only included students who lived within 2 mile of their school highlighted many of the significant positive associations between pedestrian and bicycle infrastructure and ATS (Kweon et al., 2007). SRTS projects, especially those that involve an engineering component, should be prioritized for funding in areas with objectively documented traffic dangers. SRTS administrators need to objectively compare the safety of school environments across project applicants. Numerous methods and tools exist for evaluating the pedestrian and bicycle safety near schools and along school walk routes (Medina et al., 2010; National Center for Safe Routes to School (NCSRTS), 2010b). These tools should be used to inform the design of programs. Geo-referenced multi-year collisions, traffic volume, and signalization data could supplement detailed site audits and allow for a coarse yet

objective comparison of the safety environment across numerous schools.

SRTS programs must also identify and address parental fears of traffic that may not register through collision data or walk audits. The NCSRTS parent survey contains information to gauge and compare parental safety concern across programs. In areas with high levels of parent concerns about traffic danger but low levels of objective traffic danger, increase rates of ATS may be achieved through relatively low-cost education and encouragement activities. The NCSRTS parent survey is also a useful tool to identify areas with high levels of concern about crime. SRTS programs in these areas may wish to partner with police or neighborhood watch organizations to address public safety concerns during school commutes. For younger children, the walking school bus, a system where one or more parent volunteer chaperones a group of children along the walk to or from school, appears to be a particularly effective activity for alleviating parent safety concerns of both traffic and crime (Kearns et al., 2003). For older children, systems that would require a child's school to alert his or her parent if the child failed to arrive could be effective at alleviating parental fears of abduction (Ahlport et al., 2008). The parent ultimately makes the commute mode choice and must be convinced that his or her child will be safe during the trip to and from school.

5.3. Schedule constraints

Because schedules are likely to vary considerably from family to family and from day to day, SRTS programs should seek to identify the range of schedule conflicts that exist within a school-based community and develop activities accordingly. The NCSRTS parent survey contains information to identify the extent to which schedule conflicts act as a barrier to walking or biking to school. Better yet, SRTS planning that involves parent stakeholders would provide a more in-depth understanding of the scheduling nuances that may prevent children from walking and biking to school. Such details could inform solutions that reduce the parental time requirements for ATS (e.g., a walking school bus) or incorporate flexibility into the school commute (e.g., before- and after-school daycare). Furthermore it may be beneficial for SRTS programs to encourage collaboration with local employers to encourage active commuting for all family members, not just children.

5.4. Values

Fears of the dangers of walking or biking deter parents from allowing their children to use these modes of travel to school. In contrast, the positive aspects of walking and biking – health benefits, social interactions, reduced carbon footprints – can attract parents to these modes. Strong parental support for an SRTS program could be a good indicator of attitudes that support ATS. Parental values can be identified through the NCSRTS parent survey; and a SRTS planning process that involves parent input is yet one more technique for ensuring that an SRTS program is designed to address parental values.

It is also important to remember that the student is ultimately the one travelling to school. Students who rode their bikes to school did so because it was enjoyable and provided a fitness challenge (Orsini and O'Brien, 2006). Some parents drove their children to school because it was their child's preference (McDonald and Aalborg, 2009). Even though the parent decides how the child travels to school (Faulkner et al., 2010), SRTS efforts should also seek to understand children's transportation attitudes and address negative perceptions of walking and cycling to school. Some SRTS programs have developed student surveys that capture these perceptions (Kauffman et al., 2010).

5.5. Weather

Children who normally walk to school may be driven to school when the weather is bad, and children who are normally driven may walk when the weather is nice, but data indicate that rates of ATS change little under different weather conditions (National Center for Safe Routes to School (NCSRTS), 2010c). School-based programs to support walking and bicycling should at least ensure that the proper storage facilities exist for jackets, umbrellas, and other weather gear to make walking in inclement weather more comfortable.

