Changes in Self-Efficacy and Outcome Expectations from Child Participation in Bicycle Trains for Commuting to and from School

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Public Health

University of Washington

2017

Committee:

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Program Authorized to Offer Degree:

School of Public Health - Nutritional Sciences

University of Washington

Abstract

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Background: Active commuting to school (ACS) is associated with increased physical activity and lowered risk of obesity. In observational studies, ACS was associated with child self-efficacy, parent self-efficacy and parent outcome expectations, although few experiments have assessed changes in these behavioral constructs.

Aim: This study examined the effects of a bicycle train intervention on child self-efficacy, parent self-efficacy and parent outcome expectations in a diverse, low socioeconomic status (SES) population.

Methods: Data was from a 2014 bicycle train pilot randomized controlled trial (RCT) on 4-5th graders, n=54, from four schools serving low-income populations in Seattle, WA. The intervention was a bicycle train program led by study staff who cycled to/from school daily while controls received no intervention. Responses to validated child self-efficacy, parent self-efficacy, and parent outcome expectations questionnaires ranged from 1-3. Adjusted linear mixed effects models estimated standardized coefficients for child self-efficacy, parent self-efficacy and parent outcome expectations comparing intervention and controls from time 1 (pre-intervention) to time 2 (final 4-6 weeks of intervention).

Results: The intervention group had increases in child self-efficacy of 0.84 standard deviations (95% CI [0.37, 1.31]), parent self-efficacy of 0.46 standard deviations (95% CI [0.05, 0.86]) and parent self-efficacy of 0.47 standard deviations (95% CI [0.17, 0.76]) compared to controls from times 1 to 2.

Conclusion: A bicycle train improved child self-efficacy, parent self-efficacy and parent outcome expectations, which warrants a larger RCT to examine long term changes to these behavioral constructs and ACS.

INTRODUCTION

Childhood obesity has been on the rise in the United States for decades[1]. Among children 6-11 years old, approximately 17.5% are obese and 5.6% are extremely obese, with even higher percentages in several minority racial/ethnic groups[1]. Childhood obesity is associated with numerous health conditions such as type 2 diabetes, asthma, and cardiovascular disease as well as negative social, emotional and academic consequences[2]. Inadequate physical activity is strongly tied to overweight and obesity in children, and greater physical activity is linked to numerous health benefits[2,3].

Active commuting to school (ACS) through walking or cycling is associated with higher moderate-to-vigorous physical activity in children and lower body mass index (BMI) z-score, waist circumference and skinfolds[4,5,6]. Hence, bicycle trains[7], an encouragement component of the Safe Routes to School program, is a promising way to increase children's physical activity. A bicycle train is an adult-chaperoned group of children that cycles together to and from school and picks up or drops off children along designated stops. A child's participation in ACS is associated with greater child self-efficacy[8], parent outcome expectations[9], parent self-efficacy[10] and support[8,11]. Self-efficacy can be defined as one's confidence in their ability to complete an action and has been repeatedly shown to have a strong correlation to physical activity in youth[12,13]. Outcome expectations can be defined as the anticipated risks and benefits associated with performing an action and has been shown to be associated with a child's participation in ACS[9].

We sought to determine the effects of a bicycle train intervention on child self-efficacy (the child's confidence in their own ability to cycle to and from school), parent self-efficacy (the parent's confidence in their ability to allow their child to cycle to and from school), and parent outcome expectations (the parent's anticipated positive and negative outcomes of their child cycling to and from school) in a diverse, low socioeconomic status (SES) population. While the original pilot randomized controlled trial (RCT) of the bicycle train intervention[14] reported improvements in cycling to school and physical activity, we focused the present study on the behavioral constructs of self-efficacy and outcome expectations to provide preliminary results and inform a larger and longer future RCT. We hypothesized that participation in a bicycle train would lead to improved self-efficacy and outcome expectations, which can in turn lead to more physical activity among the children.

