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Changes in bicycling over time associated with a new bike lane: Relations with kilocalories energy expenditure and body mass index

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ABSTRACT

Although bicycling has been related to positive health indicators, few studies examine health-related measures associated with non-competitive community cycling before and after cycling infrastructure improvements. This study examined cycling changes in a neighborhood receiving a bike lane, light rail, and other "complete street" improvements. Participants wore accelerometers and global positioning system (GPS) data loggers for one week in both 2012 and 2013, pre- and post-construction completion. Participants sampled within 2 km of the complete street improvements had the following patterns of cycling: never cyclists ($n=434$), continuing cyclists ($n=29$), former cyclists ($n=33$, who bicycled in 2012 but not 2013), and new cyclists ($n=40$, who bicycled in 2013 but not 2012). Results show that all three cycling groups, as identified by GPS/accelerometry data, expended more estimated kilocalories (kcal) of energy per minute during the monitoring week than those who were never detected cycling, net of control variables. Similar but attenuated results emerged when cycling self-report measures were used. BMI was not related to cycling group but those who cycled longer on the new path had lower BMI. Although cyclists burn more calories than non-cyclists across the week, among cyclists, their cycling days involved more calories expended than their non-cycling days. The new cyclists account for 39% of the cyclists identified in this study and former cyclists account for 32% of cyclists. These results suggest that cycling is healthy, but that sustaining rates of cycling will be an important goal for future policy and research.

1. Introduction

Bicycling is an uncommon but healthy mode of transportation in the United States that is growing in popularity. According to National Household Travel Survey data, small but significant increases in cycling occurred in the U.S. between 2001 and 2009, from 12.4 to 14.2 trips per year (Pucher et al., 2011). Where city officials have invested substantially in bike lanes or paths more cycling is reported, but most evidence is from cross-sectional surveys that rely on self-reports and have limited health measures (Buehler and Pucher, 2012; Cervero et al., 2013). In contrast, the present research examines how objectively-measured and self-reported cycling changes over time in association with new cycling infrastructure and how cycling relates to kcal expenditure and body mass index (BMI). The new bike lane was part of a "complete street" implementation (McCann, 2013) that improved and completed a bike lane, added a light rail transit line, and widened sidewalks in a downtown corridor in Salt Lake City, Utah.

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1.1. Cycling and health

Despite historically low population participation in cycling in the U.S., cycling is associated with immediate and long-range health benefits. Areas with more cycling have lower proportions of obese adults (Pucher et al., 2010) and more self-reported physical activity (Pucher et al., 2010, 2011). Cyclists in the CARDIA (Coronary Artery Risk Development in Young Adults) study had lower BMIs and lower lifetime cardiovascular risk (Boone-Heinonen et al., 2009). A recent review sought to identify causal relationships between cycling and health benefits by selecting prospective observational, case-control, or interventional studies (Oja et al., 2011). Notably, 8 of the 10 studies that examined adult cyclists and their physical activity or weight outcomes were from Western Europe (Besson et al., 2008; Bo Andersen et al., 2000; De Geus et al., 2008, 2009; Hendriksen et al., 2000; Hoevenaar-Blom et al., 2011; Oja et al., 1991) or China (Matthews et al., 2007), which has higher base rates of cycling than the U.S. (Bassett Jr et al., 2008). These and other studies show cycling is associated with lower all-cause (Bo Andersen et al., 2000; Kelly et al., 2014; Matthews et al., 2007; Sahlqvist et al., 2013b) and cardiovascular disease mortality (Hoevenaar-Blom et al., 2011) and generally greater cardiovascular fitness (Oja et al., 1991). A U.S. study, the Nurses' Health Study II, showed that self-reported weight decreased for those who increased their cycling or stationary cycling and weight increased for those who decreased their cycling; however, 48% of their sample reported cycling, making this an unusual sample for the U.S. (Lusk et al., 2010). In sum, cycling is linked to greater self-reported physical activity as well as distal health outcomes such as lower BMI and cardiovascular risk, especially where cycling is common.

