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Longitudinal evaluation of travel and health outcomes in relation to new bicycle infrastructure, Sydney, Australia

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ABSTRACT

Background: This study sought to evaluate the health and transport impacts of urban bicycle infrastructure for transport through a commuting corridor in Sydney, Australia.
Methods: An online survey and seven-day travel diary collected health and travel data from intervention area residents, and residents of a control area with similar characteristics and distance from the city, at baseline (n = 846), and follow-up, four months (wave 2; n = 512) and 16 months (wave 3; n = 418) post-construction. Multilevel regression modelling was used to compare changes over time with distance from the cycleway.
Results: In wave 3 24.5% of the intervention group reported using the new cycleway. Residents who started using the cycleway predominantly lived within 1 km of the cycleway (62%); however 13% of users in wave 3 lived more than 3 km from the cycleway. Frequent cycling (weekly) was strongly associated with use of the cycleway ($p < 0.001$), and remained consistent between waves 2 and 3 ($p = 0.3$). Changes in cycling frequency associated with distance from the cycleway were observed over time; specifically, those who lived 1.00–2.99 km from the cycleway increased their weekly cycling, compared with those either closer to or further from the cycleway ($p = 0.08$). These findings were replicated in a smaller sample of cyclists who recorded minutes/week cycling ($p = 0.007$). Improved social capital was observed in the intervention group over time; however, changes in physical activity and quality of life were not observed within the time period.
Conclusions: Cycling participation has been decreasing in Sydney and Australia in recent years; however, urban bicycle transport infrastructure can have a positive impact on cycling, particularly urban cycling for transport, and has the potential to improve health and transport outcomes for city residents.

1. Introduction

Public policy to encourage greater investment in cycling infrastructure has been supported by consistent evidence that suggests there is a positive association between bicycle infrastructure and cycling participation (Pucher et al., 2010; Yang et al., 2010). However, the evidence has been limited by weak (predominantly cross-sectional) studies. Rigorous evidence is needed to support causality, and in particular to determine if the provision of cycling infrastructure increases cycling participation and whether this has

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any effect on health outcomes at the population level.

A small number of natural experiments with before-and-after measurements and control group comparison data are beginning to answer these questions (Fitzhugh et al., 2010; Burbidge and Goulias, 2009; Dill et al., 2014; Goodman et al., 2014; Heinen et al., 2015; Keall et al., 2015; Rissel et al., 2015) (Table 1). Together, these findings indicate that new walking and cycling infrastructure has had minimal impact on local use and changes in physical activity in the short-term, but longer follow-up times have a positive effect on cycling volumes and physical activity (Goodman et al., 2014). The results suggest that cycling participation is a behaviour that takes more than a year to develop, at least, in the car-dependent cities from which these studies are derived. It is possible that the type of infrastructure and its purpose may contribute to this variability. Multi-use paths for walking and cycling have been the focus of evaluation to-date, and these paths appear to attract more recreational users than commuters. A more detailed investigation of factors determining bicycle commuting, separated from walking is needed because, while there is some similarity between the two modes, different factors contribute to the uptake of each mode (Krizek et al., 2009; Muhs and Clifton, 2016).

The international evidence on bicycle commuting suggests there is a strong preference for infrastructure which is separated from motor traffic (Tilahun et al., 2007; Caulfield et al., 2012; Akar and Clifton, 2009; Winters and Teschke, 2010; Stinson and Bhat, 2003). More recently, observational studies have shown that cyclists are sensitive to traffic volumes and the type of infrastructure (Dill, 2009; Buehler and Pucher, 2012; Broach et al., 2012). In countries lacking an extensive network of cycling infrastructure (like the US and Australia where these studies have been carried out), cyclists travel out of their way to use bicycle infrastructure separated from motor traffic (Dill, 2009; Garrard et al., 2008; Krizek et al., 2007). The motivating factor is most likely the greater safety and amenity offered by designated cycling infrastructure (Thomas and DeRobertis, 2013). Indeed, perception of safety is a deciding factor in the uptake of cycling (Winters et al., 2011). Thus, cities with safer cycling infrastructure have been found to have greater volumes of cyclists commuting (Buehler and Pucher, 2012).

To date, the focus of many of these impact studies has been on transport outcomes (trips), and some growing interest in physical activity impacts. It is not known what effect cycling infrastructure may have on the health of individuals beyond the parameters of physical activity and road safety (Schepers et al., 2015; Reynolds et al., 2009). However there is a growing understanding that cycling may provide other health benefits including quality of life (Crane et al., 2015; Mytton et al., 2016). There is also a large gap in our understanding of what effect bicycle paths may have on the health of the wider community, not only current users of the infrastructure. For example as we have discovered in previous qualitative research, having access to a bicycle path may encourage other forms of activity such as walking, and lead to greater physical activity in the community (Crane et al., 2016). Lucas and Jones also argue that the social impacts of transport interventions and policies also need to be assessed, particularly because they can have far reaching effects, not only on other areas of health such as physical activity and quality of life, but also on other important areas of economic and social policy(Jones and Lucas, 2012). We therefore need to think more broadly about our assessment of transport interventions including new bicycle infrastructure. To date, however, the evidence regarding transport provision and social impacts, particularly in urban settings, is sparse, ill recognised for its policy impact and often poorly conceived (Jones and Lucas, 2012). The aim of this study was to examine how exposure to new urban cycling infrastructure impacts cycling, physical activity, and social and quality of life outcomes over time, by evaluating a new bicycle path through a commuting corridor in Sydney, Australia.

2. Methods

2.1. Intervention

A new 2.4km bi-directional protected cycleway was built through Sydney's inner city suburbs of Redfern and Waterloo, and opened in June 2015. The cycleway was built primarily as a commuting link between a new high density urban renewal area in development in the south of the city and the central business district (CBD). The cycleway is separated from road traffic and pedestrian thoroughfares by raised kerbs. It is complemented by traffic calming measures (new speed restrictions (40 km/h), one-way traffic flow sections and shared environments), and pedestrian infrastructure improvements (improved footpaths, pedestrian crossings and tree coverage). A number of paths now exist in the CBD and inner city residential area; yet at the time of this study there were many missing links in the bicycle network (Fig. 1).

The intervention area included the suburbs surrounding the cycleway. A comparison area of similar distance from the CBD and demographic characteristics was used as the control group (Rissel et al., 2013). No similar cycling infrastructure exists in the control area.

2.2. Design

A quasi-experimental longitudinal design was used to compare changes in the intervention area and control area at baseline (Wave 1) and at two time points post-construction (Wave 2 and 3). Baseline data was collected in October 2013 using an online questionnaire. Participants were recruited through community groups and events. Follow-up data was collected in September-October 2014 (4 months after the cycleway opened), and one year later (September-November 2015). Participants were also invited to complete a seven-day online travel diary, which tracked travel behaviour (including transport mode and duration). Participant eligibility and baseline recruitment is discussed in more detail elsewhere (Rissel et al., 2015; Rissel et al., 2013). In the follow-up waves, participants were re-invited by email to complete the questionnaire and travel diary, unless they had moved outside the intervention or control areas. Those who completed the travel diary at baseline, yet chose not to participate in Wave 2 were re-invited

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