ACSP
Connecting educators, researchers and students

Journal of Planning Education and Research
2022, Vol. 42(3) 365–374

DOI: 10.1177/0739456X18817353
journals.sagepub.com/home/jpe
SAGE

Walking School Bus Program Feasibility in a Suburban Setting

Bumjoon Kang[1] and Chunyuan Diao[2]

Abstract

A walking school bus (WSB), a group of children walking to school under adult supervision, has social, environmental, and public health benefits. Although WSBs may require a certain neighborhood density and street configuration to recruit and organize groups, our spatial analysis showed that when 20% of students living near their school join WSBs, those students could form an adequately sized WSB group. Our parent survey showed that about 40% of parents were likely to allow their children to walk to school if a friend accompanies them. Thus, we conclude that WSBs are feasible in a low-density suburban neighborhood setting.

Keywords

Safe routes to school, walkability, public health, transportation, child pedestrians, traffic safety

Introduction

Active transportation (e.g., walking or bicycling) to or from school (ATS) among K- to eighth-grade children notably declined from 40.7% to 12.9% between 1969 and 2001 in the USA (McDonald 2007). Studies have associated the rapid ATS decrease with falls in childhood physical activity levels (Lee, Orenstein, and Richardson 2008; Tudor-Locke, Ainsworth, and Popkin 2001), an increase in childhood obesity (Davison, Werder, and Lawson 2008), and an increase in traffic congestion near schools (Smith et al. 2015). To reverse this trend, public health programs, such as Safe Routes to School (SRTS) programs, were initiated by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005. Since then, the national SRTS has funded over $1 billion of infrastructure improvements, law enforcement, and school education and activities, aiming to promote children's ATS (National Center for Safe Routes to School 2015a). However, SRTS programs have not made substantial improvements in ATS behavior. Only about a 3% increase in ATS was reported among 5227 schools participating in SRTS between 2007 and 2013 (National Center for Safe Routes to School 2015b). SRTS interventions generally had little impact (Cohen's $d <$ 0.33), according to a systematic review paper (Chillón et al. 2011).

SRTS evaluation studies repeatedly identified safety and parents' inconvenience, rather than infrastructure, as the most significant barrier to ATS (Kerr et al. 2006; McDonald et al. 2014; Mendoza et al. 2012; Pont et al. 2009; Stewart 2011). Increased cultural, social, and legal pressure for parental supervision outside the home, caused by parents' safety concerns, may deter ATS decisions (Collins and Kearns 2001). However, most mainstream SRTS projects may have assumed that children can walk or bike independently and have attempted to identify characteristics of individuals who were more likely to do ATS. A child's commuting behavior may be affected by her or his social network, peer support, or commuting route interactions (Mikkelsen and Christensen 2009; Panter et al. 2010a; Sidharthan et al. 2011). For example, parents may feel comfortable allowing their children to walk to school if the child's friends in the neighborhood walk to school in a group. In the current paper, we discuss a different SRTS approach that focuses on student groups more than individuals and test whether such programs would be feasible in a low-density suburban neighborhood.

Walking School Bus Programs

A walking school bus (WSB) is a group of children who walk to and from school, escorted by responsible adults (National Center for Safe Routes to School. n.d.-b). The concept of a WSB, originally proposed in the early 1990s in Australia (Engwicht 1993; Kingham and Ussher 2007), spread throughout the UK, Australia, Canada, and New Zealand

Initial submission, March 2017; revised submissions, October 2017, June and October 2018; final acceptance, November 2018

[1]University at Buffalo, State University of New York, Buffalo, NY, USA
[2]University of Illinois at Urbana-Champaign, Champaign, IL, USA

Corresponding Author:
Bumjoon Kang, Department of Urban and Regional Planning, School of Architecture and Planning, University at Buffalo (SUNY), 3435 Main St, Buffalo, NY 14214-8032, USA.
Email: bumjoonk@buffalo.edu

(Collins and Kearns 2010; Kearns, Collins, and Neuwelt 2003). A WSB program is a relatively new form of ATS in the USA, which is intended to deal with parents' safety concerns (McDonald and Aalborg 2009). Compared to individual-level SRTS programs, WSB has many benefits. With responsible adult escorts, WSB programs protect children from traffic and other street risks and teach safe pedestrian behaviors (Mendoza et al. 2012). Various social and community benefits were reported from previous WSB programs (Kingham and Ussher 2007).

However, there are challenges in implementing and marketing WSB programs. WSB programs are restricted by route lengths for children's walking capability and adequate WSB group sizes for adult supervision. For example, a WSB intervention study in Houston, TX, set walking route lengths averaging 1.3 km and grouped 8–12 children with two adult escorts per route (Mendoza et al. 2011). Other WSB studies determined the maximum walking route distance as 1.6 km (Kong et al. 2009; Sirard et al. 2008). The National Center for SRTS recommends that one adult supervise six children aged 7–9 years (National Center for Safe Routes to School. n.d.-b). In some low-density neighborhoods, it may not be possible to form a WSB group with such sizes. Thus, neighborhood and student density play important roles in identifying areas where WSB might succeed.

Research Objectives

The present study examined whether a WSB program is spatially feasible in a suburb locale school district. In other words, would it be possible in that given district to form a large enough group of elementary students for WSB? We estimated potential WSB group sizes by calculating the overlap of students' walking routes under different levels of hypothetical WSB participation. Next, using a parent survey we assessed potential WSB participation. Finally, we examined characteristics of those who were likely to participate in a WSB program.

