**Inequality in usage of bicycles: A literature review**

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**ABSTRACT**

Fairness and justice in transport provision, or the lack thereof, is a growing concern among both researchers and policy makers, and it is vital for transport planners and decision-makers to undertake measures to tackle such issues. Fairness in transportation is defined based on the concepts of both equality and equity. Unequal usage of transportation modes can be one of the results of inequitable transport systems or arise from populations’ different desires about using bicycles. Understanding the differences between the two aforementioned causes of unequal usage of bicycles and implementing appropriate cycling policies can increase bicycle usage, as well as provide an equitable cycling environment. Primarily, researchers have focused on solving inequality of usage issues related to public transportation, however, there are a number of studies, albeit limitedly that consider inequality in bicycle usage. The aim of this study is to, firstly, provide a better insight into conceptual differences between inequality of usage and inequity, and also to highlight the importance of analysing unequal usage of bicycles. Secondly, this study attempts to review inequalities in usage of bicycles, including private bicycles and bicycle sharing systems, in order to highlight the differences between usage behaviour of different population groups and communities. Finally, recommendations to reduce inequality of usage of bicycles are provided, to support better policy-making, and further research needs are highlighted.

**Keywords:** Bicycle, bicycle sharing system, unequal usage, equality, equity

**Introduction**

From a conceptual view point, fairness and justice in transportation can be defined based on the concept of equality and equity. Equality considers the same services for all population groups, while equity reflects on the different needs of populations and aims to distribute the benefits due to the populations’ needs (Krumholz & Forester, 1990; Camporeale, Caggiani, and Ottomanelli, 2019). Equal systems can result in unfairness due to a lack of consideration of different populations’ needs (Litman, 2002), while equitable systems can provide fairness for all, thereby resulting in equitable distribution of the positive impacts of a transportation mode, such as health impacts, safety, and wellbeing. Equity in transportation is of paramount importance, and its significance is rising due to increasing social consciousness (Di Ciommo & Shiftan, 2017). Despite the increasing importance of transportation equity in terms of social consciousness, in practice, most transport projects and policies do not consider equity (Di Ciommo & Shiftan, 2017).

Many researchers in the literature attempt to evaluate and highlight unequal usage of transportation modes by different groups of populations (Banister & Bowling 2004; Wennberg, Hyden & Stahl 2010; Mackett & Thoreau 2015; Cornut & Madre 2017; Guzman & Oviedo 2018). Primarily, researchers have focused on inequality of usage related to public transportation, however, there are limited studies that consider inequality in the usage of bicycles. It seems prudent to assess the literature on inequalities in usage of bicycles in order to better understand different bicycle usage behaviours within population groups as well as exploring the reasons of this unequal usage. This study attempts to review the literature on inequalities in usage of bicycles, including private bicycles and bicycle sharing systems (BSS). It investigates how different population groups differ in usage rates of bicycles and BSS owing to socioeconomic characteristics such as age, gender, income, ethnicity, place of residence and education, observe the similarities and differences between usage of bicycles and BSS, and provide recommendations for policy-makers and future research.

**Methodology**

In order to source papers on inequalities in usage of bicycles and BSS, databases including Scopus and Google Scholar were searched. A combination of the following identified keywords was used: bicycle, bike-sharing, bicycle-sharing, equality, equity, age, gender, income, ethnicity, place of residence, education. In addition, forward snowballing (finding citations to papers) and backward snowballing (finding papers from the references lists) were used in this study. Potential articles were then identified through scanning the titles of the papers.

Next, the identified papers were assessed by the authors for inclusion or exclusion in the study. A two-stage reading process was adopted involving an initial read of the abstracts and, for those papers still considered relevant, the full-texts were read. After the exclusion of several documents through this process, 21 papers remained for inclusion in this study. No restriction was put on the year of publication – the first paper to address unequal usage of bicycles was published in 2011.

In the following section, the impact of socio-demographic characteristics on transportation usage will be discussed, before inequalities in usage of bicycles and in usage of BSS are reviewed and discussed.

