ann. behav. med. (2013) 45 (Suppl 1):S101–S107
DOI 10.1007/s12160-012-9440-z

BRIEF REPORT

Effect of Bike Lane Infrastructure Improvements on Ridership in One New Orleans Neighborhood

Kathryn M. Parker, M.P.H. · Janet Rice, Ph.D. · Jeanette Gustat, Ph.D. · Jennifer Ruley, P.E. · Aubrey Spriggs, Ph.D. · Carolyn Johnson, Ph.D.

Published online: 19 January 2013

Abstract
Background Incorporating cycling into daily life is one way to increase physical activity.
Purpose This study examined the impact of building new bike lanes in New Orleans to determine whether more people were cycling on the street and with the flow of traffic after bike lanes were built.
Methods Through direct observation of one intervention and two adjacent streets, observers counted cyclists riding on the street and sidewalk, with and against traffic, before and after installation of the lanes. Data were tallied separately for adults, children, males, females, and by race for each location.
Results There was an increase in cyclists on all three streets after the installation of the bike lanes, with the largest increase on the street with the new lane. Additionally, the proportion of riders cycling with traffic increased after the lanes were striped.
Conclusions Bike lanes can have a positive impact in creating a healthy neighborhood.

Keywords Bicycling · Built environment · Bicycle lanes · Transportation infrastructure · Environmental design · Active living

K. M. Parker (✉)
Prevention Research Center, Tulane School of Public Health and Tropical Medicine,
1440 Canal Street, TW-19, Suite 2301,
New Orleans, LA 70112, USA
e-mail: kparker1@tulane.edu

J. Rice
Department of Biostatistics and Bioinformatics, Tulane School of Public Health and Tropical Medicine,
1440 Canal Street, TW-19, Suite 2301,
New Orleans, LA 70112, USA

J. Gustat
Department of Epidemiology, Tulane School of Public Health and Tropical Medicine,
1440 Canal Street, TW-19, Suite 2301,
New Orleans, LA 70112, USA

J. Ruley
Louisiana Public Health Institute,
1515 Poydras Street Suite 1200,
New Orleans, LA 70112, USA

A. Spriggs · C. Johnson
Department of Global Community Health and Behavioral Sciences, Tulane University School of Public Health and Tropical Medicine,
1440 Canal Street, TW-19, Suite 2301,
New Orleans, LA 70112, USA

Background

Overweight and obesity are major public health problems in the USA affecting both children and adults. Some 68 % of men and women over 20 years of age living in the USA are either overweight or obese [1]. Overweight and obesity are also affecting children; 16.9 % of children and adolescents aged 2–19 are above the 95th percentile, and 31.7 % are above the 85th percentile [2]. In New Orleans, rates of obesity and overweight are near national averages. According to the 2010 New Orleans Behavioral Risk Factor Surveillance System telephone survey, 31.4 % of adults were classified as obese and 32.6 % were overweight [3]. For New Orleans youth, 17 % were obese, compared to 13 % nationally [4].

Active transportation, such as biking and walking for shopping and going to work or school, is one way for people to fit regular exercise into their daily schedule. A comparison of both self-reported and objectively measured health and travel data for 14 countries, 50 US states, and 47 US cities found that countries with higher levels of active transportation have lower rates of obesity [5]. Infrastructure such as mixed land use where shops and public services are dispersed within residential areas, increased housing density, availability of public transit, and sidewalks, trails, and bike lanes can increase the possibility that people will walk or bike to meet their daily needs [6–9]. The more attributes present, i.e., local shops, transit, sidewalks, and bike facilities, the greater the likelihood that an adult living near those attributes will meet the guidelines for physical activity [10].

Building infrastructure for safer bicycling is one way to promote physical activity [11]. One cross-sectional study analyzing data from 43 large cities in the USA found that for every 1-mile increase in the length of on-street bike lanes, there was a 1 % increase in bike commuters [12]. Previous research on factors affecting cycling found that cyclists prefer bike lanes to riding on open streets [13]. Experienced cyclists prefer on-street bike facilities, such as bike lanes (where cyclists ride on the street but are separated from vehicle traffic by striping), and shared-lane markings (where cyclists ride on the street, are not separated but indicated by a cyclist with two arrows above the cyclist) to off-street bike paths that may take the cyclist out of their way [14]. However, women cyclists prefer low-traffic streets and feel more comfortable than men riding on off-street bike paths [15].