Methods

Study School District

This study employed data from four public elementary schools in the Sweet Home Central School District in Erie County, NY, USA. The school district intersects with two 1960s suburban towns (Amherst and Tonawanda), about 25 km north of downtown Buffalo (Supplementary File 1). Collaborating with the school district, the research team, including the authors, participated in a district-level SRTS program for two years (2014–2016). The census tracts served by the district had a total population of 36,757 (2009–2013 American Community Survey). The census tracts were dominantly white (78.4%), similar to those of the Erie County (79.1%), and had a median household income of $49,130, lower than that of the whole county ($49,977) and neighboring towns ($52,288–$68,018). The area was a car-dominant neighborhood for families (74.5% of households with one child under 18 years; 43.2% with one vehicle available and 49.6% with two or more vehicles available). The school district was established following the completion of local transportation projects in the 1950s (KTA Preservation Specialists/Archaeological Survey 2011). Figure 1 shows maps of the schools. Overall, the school district area was a typical post-war, white-dominant, car-dependent, residential suburb for middle- or lower-middle-class families in western New York. Residential density of the district was about 2.5 dwelling units per gross hectare (du/ha.gross), lower than the suggested base density for suburban zones by New Urbanists (5 du/ha.gross) (Duany, Sorien, and Wright 2009).

Walking Route Data

First, we conducted analyses using students' potential walking routes. It was assumed that a WSB program is planned based on students' shortest network routes from their homes to their schools. For home addresses, we used student directory data provided by the school district transportation office. The directory data, as of March 2014, included all enrolled students' home addresses and school-bus scheduling information. After de-identifying students' information, home addresses were geocoded using the 2012 Erie Street Address Locator in ArcMap 10.1 (ESRI, Redland, CA). Four school locations were manually geocoded using Google Maps imageries and site visits. For each of the study schools, we manually geocoded access points where pedestrians may walk or bike to the school property lot (e.g., property entrances for pedestrians). We geocoded 1–4 access points per school, totaling 10 points. Finally, the shortest network routes were calculated from each student's geocoded home point to the closest access point of his or her own school. The street network dataset was built from the 2013 TIGER Census street line files. The shortest routes were calculated by the ESRI Network Analyst extension, excluding street segments not traversable by pedestrians (e.g., highways or onramps). The current study only included students having the calculated shortest network distance ≤1.6 km. The 1.6 km threshold was selected as a realistic upper bound of walkable distances for elementary students (McMillan 2007). The 1.6 km sample was determined to consist of *all* students that have the shortest network distance ≤1.6 km from home to school in the school district transportation list.

Walking routes were characterized with variables selected from prior SRTS studies (Kerr et al. 2006; Stewart 2011). Included variables were route distance (McDonald 2008), route directness (Panter et al. 2010b), defined as the ratio of airline distance (Euclidean distance) to network distance (Manhattan distance), and busy road crossings (Timperio et al. 2004), defined as the number of crossings along the route as highways, major roads, and local roads with speed limit ≥56.3 km/h (35 mph).

Figure 1. Study school maps.

Second, we measured the built environment around walking routes. Residential unit density and street intersection density were measured within 200 m buffers around walking routes. The buffer distance of 200 m was determined using the average block length in the school district area. It was calculated from the total length of street segments excluding cul-de-sac segments divided by the number of intersections. The 200 m buffer size was also selected in many walking-route-level SRTS studies (Agrawal, Schlossberg, and Irvin 2008; Bringolf-Isler et al. 2008; Schlossberg et al. 2006).

Walking Route Overlap

We counted how many walking routes each student among the 1.6 km sample (all students living ≤1.6 km from school) shared with other students, When R(A), A's walking route to school fully contains R(B), B's walking route, we defined that R(A) forward-overlaps with R(B) and R(B) backward-overlaps with R(A) (Figure 2(a)). When, between R(B) and R(C), no one route fully contains the other, R(B) neither forward-overlaps nor backward-overlaps with R(C), nor vice versa (Figure 2(b)). We operationalized the process through the following steps: (1) define $R(i)$, the ith student's walking route, as a set of street segments which makes up the route; (2) define $R(i)$ *forward-overlaps* with $R(j)$ if $R(i) \supset R(j)$; and (3) $R(i)$ *backward-overlaps* with $R(j)$ if $R(i) \subset R(j)$.

Finally, within the 1.6 km sample, we calculated the total number of overlaps as the sum of forward-overlaps and backward-overlaps for each student among all other students, among the same school, and among the same grade in the same school, respectively.

School Catchment Area

The towns provided us with a list of street addresses served by each school as of March 2014. We delineated school catchment areas (school attendance boundaries) as multi-part polygons with residential parcels and street addresses in the list. For each of the catchment areas of the four schools, the built environment characteristics were measured, including street line, intersection, and residential unit densities using the 2013 street line data (NYS GIS Clearing House) and the 2014 Erie County residential parcel data (Office of Geographic Information Services, Erie County, NY). The built environments within catchment areas were measured for school-level comparisons.

