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Original Research

Exploring the associations between active school transport, child obesity, and child poverty in California

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Abstract

Background: Over the last few decades, rates of active transport (AST) among school age children have decreased as rates of child obesity have increased. Thus, it has been proposed that increasing AST in this population would help stem the tide of child obesity and improve child health. The evidence for the capacity of AST to reduce child obesity, however, is mixed. Purpose: To examine the association between AST and child obesity among California school-age children and further investigate alternative explanations for the aforementioned mixed evidence. Methods: Spearman's correlation analyses were conducted in 2012 using AST data obtained from public elementary schools participating in the California Safe Routes to Schools program in 2010 (n=168), along with child health measures inversely related to child obesity, i.e., Body Composition (BC) and Aerobic Capacity (AC), extrapolated from the 2010-11 California Physical Fitness Test required by the State, and administered annually to students. The use of coded private information did not meet the definition of a human subject and did not require IRB review. Results: A negative and weak but significant association emerged between AST and BC (rs = -0.189, p=0.0014), indicating that AST rates increased, child obesity rates increased as well. A similar association emerged between AST and AC, but it was not statistically significant. A weak but significant association emerged between AST and child poverty (rs = 0.252, p=0.0017), indicating that as AST rates were higher among poor children. Strong and very significant associations emerged between child poverty and both AC (rs = -0.751, p<.0001) and BC (rs = -0.826, p<.0001), indicating that poor children had significantly worse health and higher weight. Conclusion: This study provides support for the scarce studies that have found that higher rates of AST are associated with higher rates of child obesity. It also replicates studies showing greater AST participation among poor children, and suggests that poverty may explain both higher obesity and higher AST rates among poor children, thus the observed, counterintuitive association between the latter. These results warn against child obesity policies that focus unduly on behavioral/environmental interventions yet neglect the role of the social determinants of child health. Further exploring how socioeconomic status interacts with health behaviors could help better understand the relationship between AST and child health and inform more effective public health policies.

INTRODUCTION

As rates of child obesity have increased exponentially over the last three decades[1-3] the percentage of students adopting active modes of school transport (AST) – such as walking or biking – has declined more than three-fold.[4,5] Because the relative imbalance between calories consumed and calories spent is largely seen as causing these higher rates of child obesity, researchers have been particularly interested in investigating how children's commuting practices relate to energy expenditure and child health in societies dominated by motor vehicle transportation.[6,7,8,9]

Relying on studies that show that children who adopt AST have higher levels of daily physical activity than those who do not,[10] researchers have proposed that increasing AST participation may help lower child obesity and improve child health.[10,11] However, the relationship between AST and the actual variable of interest, i.e., child obesity (as a marker of child health), is less clear, and little empirical evidence supports the position that AST leads to lower child obesity rates.[12] For instance, in a review of thirteen studies by Faulkner et al., nine demonstrated a positive association between children adopting AST and physical activity; two demonstrated a positive association between AST and calories expended; but only one out of ten studies examining body weight reported an association between engaging in AST and having a lower body weight.[12] In another review by Davison et al. most studies examined indicated that adopting AST was associated with greater levels of physical activity, but failed to support the hypothesis that AST may decrease Body Mass Index (BMI).[10] In a longitudinal study by Rosenberg et al., no association was found between adopting AST and changes in BMI.[13] Lastly, a study by Heelan et al. reported a statistically significant association between AST and BMI (only among obese children), albeit in the 'wrong' direction, i.e., engaging in AST was associated with higher BMI.[14]

In this retrospective, ecological, cross sectional study our primary examination is the association between AST and child obesity among 5th grade students in California. We further examine this association by exploring the relationship between child obesity and child poverty. This study is part of a larger project evaluating behavioral, environmental, socioeconomic and other determinants of child health.[15,16]

DATA AND METHODS

We obtained AST data from public elementary schools (N=168) within 17 counties participating in the California Safe Routes to Schools (SRTS) program. These data, collected via surveys over a two-year period ending in October 2010, estimated the percentage of school-age children adopting AST in each participating school. We have published detailed information about this dataset elsewhere.[15,16]

We extrapolated outcome measures of child health and obesity from the 2010-2011 Physical Fitness Test[17] – known as the FITNESSGRAM® – for students in California public schools.[18,19] The FITNESSGRAM® is a comprehensive battery of health-related tests that each California educational agency is required to administer annually to students in 5th, 7th, and 9th grades to monitor changes in physical fitness.[18,19] The test is comprised of six areas: 1) aerobic capacity (AC); 2) abdominal strength and endurance; 3) upper body strength and endurance; 4) body composition (BC); 5) trunk extensor strength and flexibility; and 6) flexibility.[18] Among these six areas, we selected two as proxy outcome measures for child obesity – the percentage of children who met healthy AC and BC standards – because they incorporated indicators that are clinically relevant when assessing the health effects of obesity (e.g. BMI, see Table 1 for the variable descriptions).[20,21]

