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Predictors of Children's Active Commuting to School: an Observational Evaluation in Five US Communities

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Abstract

Background—Few reports examined long term predictors of children's active commuting to school (walking or cycling to school, ACS).

Purpose—To identify predictors of ACS over one school year among a sample of children with relatively high rates of ACS.

Methods—Parents were surveyed in September 2010 (Time 1) and April 2011 (Time 2). The dependent variable was children's commuting mode to school (active versus passive). Independent variables included: 1) parents' outcome expectations (from Social Cognitive Theory: the expected risks/benefits for their child doing ACS), 2) distance to school, 3) participation in an adult-led walk to school group, 4) temperature, and 5) child demographics. Generalized mixed-models estimated odds ratios for ACS (n=369 or 49.7% of Time 1 respondents).

Results—Males (OR=2.59, 95% CI [1.57–4.30]), adult-led walk to school group participation (OR=1.80, 95% CI [1.14–2.86]), parents' outcome expectations (OR=1.26, 95% CI [1.14–1.39]), temperature (OR=1.03, 95% CI [1.01–1.07), distance to school (OR=0.23, 95% CI [0.14–0.37]), and Latino ethnicity (OR=0.28, 95% CI [0.12–0.65]) were associated with ACS.

Conclusions—Programs and policies sensitive to parents' concerns, e.g. adult-led walk to school groups, and targeting Latinos and girls appear promising for increasing ACS.

INTRODUCTION

Inadequate physical activity is a major public health problem in the United States (US) and worldwide,[1] and improving children's physical activity is an important US public health

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goal.[2, 3] Most children in the US did not meet the recommended minimum of 1-hour of daily moderate-to-vigorous physical activity (MVPA).[4] Children's active commuting to school (ACS), i.e. walking or cycling to and from school, has been consistently associated with more MVPA.[5–8] A growing number of epidemiological studies have reported inverse associations between ACS and adiposity.[9–12] Since the majority of children in the US must commute to and from school 5-days per week during the school-year, ACS could broadly provide a frequent opportunity for children to regularly obtain MVPA. In 1969, 47.7% of US children regularly did ACS, a percentage which decreased to 12.7% in 2009.[13] In order to help reverse this trend, increasing children's ACS was a national health objective of US Healthy People 2020.[3]

Identifying predictors of children's ACS may help inform interventions and policies to improve children's ACS. However, previous reports on predictors of children's ACS consisted mostly of cross-sectional studies that lacked diversity in study settings.[5, 7, 8] Some of these studies reported parent-identified barriers to ACS, such as distance from home to school or weather conditions,[14–16] but have not quantified the relationship. A walking school bus randomized controlled trial in Houston, Texas, reported that parents' outcome expectations for their children's ACS, i.e. the expected outcomes from their child doing ACS, were influential in changing children's ACS.[17] In the most recent systematic review,[8] only two studies were identified as longitudinal in design. One was based on data from Poway, California collected in 1990–1992,[18] and may not reflect more recent trends in ACS. The other study examined cycling to school among Danish children[19] and may not be generalizable to US children who cycle to school much less frequently. Contemporary long term evaluations examining children's ACS in multiple US locations are necessary to establish temporality of relationships and address previous gaps. The objective was to conduct an observational program evaluation of US children with relatively high rates of ACS from five different communities to identify and characterize predictors of ACS over the course of one school year.

METHODS

Participants

A convenience sample of schools, who were members of the Safe Routes to School National Partnership, was recruited in June-September of 2010 for an intervention study, reported elsewhere.[20] Inclusion criteria included: commit to encouraging students to safely walk and cycle to school (e.g. monthly encouragement events), participate in National Walk to School Day, and oversee potential installation of infrastructure projects (sidewalk or roadway-related enhancements for pedestrians and cyclists). Schools received a modest stipend for this programming. Schools were also chosen by the National Partnership to include a range of populations including those with substantial ethnic minorities, rural setting, or lower income families. Parents of children in kindergarten through 5th grade attending the enrolled elementary schools or 6th–8th grade attending the one middle school were eligible for participation in the study (n=2711 students) and completed a written survey for each of their children at eligible schools. Study consent forms and surveys were sent to parents through US mail or sent home with their children. Parents were not provided with incentives to

participate. Informed consent was obtained from parents. This study, conducted by the National Partnership, was approved by the Copernicus Group Institutional Review Board (Durham, North Carolina).