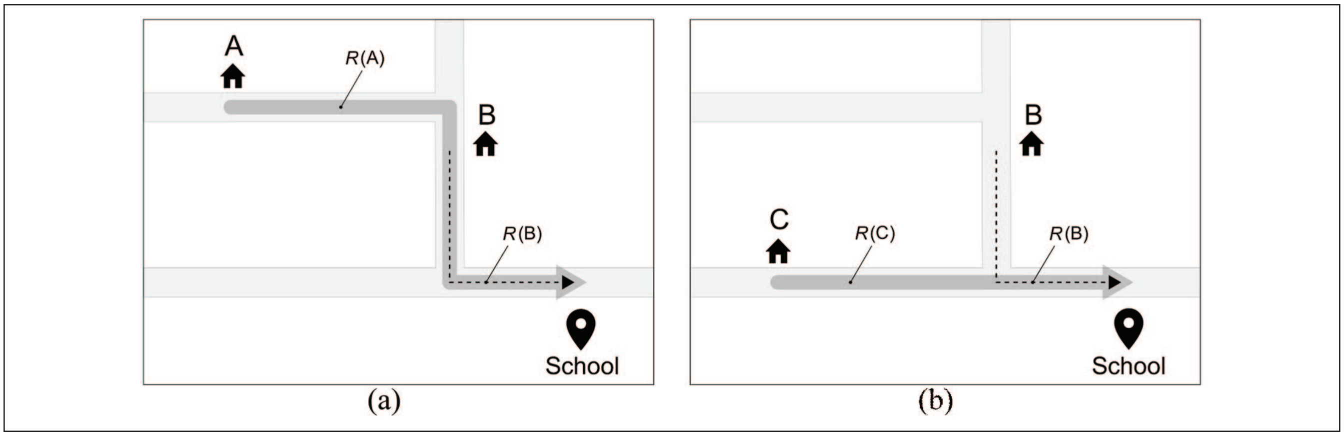

Figure 2. Walking routes and overlaps. (a) A's walking route *R*(A) forward-overlaps with B's walking route *R*(B). *R*(B) backward-overlaps with *R*(A). (b) B's walking route *R*(B) does not forward-overlap nor backward-overlap with *R*(C). There are no overlaps between A and C. The total number of walking route overlaps among A, B, and C are 1, 1, and 0, respectively.

Parent Survey

We conducted a parent survey to collect students' and parents' demographic information, household information, and children's current school-commuting behaviors. In March 2014, the research team sent an online survey invitation to all parents and caregivers registered in the school directory, via email from the transportation office or via paper letter with the school district's support (if email was not available). A total of three follow-up email invitations and reminder letters were sent until May 2014. The parent survey, designed to take about 15–20 minutes, included questions adapted from the National SRTS Center's parent survey (National Center for Safe Routes to School. n.d.-a). In addition to demographic information, the survey asked parents about their perceptions relevant to ATS decisions with a five-point Likert scale, with one indicating "strongly disagree" and five indicating "strongly agree," or similar ordinal answer scales. Specifically, the survey questioned parents about their positive attitudes toward walking (pro-walking), about their perception of traffic risks (high traffic), and about their perception of crime risks in the neighborhood (high crime), selected from prior studies on relevant SRTS studies (Dellinger and Staunton 2002; Mendoza et al. 2012; Stewart 2011). The "pro-walking" measure was the average of response values to two attitude questions on walking or biking in the survey. The "high traffic" measure was from a neighborhood traffic perception and the "high crime" measure was from a neighborhood crime perception question. They were treated as numerical values in the following analyses. The survey items are shown in Supplementary File 2, and the survey background information was published elsewhere (Raja et al. 2016).

To determine the potential participants in a WSB program, we asked parents/caregivers to "express agreement with" the statement "if a school friend were to join my child on his/her way to and from school, my child would be more likely to walk/bike to/from school." Answers were selected from "strongly disagree," "somewhat disagree," "neutral," "somewhat agree," or "strongly agree." We considered the survey answer "strongly agree" and "somewhat agree" as indicating likely participation in a WSB program (potential WSB participation) and "neutral," "somewhat disagree," or "strongly disagree" as indicating no participation. We joined the survey data with the walking route GIS data, based on the related email address in the directory data. Multiple children at the same home address or under the same parents were treated as separate study participants.

The *survey sample* was determined as those who were in the 1.6 km sample (living ≤1.6 km from school) and who also completed the survey. Survey participants completed a written consent form in participating in the study. The study was approved by the school district and the research team's Institutional Review Board.

Analysis

First, using the 1.6 km sample, we analyzed characteristics of walking routes and calculated walking route overlaps for each student. We defined a WSB as feasible when a student's route overlaps with five or more other students' routes; therefore, a WSB group size is expected to be six or larger. The threshold was determined by the National Center for SRTS's WSB passenger size recommendation (six children aged 7–9 with one adult supervisor) (National Center for Safe Routes to School. n.d.-b). Second, we conducted WSB simulations. We assumed different levels of WSB participation (10–100%) and randomly sampled WSB participants among those who were living ≤1.6 km from each school. We examined how these various participation levels changed walking route overlap counts and identified the minimum participation level to meet the WSB spatial feasibility threshold.

Table 1. School Catchment Areas and Students' Walking Route Overlaps By School.