METHODS

Participants

We conducted a secondary analysis of the original pilot bicycle train cluster RCT[14]. This trial and the present analyses were approved by the Institutional Review Board (IRB) of Seattle Children's Hospital and by the Research, Evaluation, and Assessment Office of Seattle Public Schools. This analysis focuses on self-efficacy and outcome expectations as outcomes. For the bicycle train RCT, we recruited four Seattle Public Schools designated as federal Title 1 to participate and applied the following school-level inclusion criteria: >60% of students qualified for federal free or reduced lunches, <50% of the student body were non-Latino white students, and none had existing bicycle train or walking school bus programs. Within these schools, participants were recruited based on the following participant-level inclusion criteria: currently enrolled in the 4th or 5th grade, ability to ride or learn to ride a bicycle, and lived within a 2-mile radius of the school or had parents who agreed to drop off the participant and bicycle within the

2-mile zone. Enrollment at each school was capped at n=15, i.e. n=60 total students for all four schools, to fit the size and staffing allowed by the grant funding mechanism. Child participants provided written informed assent and parents provided written informed parental consent prior to any study procedures. After participant baseline assessments were completed, schools were randomly assigned to either intervention (2 schools) or control (2 schools) conditions.

Prior to randomization, all participants received bicycles (provided in part by Bike Works, bikeworks.org), equipment (helmets, locks, and front/rear lights), and a 2-3 hour professional riding safety course designed for children and provided by our community partner, Cascade Bicycle Club (www.cascade.org). Only the intervention group received the voluntary Bicycle Train program where there was a designated cycling route to and from school with stops assigned based on proximity to the participants' home addresses. Study staff rode the route and chaperoned participants to and from school Monday through Fridays for the 4-6 week intervention period, except on days with severe weather, early dismissal, or no school.

Covariates

Parents reported their children's age, sex, race/ethnicity and home address (Table 1). Their reported address was entered into the Google maps website (http://maps.google.com) to obtain the network distance from home to school using the pedestrian option. For children who lived beyond the 2-mile radius from their respective school, distance from home to school was measured from their designated starting bicycle train stop to their school. Parents also reported their perceived neighborhood disorder using the 8-item neighborhood disorder scale that measures neighborhood safety, violence, drug traffic, and child victimization with scores from 0-24[15,16]. A Bike Score ranging from 0-100 (with 100 being best for cycling) was obtained for each participant by entering their home address into the WalkScore website (http://walkscore.com). Bike Score assesses how bike-friendly an area is based on four factors: 1) bike lanes, 2) hills, 3) destinations and road connectivity, and 4) the amount of bike commuters, and this value is associated with cycling behavior among adolescents and adults[17]. Each participant's height and weight were measured at school twice by trained research staff using the Seca 214 stadiometer and the Tanita BWB-800S digital scale. If the two measurements were more than 0.2cm or 0.2kg apart, a third measurement was taken and the average of the two closest measurements were used to calculate their BMI z-score based on United States growth charts[18]. BMI z-score was intended as a covariate in the original pilot study, rather than as an outcome variable, due to the brief duration of the intervention.

Survey

All child participants and parents completed a survey in the 1-2 weeks prior to randomization (time 1) and during the final 4-6 weeks of the intervention period (time 2). Children responded to 16 questions and parents responded to 15 questions indicating self-efficacy on a scale of 1 to 3, 1 being "Not Sure," 2 being "A Little Sure," and 3 being "Very Sure" that the child can ride a bicycle to and from school. Parents also answered an additional 14 questions on a scale of 1-3, 1 being "Do Not Agree," 2 being "Agree a little," and 3 being "Agree a lot" to positive outcome expectations (better health, being on time) and negative outcome expectations (getting lost, being unsafe) for their child riding a bicycle to and from school. These surveys were adapted from questionnaires that assessed child and parent self-efficacy and parent outcome expectations for children's walking to school[5,8,19], which had acceptable internal constancy (Cronbach's alpha $\geq$0.75)[19] and validity with children's active commuting to school in bivariate ($r=0.165$ to 0.182) and adjusted analyses (βeta=1.60, $p<0.05$)[5]. Negative outcome expectations were reverse coded for analyses.