**Impact of socio-demographic characteristics on transportation usage**

Socio-demographic characteristics of the population such as age, gender, income, employment status, educational level, physical impairment and other factors, which differentiate population groups, can affect equalities in usage of transportation modes. There are a number of studies relating to the demographic aspects of transportation. For instance, older people are more car-dependent, have less physical ability for cycling, and experience greater mobility difficulties. Young people can be affected by cost-related problems and children can be influenced by their parents (Banister & Bowling 2004; Wennberg, Hyden & Stahl 2010; Mackett & Thoreau 2015). Evidence indicates that women are different from men in mobility and transport behaviour, resulting in different needs, expectations and usage behaviour. Therefore, providing the same level of service for both men and women can lead to inequity in transportation. Reviewing the literature, a number of studies considered low-income populations (Cornut & Madre 2017; Guzman & Oviedo 2018). Employment status is another important factor which differentiates the population with respect to using transportation modes. It plays an important role in income level, distance between home and employment location, and perceived social status of population groups. In this regard, it can be said that population groups with differing employment status can have different mobility needs, expectations, and limitations [(Legrain, Buliung & El-Geneidy 2016; McArthur, Robin & Smeds](https://www.sciencedirect.com/science/article/pii/S0965856418301381%22%20%5Cl%20%22%21) 2019). A number of other studies evaluated the challenges that those with disabilities and mobility impairment encounter (Gaete-Reyes, 2015; Goodman & Aldred 2018). As outlined above, different socio-demographic characteristics of population groups affect their transport usage behaviour. Therefore, desires and demands for using bicycles can be different among different population groups resulting in unequal usage of bicycles.

**Literature on Inequalities in usage of private bicycles**

As previously mentioned, inequalities in usage of transportation modes arise from the fact that people are different and have different needs. The literature on inequalities in usage of bicycles discusses the phenomenon that usage and uptake of bicycles is not equal across population groups along different socio-demographic lines. It should be clear that this inequality results in an unequal distribution of benefits and costs through using bicycles. Table 1 summarises the literature on inequalities in usage of bicycles due to socioeconomic differences and among different population groups. Reported inequalities in bicycle usage observed by researchers were based on different age, gender, ethnicity, income level, education, place of residence, household composition, car ownership, and disability.

Studies on gender, age, and income level mostly found that men, younger people and more affluent people use bicycles more than others (Steinbach et al., 2011; Davison et al., 2013; Aldred, Woodcock & Goodman 2016; Tompkins, 2017; Goodman & Aldred 2018; Fuller & Winters 2017). However, an interesting finding of a study in the Netherlands, a mature cycling country, showed that in contrast to most of the studied cases, women in the Netherlands cycle more than men, especially for work and shopping purposes (Harms, Bertolini & Brommelstroet, 2014). This is the result of elimination of most of the common impediments to cycling in the Netherlands. For instance, due to the fact that women are more risk averse than men, providing a safe and quality cycling environment and infrastructure, such as bicycle paths and more cycling safety-oriented regulations, helped to increase women’s bicycle usage.

As for ethnicity, studies reveal that ethnic minorities are using bicycles less than others. For instance, people of European ethnicity are the main bicycle users in western countries (Steinbach et al., 2011; Harms, Bertolini & Brommelstroet 2014; Tompkins, 2017; Goodman & Aldred 2018), along with people who were born in the country of study (Harms, Bertolini & Brommelstroet, 2014).

Some of the studies considered place of residence and found that people living in urban areas use bicycles more than people in rural areas (Harms, Bertolini & Brommelstroet, 2014), or that they are mostly residents of small towns (Davison et al., 2013). Other studies also revealed that bicycle users are mostly educated (Goodman & Aldred, 2018).

Recently, Goodman and Aldred (2018) evaluated the association between car ownership, disability, and co-resident children in a household, and cycling usage rates considering both utility and leisure cycling. They found that cycling usage is mostly undertaken by people without a physical disability, and those living with a child aged 5 to 15. As for utility cycling, there were more age and gender inequalities, while leisure cycling resulted in more inequality among different ethnicities and different household compositions. In addition, car ownership was positively associated with recreational cycling but negatively associated with utility cycling.

Some of the studies discussed the changes in the cycling environment and inequality of bicycle usage. Based on a study of the impacts of implementation of town-wide cycling initiatives in England, Goodman et al. (2013) showed that cycling usage rates increased, but not in an equal way. Cycling usage rates for people who live in more-deprived areas increased at a lower rate. The association between cycling usage and socioeconomic advantages over a period of time was also studied by Zander et al. (2014) in Sydney, where they considered socioeconomic advantage, housing location and car ownership, and found that people with higher socioeconomic status, living in rural areas and with low car ownership had increased usage for commuting to work. Considering the usage rates of cycling to work in the UK, Aldred, Woodcock and Goodman (2016) evaluated to what extent changes in cycling levels from 2001 to 2011 were associated with social equality of usage, focusing on age and gender. They found that gender and age inequality did not improve through increasing bicycle usage rates in the study period, instead age inequality increased with a decline in the percentage of older adults cycling over time. They argued that it is more of a bicycling equity issue when considering infrastructural preferences of women, older people and generally underrepresented groups of people compared to just increasing cycling usage rates.