	Unit	Schools								All		p^*
		A		B		C		D				
Students and walking route overlap												
No. students living ≤1.6 km		134		102		115		168		519		
No. overlaps among the same grade in the same school	Mean (SD)	2.0	(1.8)	3.5	(2.3)	1.6	(1.5)	2.6	(2.3)	2.4	(2.1)	<.001
No. overlaps among the same school	Mean (SD)	12.7	(8.3)	21.2	(12.3)	10.6	(5.8)	15.4	(9.7)	14.8	(9.9)	<.001
School-level built environments (catchment area)												
Enrollment	*n*	365		327		372		318		1382		
Total area	km^2	8.3		8.5		8.7		7.8		–		
Total area of parks	km^2	0.9		0.2		0.1		0.1				
Total street length	km	88.0		59.5		98.3		72.1		–		
Residential units	unit	3935		2101		4013		2376		–		
Percentage of one- or two-family type of residential parcels	%	99.8		99.6		99.7		99.6				

Note: SD = standard deviation. * ANOVA tests comparing group means across schools.

Third, using the survey data, we compared how those who were likely to participate in a WSB program were different from those who were not, in terms of demographic characteristics, parents' attitudes toward walking (pro-walking), perceptions of traffic (high traffic) and crime safety (high crime), and the walking route's built environment characteristics. For categorical variables, chi-squared and analysis of variance (ANOVA) tests were used for variables in continuous or Likert scales. Statistical significance level was set to $p = 0.05$. All data processing and analyses were conducted using R 3.3.1 (R Core Team, Vienna, Austria).

Results

After excluding students living outside the district service areas, the enrollment sample consisted of 1382 K- to fifth-grade students from four elementary schools in the study school district. The validated home addresses from the directory data were used to calculate the shortest walking routes to students' own schools for all the enrollment sample participants. Of the enrollment sample, 519 (37.6%) students had walking route lengths ≤1.6 km and were determined to enter the 1.6 km sample. Within the 1.6 km sample, a student had an average of 2.4 walking route overlaps with other students in the same grade of the same school, and 14.8 walking route overlaps with other students in the same school. The four schools had significantly different mean numbers of walking route overlaps ($p < 0.001$). The mean number of walking route overlaps between a student and others in the same school varied between 10.6 and 21.2. The schools had comparable catchment area sizes (7.8–8.7 km^2); however, there were differences in total street length, residential unit count, and housing-type composition (Table 1). At the school level, the mean number of walking routes overlaps was larger when the school catchment area had fewer residential units and shorter street lengths. Additional demographics and neighborhood characteristics in the study area are reported in detail elsewhere (Raja et al. 2016).

Of the 1.6 km sample, parents of 104 students completed the survey (response rate = 20.0%; based on the number of students), and they comprised the survey sample. There were no significant differences in the built environment between the 1.6 km and the survey samples' walking routes. On average, the two samples' walking routes had a length of 0.8 km, crossed 0.4 busy roads, were located along areas of 5.0–5.2 du/ha.gross, had a route directness of 0.4, and had 33.6–34.3 nearby intersections per square kilometer.

Table 2 describes the descriptive statistics and school-commuting behaviors of the survey sample. Only 5 (4.8%) students walked or bicycled to school and 80 (76.9%) used school buses. A total of 41 (39.4%) parents answered that they were likely to participate in a WSB program. Table 3 shows the average count of walking route overlaps when WSB participants were randomly sampled. A WSB was spatially feasible when we assigned 20% of the sample as WSB participants (average 5.2 overlaps with others).

The results of the comparisons between those who were likely to participate in a WSB program and those who were not are shown in Table 4. Children's grade, gender, and number of siblings, parents' gender, race/ethnicity, education, and household income were not significant different between the two groups. Significant differences were found in parents' perceptions ($p< 0.05$). Those who showed potential participation in a WSB had higher positive perception of walking and lower perception of neighborhood traffic and crime risks than those who did not. There were no significant differences in the built environment characteristics of walking routes between the two groups.

Table 2. The Survey Sample and Results.

		Count	(%)
Child information			
Gender	Female	46	(44.2)
	Male	58	(55.8)
Grade	K	17	(16.3)
	1	14	(13.5)
	2	24	(23.1)
	3	19	(18.3)
	4	15	(14.4)
	5	15	(14.4)
Number of siblings	0	67	(64.4)
	1	33	(31.7)
	2	4	(3.8)
Race/ethnicity	Non-Hispanic white	82	(78.8)
	Other	22	(21.2)
Child's current commuting mode			
Mode to school	Walk	3	(2.9)
	Bike	2	(1.9)
	School bus	80	(76.9)
	Family vehicle	19	(18.3)
Parent and household information			
Gender	Female	88	(84.6)
	Male	12	(11.5)
	NA	4	(3.8)
Education	Some college or below	40	(38.5)
	College graduate or more	60	(57.7)
	NA	4	(3.8)
Household income	<US$50K	10	(9.6)
	US$50K to <100K	42	(40.4)
	≥US$100K	32	(30.8)
	NA	20	(19.2)
Parent's WSB interest			
	Potential participation	41	(39.4)
	No participation	63	(60.6)
Parent perception		Mean	SD
Pro-walking	[1 = strongly disagree,	3.9	0.7
High traffic	…, 5 = strongly agree]	2.3	1.2
High crime		1.7	0.9

Note: SD = standard deviation; WSB = walking school bus.

Table 3. Average Number of Walking Route Overlaps, Under Different Levels of Hypothetical WSB Participation (Random Sampling).

WSB participation (%)	Average number of walking route overlaps*
10	2.5
15	3.7
20	5.2
25	6.0
30	7.5
35	9.1
40	9.9
45	10.5
50	11.7
60	12.4
70	13.3
80	14.3
90	14.7
100	14.8

Note: WSB = walking school bus. * Overlaps with other students' routes in the same school.

