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Health impacts of bike sharing systems in Europe

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ABSTRACT

Background: Bike-sharing systems (BSS) have been implemented in several cities around the world as policies to mitigate climate change, reduce traffic congestion, and promote physical activity. This study aims to assess the health impacts (risks and benefits) of major BSS in Europe.

Methods: We performed a health impact assessment study to quantify the health risks and benefits of car trips substitution by bikes trips (regular-bikes and/or electric-bikes) from European BSS with > 2000 bikes. Four scenarios were created to estimate the annual expected number of deaths (increasing or reduced) due to physical activity, road traffic fatalities, and air pollution. A quantitative model was built using data from transport and health surveys and environmental and traffic safety records. The study population was BSS users between 18 and 64 years old.

Results: Twelve BSS were included in the analysis. In all scenarios and cities, the health benefits of physical activity outweighed the health risk of traffic fatalities and air pollution. It was estimated that 5.17 (95%CI: 3.11–7.01) annual deaths are avoided in the twelve BSS, with the actual level of car trip substitution, corresponding to an annual saving of 18 million of Euros. If all BSS trips replaced car trips, 73.25 deaths could be avoided each year (225 million Euros saving) in the twelve cities.

Conclusions: The twelve major Bike-sharing systems in Europe provide health and economic benefits. The promotion of shifting car drivers to use BSS can significantly increase the health benefits. BSS in Europe can be used as a tool for health promotion and prevention.

1. Introduction

Motorized vehicles help the transportation of people and goods, stimulating the economy. However, the increasing use of motorized transport is also negatively influencing people's health and the environment due to high levels of pollution and traffic incidents (Khreis et al., 2016). Motorized vehicles are one of the major sources of environmental pollution and noise in urban areas (Schwela et al., 2008). About 70% of environmental pollution and 40% of greenhouse gas emissions in European cities comes from motorized transport (European Environment Agency, 2010).

Several international organizations have requested the implementation of public policies to increase the use of active transport, such as walking or cycling, and public transport in order to reduce car use in urban areas, reducing greenhouse gas emissions, climate change impacts, encouraging physical activity and traffic safety (Dora and Phillips, 2000; Kim and Dumitrescu, 2010).

Bike-sharing systems (BSS) have been implemented in several cities around the world as policies to mitigate climate change, reduce traffic congestion, and promote physical activity. A bike-sharing system or bike-share scheme is a service in which bikes are made available for shared use to individuals on a very short-term basis. BSS allow people to borrow a bike from one point and return it to a different point. BSS has become very popular in cities across Europe, Asia and America, and in 2013 > 500 BSS were implemented around the world (Larsen, 2013). The first bike share began in Europe in 1965, and the first large-scale bike-sharing program was launched in 1995, in Copenhagen as Bycyklen (City Bikes) with 1100 bikes (Shaheen et al., 2010). Currently the BSS in Paris called “Vélib”, is the biggest in Europe with 23,600 bikes and 1800 stations; other BSS have also reached a considerable large size as London (12,000 bikes), Barcelona (6000), Lyon (4000) or Valencia, Seville, Milan or Brussels with > 2000 bikes. In some

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countries like Spain, there has been a rapid increase in the number of BSS, almost doubling the number of systems implemented from 58 to 97 between 2008 and 2009. Currently, the world's largest systems are in China, in the cities of Hangzhou and Wuhan, with 90,000 and 70,000 bikes, respectively (Oortwijn, 2015). Recently new BSS's have also introduced electric-bikes in their systems as part of the bicycle fleet.

Previous studies have estimated the health risks and benefits of replacing the car trips by bike trips from BSS's in Barcelona (Rojas-Rueda et al., 2011) and London (Woodcock et al., 2014). These two previous studies have found that health benefits (from physical activity) can outweigh health risks (from traffic incidents and air pollution inhalation). Until now a comprehensive analysis of the health implication of multiple BSS has not been performed. Neither, any of the previous studies have included electric-bicycles in their assessments. This study aims to assess the health impacts (in travelers) of major BSS's across Europe, describing the differences between cities according to their travel and BSS characteristics, levels of air pollution and traffic safety. This study also includes, for the first time, the assessment of health risks and benefits related to the introduction of electric-bikes in BSS's.