Table 1. Health indicators from the FITNESSGRAM® California Department of Education, Statewide Assessment Division

FITNESSGRAM® Fitness Component	Variable Description	Variable Details
Aerobic Capacity (AC)	% of 5th grade students who passed the Calif. Physical Fitness Test - Aerobic Capacity area.	Test items: 1) Progressive Aerobic Cardiovascular Run (PACER); 2) One-Mile Run. Passing Score: a) Female & Male, ages 10 -11: score ≥40.2.
Body Composition (BC)	% of 5th grade students who passed the Calif. Physical Fitness Test - Body Composition area.	Test items: 1) Percent Body Fat (Skinfold Measurements/ Bioelectric Impedance Analyzer); 2) Body Mass Index. Passing Score: a) Female @ age 10: 11.6 - 24.3 % Body Fat & 14.1 - 19.5 BMI; b) Female @ age 11: 12.2 - 25.7 % Body Fat & 14.5 - 20.4 BMI; c) Male @ age 10: 8.9 - 22.4 % Body Fat & 14.3 - 18.9 BMI; d) Male @ age 11: 8.8 - 23.6 % Body Fat & 14.6 - 19.7 BMI.

Table 2. Rate of children in each school participating in AST, meeting aerobic capacity and body composition standards, 2010

Rate of children in each school:	Range	Median	Mean *(sd)*	
Participating in AST	2 - 71%	24%	26%	*(0.15)*
Meeting aerobic capacity standards	2-99%	73%	68%	*(0.19)*
Meeting body composition standards	26-87%	55%	57%	*(0.14)*

Table 3. Percentage of schools that met health standards when baselines were set at 70%, 80%, and 90% of children in each school meeting BC and AC criteria (n=168)

Grade	Percentage of children in each school meeting BC and AC standards	Percentage of schools meeting health standards *(n)*	
		Body Composition	Aerobic Capacity
C	*>= 70%*	23.21% *(39)*	53.57% *(90)*
B	*>=80%*	4.17% *(7)*	32.74% *(55)*
A	*>=90%*	0% *(0)*	8.93% *(15)*

Only child health data at the 5th grade level was available for all of the schools that were included in the SRTS dataset, therefore, only this grade was analyzed for this study. Further, we conducted our analyses at the school level for two reasons: 1) we did not have individual level data for AST because these data were reported de-identified by participating schools in the CA SRTS program and 2) we were able to obtain school level, and not individual level, data on child health from the California Department of Education because public schools in the state are required to administer the FITNESSGRAM test annually and report the results. Thus, we were unable to apply a hierarchical model to our analysis because we could not connect individual child level data across these data sets.

To further explore the mixed relationship between AST and child obesity, we examined the relationship between AST rates and child poverty. For this purpose we obtained school level data on free and reduced price meals (FRPM), where eligibility is determined by income,[22] from the California Department of Education, and used this information as a proxy measure for child poverty. We excluded schools with missing FRPM data (n=153) from the analysis.

We used SAS software (SAS, version 9.2) for all analyses, including bivariate analyses, means, and Spearman rank correlations. Spearman rank correlation coefficients were used because the data in this study did not meet the assumption of normal distribution. We considered a Spearman rank correlation coefficients between 0.1 and 0.3 *weak*, greater than 0.3 up to 0.5 *moderate*, and greater than 0.5 through 1.0 *strong*. We considered correlations *significant* if the p-value was equal to or smaller than 0.05 and *very significant* if the p-value was equal to or smaller than 0.001. The use of coded private information did not meet the definition of a human subject and did not require IRB review.

FINDINGS

There was quite a variable range in the rate of children in each school participating in AST, meeting AC and BC standards (Table 2). AST participation rates in each school ranged from as low as 2 percent to as high as 71 percent, with a mean of 26 percent. The percentage of children in each school meeting healthy AC standards ranged from as low as 2 percent to as high as 99 percent with a mean of 57 percent, whereas the percentage of children in each school meeting healthy BC standards ranged from as low as 26 percent to as high as 87 percent with a mean of 68% percent.