Discussion

Using real school enrollment and home address data, the current study tested the spatial feasibility of WSB programs in a suburb where single-family houses were dominant (over 99% of all residential parcels). Despite the low residential densities in the area, we found a high number of walking route overlaps among students living ≤1.6 km from school. On average, a student's walking route overlapped with 14.8 other students' routes. To form WSB groups with a recommended size (six students), it is necessary to recruit at least 20% of the students. In the survey data, about 40% of parents were likely to participate in a WSB program. If half or more of them actually join, it will make a sufficient WSB group size. Because there was no difference in the potential WSB participation across grade levels, we did not consider different conditions for WSB grouping by age. However, an additional adult supervisor may be needed for groups with younger children (National Center for Safe Routes to School. n.d.-b).

WSB can be an ATS solution in such neighborhoods where the ATS rate is low yet residents have positive attitudes toward walking. In our data, only 4.8% of students living ≤1.6 km from school participated in ATS. It is noteworthy that a majority of parents in the sample (78.8%; data not shown) had positive attitudes toward walking. However, parents who perceived high neighborhood traffic and crime risks were not likely to participate in WSB programs. Safety concerns seem to outweigh ATS benefits for most parents (Carver, Timperio, and Crawford 2008; McDonald and Aalborg 2009). Educating parents regarding ATS benefits (e.g., SRTS classes and campaigns emphasizing physical activity benefits) may not be effective in changing their decisions. Proactive approaches, such as WSB, that directly address parents' safety concerns may be effective in changing ATS behavior decisions.

The current study developed a method to measure the spatial feasibility of a WSB program. It estimates the potential WSB group size and walking route overlaps. The National Center for Safe Routes provides an online guide for WSB program development (National Center for Safe Routes to School. n.d.-c). It introduces useful case studies and resources (e.g., parent consent forms); however, it does not show systematic methods to measure program possibilities and impacts. The walking route overlap assessment method would be useful for a school community to explore WSB possibilities simply by using its school directory data.

Table 4. Comparisons Between Those Who Were Likely to Participate in WSB and Those Who Were Not.

		Potential participation (n = 41)		No participation (n = 63)		
		Count	(%)	Count	(%)	p*
Child information						
Grade	K	7	(17.1)	10	(15.9)	0.455
	1	7	(17.1)	7	(11.1)	
	2	8	(19.5)	16	(25.4)	
	3	8	(19.5)	11	(17.5)	
	4	3	(7.3)	12	(19.0)	
	5	8	(19.5)	7	(11.1)	
Child's gender	Female	16	(39.0)	30	(47.6)	0.509
	Male	25	(61.0)	33	(52.4)	
Number of siblings	0	28	(68.3)	39	(61.9)	0.649
	1+	13	(31.7)	24	(38.1)	
Parent information						
Parent's gender	Female	33	(84.6)	55	(90.2)	0.605
	Male	6	(15.4)	6	(9.8)	
Race/ethnicity	Non-Hispanic White	33	(80.5)	49	(77.8)	0.932
	Other	8	(19.5)	14	(22.2)	
Education	Some college or below	14	(35.9)	26	(42.6)	0.645
	College graduate +	25	(64.1)	35	(57.4)	
		Mean	(SD)	Mean	(SD)	P**
Household income						
<US$50K		5	(15.2)	5	(9.8)	0.694
US$50K to <100K		13	(39.4)	19	(37.3)	
≥US$100K		15	(45.5)	27	(52.9)	
Parent perception						
Pro-walking	[1 = strongly disagree,	4.18	(0.65)	3.72	(0.73)	**0.001**
High traffic	…, 5 = strongly agree]	1.80	(1.10)	2.70	(1.21)	<**0.001**
High crime		1.39	(0.83)	1.83	(0.83)	**0.011**
Walking route characteristics						
Distance to school	km	0.76	(0.34)	0.83	(0.33)	0.258
Dwelling unit density	du/ha	5.24	(2.51)	5.23	(2.52)	0.985
Route directness	[1, + ∞)	1.42	(0.45)	1.47	(0.47)	0.607
Number of busy road crossings	count	0.32	(1.17)	0.48	(1.49)	0.565
Intersection density	count/km	32.67	(7.28)	34.20	(6.41)	0.262

Note: SD = standard deviation. * Chi-squared test result. ** ANOVA test result (bold for significance $p < 0.05$).

This study has several limitations. First, the survey response rate was 20%, which is lower than the rates in other SRTS studies (Kerr et al. 2006; McDonald and Aalborg 2009). It is possible that our sample was not representative and missing data may affect findings of the potential WSB participation. It is possible that parents' survey participation may be related to their willingness to participate in school activities, including WSBs. In the current study, we assumed they were missing at random. Second, the study did not account for volunteer WSB drivers (adult escorts). It may or may not be difficult to recruit volunteers and administrate WSB programs. Some studies have reported challenges in sustainable recruitment of lead parent volunteers (Collins and Kearns 2010; Kingham and Ussher 2005; Kong et al. 2009). Other pilot studies did not substantially discuss such difficulties (Pont et al. 2009). The research team once approached one school's Parent Teacher Organization (PTO) and asked it to support WSB administration and organization, yet the PTO did not take further actions to start a WSB. As a part of the related SRTS project in the study schools, the research team joined the study schools' PTO meetings, Walk to School Day activities, and Bike Rodeo events, and had informal conversations with parents. While they might be anecdotal responses, some parents showed strong interest in potential WSB programs and would participate as volunteer drivers or support the recruitment. There is a further need for systematic surveys to assess parents' or community members' WSB participation as volunteer drivers. A study suggested that small yet symbolically important incentives may help to recruit volunteers (Collins and Kearns 2010).