2. Methods

2.1. Framework and BSS selection

We used a health impact assessment (HIA) approach to quantify the health risk and benefits of car trips substitution by bikes trips from European BSS with > 2000 bikes. The estimated health outcome was the annual expected number of deaths (increased or avoided) due to physical activity, road traffic fatalities and air pollution (particulate matter < 2.5 μm ($PM_{2.5}$)) due to car trips substitution for BSS trips (Fig. 1). The analysis was focused only on BSS with > 2000 bikes (bikes and/or e-bikes) in cities of the European Union of 28 countries (Table 1). This selection criterion was based on the assumption that the larger BSS would impact larger populations, and will have a greater (temporal and political) stability to produce a long-term usability and impacts. London, UK, BSS was excluded from the analysis because a recent assessment has been performed (Woodcock et al., 2014). Barcelona, Spain, BSS was included in the analysis in spite of existing a previous assessment (Rojas-Rueda et al., 2011) because of its recent expansion, introducing e-bikes in the system and this expansion has not been considered in the previous assessment. Another European BSS's like the case of Strasbourg or Grenoble were not included in the analysis, although they met the inclusion criteria of > 2000 bikes because it was not possible to access the data (number of trips, distance, duration, etc.) required to perform the assessment.

2.2. Scenarios and input data

Four scenarios were created to assess the health impacts of shifting from car to BSS bikes: the first scenario was focused on the observed (reported by a travel survey performed by each BSS) car substitution by BSS bike trips in the 12 cities (see supplemental material); the other three scenarios were focused on assumptions to assess “what if” the cars substitution would be larger for the 12 BSS (Table 2). Scenario 1) the car trip substitution (by BSS trips) used in this scenario was the minimum percentage reported by each city (for those cities that have not reported the percentage of car trip substitution, was applied the minimum reported (4.7%) between the 12 cities); Scenario 2) what if the car trip substitution (by BSS) was the maximum reported (12%) in the 12 European cities; Scenario 3) what if 50% of all BSS trips come from car trips; and 4) what if 100% of all BSS trips would come from car trips (see supplemental material). These last three scenarios (2,3 and 4) were aimed to show the potential of the BSS if higher levels of car trip substitution could be achieved.

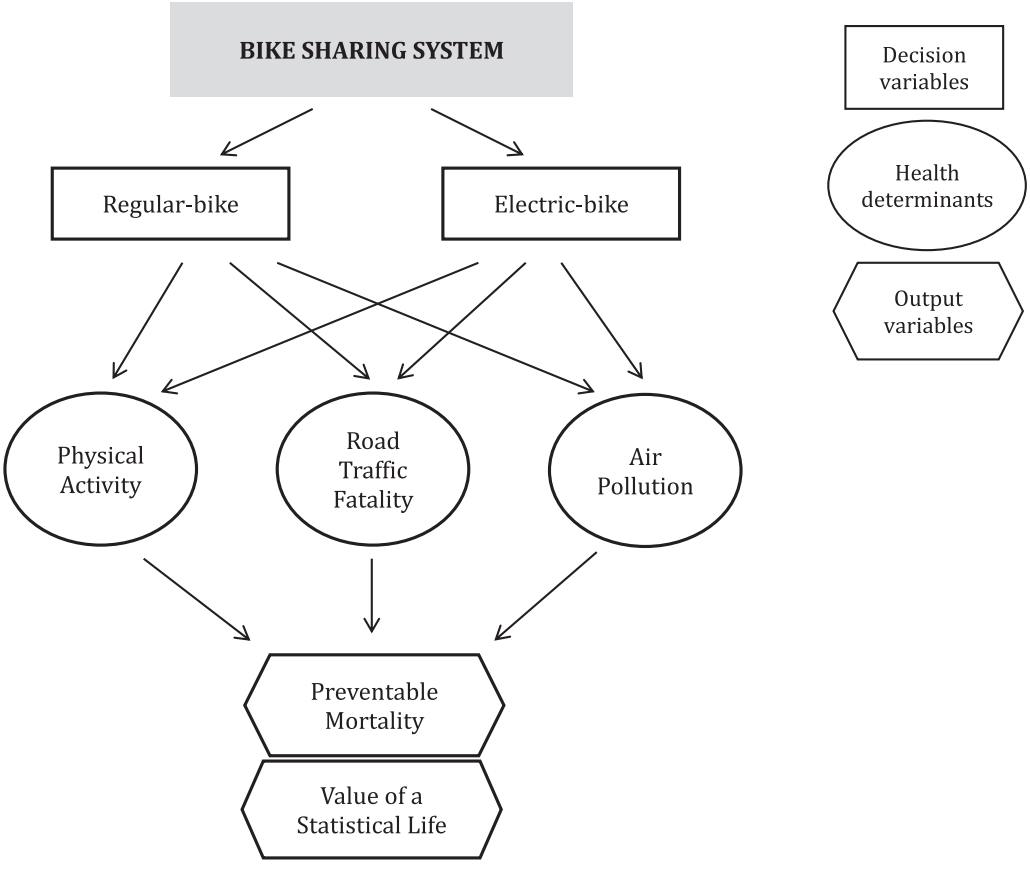

Fig. 1. Conceptual framework of bike sharing systems and health.