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Using local knowledge and sustainable transport to promote a greener city: The case of Bucharest, Romania

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ABSTRACT

Cities undergoing climate change and rapid urbanization are faced with significant transformational processes that affect the environment and society, challenging them to become more sustainable and resilient. The promotion of nature-based solutions represents an efficient approach to meet sustainability targets in cities and improve the quality of life of citizens. The association of large components of green infrastructure, such as urban parks, with physical activity can counteract the sedentary lifestyle endemic to cities and improve the overall health and well-being of individuals (Carrus et al., 2013; Scopelliti et al., 2016). By promoting a sustainable means of transport and connecting green spaces within a highly urbanized city, bicycle lanes represent an effective tool for associating physical activity with nature in cities allowing bicycle users to benefit from the positive health effects of nature-based solutions. Our study focuses on the potential of bicycle lanes to improve functional connectivity among green spaces. We administered 820 questionnaires in 34 green spaces (i.e., urban parks) in Bucharest, Romania, to identify the factors influencing the use of bicycle lanes connecting urban parks and to understand which planning criteria for bicycle lanes are considered as the most important by park visitors. We applied binary and ordinal logistic regressions and found that the factors affecting bicycle lane use are illegally parked cars and lack of accessibility to urban parks. The criteria preferred by park visitors for bicycle lane planning are determined by experience level and frequency of bicycle use. To develop a functional and integrated bicycle lane network that can make cities healthier and more sustainable, policy makers are advised to engage in a public participatory process and focus on the needs of bicycle users.

1. Introduction

Mounting levels of urbanization in the last century have led to significant transformations of the environment in many cities, which have been further aggravated by climate change effects (Kammen and Sunter, 2016; Kelly and Zhu, 2016). Urbanization processes have also contributed to human health deterioration (Schnell et al., 2016), e.g., in the case of respiratory diseases (Zhou et al., 2015), and have facilitated a common sense of sedentary lifestyle (Normile, 2016). From the dependency on automobiles (Geller, 2003) to desk-bound jobs (Popkin, 1999) and reduced physical activity, such a sedentary lifestyle can undermine citizens' health and well-being (Deweerdt, 2016; Hodson, 2016).

To tackle the challenge of sustainable urbanization, cities need to become more resilient (Moran and Lopez, 2016; United Nations, 2016) through the planning of nature-based solutions (NBS) within a larger urban green infrastructure approach (Kabisch et al., 2016; Lafortezza and Giannico, 2017; van den Bosch and Sang, 2017; Lafortezza and Konijnendijk, 2018). NBS can contribute to achieving sustainability targets (Badiu et al., 2016) due to their relevance to the quality of environmental factors (Spanò et al., 2017). NBS provide a wide range of ecosystem services which, in turn, generate important health and resilience benefits (Gómez-Baggethun and Barton, 2013; Lafortezza and Chen, 2016; van den Bosch and Sang, 2017).

However, the benefits deriving from NBS within cities are strictly dependent on the spatial location of green spaces and their connectivity/

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accessibility (Ngom et al., 2016). The connectivity and access to NBS promote the mobility of residents (Artmann et al., 2017), allowing them to move across cities in a sustainable manner. The greater the connectivity of urban green spaces, the greater the capacity to provide ecosystem services (Hansen and Pauleit, 2014).

Bicycle lanes are an example of NBS that can be used to connect and access urban green spaces, thus enhancing overall human health and well-being (Carrus et al., 2013; Scopelliti et al., 2016; Lafortezza and Konijnendijk, 2018) and further a greener city. Bicycle lanes have proven to be an effective tool for increasing the connectivity of recreational green spaces. They promote sustainable transport (Midgley, 2011), contribute to the reduction of air pollutants (Grabow et al., 2012; Chen et al., 2016; Johansson et al., 2017) and can connect elements of NBS, such as urban parks, while maintaining their recreational function. Bicycle lanes can also foster a healthy behavior by promoting physical activity (Pucher and Dijkstra, 2003).

Numerous cities have begun to invest in cycling infrastructure and other means of transport (Nieuwenhuijsen and Khreis, 2016) to increase connectivity among urban green spaces. Examples include urban areas in The Netherlands, Germany and Denmark where decision-makers strongly advocate for the use of bicycles (Pucher and Buehler, 2008). The association of bicycle lanes with green spaces (e.g., urban parks) is mentioned in various studies (Bedimo-Rung et al., 2005; Santos et al., 2016). Topics mainly address the health benefits that bicycle riding provides (Pucher and Dijkstra, 2003). For example, Wolch et al. (2011) applied a growth curve model to identify the relationship between cases of obesity in children and access to urban parks or other recreational areas. The authors concluded that residents in proximity of urban parks (10–15 min by bicycle) have a lower probability of developing obesity. Cranz and Boland (2004) mention the use of bicycles as an important activity within recreational spaces, besides other social or cultural means of entertainment. Another topic frequently addressed in the literature is the adequate and efficient planning of bicycle lanes responding to user needs. Winters et al. (2011) have established that the presence of major junctions, level of safety, lighting and exclusive sections for users constitute important factors in the development of bicycle lanes.