Another limitation is the validity of the survey question. The potential participants in a WSB program was determined by the agreement with a hypothetical question that assumes a school friend joining their child's way to and from school. It is possible that parents may have been less likely to agree with the question if there are no school friends in a given WSB group. In actual WSB operations, some groups may need to be formed by walking route availability, not by friendship. However, a WSB program may be used for friendship development. For example, in a New Zealand WSB practice, almost half of the parents reported that children developed new friendships with children of all ages from different classes through WSB participation (Kingham and Ussher 2007). Because parents were asked about theoretical WSBs, we used hypothetical questions.

Findings of the study may be applicable to neighborhoods similar to the study area. As shown in Figure 1, the built environment forms in the study area are similar to the *warped parallel street pattern*, a typical suburban development pattern in neighborhoods from the 1960s (Southworth 1997). The study neighborhoods have schools at their centers and have no major arterials and traffic routes going through. There are not many curvilinear streets and culs-de-sac in the study areas. Considering that the study schools were established between 1961 and 1971, the current results can be generalized to suburban neighborhoods built and grown in the 1960s and 1970s. The range of residential density around the sample's walking routes (5.0–5.2 du/ha.gross) is nearly the same as New Urbanist's low-density suburban density (5 du/ha.gross) (Duany, Sorien, and Wright 2009) but lower than suburbs within large metropolitan areas (7–10 du/ha.gross) (Gordon and Vipond 2005; Moudon et al. 1997). However, gross densities could vary depending on calculation methods, and caution in interpretation is needed. In the USA, 29% of public K- to eighth-grade schools are in the census-defined suburb locale (26% in cities, 13% in towns, and 32% in rural areas) (National Center for Safe Routes to School 2015b). Potential WSB programs show great promise in those suburban areas.

Future studies are needed to integrate WSB programs within school transportation plans. The survey data showed school-bus usage was high (80%) even among students living ≤1.6 km from school. Classroom tally data of students' modes of travel to school, separately conducted in the studied schools, also show low ATS (≤8%) and high school-bus usage (68–85%) (Raja et al. 2016). Because the school district had no minimum bussing distance policy (100% bussing), many parents may prefer school bus to ATS regardless of their positive attitudes toward walking. A qualitative study concluded that children's commuting modes are influenced by parents' perceptions of travel convenience (Faulkner et al. 2010). If the district provides viable, convenient, and safe ATS alternatives to school buses and restricts bussing for students living near school, many parents may choose such ATS alternatives. For example, in the Auckland region of New Zealand, primary schools incorporated WSB programs as well as other ATS promotions within school travel plans and the Auckland Regional Transport Authority provided financial support for schools to organize WSB routes (Collins and Kearns 2010). A 40% increase in ATS was observed after the student travel plan implementation (Hinckson 2016).

WSB incentive programs may be needed. For example, in New Zealand, WSB route development was supported by the Auckland Regional Transport Authority with start-up funds up to NZD1500 per route in 2010 (around US$1125 in 2010) (Collins and Kearns 2010). The district budgeted over US$4.4 million for transportation to serve about 4000 students in 2017–2018 (Sweet Home Central School District 2017). Because more than one-third of elementary students were living ≤1.6 km from school, reducing short-distance bussing could reduce transportation costs. A simulation study estimated that US$206,000–459,000 per school could be saved over 10 years if school-bus usage rate were reduced from 100% to 50% for students living ≤`1.6 km from school (264–604 enrollments) (McDonald et al. 2016). If WSB programs reduce transportation expenses, incentives for WSB can be easily justified. Studies are needed to develop WSB incentives and integrate them within school transportation plans.

Acknowledgments

We thank the students, parents, teachers, and staff of the Sweet Home Central School District who gave generously their time for this effort. This study was made possible in part by a larger project conducted by the research team at the UB Food Systems Planning and Healthy Communities Lab (UB Food Lab), the principal investigator Dr. Samina Raja, and co-investigator Dr. So-Ra Baek. We thank funding support from a Safe Routes to School Grant to the town of Amherst and the 3E grant on Built Environment, Health Behaviors, and Health Outcomes from the University at Buffalo, The State University of New York.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article: This study was made possible in part by funding from a Safe Routes to School Grant to the Town of Amherst and the 3E grant on Built Environment, Health Behaviors, and Health Outcomes from the University at Buffalo, The State University of New York.

Supplemental Material

Supplemental material for this article is available on the *JPER* website.

ORCID iD

Bumjoon Kang https://orcid.org/0000-0002-8551-7652

References

Agrawal, Asha Weinstein, Marc Schlossberg, and Katja Irvin. 2008. "How Far, By Which Route and Why? A Spatial Analysis of Pedestrian Preference." *Journal of Urban Design* 13 (1): 81–98.

Bringolf-Isler, Bettina, Leticia Grize, Urs Mäder, Nicole Ruch, Felix Sennhauser, and Charlotte Braun-Fahrländer. 2008. "Personal and Environmental Factors Associated with Active Commuting to School in Switzerland." *Preventive Medicine* 46 (1): 67–73.

Carver, Alison, Anna Timperio, and David Crawford. 2008. "Playing It Safe: The Influence of Neighbourhood Safety on Children's Physical Activity—A Review." *Health and Place* 14 (2): 217–227.