Statistical Analysis

We conducted statistical analyses using STATA 12.0 (StataCorp LP, College Station, TX) in 2016. Using the same methods as the original bicycle train RCT[14], we conducted our primary analysis using three independent linear mixed effects models[20,21] (xtmixed command) to measure the association between the bicycle train intervention and each of the outcomes of child self-efficacy, parent self-efficacy or parent outcome expectations from time 1 to time 2. We used a mixed effects approach due to several advantages over linear regression and ANOVA approaches[20,21,22]: (1) it is robust to error distribution misspecification and (2) it maximizes use of all available data because participants are not dropped from the analyses when missing data at a single time point. Random effects included participants (n=54), who were nested within schools (n=4), which accounts for within-child correlation and within-school correlation from time 1 to time 2, respectively. Fixed effects included experimental group, time point, and a group x time interaction term. Because participants were randomized to intervention or control groups, the group x time interaction term estimates how changes from time 1 to time 2 differ between intervention and control groups. Coefficients were standardized to show the difference in differences in terms of standard deviations. We adjusted for the following covariates (fixed effects): age, sex, race/ethnicity, BMI z-score, neighborhood disorder, distance from home to school, and Bike Score.

RESULTS

54 participants were successfully enrolled in the study, 24 from the two intervention schools and 30 from the two control schools. Only one school did not enroll the expected 15 students, and this reflected the smaller size of the school; the other three schools had a waitlist of

>40 students who fell outside of the enrollment cap. Overall, the mean age was 9.9 ± 0.7 years with 64.8% females (Table 1). 27.8% were Latino, 24.0% were non-Latino Black, 20.4% were Asian, 5.6% were Non-Latino White, and 14.8% were Other race/ethnicity. Mean child BMI z-score was 0.84 ± 1.00, mean neighborhood disorder was 15.7 ± 7.4 out of 24, mean distance from home to school was 0.8 ± 0.6 miles, and mean Bike Score was 63.2 ± 16.9 out of 100. No adverse events, such as injuries requiring medical help, were reported throughout the study.

For child self-efficacy, the intraclass correlation coefficient (ICC) was 0.003 (95% CI [<0.00001, 0.13]). In an unadjusted linear mixed effects model, the intervention group had an increase in child self-efficacy of 0.93 standard deviations (95% CI [0.46, 1.40]) compared to the control group from times 1 to 2. In an adjusted linear mixed effects model (Table 2), the intervention group had an increase in child self-efficacy of 0.84 standard deviations (95% CI [0.37, 1.31]) compared to the control group from times 1 to 2. This difference was due to an average decrease in child self-efficacy of 0.43 standard deviations (95% CI [-0.76, -0.11]) in the control group and an average increase of 0.40 standard deviations (95% CI [0.05, 0.75]) in the intervention group from times 1 to 2.

For parent self-efficacy, the ICC was 0.10 (95% CI [<0.00001, 0.36]). In an unadjusted linear mixed effects model, the intervention group had an increase in parent self-efficacy of 0.63 standard deviations (95% CI [0.21, 1.04]) compared to the control group from times 1 to 2. In an adjusted linear mixed effects model (Table 3), the intervention group had an increase in parent self-efficacy of 0.46 standard deviations (95% CI [0.05, 0.86]) compared to the control group from times 1 to 2. This difference was due to an average decrease in parent self-efficacy of 0.25 standard deviations (95% CI [-0.52, 0.03]) in the control group and an average increase of 0.21 standard deviations (95% CI [-0.09, 0.51]) in the intervention group from times 1 to 2.

For parent outcome expectations, the ICC was 0.04 (95% CI [<0.00001, 0.23]). In an unadjusted linear mixed effects model, the intervention group had an increase in parent outcome expectations of 0.65 standard deviations (95% CI [0.33, 0.98]) compared to the control group from times 1 to 2. In an adjusted linear mixed effects model (Table 4), the intervention group had an increase in parent outcome expectations of 0.47 standard deviations (95% CI [0.17, 0.76]) compared to the control group from times 1 to 2. This difference was due to an average decrease in parent outcome expectations of 0.32 standard deviations (95% CI [-0.52, -0.12]) in the control group and an average increase of 0.14 standard deviations (95% CI [-0.07, 0.36]) in the intervention group from times 1 to 2.