Research conducted in New Orleans showed increases in the number of people cycling after the introduction of bike lanes, but results were limited by a lack of comparison streets [16]. No before and after studies of bicycle lane treatments with demographic data on the user type (age group, gender, race) and direction of travel (with or against traffic) in Southern US cities were located. Researchers in cities with high bicycling rates such as Berkeley, CA, and Portland, OR, conducted count studies before and after installation of bike lanes [17–19]. However, only one of these studies included counts on nearby streets where there were no lanes, and it was likely that cyclists were diverted to the new lanes from another street [17].

This study examined the impact of striping new bike lanes in New Orleans through direct observation of one intervention street with a new bike lane and two adjacent streets without bike lanes, before and after the bike lane was striped. The main research objectives were to determine whether adding bike lanes led to an increase in the number of people observed cycling and to determine if more people chose to ride with the flow of traffic and on the street, rather than the sidewalk, after the lanes were striped.

Methods

Setting

This study took place in New Orleans, LA, a flat city with a temperate climate and well suited to cycling. Baseline (September 2009) and follow-up observations (September 2010) took place at the same location mid-block on three parallel streets: South Carrollton Avenue (the street with the new bike lane) and Dublin and Short streets (streets one block off and parallel to S. Carrollton without bike lanes, see Fig. 1). S. Carrollton Avenue is an urban principal arterial street that connects the Mississippi River levee to several neighborhoods. The observation area was between St. Charles Ave. and Claiborne Ave., two other urban principal streets. The observation location was between two neighborhoods that differ substantially on race, poverty status and access to vehicles. Residents living northwest of S. Carrollton were 58 % African American, 33 % below the poverty line, and 35 % without access to a car [20]. Residents east of S. Carrollton were 28 % African American, 26 % below the poverty line, and 18 % without access to a car [20].

The Bike Lane

The 1-mile dedicated bike lane on S. Carrollton Avenue is located between the travel lane and the parking lane and was completed in June 2010. Bike lanes were striped on both sides of the road and are 5 feet wide. There is one 11 feet wide travel lane on either side of the road, separated by a 60 feet wide median. A streetcar runs in the median, stopping approximately every two blocks to pick up and drop off passengers. The posted speed limit on S. Carrollton is 35 mph, and the average daily traffic reported by the metropolitan planning organization was 23,900 vehicles in 2008 [21]. This section of S. Carrollton includes a mix of land

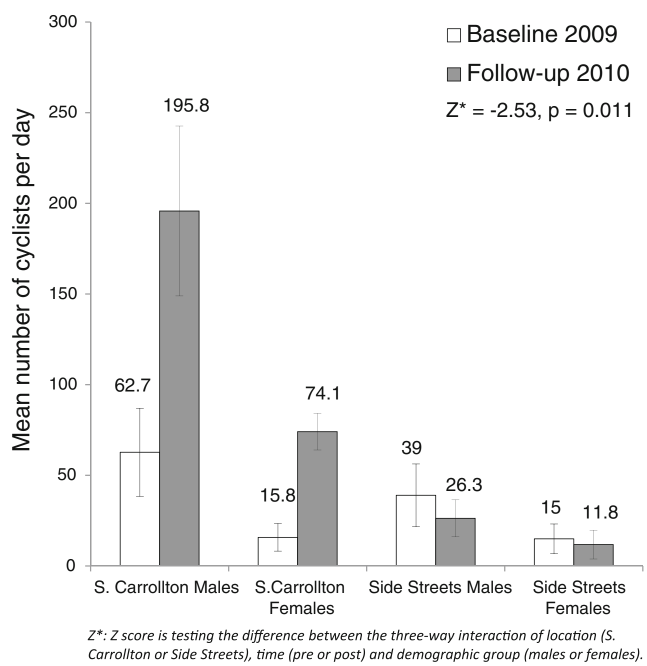

Fig. 1 Observed male and female cyclists on S. Carrollton and adjacent side streets in New Orleans, LA, 2009 and 2010

uses, including low-density residential and commercial. Several destinations including public and private schools, churches, and businesses are located along the corridor. Additionally, a 5.6-acre neighborhood park is located at one end, and the Mississippi River levee and St. Charles Avenue are located at the other end of the corridor.