However, most of the studies have focused on specific benefits associated with the use of bicycle lanes in cities without considering the issue within a larger spatial dimension (i.e., green infrastructure) and a multiple ecosystem services approach. Encouraging the use of bicycle lanes is a priority to achieve sustainability targets in cities (Newman and Jennings, 2012; Portney, 2013). Consequently, there is a need to explore local knowledge such as the factors that determine citizens' behavior in using bicycle lanes (as an example of NBS) and the multiple associated benefits.

Within this context, we developed a study with the overarching goal to understand the factors influencing the use of the bicycle as a means of sustainable transport in contemporary cities. We used the city of Bucharest, Romania (Eastern Europe), as a case study due to the rapid urbanization that is ongoing at the expense of local sustainability and resilience. We analyzed the factors that influence bicycle users' preferences and investigated the criteria used to plan new bicycle lanes connecting green spaces. In our analysis, we specifically focused on the concept of "functional" connectivity as the ability of bicycle users to transit between urban green spaces and perceive multiple benefits (i.e., health and well-being from recreation, socialization and physical activities). Results from this study, based on public perception and knowledge, may have policy and planning implications for developing new NBS to counter the effects of urbanization and climate change in the European continent (Mariani et al., 2016; Panno et al., 2017) and others worldwide.

2. Materials and methods

2.1. Study area

Bucharest is considered one of the most congested cities in Europe (Morar and Bertolini, 2013). It is located in a plain where the average summer temperature rises above 22 °C (Cheval et al., 2009). With a population density of more than 8000 inhabitants/km^2 and a total of over 1.9 million, the city is facing problems such as urban sprawl (Grădinaru et al., 2015), traffic congestion and air pollution (Pătroescu et al., 2009). As a consequence of economic development and the increase in number of private cars, the city's transport infrastructure is forced to withstand frequent traffic jams and an insufficient number of parking lots, often supplemented at the expense of green spaces. The transport infrastructure is 3404 km long (National Institute of Statistics, 2014) and bicycle lanes occupy approximately 58 km (1.7%), while the modal share of cycling is less than 5% (van den Noort et al., 2009). Twenty-three parks from a total of 60 are within a distance of 100 m from bicycle lanes. The lanes provide access to metropolitan parks, yet their presence on the outskirts of the city remains insufficient.

The surface area of the city's green spaces, including parks, has decreased as a result of land conversion into commercial or residential areas (Iojă et al., 2014). Urban parks occupy an area of 812 ha (3.3% of the total surface area) and are unevenly distributed within residential spaces (Iojă et al., 2010). Depending on the area and population serviced, urban parks are divided into metropolitan parks (> 5000 visitors per weekend day), municipal parks (between 2000 and 5000 visitors per weekend day), district parks (< 2000 visitors per weekend day) and transit parks (20% of the visitors on a weekend day are passers-by) (Iojă et al., 2011). For the study we selected a sample of 34 urban parks (representing 86% of the total surface area of Bucharest's urban parks) (Iojă et al., 2011) that fall within the four aforementioned categories – 6 metropolitan, 10 municipal, 10 district, and 8 transit parks – with an even spatial distribution in Bucharest (Fig. 1).

To gather information on (1) the level of bicycle use and the factors that influence the use of existing bicycle lanes as well as (2) the relevant criteria for bicycle lane planning, we applied a questionnaire in all 34 urban parks. Bicycle users were asked to respond to 18 items of a 3-point Likert scale (1, low importance – 3, high importance) (Tyrväinen et al., 2014). The items covered the users' profile (frequency of use, experience), purpose of visit, elements of attraction, route preferences, perceived problems and limiting factors and bicycle lane planning criteria. The questionnaire was administered to the sample of urban park visitors (all respondents traveled by bicycle to the park) in two different stages during the March-May 2016 time period. To ensure a sufficient flow of respondents, the questionnaires were administered from 10:00 a.m. to 8:00 p.m. on days with favorable weather conditions, as required by the methodology (Sanesi and Chiarello, 2006; Iojă et al., 2011). Eight hundred and twenty questionnaires were distributed and administered in proportion to the importance and size of the parks: 40 in metropolitan parks, 30 in municipal parks, 20 in district parks and 10 in transit parks. Of the total, 687 questionnaires were considered valid, containing replies for all 18 items, and included in the analysis.

2.2. Identifying the factors influencing the use of bicycle lanes in Bucharest's urban parks

Binary logistic regression (Hosmer et al., 2013) was used to identify the factors that influence the use of existing bicycle lanes. This methodology is used to test whether the use of existing bicycle lanes can be predicted from 6 factors identified as issues in the urban landscape. Within the model, the dependent variable is represented by the use of existing bicycle lanes while the explanatory variables are types of factors that cyclists assessed as being of high, medium, or low importance. The factors we considered are the following: a) insufficient lanes to access urban parks; b) lack of accessibility to urban parks; c) illegally parked cars on bicycle lanes; d) conflicts with pedestrians; e) speed limits; and f) no connectivity to urban parks. The selection of independent variables was based on a scientific literature analysis (Dill and Voros, 2007; Parkin et al., 2007).

We checked the overall fit of the model to ascertain if the model