Bike, Walk, and Wheel
A Way of Life in Columbia, Missouri, Revisited

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Background: In 2003, Columbia MO was the recipient of a Robert Wood Johnson Foundation (RWJF) Active Living by Design (ALbD) grant to foster active living in the community through behavioral (social marketing, education) and environmental change (improved street design standards, sidewalks around schools, activity-friendly infrastructure) strategies.

Purpose: To examine the extent to which the ALbD intervention was associated with increased active living in children and adults community-wide.

Methods: Seasonal pedestrian and bicyclist counts were performed quarterly in January, April, July, and October at four intersections in downtown Columbia from 2007 to 2009.

Results: Pedestrian counts increased significantly during July 2009 and October 2009 compared to 2007 and 2008, whereas cyclist counts increased significantly during only July 2009 compared to 2007 and 2008.

Conclusions: The ALbD intervention in Columbia was associated with modest increases in active living in the community, and continued evaluation of these behavior patterns is warranted. The combination of multiple strategies (social marketing, local programming, and infrastructure changes) may be a critical factor in improving active living in communities.
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Introduction

In 2001, the Robert Wood Johnson Foundation (RWJF) developed a national program to foster active living in communities around the country. This initiative, Active Living by Design (ALbD), sought to increase the ease, accessibility, and affordability of active living through community-based approaches. In 2003, Columbia MO was a recipient of one of the 25 ALbD grants to U.S. cities.

The Columbia intervention Bike, Walk, and Wheel: A Way of Life in Columbia Missouri (BW&W) was designed to help citizens increase active living through the implementation of ALbD's 5P model (preparation, promotions, programs, policy influences, and physical projects).[1] In Columbia, this model was applied to develop partnerships (part of P1) among community leaders and stakeholders with an interest in the long-term health of the community; increase promotions and awareness (P2) of the benefits of active living through a social marketing campaign featuring educational and motivational messages disseminated through the media (jingles, print and radio advertisement) and via posters at libraries, downtown businesses, and schools; increase community-wide physical activity programs (P3) for children and adolescents; advocate for local policy changes (P4) to create a more activity-friendly environment; and develop physical projects (P5) to make active living and physical activity opportunities more accessible and attractive.

Several of the aforementioned approaches have demonstrated success in other communities. For example, the VERB™ campaign was a successful social marketing campaign targeting children and teenagers about the importance of physical activity through mass media, school, and community promotions.[2] Physical activity and positive attitudes toward physical activity increased as exposure to these messages increased.[3]

It appears that social marketing programs are most successful when combined with other community-based strategies to promote physical activity,[4] an approach similar to that used in designing the ALbD project. Community-

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wide physical activity programs such as the Walking School Bus have been successful at increasing moderate-to-vigorous physical activity, overall physical activity, and active commuting behavior in children.[5,6] Finally, both leisure-time and transportation physical activity have been shown to be related to access to recreational facilities as well as the characteristics of infrastructure related to walking and cycling, such as adequate sidewalks, trails, and striped lanes on roads.[4,7,8] Exposure to elements of the physical environment also have been shown to contribute to health-related indices such as BMI.[9]

In a separate 2006 project, RWJF's Active Living Research program funded ALbD in Columbia to evaluate the extent to which BW&W increased active living. The first aspect of this project evaluated physical activity among children and adults community-wide by assessing pedestrian and cyclist activity at four intersections leading into downtown Columbia. The purpose of the present study was to evaluate whether pedestrian and cyclist activity increased in the community over a 3-year period.

Methods

Setting and Population

Columbia is a moderately sized Midwest college town with a population of ~100,000 residents and a transient student population of ~25,000. The project area contained two populations with distinct demographic profiles: ~7500 residents living north of Broadway Boulevard (which bisects the project area of Columbia into northern and southern neighborhoods) in which residents are 35% non-Hispanic black, 57% white, and 12% other race/ethnicity with a median household income <\$20,000; and 5000 residents living south of Broadway in which 95% of residents were white and had a median household income >\$60,000.