Chillón, Palma, Kelly Evenson, Amber Vaughn, and Dianne Ward. 2011. "A Systematic Review of Interventions for Promoting Active Transportation to School." *International Journal of Behavioral Nutrition and Physical Activity* 8 (1): 10.

Collins, Damian, and Robin Kearns. 2001. "The Safe Journeys of an Enterprising School: Negotiating Landscapes of Opportunity and Risk." *Health and Place* 7 (4): 293–306.

Collins, Damian, and Robin Kearns. 2010. "Walking School Buses in the Auckland Region: A Longitudinal Assessment." *Transport Policy* 17 (1): 1–8.

Davison, Kirsten, Jessica Werder, and Catherine Lawson. 2008. "Children's Active Commuting to School: Current Knowledge and Future Directions." *Preventing Chronic Disease* 5 (3): A100.

Dellinger, Ann, and Catherine Staunton. 2002. "Barriers to Children Walking and Biking to School: United States, 1999." *Morbidity and Mortality Weekly Report* 51 (32).

Duany, Andres, Sandy Sorien, and William Wright. 2009. *SmartCode Version 9.2*. Miami, FL: The Town Paper Publisher.

Engwicht, David. 1993. *Reclaiming Our Cities and Towns: Better Living with Less Traffic*. Philadelphia: New Society Publishing.

Faulkner, Guy, Vanessa Richichi, Ronald Buliung, Caroline Fusco, and Fiona Moola. 2010. "'What's Quickest and Easiest?': Parental Decision Making About School Trip Mode." *International Journal of Behavioral Nutrition and Physical Activity* 7 (1): 62.

Gordon, David, and Shayne Vipond. 2005. "Gross Density and New Urbanism: Comparing Conventional and New Urbanist Suburbs in Markham, Ontario." *Journal of the American Planning Association* 71 (1): 41.

Hinckson, Erica. 2016. "Perceived Challenges and Facilitators of Active Travel Following Implementation of the School Travel-Plan Programme in New Zealand Children and Adolescents." *Journal of Transport & Health* 3 (3): 321–325.

Kearns, Robin, Damian Collins, and Patricia Neuwelt. 2003. "The Walking School Bus: Extending Children's Geographies?" *Area* 35 (3): 285–292.

Kerr, Jacqueline, Dori Rosenberg, James Sallis, Brian Saelens, Lawrence Frank, and Terry Conway. 2006. "Active Commuting to School: Associations with Environment and Parental Concerns." *Medicine and Science in Sports and Exercise* 38 (4): 787.

Kingham, Simon, and Shannon Ussher. 2005. "Ticket to a Sustainable Future: An Evaluation of the Long-Term Durability of the Walking School Bus Programme in Christchurch, New Zealand." *Transport Policy* 12 (4): 314–323.

Kingham, Simon, and Shannon Ussher. 2007. "An Assessment of the Benefits of the Walking School Bus in Christchurch, New Zealand." *Transportation Research Part A: Policy and Practice* 41 (6): 502–510.

Kong, Alberta, Andrew Sussman, Sylvia Negrete, Nissa Patterson, Rachel Mittleman, and Richard Hough. 2009. "Implementation of a Walking School Bus: Lessons Learned." *Journal of School Health* 79 (7): 319–325.

KTA Preservation Specialists/Archaeological Survey. 2011. *Updated Reconnaissance Level Survey of Historic Resources*, edited by Historic Preservation Commission. Town of Amherst.

Lee, Murray, Marla Orenstein, and Maxwell Richardson. 2008. "Systematic Review of Active Commuting to School and Children's Physical Activity and Weight." *Journal of Physical Activity and Health* 5 (6): 930–949.

McDonald, Noreen. 2007. "Active Transportation to School: Trends Among US Schoolchildren, 1969–2001." *American Journal of Preventive Medicine* 32 (6): 509–516.

McDonald, Noreen. 2008. "Children's Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School." *Transportation* 35 (1): 23–35.

McDonald, Noreen, and Annette Aalborg. 2009. "Why Parents Drive Children to School: Implications for Safe Routes to School Programs." *Journal of the American Planning Association* 75 (3): 331–342.

McDonald, Noreen, Ruth Steiner, Chanam Lee, Tori Rhoulac Smith, Xuemei Zhu, and Yizhao Yang. 2014. "Impact of the Safe Routes to School Program on Walking and Bicycling." *Journal of the American Planning Association* 80 (2): 153–167.

McDonald, Noreen, Ruth Steiner, Mathew Palmer, Allison Bullock, Virginia Sisiopiku, and Benjamin Lytle. 2016. "Costs of School Transportation: Quantifying the Fiscal Impacts of Encouraging Walking and Bicycling for School Travel." *Transportation* 43 (1): 159–175.

McMillan, Tracy. 2007. "The Relative Influence of Urban Form on a Child's Travel Mode to School." *Transportation Research Part A: Policy and Practice* 41 (1): 69–79.

Mendoza, Jason, Kathy Watson, Tom Baranowski, Theresa Nicklas, Doris Uscanga, and Marcus Hanfling. 2011. "The Walking School Bus and Children's Physical Activity: A Pilot Cluster Randomized Controlled Trial." *Pediatrics* 128 (3):e537–e544.