Data Collection

Using standardized forms adapted from an earlier study observing cyclists, pairs of trained observers tallied the number of cyclists in September 2009 (baseline) and September 2010 (follow-up) for 10 days: 6 weekdays and 4 weekend days for an 11 hour period from 7 am to 6 pm each day [16]. Observers counted cyclists who crossed an imaginary plane that ran from the sidewalk into the street on both sides of the road. The average temperature over data collection was 79.4 and 78.1 °F in 2009 and 2010, respectively. On days of heavy rain, observations ceased and another full day was completed on the same day the following week. Data collected included the number of males, females, adults, and children riding a bicycle with traffic, against traffic, and on sidewalks on S. Carrollton Avenue and the two adjacent side streets, Short and Dublin Streets. Race of observed riders was categorized as white, black, or other by observers. Observers were certified for data collection when their overall proportion of agreement was greater than 80 % for location (street, neutral ground/median, or sidewalk), gender and age group (adult male, adult female, boy, girl), and race (white, black, or other).

Procedures for observation of human subjects were followed according to guidelines established by the institutional review board of Tulane University.

Data Analysis

Counts of male, female, adult, child, black, white, and other cyclists were totaled for each hour and day. Cyclists observed on Short and Dublin Streets were summed and analyzed as the adjacent side streets where there was no bike lane. Means and standard deviations were calculated for the number of people observed cycling before and after the bike lanes were installed. We tested two main hypotheses: (1) more people would be observed cycling on the intervention street after the bike lane was striped and (2) people would be more likely to ride with traffic and in the bike lane instead of on the sidewalk. The unit of analysis was day for the first hypothesis and individual cyclists for the second hypothesis. The outcome for the first hypothesis was the number of people observed cycling. For the second hypothesis, the outcome was binary, indicating appropriate versus inappropriate behavior (e.g., riding on the street or sidewalk and with or against traffic). We used negative binomial regression to test the first hypothesis and binary logistic regression to test the second. Separate models were constructed for gender, age, and race groups. We considered a P value of 0.05 or less to be statistically significant. Models included predictors such as time (pre/post), location (intervention or adjacent streets), and location by time interactions. Additional interactions were included for post-hoc analysis where appropriate.

Results

Table 1 shows the number of cyclists observed riding on S. Carrollton Avenue and adjacent side streets before and after a new bike lane was striped during both weekdays and weekends. In the Carrollton neighborhood overall, we observed an average of 62.5 (±28.8) cyclists at baseline. Of those people, we observed more males than females, adults than children and whites than blacks (Table 1).

To determine if there was a change in the number of riders, we fit models using time (pre/post) as a single predictor. This model was significant; we saw an overall increase in the mean number of people cycling per day on all three streets combined from baseline to follow-up [62.5 (±28.8) vs 110 (±109); Z=8.97, p<0.000].

To test if the number of riders changed more on S. Carrollton than on the adjacent side streets, we examined a model that included location (S. Carrollton or side streets), time (pre and post), and location by time interaction. The location by time interaction was significant (Z=24.27, p< 0.000); therefore, we performed additional analyses comparing the number of riders at each location from baseline to follow-up. More cyclists were observed on S. Carrollton than the combined adjacent side streets [79.2 (±30.5) vs 54.4 (±24.1), Z=43.58, p<0.000] before the lanes were striped. The average number of cyclists increased from baseline to follow-up on S. Carrollton [pre 79.2 (±30.5), post 257.1 (±50.9); Z=10.79, p<0.000] but

Table 1 Observed cyclists on S. Carrollton Avenue and two adjacent side streets in New Orleans, LA, 2009 and 2010

Total (*n*/day)		Pre	SD	Post	SD
Total neighborhood	All riders	62.5	28.8	110.0	109.0
Sex	Male	46.8	1.3	82.9	4.4
	Female	15.2	0.4	32.6	1.6
Age	Youth	2.2	3.1	5.2	7.4
	Adult	59.8	27.8	110.3	109.5
Race	White	38.0	19.9	81.6	82.8
	Black	18.6	9.4	28.1	24.6
S. Carrollton	All riders	79.2	30.5	257.1	50.9
Side streets	All riders	54.4	24.1	36.4	16.1

decreased on the adjacent side streets (pre 54.4 (±24.1), post 36.4 (±16.1); $Z=-10.79$, $p<0.000$].