Design

Since there were no significant intervention effects in the original study,[20] the design was an observational study over the course of one school year with two assessment points. Parents were sent questionnaires, including questions on parent and child demographics, in September 2010 (Time 1) and April 2011 (Time 2). Walk to school events and infrastructure projects were started after Time 1 measurements were completed. Children were eligible to receive small incentives such as pencils or bracelets for participating in walk and cycle to school events.

Outcome variable

The main dependent variable was parents' report of their children's commuting mode to school. The school travel question asked, "how did [child's name] get to school today?" Parents chose the single best answer: rode school bus, came by carpool, came by car, rode metro bus, walked with an adult, walked without an adult, or biked). The survey had high agreement between parent and child reports (kappa=0.87, $p<0.001$) and child test-retest reliability (kappa=0.97, $p<0.001$).[21] The variable was dichotomized into active commuting (walked with an adult, walked without an adult, or biked) or passive commuting (rode by school bus, carpool, car, or Metro bus). Schools distributed surveys on different days of the week and made several attempts to collect data from non-responders. Thus, data on school travel does not reflect any one day of the week.

Predictors

Main predictors of interest were assessed by written survey and included: 1) parents' outcome expectations, a construct from Social Cognitive Theory assessed using 5-items (Cronbach's alpha=0.71) and three response categories from a previously validated 15-item questionnaire[22] that was positively related to children's ACS[17] (e.g. "If my child walks to and from school: [a] My child will get more physical activity; [b] my child will cross the street safely; [c] My child will be ready to learn in school; [d] My child will be on-time for school; and [e] I will have more time for other things); 2) study staff calculated the distance from home to school on the maps.google.com website using the pedestrian "Get Directions" function; 3) participation in a walk to school group, assessed by asking the parents if their child was part of a group of children who walked to/from school with adult supervision at least once per week (these were not considered walking school buses since some of the children likely walked with their own parents and family members only, i.e. no other families or children were involved); 4) the daily low temperature for each school's city on weather.com recorded by study staff each day as a proxy of the morning commuting temperature; and 5) the demographic variables of child's age, gender, race/ethnicity, and family income assessed by questionnaire and considered time invariant.

Statistical Analysis

Frequencies and percentages were used to describe participant characteristics. The income variable had 35.2% missing data, which was not missing at random,[23] and was therefore dropped from the main analyses. Comparisons of demographics between excluded and included participants were examined using independent T-tests and Chi-squared tests. Generalized mixed-models for repeated measures (PROC GLIMMIX specifying the ODDSRATIO option in SAS 9.2, SAS Institute Inc., Cary, North Carolina) of parent outcome expectations, walk to school group participation (reference=no), distance from home to school, and daily low temperature were used to calculate odds ratios (OR) and 95% confidence intervals for the dichotomous dependent variable of mode of commuting to school (active or passive). This model included child's age, gender, race/ethnicity, and school as covariates. Due to a skewed distribution (not shown), distance from home to school was dichotomized (≤0.5 miles and >0.5 miles) for all analyses. A significance level of $p<0.05$ was chosen.

RESULTS

A total of four elementary and one middle school from five communities met eligibility requirements and enrolled in the program evaluation (Table 1). There was a mix of school settings, size, race/ethnicity, and income levels, the latter indicated by proxy as the percentage qualifying for the federal free/reduced school lunch program.

Of the total 2711 children attending Kindergarten to 5th grade at the four elementary schools or 6th–8th grade at the one middle school, 742 of their parents consented and enrolled in the original evaluation study.[20] Of the 742 parents enrolled, 369 completed assessments at Time 1 and Time 2 (49.7% of enrolled parents) and constitute this evaluation's sample. The remaining 373 parents were excluded from analyses due to missing data for one or more of the variables in the model. Compared to enrolled parents included in analyses, excluded children were older (9.3 versus 8.0 years, $p=0.0003$) and lived farther from school (68.6% lived >0.5 miles from school versus 57.3%, $p=0.002$). There were no differences between included and excluded children for gender, race/ethnicity, or household income (all $p>0.05$).

The average child's age was 8.0 years at Time 1 and 9.0 years at Time 2, 52.3% were female, and 18.7% had family annual incomes <$50,000 (Table 2). For race/ethnicity, 60.4% were White, 18.2% African American, 10.0% Latino, and 7.0% Other. The majority of children walked or cycled to school on the day of the survey at Time 1 (59.6%) and Time 2 (64.2%). Over half lived >0.5 miles from school (57.3%). At Time 1, 79.4% of children regularly participated in an adult-led walk to school group at least once per week, which was similar to the percentage at Time 2 (78.3%).