Mendoza, Jason, Kathy Watson, Tzu-An Chen, Tom Baranowski, Theresa Nicklas, Doris Uscanga, and Marcus Hanfling. 2012. "Impact of a Pilot Walking School Bus Intervention on Children's Pedestrian Safety Behaviors: A Pilot Study." *Health & Place* 18 (1): 24–30.

Mikkelsen, Miguel Romero, and Pia Christensen. 2009. "Is Children's Independent Mobility Really Independent? A Study of Children's Mobility Combining Ethnography and GPS/Mobile Phone Technologies." *Mobilities* 4 (1): 37–58.

Moudon, Anne, Paul Hess, Mary Snyder, and Kiril Stanilov. 1997. "Effects of Site Design on Pedestrian Travel in Mixed-Use, Medium-Density Environments." *Transportation Research Record: Journal of the Transportation Research Board* 1578: 48–55.

National Center for Safe Routes to School. n.d.-a. "Evaluation: Parent Survey." Accessed June 27, 2016. http://saferoutesinfo.org/program-tools/evaluation-parent-survey.

National Center for Safe Routes to School. n.d.-b. "Starting a Walking School Bus." Accessed March 4, 2015. http://www.walkingschoolbus.org/index.html.

National Center for Safe Routes to School. n.d.-c. "The Walking School Bus: Combining Safety, Fun and the Walk to School." Accessed June 17, 2017. http://guide.saferoutesinfo.org/walking_school_bus.

National Center for Safe Routes to School. 2015a. *Creating Healthier Generations: A Look at 10 Years of the Federal SRTS Program*. Chapel Hill: Federal Highway Administration, Department of Transportation.

National Center for Safe Routes to School. 2015b. *Trends in Walking and Bicycling to School from 2007 to 2013*. Chapel Hill: Federal Highway Administration, Department of Transportation.

Panter, Jenna, Andrew Jones, Esther Van Sluijs, and Simon Griffin. 2010a. "Attitudes, Social Support and Environmental Perceptions as Predictors of Active Commuting Behaviour in School Children." *Journal of Epidemiology & Community Health* 64 (1): 41–48.

Panter, Jenna, Andrew Jones, Esther Van Sluijs, and Simon Griffin. 2010b. "Neighborhood, Route, and School Environments and Children's Active Commuting." *American Journal of Preventive Medicine* 38 (3): 268–278.

Pont, Karina, Jenny Ziviani, David Wadley, Sally Bennett, and Rebecca Abbott. 2009. "Environmental Correlates of Children's Active Transportation: A Systematic Literature Review." *Health & Place* 15 (3): 849–862.

Raja, Samina, So-Ra Baek, Bumjoon Kang, Elizabeth Machnica, Nathan Attard, Maryam Khojasteh, Samantha Bulkilvish, Leccese Jeanne, Chunyuan Diao, Hailey Stern, and Abdulrahman Ibrahim. 2016. *Moving Together: Promoting Active Commuting to School in the Sweet Home Central School District and the Town of Amherst*. New York: Department of Urban and Regional Planning, School of Architecture and Planning, University at Buffalo, The State University of New York.

Schlossberg, Marc, Jessica Greene, Page Paulsen Phillips, Bethany Johnson, and Bob Parker. 2006. "School Trips: Effects of Urban Form and Distance on Travel Mode." *Journal of the American Planning Association* 72 (3): 337–346.

Sidharthan, Raghuprasad, Chandra Bhat, Ram Pendyala, and Konstadinos Goulias. 2011. "Model for Children's School Travel Mode Choice: Accounting for Effects of Spatial and Social Interaction." *Transportation Research Record: Journal of the Transportation Research Board* 2213: 78–86.

Sirard, John, Sofiya Alhassan, Tirzah Spencer, and Thomas Robinson. 2008. "Changes in Physical Activity from Walking to School." *Journal of Nutrition Education and Behavior* 40 (5): 324.

Smith, Liz, Sarah Norgate, Tom Cherrett, Nigel Davies, Christopher Winstanley, and Mike Harding. 2015. "Walking School Buses as a Form of Active Transportation for Children: A Review of the Evidence." *Journal of School Health* 85 (3): 197–210.

Southworth, Michael. 1997. "Walkable Suburbs? An Evaluation of Neotraditional Communities at the Urban Edge." *Journal of the American Planning Association* 63 (1): 28–44.

Stewart, Orion. 2011. "Findings from Research on Active Transportation to School and Implications for Safe Routes to School Programs." *Journal of Planning Literature* 26 (2): 127–150.

Sweet Home Central School District. 2017. "2017–18 Budget Issue." Accessed June 17, 2017. http://sweethomeschools.org/files/user/3/file/May2017Newsletter(1).pdf.

Timperio, Anna, David Crawford, Amanda Telford, and Jo Salmon. 2004. "Perceptions about the Local Neighborhood and Walking and Cycling Among Children." *Preventive Medicine* 38 (1): 39–47.

Tudor-Locke, Catrine, Barbara Ainsworth, and Barry Popkin. 2001. "Active Commuting to School: An Overlooked Source of Children's Physical Activity?" *Sports Medicine* 31 (5): 309–313.

Author Biographies

Bumjoon Kang is an assistant professor in the Department of Urban & Regional Planning, University at Buffalo (The State University of New York). His research interests include active transportation, GIS, and urban design.

Chunyuan Diao is an assistant professor in the Department of Geography & Geographic Information Science, University of Illinois at Urbana-Champaign. Her research interests include GIS and rivers, watersheds, and landscape dynamics.