We then compared the impact of the intervention on different subgroups, such as gender, race, and age. We included location, time, location by time, and demographic group as main effects in negative binomial regression models. We also included three first-order interactions of the demographic groups, location by demographic group (gender: male or female; race: black or white; age: adult or youth), time by demographic group, and a three-way interaction of time by location by demographic group.

We saw an increase in both the number of male and female cyclists on S. Carrollton and a decrease in the number of male and female cyclists on the side streets (Fig. 1). Additionally, males and females responded differently to the intervention of new bike lanes on S. Carrollton, tested in the model which included a three-way interaction of location by time by gender ($Z=-2.53$; $p<0.011$). This differential response can be seen in the ratio of post- to pre-ridership by gender. The ratio for females was 4.69, while for males it was 3.12; thus, the increase in cyclists was greater among females than males on S. Carrollton after the lane was striped.

Both whites and blacks showed an increase in cycling after the lanes were striped, and there was a decrease on the adjacent side streets (Fig. 2). The three-way interaction of race by location by time, however, was not significant ($Z=-1.26$, $p=0.206$). Therefore, the change between racial groups was not significantly different by location, i.e., striping the bike lane did not have a differential effect on either race.

The number of youth and adults cycling on S. Carrollton increased after installation of the bike lane (Fig. 3). The three-way interaction term of age group, location, and time was significant ($Z=-2.14$, $p=0.032$). This is due in part to the decrease in adults on the side streets (Fig. 4).

The proportion of people observed cycling on the sidewalk changed differentially for S. Carrollton and the adjacent side streets ($Z=-3.87$, $p<0.000$). There was no change in the proportion of people observed riding in the street versus the sidewalk on S. Carrollton after the bike lane was striped (pre 93 %, post 93 %; $Z=-0.24$, $p=0.81$). There was a significant decrease in the number of people observed riding in the street on the side streets after the lane was installed on S. Carrollton (pre 99.5 %, post 97.8 %; $Z=-4.03$, $p<0.000$).

After the bike lane was constructed on S. Carrollton, the proportion of riders observed traveling with the direction of traffic increased (pre 92.8 %, post 95.6 %; $Z=2.93$, $p<0.003$) on the intervention street. The proportion of people traveling with traffic on the side streets, however, decreased (pre 96.6 %, post 93.5 %; $Z=-3.05$, $p=0.002$).

Discussion

We found that when bike lanes were striped in a racially and economically diverse and mixed-use urban neighborhood in New Orleans, more people were observed riding their

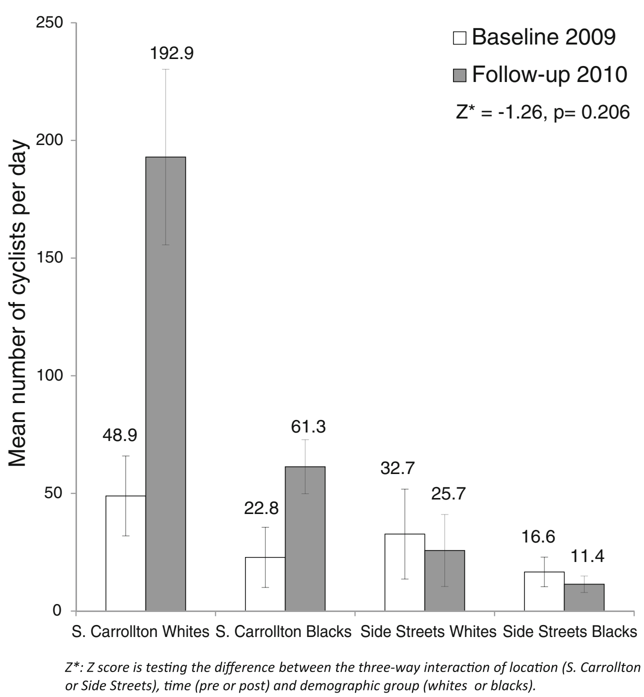

Fig. 2 Observed white and black cyclists on S. Carrollton and adjacent side streets in New Orleans, LA, 2009 and 2010

