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The mortality impact of bicycle paths and lanes related to physical activity, air pollution exposure and road safety

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ABSTRACT

Objective: Guidelines for bicycle infrastructure design tend to consider safety issues but not wider health issues. This paper explores the overall health impact of bicycle infrastructure provision, including not just road safety impacts, but also the population health impacts stemming from physical activity as well as cyclists' exposure to air pollution.

Data and methods: We have summarised key publications on how bicycle paths and lanes affect cyclists' exposure to physical activity, air pollution, and road safety. The health impact is modelled using all-cause mortality as a metric for a scenario with new bicycle lanes and paths in a hypothetical city.

Results: The outcomes of the study suggest that, based on currently available research, a reduction of all-cause mortality is to be expected from building bicycle lanes and paths along busy roads with mixed traffic. Increased physical activity through more time spent cycling is the major contribution, but is also the most uncertain aspect. Effects related to air pollution and cycling safety are likely to reduce mortality but are small. The overall benefits are large enough to achieve a high benefit-cost ratio for bicycle infrastructure.

Conclusions: The introduction of bicycle paths and lanes is likely to be associated with health benefits, primarily due to increased physical activity. More research is needed to estimate the absolute size of the health benefits. In particular, evaluations of the effects of bicycle infrastructure on time spent cycling are limited or of insufficient quality to infer causality. We recommend before-after studies measuring the effects of different interventions and in areas representing a wide range of base levels of cycling participation.

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1. Introduction

Bicycle infrastructure along distributor roads (separated bicycle paths, see Fig. 1; and marked lanes, see Fig. 2) has been suggested as an effective means to encourage cycling and thereby improve health at the population level (Handy et al., 2014; Heinen et al., 2010; Hoehner et al., 2005; Pooley et al., 2013; Pucher and Buehler, 2010), but the application has been debated by adherents to so-called “vehicular cycling”. The term “vehicular cycling” was coined by Forester to suggest that “cyclists fare best when they act and are treated as drivers of vehicles” (Forester, 2001b, page 557) meaning that they should share the road with other vehicles. They have opposed separate facilities such as bicycle paths and lanes for cycling because of safety concerns (Alrutz, 2012; Forester, 2001a; Pucher, 2001). On the other hand, guidelines in many countries are positive towards bicycle lanes within the carriageway for general traffic. For instance, the design guide by UK Department for Transport (2008) advises on-road facilities for roads with a large number of side road junctions because it reduces the potential for conflict at these locations. Such advice is supported by research suggesting that bicycle lanes improve cycling safety

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Fig. 1. Physically separated bicycle path along a distributor road.



Fig. 2. On road bicycle lane along a distributor road.



Fig. 3. Distributor road without bicycle infrastructure.

(Reynolds et al., 2009) as well as the *perception* of safety, for *would-be* cyclists (Fishman et al., 2012a, 2012b). Some agencies however caution against building physically separated bicycle paths (AASHTO, 1999, 2012; Department for Transport, 2008), based on worse road safety outcomes that have been reported in some publications (e.g. meta-analysis in the influential ‘Handbook of Road Safety Measures’, Elvik et al., 2009). Danish, Dutch and US guidance recommends ‘truncating’ cycle paths (converting it to a marked lane) before intersections to improve visibility and avoid conflicts (CROW, 2007a, 2007b; Jensen et al., 2000; NACTO, 2011).

Despite the dominance of cycling safety as an issue in design guidelines, an assessment of the overall health impact of bicycle infrastructure (including air pollution and physical activity) seems to be missing in the scientific literature. Such knowledge is also needed to economically value bicycle infrastructure and inform policy makers. The benefits of more time spent cycling (by existing and new cyclists) as a result of bicycle infrastructure improvements dominate in economic valuations (Cavill et al., 2008). The direct impact of bicycle infrastructure on road safety risks and air pollution exposure among *all cyclists* is often mentioned but has not yet quantitatively been included in economic appraisals (Cavill et al., 2008; Department for Transport, 2014; Lind et al., 2005; Sælensminde, 2004). Therefore, this paper sets out to compare the health impact of bicycle paths and lanes in relation to; 1) physical activity, 2) air pollution

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