Evaluation of Pedestrians and Cyclist Activity

Changes in community-based active living were compared by employing a cross-sectional study design using serial measurements of pedestrian and cyclist activity at four major intersections over a 3-year period. Data were collected at each intersection for 5 consecutive days (Monday–Friday) from 7:45AM–8:45AM in the final week of January, April, July, and October from 2007 to 2009. Specific intersections were chosen because they accounted for much of the motorized and nonmotorized travel into and out of the city. Data were collected during the same week of each month to ensure consistent and accurate year-to-year comparison.

Pilot-testing indicated that numbers of pedestrians and cyclists were highest between 7:45AM and 8:45AM. Five consecutive mornings were evaluated to minimize the impact of weather conditions on year-to-year comparisons as well as to minimize the impact of missing data. Each quarterly session contained 20 possible sets of observations for both cyclists and pedestrians (five mornings X four intersections). The project was approved by the University of Missouri IRB.

All data collectors received training. Pedestrian/cyclist counters were positioned where they could directly observe and tabulate all nonmotorized traffic entering an intersection. Direct observation of physical activity through the counting of individuals in various settings (parks, schools, buildings) has been used for more than 30 years[10,11] and can be a relatively simple yet reliable method.[12] In the present study, an observation "count" was recorded when a pedestrian or cyclist was observed passing through an intersection or using an adjacent sidewalk. Counters were instructed to envision a large circle that encompassed the entire intersection (including sidewalks) and to count all who entered that circle. All counters were evaluated for accuracy during their first 1-hour session by an experienced second counter. At the busiest intersections, two counters were employed, one as a spotter and the second as recorder.

At one particular site, the intersection was connected to a heavily traveled mixed-use trail that either brought pedestrian and cyclist traffic into the intersection or diverted it underneath it into the city. Many users of this trail who were commuting into the city would not be counted at this intersection because of this design. To account for these travelers, an additional counter was situated along the trail and instructed to envision a line extending across the plane of the trail and to count any pedestrian or cyclist who traveled across this line. The number of travelers at the intersection and the number of trail users were then summed for a total intersection score.

Statistical Analysis

The inter-rater reliability of pedestrian and cyclists counts obtained from the 58 pairs of new and established pedestrian/cyclist counters was evaluated using Pearson's r. Pedestrian and cyclist counts were analyzed separately, each using a repeated-measures ANOVA model with "intersection" treated as a random effect. Fixed effects were season, year, and the year X season interaction term. Main effects in an ANOVA model are not directly interpretable in the presence of significant ($p<0.05$) interactions. When the year X season interaction was significant, then seasonal comparisons were made by year, and years were compared by seasons. Graphical examination of ANOVA residuals indicated a reasonable fit to normality but with substantial seasonal variation, so the ANOVA model was modified to allow for different variance estimates for each season. Model fitting was done using the mixed-model procedure in SAS/STAT®, version 9.2.

Results

Reliability between new and established pedestrian/cyclist counters was excellent, with 58 pairs of raters demonstrating an inter-rater reliability of $r=0.99$ ($p<0.001$). Average year-by-year cyclist and pedestrian counts are shown in Figure 1.

Cyclist Counts

There was a greater number of cyclist counts in 2009 compared to either 2007 or 2008, but these counts were only greater during the summer season (July). Repeated-measures ANOVA demonstrated no main effect for year ($p=0.23$), but there was a main effect for season ($p<0.001$) and year X season interaction ($p=0.05$). Pairwise comparisons ($p\leq0.05$) indicate differences in cyclist counts between Years 2007 and 2009 (mean difference=7.8, 95% CI=1.8, 13.7) and between Years 2008 and 2009 (mean difference=8.2, 95% CI=2.3, 14.2) during July.