To better illustrate the differences in child health achievements at the school level, we “graded” the schools based on the percentage of students in each school meeting physical fitness tests. We set standards to determine in what percentage of schools 70%, 80%, or 90% of the children met healthy BC or AC standards. Our chosen values of 70% = C, 80% = B, or 90% = A are commonly used to score academic performance and are relatable scales that are broadly and easily understood. Our results were astounding – in most schools the majority of children failed to meet AC and BC standards. For BC standards, the percentage of schools that scored in the C grade range was 23.21%, in the B grade range was 4.17%, and in the A grade range was 0%. Results were slightly better for meeting AC standards: the percentage of schools that scored in the C grade range was 53.57%, in the B grade range was 32.74% and in the A grade range was 8.93% (Table 3).

The Spearman rank correlation revealed a negative association between AST participation and BC (r_s = -0.189) indicating that as the percentage of children meeting healthy BC standards *increased*, the percentage of children engaging in AST *decreased* (Table 4). Although this association was weak by our own definition, the finding was statistically significant (p=0.014). Similarly, a weak negative association emerged between AST participation and AC (r_s = -0.093) indicating that as the percentage of children meeting AC standards *increased*, the percentage of children engaging in AST *decreased*. However, this association was not statistically significant (p=0.232). Thus, these data provide support for an association between higher AST and poorer health outcomes (Figure 1).

The correlation analysis between AST rates and child poverty indicate that in schools with worse BC and AC outcomes and slightly higher AST rates, generally higher percentages of students received free or reduced price meals from the National School Lunch Program (Table 4 & Figures 2). The Spearman rank correlation revealed a weak, positive association between AST and FRPM (r_s = 0.252) indicating that as the percentage of children receiving FRPM, i.e., poor, *increased*, the percentage of children engaging in AST *increased* as well. This association was statistically significant (p=0.0017). Furthermore, a strong, negative and very significant association emerged between FRPM and AC standards (r_s = -0.751, p<0.0001) as well as between FRPM and BC standards (r_s = -0.826, p<0.0001), indicating that worse child health coexisted with significantly higher rates of child poverty.

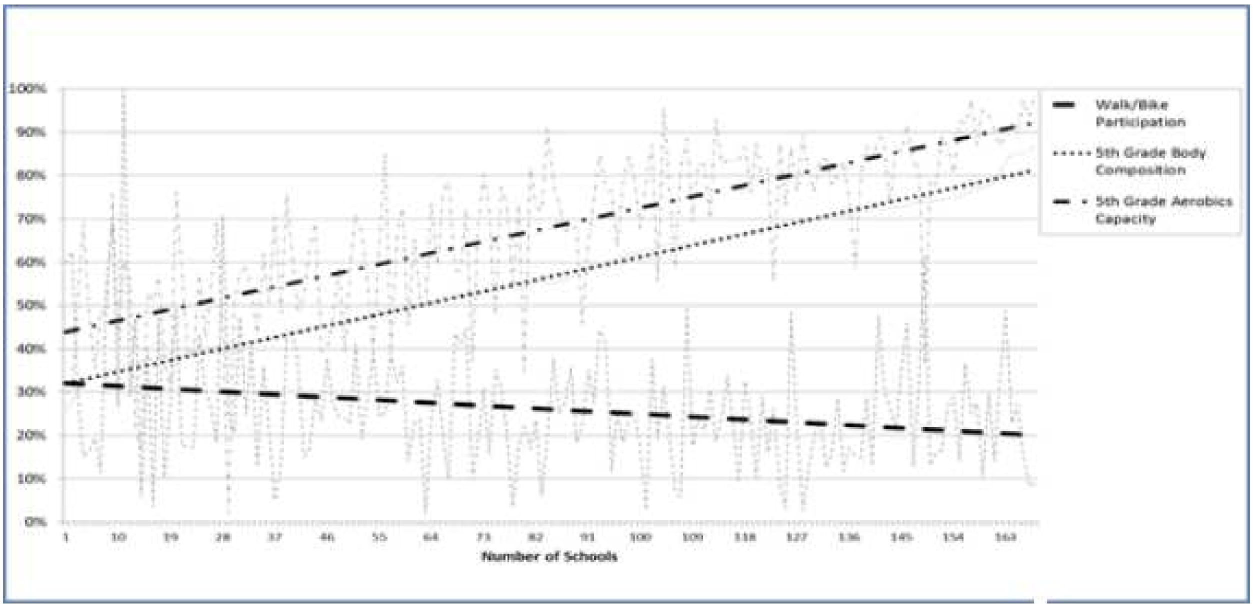

Figure 1. Percent of Children Meeting Healthy Body Composition (BC) and Aerobic Capacity (AC) Standards vs. Percent of Children Participating in Active School Transport Programs (AST)