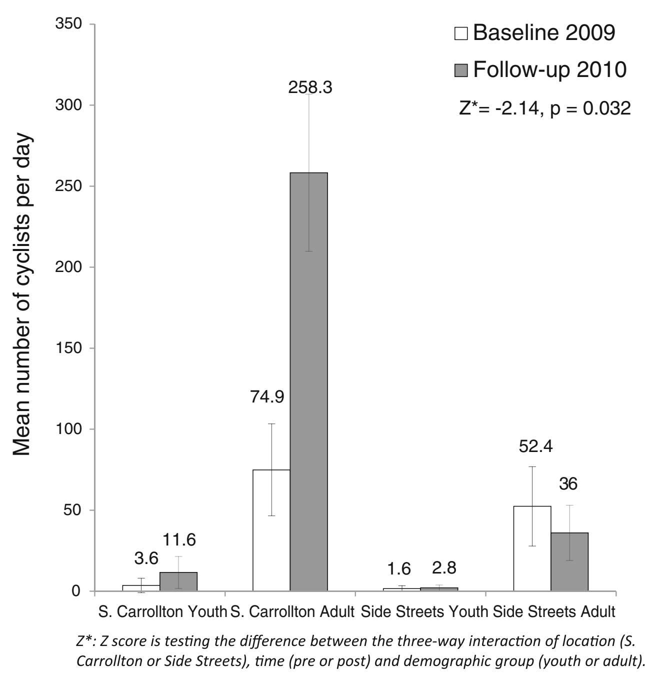

Fig. 3 Observed youth and adult cyclists on S. Carrollton and adjacent side streets in New Orleans, LA, 2009 and 2010

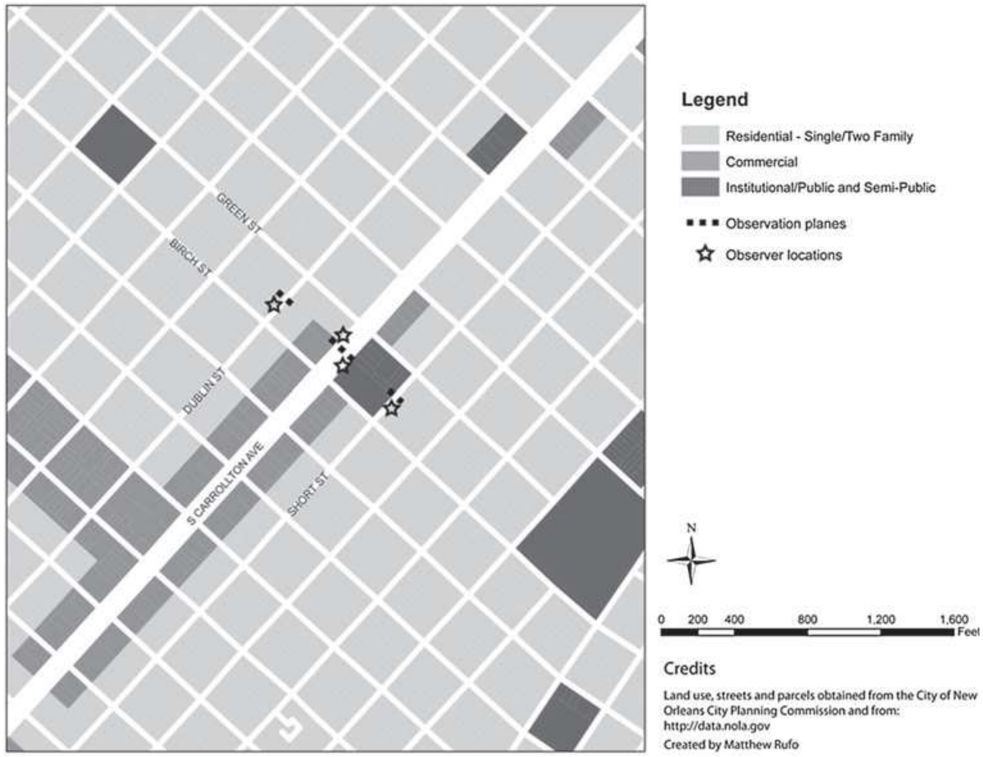

Fig. 4 Observation location and land uses within one-half mile of S. Carrollton Avenue and Birch and Green Streets, New Orleans, LA

bicycles. More people rode in the overall neighborhood after the lanes were striped; however, the increase in cyclists was greatest on the street with the new bike lane. The decrease in cyclists on the side streets suggests that some of those cyclists may have started using the dedicated bike lane. The large increase on S. Carrollton suggests that even in a city not widely known for a cycling culture, new bicycle lanes appeared effective in attracting new cyclists who were diverse in race, sex, and age. It is possible that large numbers of cyclists could act as role models, making cycling more normal and accepted.