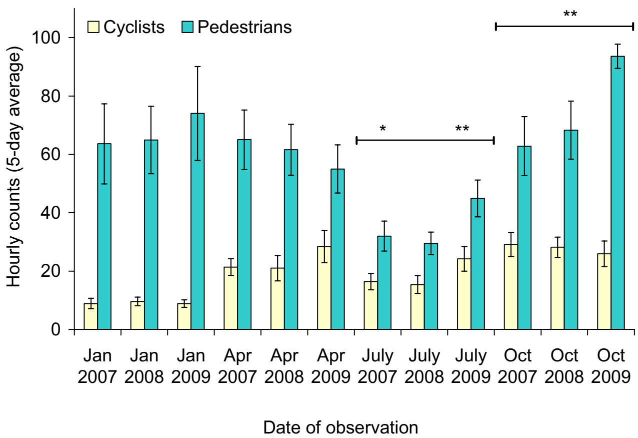

Figure 1. Cyclist and pedestrian counts, 2007–2009, Columbia MO

Note: Data are expressed as M±SE of the M.

*Significant increase in cyclist counts in 2009 compared to 2007 and 2008

**Significant increase in pedestrian counts in 2009 compared to 2007 and 2008

Pedestrian Counts

There were greater numbers of pedestrian counts in 2009 compared to either 2007 or 2008, but these counts were only greater during the summer (July) and fall (October) seasons. Repeated-measures ANOVA demonstrated main effects for year (p=0.01); season (p<0.001); and year X season interaction (p=0.05). Pairwise comparisons (p≤0.05) indicate differences in pedestrian counts between Years 2007 and 2009 (13.0, 95% CI=6.0, 19.9) and between Years 2008 and 2009 (14.7, 95% CI=7.6, 21.8) during July; and between years 2007 and 2009 (33.1, 95% CI=10.1, 56.0) and Years 2008 and 2009 (27.6, 95% CI=4.6, 50.5) during October.

Discussion

Physical Projects

The current findings indicate that pedestrian and cyclist counts increased from 2007 to 2009, specifically in the latter half of 2009 compared to the previous years (Figure 1). One contributing factor to this increase was the implementation of physical projects in Columbia directly resulting from the ALbD project. The national exposure Columbia received through the ALbD project[13] resulted in Columbia being one of four communities nationwide to receive a federally funded $22 million transportation grant to increase infrastructure related to nonmotorized transportation in 2005.

These funds were used to build 147 miles of striped bicycle lanes and shared bicycle routes, 6.5 miles of new trails to be incorporated into Columbia's existing network, nine intersections to be either reconfigured to accommodate bicycle lanes or fitted with pedestrian crossing lights, and two bikeway projects to be completed by the end of 2010,[13] but which were delayed until 2012. Several of these projects commenced in the summer of 2008 (lane-striping and intersection modifications), and this may have contributed to the increase in pedestrian and cyclist counts observed in the latter part of 2009. However, no intersections evaluated in this paper involved extensive reconfiguration; thus, physical projects were likely not the only factor contributing to the changes observed.

Social Marketing

Extensive local social marketing could have increased community awareness of the benefits of active living, resulting in increased walking and cycling behavior. There was an extensive campaign to increase awareness of the benefits of physical activity through educational and motivational messages disseminated through radio advertisement and jingles, print media, and posters displayed at libraries, downtown businesses, and schools. As part of the ALbD evaluation (not reported in this article), a random sample of 817 Columbia citizens were surveyed about awareness of ALbD programming to improve physical activity in children and adults (including walking and cycling clubs) since 2003. Sixty-three percent of respondents indicated greater exposure to media and advertisement regarding these programs in 2008 than in 2003, compared to only 48% of citizens randomly sampled in Lawrence KS (n=699), a control community with similar population and demographics.

These results suggest a greater awareness of active living opportunities in Columbia, which might contribute to the behavior changes observed. Of course, when social marketing programs are combined with other community-based strategies such as infrastructure improvement and the incorporation of increased physical activity programming, there is likely to be even greater success than with social marketing alone.[4] This combination of strategies may help explain some of the successful increases in walking and cycling behavior observed over the 3-year period.