1.2. Cycling infrastructure and cycling

Few studies, however, examine the role of new bike lanes in facilitating cycling, either in cross-sectional or longitudinal analyses. Among cross-sectional studies, a study of a new car-free bike path in England showed 6% of journeys by bicycle among nearby residents compared to 2% of journeys by bicycle among residents of a control town where bike paths were distant; however, no comparison was available prior to path construction (Jones, 2012). Another correlational study showed that girls living in neighborhoods with bike paths had greater accelerometer-measured MVPA and lower BMI than girls in neighborhoods without bike paths, but the methodology could not tie the measures to bike path use (Evenson et al., 2007).

Studies that examine cycling before and after a trail has been constructed demonstrate mixed results. Cyclists near a new path in Sydney reported 11.4 min per week more cycling compared to a 14.4 min per week decrease in cycling among distant (>1.5 km) control cyclists (Merom et al., 2003). Yet a more recent Sydney study showed no increase in cycling frequency due to a new bike path (Rissel et al., 2015). A large study of multiple UK towns showed that new training programs along with new bike paths resulted in a significant reported increase from 5.8% at baseline to 6.8% cycling after construction and training programs were implemented. It was impossible to tell whether the new path or training or other aspects of the intervention were responsible for the increase (Goodman et al., 2013a). An allied study found greater activity by year two for residents who lived close to a new path when walking and cycling data were combined. However, when cycling was analyzed separately (see their online appendix Tables S4 and S5) there was no significant increase in either leisure or transport cycling after one or two years (Goodman et al., 2014).

In contrast to some positive results from non-U.S. studies reviewed above, new U.S. bike paths have not been associated with increased ridership among nearby residents. For example, one U.S. study found only 2 bicycle trips per 386 travel diary days from 144 participants, with no effect for the new suburban bike trail (Burbidge and Goulias, 2009). Another recorded only 2 of 366 residents making any bicycle trips before a rail line was converted to a multi-use trail and a decrease in cycling time after the trail was built (Evenson et al., 2005). A pre- post-study of a 1 km Santa Monica, CA complete street retrofit, which improved pre-existing sidewalks and bike paths, showed that the number of cyclists remained roughly the same but the number of pedestrians increased (Shu et al., 2014).

In sum, U.S. longitudinal studies have not shown new bicycle lanes lead to more use by nearby residents, perhaps due to low base rates of cycling, small samples, siting paths far from popular destinations, or variability of cycling over time. Indeed, only 0.6% of workers bicycled to work, according to the 2008–2012 American Community Survey (McKenzie, 2014), and cycling accounts for only 3.1% of relatively short (<3 mile) trips (Litman, 2010). Cycling is not a consistent behavior, with the most common last bike trip being over five years ago (Schroeder and Wilbur, 2013) and many reporting that they are not “regular cyclists” (Bauman et al., 2012). These realities suggest that larger samples and more varied cycling infrastructure options should be examined.

1.3. The current study

The current study examines how changing patterns of cycling in a neighborhood receiving a “complete street” intervention relates to health indicators of calories burned from physical activity (kilocalorie expenditure) and BMI. The complete street intervention provided a new complete bike lane that paralleled a new light rail extension along a main traffic corridor that connected the Salt Lake International Airport to the downtown district. As part of a larger study that examined residents' attitudes and behaviors related to the new bike lanes, light rail line, and improved sidewalks, we focus in the current study on those who cycled at least once during the data collection weeks. We examine changes in cycling over time, before and after the complete street improvement in relation to kcal expenditure and BMI. We expect that any cycling will have beneficial results for BMI and kcal expenditure and that use of the bike lane corridor will be a significant contributor to the health outcomes. Unlike prior studies, this one focuses on physical activity and body mass health outcome as well as infrastructure use, has a larger sample size ($n=536$), and is sited in an urban area, which has higher population density and more diverse land uses than past studies of more suburban neighborhoods or rail-trail conversions in isolated corridors. We expect these novel features will result in a sample with sufficient power to detect activity and weight relationships with cycling, if not increases in cycling.

1.4. Objective estimates of cycling and energy expenditure

The current study provides objective measures of cycling including the duration of bike trips using the new bike lane corridor. Due to the paucity of objective measures of cycling, most studies have used self-reported cycling (Librett et al., 2006; Pucher et al., 2010, 2011). Although accelerometers are frequently used to provide objective measurement of walking, they substantially underestimate the effort