From the mixed model (Table 3), male gender (OR=2.59, 95% CI [1.57–4.30]), participating in an adult-led walk to school group (OR=1.80, 95% CI [1.14–2.86]), parent outcome expectations (OR=1.26, 95% CI [1.14–1.39]), and morning temperature in Fahrenheit (OR=1.03, 95% CI [1.01–1.07) were positively associated with children's ACS. Compared to children who lived ≤0.5 miles from school, those who lived >0.5 miles had a lower odds of ACS (OR=0.23, 95% CI [0.14–0.37]). Latino children had lower odds of ACS (OR=0.28,

95% CI [0.12–0.65]) than non-Latino White children. There were no other differences in ACS by race/ethnicity or child's age.

DISCUSSION

In a multi-site, multi-state, program evaluation among children with relatively high rates of ACS, we identified several important predictors of their ACS over the course of one school year. One of the strongest positive predictors of children's ACS was participating in an adult supervised walk to school group, which was associated with 80% higher odds of ACS. Although our questionnaire did not distinguish between single-family walk to school groups and multi-family walk to school groups (i.e., walking school buses), we can infer that adult supervision of walk to school groups, whether single- or multi-family, is important. These results were consistent with previous trials of walking school buses, that reported increases to children's ACS: a) a quasi-experimental trial,[24] b) a small randomized trial,[25] and c) a cluster randomized controlled trial.[17] Taken together, evidence is growing that adult supervised, walk to school programs are popular among parents. Their popularity is likely because they address parental safety concerns and are convenient, since parents can alternate the days that they walk the children to school, similar to carpools. In this evaluation, walk to school groups were organized and operated entirely by parents without any specific study funding. Greater positive parents' outcome expectations, i.e. costs/benefits of their children's ACS, were also associated with 26% higher odds of children's ACS. These results confirm the central role of parents to their children's ACS and extend findings from a previous randomized controlled trial in Houston, Texas, in which parents' outcome expectations were also positively related to ACS.[17] Weather has been cited by parents as a barrier to their children's ACS.[14, 15] We are among the first to quantify the relationship: for every one degree increase in temperature (Fahrenheit), there was a 3% higher odds of children's ACS. A 10 degree increase in temperature (F) would be expected to have 30% higher odds of ACS. As expected, the warmer the morning temperature, the greater the odds of children walking or cycling to school. Similar to previous studies, distance from home to school was inversely related to children's ACS: those who lived >0.5 miles from school had 77% lower odds of ACS. For demographic predictors, we confirm that boys had higher odds of ACS than girls as reported in several other studies.[5, 7] In contrast to some previous cross-sectional studies that reported higher unadjusted rates of ACS among Latinos,[5] in the present evaluation controlling for demographics, Latinos had a 72% lower odds of ACS. This finding was consistent with a previous report[13] that examined nationally representative data using a multivariate model to reduce confounding by demographic variables.

We have identified several demographic, family, and environmental predictors of ACS among children with relatively high rates of ACS from five communities in the US. These results confirm and extend previous studies' findings to a more geographically diverse population in the US. Given that increasing children's ACS is a national objective of Healthy People 2020,[3] these findings may help inform policies and programs to support children's ACS and provide targets for interventions among children with lower rates of ACS. For example, the National Center for Safe Routes to School (SRTS) provides a publicly available guide (http://guide.saferoutesinfo.org/) to help schools and communities develop SRTS programs that support children to safely walk or bike to school. These SRTS

programs may work to improve the infrastructure around schools, such as sidewalks and roadways, or develop programs to increase children's ACS such as walking school bus programs (http://guide.saferoutesinfo.org/walking_school_bus/index.cfm) or bicycle trains (http://guide.saferoutesinfo.org/walking_school_bus/bicycle_trains.cfm). The present study's findings support the National Center's strategy for disseminating implementation guidelines on walking school bus and similar adult supervised programs to increase elementary schoolchildren's ACS. Moreover, findings on the importance of distance from home to school also corroborate that school siting/location is an important issue, since centrally located community schools in close proximity to students' homes are more supportive of ACS than schools located at the periphery of communities.[26] Results also suggest that policies and programs should particularly focus on increasing girls' and Latinos' ACS, since they were at higher risk of passive commuting to school in this and other studies.