DISCUSSION

Our pilot cluster RCT results show that a bicycle train intervention improved child and parent self-efficacy as well as parent outcome expectations for their child cycling to and from school in the short term. These increases of 0.46 to 0.84 standard deviations were all statistically significant and consistently positive, as hypothesized. Because the intervention group had significant increases in all three outcomes, these findings warrant future research on using bicycle train programs to improve self-efficacy, outcome expectations and ultimately physical activity in children.

Child self-efficacy could serve as a mediator of the intervention on the outcome, i.e., bicycle trains improve self-efficacy, which in turn increases cycling to school and physical activity[23]. Our study suggests that a bicycle train program can be an effective way to target and improve children’s self-efficacy for cycling to and from school. Future larger studies should examine self-efficacy as a mediator of the intervention on cycling to school by using rigorous mediation analytic methods[24,25,26]. Our research also suggests that simply giving a child a bicycle and related equipment, which was the control condition in our study, is not as effective as providing a behavioral intervention that also incorporates cycling to and from school to build their confidence in cycling.

Parental influences such as their own self-efficacy and outcome expectations for allowing their child to cycle to and from school can affect a child's physical activity levels, sometimes even more so than the child's own attitudes[10,12,13]. It has been shown that parental constraints due to factors such as perceived risk could lower active commuting and physical activity in their children[27]. Our study shows that a bicycle train program could potentially improve parents' positive outcome expectations and mitigate negative outcome expectations. These findings suggest that certain components of a bicycle train program (chaperoned, riding in a group) may address the concerns that contribute toward parental limitations on their children's ACS.

Our findings vary in similarity to previous studies on the association between ACS and child or parent self-efficacy or parent outcome expectations, although most previous studies were observational and reported on cross-sectional associations. For example, in a cross-sectional ACS study, there was a significant association (beta = 0.18) between parent self-efficacy and children's ACS[19]. A large study on ACS conducted in Texas identified that both child self-efficacy (beta = 0.16) and parent self-efficacy (beta = 0.63) were significantly associated with children's ACS[10]. In adjusted analyses from a walking school bus pilot RCT, parent outcome expectations were significantly associated (coefficient=1.6) with increases in children's ACS[5].

Some of the limitations of our pilot study included the small sample size and short duration of the intervention. The outcomes of our study may not reflect those of a long-term bicycle train program. Our results may not be generalizable to children who are not in the 4th or

5th grade or who are not of low SES. We provided bicycles and safety gear to the participants of this study, but obtaining cycling equipment could present as a barrier to joining bicycle trains for many low-SES children. Blinding after randomization was not possible due to the visible nature of the intervention. Strengths of the study included its rigorous cluster RCT design and low-SES sample, a population at high risk for inadequate physical activity and child obesity[28]. Finally, to the best of our knowledge, this was the first experimental bicycle train study.

CONCLUSION

Participation in a short-term bicycle train improves child and parent self-efficacy and parent outcome expectations for the child cycling to and from school. Implementing bicycle train programs in schools could be an effective way to increase physical activity in children. Our 4-6 week intervention showed that offering a voluntary bicycle train program for transportation to and from school leads to improved behavioral indicators of children's cycling to and from school among parents and children. Because this was a pilot study, further research is needed to determine the circumstances in which bicycle trains could be most effective in the long term and with a larger sample of children. Various ages, settings, distances and other factors should be examined to improve generalizability. Other considerations include school siting, school resources (e.g. availability of bicycle racks), cost effectiveness, and availability of staff to supervise ACS programs. Bicycle trains may play a valuable role in addressing inadequate physical activity and childhood obesity, and it is worthwhile to determine how to successfully implement sustainable bicycle train programs in schools.

ACKNOWLEDGEMENTS

Jason Mendoza

Andrew Dannenberg

Wren Haaland

Research staff from Seattle Children's Research Institute

Staff and participants from the Seattle Public Schools

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TABLES

Table 1. Characteristics of child participants pre-intervention for the bicycle train pilot cluster randomized controlled trial.