Additionally, while the city of New Orleans has experienced some population growth following the loss of residents after Hurricane Katrina, the growth in population is unlikely to be the reason for this increase in ridership. The number of residents receiving mail in this neighborhood remained unchanged over the course of this study [22].

Although all demographic subgroups experienced increases after the lane striping, the differences were the most pronounced among women. More women were willing to ride on S. Carrollton after the bike lane was striped, a finding consistent with other published studies from New Orleans and elsewhere that indicate women prefer dedicated spaces to ride [15, 16]. Installing the bike lanes did increase the number of both whites and blacks using the lanes but did not differentially affect one racial group more than another.

The new bike lane on S. Carrollton was not promoted through a special groundbreaking or other event. This may have been a missed opportunity, because there is evidence that providing supportive environments for physical activity, in combination with promotional activities, is an effective strategy [23]. Promotional events such as periodically closing streets to traffic (e.g., ciclovias) could allow people to sample safe places to bicycle and help build a bicycling culture [24].

The proportion of riders using the sidewalk instead of the street did not change on S. Carrollton after the bike lane was installed. This is difficult to interpret because of migration of some riders to S. Carrollton from adjacent streets. It is possible that there are riders who moved from the side streets to S. Carrollton but were still more comfortable on the sidewalk than in the bike lane.

More people chose to ride in the correct direction when the lane was implemented, perhaps due in part to the new symbols on the street that indicated the preferred direction for riders. This is consistent with other findings showing that shared-lane markings and bike lanes reduce the number of wrong-way riders [16, 25, 26]. However, the present study is the first we know of to measure this effect in bike lanes before and after striping.

This study has some limitations. First, observations were conducted three months after the bike lane was finished. It is possible there could be a novelty effect of the lanes in the immediate period after construction. A second limitation was that race was categorized by casual observation of the data collector. It is possible that individuals were categorized incorrectly. (To ascertain whether observers might be miscategorizing race, we conducted a separate substudy that compared observed race with reported race and found good overall agreement and a kappa value of 0.813, adding a high level of confidence to the method that was used). Third, this study took place in one neighborhood, where car ownership was low and access to walkable destinations was high. Other neighborhoods without similar features may not see as pronounced increases in ridership. Finally, this analysis does not include data on the purpose of the trip (transportation versus recreation) or where people started their trip.

Despite these limitations, this study has several strengths. Observations were conducted more hours per day (11 hours) and over more days (10 days) than other studies evaluating bike lanes. The inclusion of two adjacent streets allowed us to address possible displacement of riders from nearby streets to the street with the new bike lane. This study was also the first study to count cyclists by age group, gender, and race before and after a new bike lane.

Future research evaluating ridership before and after installation of bike lanes should include a variety of neighborhoods and settings to address potential barriers and facilitators to cycling, such as connectivity to destinations. The impact of other improvements such as sidewalk upgrades along with lanes could also be studied. Finally, research that compares striped on-street bike lanes to paths that separate bikes from cars would be useful to planners and engineers leveraging resources for improvements [15, 27].

Cycling for transportation or recreation is one low-cost way to improve physical activity. According to an engineer (J.E. Ruley PE, written communication, July 2012) from the New Orleans Department of Public Works, the total cost of the bike lane was less than 1 % of the total road resurfacing project. This research shows that bike lanes are well suited in diverse urban areas and that if bike lanes are built, people will use them. More lanes should be constructed in areas where residents can travel to meet daily needs by cycling. The results of this study indicate that planners, engineers, and public health practitioners should seriously consider installation of bike lanes as a means to encourage physical activity.

Acknowledgments This study received support from the Robert Wood Johnson Active Living Research Rapid Response Program (grant #67306), The Prevention Research Centers Program of the Centers for Disease Control and Prevention (Cooperative Endeavor Agreement #U48-DP-001948), ASPH/CDC Environmental Health Scholarship, and HRSA MCHB Maternal and Child Health Epidemiology Doctoral Training Program (grant T03MC07649).

Conflict of Interest The authors have no conflict of interest to disclose.

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