Behavior Change Time Frame

Increases in pedestrian and cyclist activity were observed only in the latter half of 2009, which was 6 years after the ALbD intervention began in Columbia. These findings suggest that behavior change may occur slowly following an intervention. Data on bicycle traffic patterns in Portland OR support this assertion.[14] From 1991 to 2002, bikeway miles increased 198% (from 79 to 236 miles), with a 204% increase in bicycle traffic (from 2850 to 7686 cyclists). From 2001 to 2008, bikeway miles increased only 16% (from 236 to 274 miles) but there was a 117% increase in the number of riders (from 7,686 to 16,711). Thus, although infrastructure increased only marginally, behavior change continued to increase. These data provide support for continued evaluation of behavior patterns long after infrastructure changes or social marketing cease. However, these data simply could indicate that more-active people relocate to areas with existing infrastructure.

Seasonal Effects

Seasonal variations could have played a role in the current findings. For example, increases in cycling activity were modest and occurred only during the summer months of 2009. It is possible that infrastructure changes increase some types of physical activity but only when the weather is good. It is possible that this seasonal movement from outdoor to indoor activity in Columbia accounts for the lack of increase in active living during cold-weather months. Although the pedestrian data do not bear this out (perhaps because walking can occur at any time throughout the year), more purposeful exercise such as cycling may be dependent on the weather and should be considered in evaluating the impact of infrastructure in cold-weather environments.

Study Limitations

There were several limitations to the current study and potential confounders to the data. First, Columbia experienced a robust 10% growth in population during the years 2007–2009 (from 92,937 to 102,332),[15] which could have influenced the reported increases in bicycle and pedestrian activity. However, total hourly bicycle and pedestrian counts increased 16% (75 to 87) and 20% (223 to 268), respectively, during the 3-year evaluation, suggesting that population growth may have contributed to some, but not all, of the increases reported in the present study.

Second, variation in weather from year to year could have been a potential confounder. Additional analyses were performed on temperature and rainfall using historical data on Columbia weather during the hourly counting periods in each of the four seasons from 2007 to 2009.[16] There were no differences in year-to-year rainfall or snowfall amounts in any of the seasons. However, these precipitation numbers do not adequately describe what was happening specifically during the hourly counts.

To examine this, a count was made of the number of days in which there was precipitation from 7:45AM to 8:45AM. In January and April 2007, 2008, and 2009, there were only 3 days of recorded precipitation (rainfall): 1 day in both January and April 2008 and 1 day in April 2009. Thus, it is likely that rain played a very minor role in the lack of differences in counts from 2007 to 2009 during these months. However, rainfall was much more prevalent in July and October of 2007, 2008, and 2009, with 5 days of recorded rainfall in July (3 days in 2008 and 2 days in 2009) and 4 days of recorded rainfall in October (1 day each in 2007 and 2008, and 2 in 2009).

Interestingly, there was as much, or more, reported rainfall in 2009 compared to 2007 and 2008, yet activity counts were higher in 2009. It is tempting to speculate that the higher numbers in 2009 may have been even greater had rainfall been comparable to 2007. The only difference in recorded temperature from 7:45AM to 8:45AM was in January 2008, which was notably colder than 2007 or 2009. All other seasons had comparable temperatures during data collection periods from 2007 to 2009.

Third, collection of data in the early morning hours may have captured a greater amount of active commuting compared to active leisure. However, during the pilot data collection, the highest numbers of pedestrians and cyclists were observed during the early morning hours (7:00AM–9:00AM) compared to afternoon hours (3:00PM–5:00PM). It could be that travel in and out of the city may have been more concentrated before the start of the work or school day (9:00AM) and that the afternoon provided a wider range of times at which individuals either participated in active leisure or active commuting.

Finally, pedestrian and cyclist counts taken over multiple time points or longer periods of time may have assessed physical activity patterns more accurately. Moreover, the inclusion of in-depth interviews with pedestrians and cyclists to better understand how their behavior changes related to either social marketing, programmatic changes or changes in the built environment would have been valuable. The authors have included these structured surveys as part of more-recent work.

Conclusion

The ALbD intervention appears to have had a modest impact on active living in Columbia. Significant increases were observed in bicycle and pedestrian traffic over a 3-year period; however, those increases were confined to the latter half of the final year of the study. The combination of multiple strategies (social marketing, local programming, and infrastructure changes) may be a critical factor in improving active living in communities.

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