Strengths of this report include the observational design over one school year, the inclusion of a variety of schools and communities in multiple states, and the examination of individual-level, school-level, and environmental predictors of ACS. The major limitations are 1) the low participation rate and loss to follow up, which reflects families who agreed to participate in the original evaluation study and limits external validity; 2) the sample had relatively high rates of ACS, 59.6–64.2% at Times 1 and 2 versus 12.7% nationally,[13] and children who regularly participated in a walk to school group at Times 1 and 2 (78.3–79.4%), also limiting external validity; 3) ACS was assessed on only one day each at Times 1 and 2, which may not represent habitual commuting mode; and 4) the estimate of distance from home to school using maps.google.com has not been formally validated. However, these findings suggest several factors that merit further study in order to promote walking and cycling to school among populations with lower rates of ACS. Moreover, despite these limitations, the findings corroborate several previous experimental and epidemiological studies as outlined above.

In summary, this report identified several predictors of children's ACS over one school year including gender, ethnicity, parent outcome expectations, distance from home to school, participation in an adult-led walk to school group, and morning temperature. While these findings require confirmation by larger and more representative samples, the results suggest that policies and programs to support children's ACS should consider addressing these predictors in their design. From this evaluation and other studies,[17, 24, 25, 27] walking school bus and similar programs that involve adult-led walk to school groups appear to be a strong, positive influence for increasing children's ACS and therefore should be at the forefront of Safe Routes to School efforts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

School demographics.[a,b]

School	Grades	Setting (State)	Total Enrollment	Latino (%)	African-American (%)	White (%)	Other (%)	NSLP (%)
1	K-12th	Rural (CO)	216	10	0	89	0	43
2	PreK-5th	Rural (GA)	715	4	4	69	21	3
3	K-5th	Mid-size City (VA)	701	56	11	30	3	65
4	6–8th	Small Town (MS)	476	7	43	50	0	57
5	PreK-6th	Urban (MD)	749	34	58	4	4	72

[a] Abbreviations: National School Lunch Program=NSLP, Kindergarten=K, Pre-kindergarten=PreK, Colorado=CO, Georgia=GA, Virginia=VA, Mississippi=MS, and Maryland=MD.

[b] Eligible students included K-5th grade students in schools 1–3 and 5 while school 4 included 6–8th grade students.

Table 2

Participant characteristics (n=369).

	Time 1	Time 2*
	n (%)	n (%)
Child Gender		
Male	173 (46.88)	NA
Female	193 (52.30)	
Race/Ethnicity		
White	223 (60.43)	NA
African-American	67 (18.16)	
Latino	37 (10.03)	
Other	26 (7.05)	
Distance to School		
≤0.5 miles	155 (42.70)	NA
>0.5 miles	208 (57.30)	
Houehold Income		
≤$20,000	13 (3.52)	NA
$20,001-$50,000	56 (15.18)	
>$50,001	170 (46.07)	
Active Commuting to School		
Yes	220 (59.62)	237 (64.23)
No	149 (40.38)	132 (35.77)
Regularly Participated in a Walking School Bus		
Yes	293 (79.40)	289 (78.32)
No	65 (17.62)	75 (20.33)
	Mean (SD)	Mean (SD)
Age (years)	7.98 (2.28)	8.98 (2.28)
Parents' Outcome Expectations	6.66 (2.27)	6.68 (2.29)
Morning Temperature (F)	59.90 (12.02)	53.65 (12.79)

*NA=not applicable; some participants had missing data for some variables, and thus have fewer than n=369

Table 3

Generalized mixed-model for repeated measures predicting active commuting to school (n=369).*

	OR (95% CI)
Age (years)	0.99 (0.86–1.13)
Gender (reference=female)	2.59 (1.57–4.30)**
Race/Ethnicity (reference=non-Latino White)	
African-American	0.54 (0.21–1.38)
Latino	0.28 (0.12–0.65)**
Other	0.69 (0.25–1.88)
Parents' Outcome Expectations	1.26 (1.14–1.39)**
Time (Time 1 versus Time 2)	0.80 (0.56–1.13)
Distance to school (reference: ≤0.5 miles)	0.23 (0.14–0.37)**
Regularly Participated in a Walking School Bus (reference=no)	1.80 (1.14–2.86)**
Morning Temperature (F)	1.03 (1.01–1.05)**

* Model controlled for child's school.

** Significant at $p<0.05$.