	Intervention (n=24)	Control (n=30)	All (n=54)
Child age (years)	9.8±0.8	10.0±0.7	9.9±0.7
Female, n (%)	13 (54.1%)	22 (73.3%)	35 (64.8%)
Race/Ethnicity, n (%)			
Non-Latino White	1 (4.2%)	2 (6.7%)	3 (5.6%)
Non-Latino Black	9 (37.5%)	4 (13.3%)	13 (24.0%)
Latino	5 (20.8%)	10 (33.3%)	15 (27.8%)
Asian	3 (12.5%)	8 (26.7%)	11 (20.4%)
Other	4 (16.7%)	4 (13.3%)	8 (14.8%)
Not Specified	2 (8.3%)	2 (6.7%)	4 (7.4%)
Child BMI z-score	0.96 ± 0.94	0.75 ± 1.05	0.84 ± 1.00
Neighborhood disorder	17.0 ± 7.5	14.7 ± 7.2	15.7 ± 7.4
Distance from home to school (miles)	0.8 ± 0.4	0.9 ± 0.6	0.8 ± 0.6

Bike Score	67.6 ± 15.1	59.3 ± 17.7	63.2 ± 16.9

Table 2. Adjusted linear mixed effects model for child self-efficacy (n=54)

	Beta Coefficient	95% Confidence Interval
Group		
Control	Reference	
Intervention	-0.33	-0.88, 0.22
Time		
1	Reference	
2	**-0.43**	**-0.76, -0.11**
Group x Time	**0.84**	**0.37, 1.31**
Age	-0.01	-0.15, 0.13
Sex		
Female	Reference	
Male	0.03	-0.20, 0.27
Race/Ethnicity		
Non-Latino White	Reference	

Non-Latino Black	-0.12	-0.66, 0.43
Latino	-0.02	-0.54, 0.49
Asian	-0.22	-0.76, 0.31
Other	-0.30	-0.85, 0.25
BMI z-score	0.07	-0.05, 0.20
Neighborhood disorder	0.007	-0.005, 0.02
Distance from home to school (miles)	-0.15	-0.36, 0.07
Bike Score	-0.001	-0.008, 0.006

Bolded = p<0.05

Table 3. Adjusted linear mixed effects model for parent self-efficacy (n=54)

	Beta Coefficient	95% Confidence Interval
Group		
Control	Reference	
Intervention	0.02	-0.50, -0.53
Time		
1	Reference	

2	-0.25	-0.52, 0.03
Group x Time	**0.46**	**0.05, 0.86**
Age	-0.04	-0.21, 0.13
Sex		
Female	Reference	
Male	0.22	-0.06, 0.51
Race/Ethnicity		
Non-Latino White	Reference	
Non-Latino Black	-0.17	-0.82, 0.49
Latino	0.11	-0.51, 0.74
Asian	-0.07	-0.72,0.57
Other	0.03	-0.63, 0.69
BMI z-score	-0.08	-0.23, 0.07
Neighborhood disorder	-0.005	-0.02, 0.009
Distance from home to school (miles)	-0.22	-0.48, 0.04
Bike Score	0.01	-0.002, 0.02

Bolded = $p<0.05$

Table 4. Adjusted linear mixed effects model for parent outcome expectations (n=54)

	Beta Coefficient	95% Confidence Interval
Group		
Control	Reference	
Intervention	-0.005	-0.58, 0.57
Time		
1	Reference	
2	**-0.32**	**-0.52, -0.12**
Group x Time	**0.47**	**0.17, 0.76**
Age	-0.05	-0.15, 0.06
Sex		
Female	Reference	
Male	0.10	-0.10, 0.30
Race/Ethnicity		
Non-Latino White	Reference	

Non-Latino Black	0.02	-0.45, 0.49
Latino	0.08	-0.37, 0.53
Asian	-0.13	-0.60, 0.33
Other	-0.13	-0.60, 0.34
BMI z-score	-0.05	-0.15, 0.06
Neighborhood disorder	-0.01	-0.01, 0.001
Distance from home to school (miles)	-0.05	-0.23, 0.14
Bike Score	0.003	-0.003, 0.01

Bolded = p<0.05