5.6. School characteristics

Because distance has such a strong effect on ATS, school districts should use neighborhood school attendance boundaries to site new schools or retain existing schools within family residential neighborhoods. These policies would ensure that the greatest number of children lived within walking distance to their school. Policies intended to keep children safe during the school commute, such as grade/age minimums for walking or biking to school or rules against riding push scooters to school, can undermine efforts for families to use ATS. Any SRTS program should begin with a review of school policies to ensure that walking and biking to school is supported by school policies. Although a school that was part of an SRTS grant application should logically not have policies in place that restrict walking and biking to school, SRTS coordinators should double check that this is the case before awarding grants. SRTS applications should also include an audit of the school environment to identify any physical elements that contribute to a dangerous or inconvenient walking or biking environment. An audit should include everything from the drop-off/pick-up zone to classroom coat racks. Since every child that uses ATS will have to arrive or depart school, the school environment can have a large potential impact on children's use of ATS. Care should be taken to ensure that efforts to improve the safety of the school environment does not make driving more convenient at the expense of walk and bike safety.

5.7. Resources

Children at schools in areas of greater deprivation often are more likely to have no other options but to use ATS due to lack of school bussing and to family financial resources that may be insufficient to cover the cost of driving to school. These school communities could benefit directly from SRTS engineering, education, and enforcement activities to increase the safety of children who have no choice but to walk to school. Making ATS a safe and attractive option in low-socioeconomic status neighborhoods could have the added benefit of freeing up resources that families currently spend on driving children to school. The resource barrier is important to consider in SRTS proposal selection protocols because schools in lower-income areas not only encounter greater institutional barriers to accessing SRTS funding (National Safe Routes to School Task Force, 2008), but also are often exposed to greater crime and traffic dangers (Zhu and Lee, 2008). An option for addressing this barrier is making SRTS planning assistance and program guidance available to schools in such neighborhoods. SRTS proposals could also be prioritized for funding using school-based measures of deprivation, such as the percent of students on the free or reduced lunch program, or census-based deprivation measures, such as average family income or car ownership-to-adult ratios near the school.

At the same time, higher-income neighborhoods should not be neglected during SRTS funding allocations. These areas may be capable of generating a substantial mode switch from the family auto to active transportation. SRTS programs in wealthier neighborhoods must be designed to overcome the greater prevalence of transportation options and resources available to families. These areas would likely benefit from SRTS programs that focused on encouragement.

5.8. Culture

Country of birth, and racial/ethnic, as well as regional differences in walking to school appear to be a reflection of related environmental and socioeconomic factors. Cultural dynamics at a school, however, can influence the success of programs that support ATS and should be considered by SRTS program planners (Johnston et al., 2006).

6. Limitations

This article synthesized a large amount of quantitative and qualitative research on ATS into eight factors that influence a child's use of ATS. The list, however, is subject to limitations. First, it is based on evidence from qualitative and cross-sectional research. While paths of influences are suggested based on qualitative research findings, they should not be generalized indiscriminately. Second, the tallies of significant and not significant findings shown in Table 1 are intended to serve as a rough estimate of the importance of each correlate group in influencing the decision to walk or bike to school. Further consideration of these findings should take into account the specific characteristics of the individual studies' designs and the relative strength of the associations in the analyses. Third, school characteristics and weather have only a small number of variables contributing to the evidence base. SRTS practitioners would benefit from further research into the effect of these factors on the school commute decision. Finally, the eight factors are intended to guide state-level management of the SRTS program across the U.S., but should not replace detailed, site-specific assessments of the unique barriers and facilitators to walking and biking to school that exist within individual school-based communities. Further research, including case/control, longitudinal and/or qualitative research designs should be carried out to determine the extent to which changing the common barriers/facilitators influences the actual use of ATS.

7. Conclusion

Nationwide, state DOTs received requests for SRTS funding that totaled about three times the amount allocated to the program. Unless more funding is made available, state SRTS administrators must prioritize funding for proposals with the greatest potential to increase the safety and numbers of children walking or biking to school. Programs with the greatest potential for success would be located in areas with few barriers and many facilitators to walking and biking to school, or would be designed to overcome any barriers that did exist and establish facilitators. This study reviewed qualitative and quantitative research to identify these barriers and facilitators in the form of common factors that influence a parent's decision on whether a child walks or is driven to school. Eight factors were identified: distance to school, fear of traffic and crime, schedule constraints, values, resources, culture, weather, and school characteristics. The SRTS program review process should take these factors into consideration as applications are prioritized for funding.

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Appendix A. Supplementary materials

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