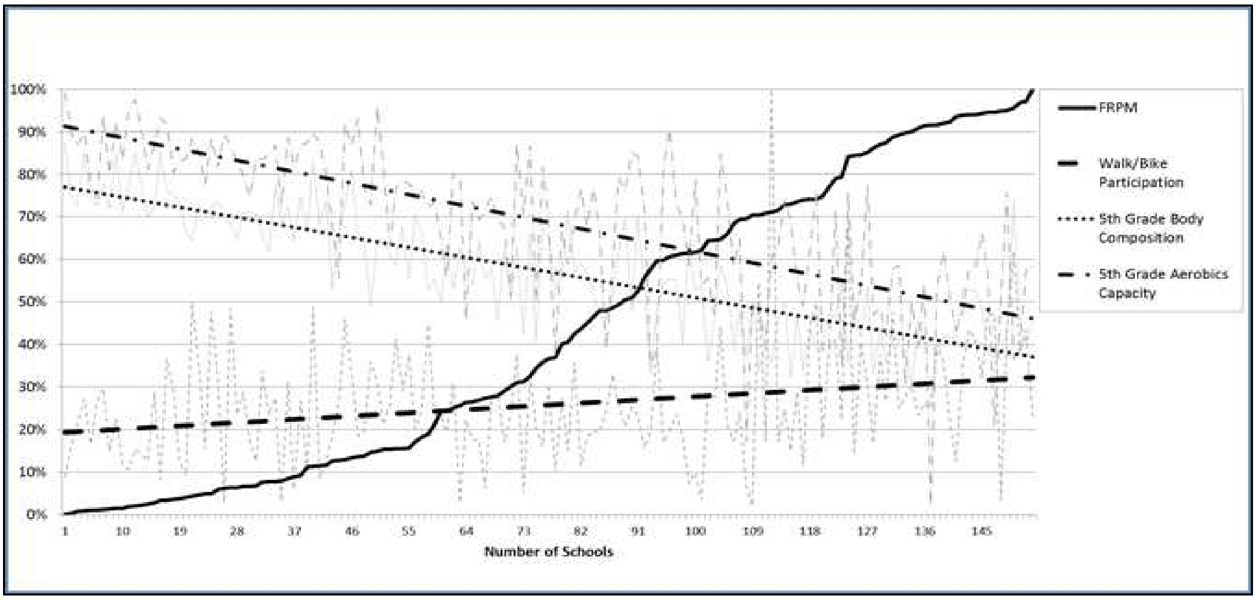

Figure 2. Percent of Children Meeting Healthy Body Composition (BC) and Aerobic Capacity (AC) Standards vs. Percent of Children Participating in Free/Reduced Price Meals (FRPM) & Active School Transport Programs (AST)

Table 4. Spearman Rank Correlations for Percent of Children Meeting Healthy Body Composition (BC) and Aerobic Capacity Standards (AC) and Percent of Children Participating in Free/Reduced Price Meals (FRPM) & Active School Transport Programs (AST)

		Walk/Bike Participation	5th Grade Aerobic Capacity	5th Grade Body Composition
Walk/Bike Participation	r_s		-0.093	-0.189
	p		*0.232*	*0.014**
	n		*(168)*	*(168)*
FRPM	r_s	0.252	-0.751	-0.826
	p	*0.0017**	*<.0001***	*<.0001***
	n	*(153)*	*(153)*	*(153)*

*=statistically significant, p-value equal to or smaller than 0.05.

**=statistically very significant, p-value equal to or smaller than 0.001

DISCUSSION

We examined the association between AST and child obesity in a non-random sample of schools in California for which data on AST was available via the SRTS program. When comparing the percentage of children meeting healthy AC and BC standards, students in this study sample performed slightly better than that reported by the California Department of Education, 2011-12 Physical Fitness Report Summary for 5th Grade students in the state in general.[23] The mean percentage of children in this study meeting healthy AC and BC standards was 68% and 57%, respectively, compared to 62.3% and 52.5% for 5th graders in California overall. [23]

When examining the association between AST and child health outcomes, we found a weak, yet statistically significant, negative association between AST rates and BC, and a weak, albeit not statistically significant, negative association between AST and AC., indicating that higher rates of AST coexist with higher rates of child obesity and overall worse child health. When examining the association between AST and child poverty, we found a weak and statistically significant association between AST and our proxy variable for poverty, FRPM, indicating that poor children are more likely to engage in AST. Last, when examining the association between our child health outcomes and child poverty, we found a negative, very strong and statistically significant association between them, providing further evidence for the well-established fact that poor children tend to have worse health. Thus our findings suggest that child poverty is associated not only with worse health, including but not limited to higher BMI, but also higher AST, for reasons that require further investigation. They also suggest that child poverty is the third variable that explains the counterintuitive association between the variables AST and child obesity.

To our knowledge, only one previous study found higher rates of AST coexisting with higher rates of child BMI. [14] This study included six hundred U.S. child participants ages 9-11 years old, a population that is comparable to our examination of 5th graders. As noted by the authors, the findings from this study suggest that "the more physical activity accumulated from active commuting, the greater the BMI." [14] This trend appeared to be led by the weight gain of children in the overweight subsample, who gained as much weight as their driven peers and more weight than their normal weight peers over a 6 month period. The authors of this study state that this finding was "quite surprising," [14] but do not explore it further. Instead, they explain it away by suggesting that participants must not have accumulated enough physical activity through AST to make a difference in their weight, and conclude that "by increasing the frequency of active commuting trips to and from school additional energy expenditure necessary to attenuate excessive weight gain may be accumulated." [14]

In contrast to Heelan et al., [14] we did not assume that the frequency of AST was not high enough to yield the expected and only possible association, but explored alternative explanations. After all, that AST participation is associated with worse health outcomes, including higher BMI, does not necessarily mean that AST worsens child health, but could well mean that children with worse health, including higher BMI – for other reasons, such as their low socioeconomic status (SES) – are more likely to adopt AST. Indeed, there is evidence that children adopting AST tend to be lower income[24-27] and that rates of child obesity are greater for poor than for non-poor children.[28] A study conducted by the first author in a low-income neighborhood found transportation barriers – lack of car ownership or appropriate public transportation substitutes – to purchasing healthy foods, lending support to the hypothesis that lack of car ownership due to poverty may lead both to difficulties for families to access healthy nutrition and to a greater adoption of AST among children.[29] Thus while our findings were similar to that of Heelan et al.,[14] our study goes further by exploring and proposing poverty as a potential explanatory factor. Specifically, our findings suggest that it is poverty that explains the negative association between AST and at least one child health outcome.

Our study has limitations. The California Safe Routes to School Student Tallies used to assess AST do not provide a complete estimate of AST among school-age children attending all public schools in the state, so our findings are not generalizable. Second, only health data for 5th grade was available for all schools, whereas AST data represented students of a wider age range. Third, we did not control for other covariates, such as race, ethnicity or percent English-proficient children per school, which may help explain the counterintuitive findings. To note, however, these covariates are also associated with, and are indicators of, poverty,[30,31] so their inclusion would likely reinforce our findings. Fourth, the cross-sectional and observational design of this study does not permit to distinguish correlation from causation. Finally, while this study is ecological in nature, we caution readers against the ecological fallacy, especially because there is no information available about the individual members of the populations compared. Data was analyzed at the aggregate, rather than the individual, level, so the full meaning of the identified correlations remains unclear.

Nonetheless, these limitations are pervasive in studies on the effects of AST on child health. In the review by Faulkner et al. mentioned earlier, only about 50% of the studies included some form of random selection of cases that could strengthen generalizability.[12] Also, few studies of AST examine socioeconomic variables,[7] or do so in relation to child health outcomes. Last, problems of interpretation of observational studies pervade even the handful of studies that indicate that AST may reduce BMI, thus favorably affect child health. As Rosenberg et al. pointed out, findings indicating that greater AST participation is associated with lower BMI do not necessarily indicate that AST *lowers* BMI, but may well indicate that leaner children are more likely to adopt AST, at least in some cases.[10]

In concluding, the results of our study, while preliminary given the methodological limitations, are interesting enough to report and to suggest the need for more carefully designed studies that build on our initial observation. For instance, longitudinal, quasi-experimental designs can assist in inferring causation from correlation. Further, the qualitative investigation and comparative analysis of the multiple factors contributing to child obesity in *both* lower *and* higher income communities can help clarify the nature of the identified associations, and the systematic examination of how SES interacts with child health more generally can help improve the understanding of the precise role of AST in contributing to the latter.

Importantly, we do not wish to suggest that policy makers should not encourage AST, nor do we intend to argue that AST is not beneficial to child health, and may even yield additional benefits (e.g. be more favorable to environmental sustainability). However, our findings do indicate the need to reexamine policy efforts that focus unduly on behavioral/environmental interventions, like encouraging AST, as a means to counteract child obesity, yet fail to pay due attention to critical social determinants of child health, such as child poverty.

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