In summary, unequal usage of bicycles can stem from a number of different reasons including different needs and behaviour of population groups, or inequity in cycling provision. Unequal usage of bicycles by women can stem from, for instance, cultural inappropriateness, perceived safety, and trip complexity (Pucher & Buehler 2008; Ogilvie & Goodman 2012) or can be country or context-specific (Heinen, van Wee & Maat 2010; Harms, Bertolini & Brommelstroet 2014; Goodman & Aldred 2018; Jahanshahi, van Wee & Kharazmi 2019) and not just directly related to an inequitable cycling environment. As explained in Table 1, most of the studied cases reported inequality in usage of bicycles, and bicycle usage rates are typically associated with people’s socioeconomic characteristics.

Socioeconomic References Key findings

Characteristics

Gender Steinbach et al., 2011; Bicycles are mostly used by men Davison et al., 2013;

 Harms, Bertolini & Brommelstroet, 2014;

 Aldred, Woodcock & Goodman 2016; Tompkins, 2017;

 Goodman & Aldred, 2018

Ethnicity Steinbach et al., 2011; Bicycles are mostly used by people with Harms, Bertolini & Brommelstroet, 2014; European ethnicity (or more advantaged Tompkins, 2017; ethnicities)

 Goodman & Aldred, 2018

Income Steinbach et al., 2011; Bicycles are mostly used by higher income Davison et al., 2013; people

 Fuller & Winters, 2017

Age Davison et al., 2013; Bicycles are mostly used by younger people Harms, Bertolini & Brommelstroet, 2014;

 Aldred, Woodcock & Goodman 2016;

 Goodman & Aldred, 2018

Place of Residence Davison et al., 2013; Bicycles are mostly used by people who live Goodman et al., 2013; closer to bicycle infrastructure

 Harms, Bertolini & Brommelstroet, 2014; Zander et al., 2014

Education Goodman & Aldred, 2018 Bicycles are mostly used by more educated people

Household Goodman & Aldred, 2018 Bicycles are mostly used by families with a child

composition aged 5-15

Car ownership Zander et al., 2014; Lower car ownership leads to more cycling. Goodman & Aldred, 2018 Car ownership was positively associated with

recreational cycling but negatively associated with utility cycling

Disability Goodman & Aldred, 2018 Bicycles are mostly used by people without a

 disability

**Table. 1: An overview of literature on inequality in private bicycle usage**

Despite the lack of correlation assessments in the literature, there appears to be a positive association between income, place of residence, education, and car ownership for bicycle usage. For instance, people with higher income levels, usually have higher car ownership rates, live in wealthier neighbourhoods, and are more educated. The literature on inequalities in usage of BSS will be discussed in the following section.

**Literature on Inequalities in usage of BSS**

BSSs are considered sustainable and pollution-free transportation systems that provide shared bicycles for people in order to fulfil their needs for both utility and leisure. These programmes are short-distance transportation innovations that are provided by governments to tackle cycling barriers in cities (Shaheen et al., 2011). The first BSS started operating in 1965 in the Netherlands, and there are presently more than 2100 programmes operating around the world (Frade & Ribeiro 2015; Meddin & DeMaio 2020). In the last decade, dock-less BSSs have emerged, providing lockable shared bicycles without any need to pick up/return the bicycles to the stations (Gu, Kim & Currie, 2019). The growing number of BSS implementations, as well as the various challenges they present, have caught the interest of researchers. Studies mainly focused on topics such as motivators and barriers to using BSS (Shaheen et al., 2011; Fishman et al., 2014; Bernatchez et al., 2015; Fishman et al., 2015; Chen, 2016; Jahanshahi, van Wee & Kharazmi 2019), service quality and performance analysis of the systems (Castillo-Manzano & Sánchez-Braza 2013; Zhang, Xu & Yang 2015; Manzi & Saibene 2018; Morton, 2018), and spatial analysis related to BSS stations (Karki & Tao 2016; Jahanshahi et al, 2019). In addition, inequalities in usage of BSS have emerged recently as a focus for research (Ogilvie & Goodman, 2012; Goodman et al., 2013; Goodman & Cheshire, 2014; Zander et al., 2014; Gavin et al., 2016; Aldred, Woodcock & Goodman 2016; Goodman & Aldred, 2018). There are a number of literature review papers focused on BSS, discussing topics such as its history, concept, and research trends (DeMaio 2009, Fishman, Washington, & Haworth 2013, Fishman, 2016, Gu, Kim & Currie 2019). However, there is no study reviewing the literature on inequality of usage of BSS.

As Mateo-Babiano (2015) argued, BSSs should ideally provide easy and affordable access for all groups of the population, and this could be achieved by considering different socioeconomic characteristics. There is overwhelming evidence to indicate that BSSs typically have unequal usage rates among different population groups (Ogilvie & Goodman, 2012; Goodman et al., 2013; Goodman & Cheshire, 2014; Zander et al., 2014; Gavin et al., 2016; Aldred, Woodcock & Goodman 2016; Goodman & Aldred 2018). This phenomenon could stem from inequitable BSSs or could be the result of unavoidable differences among population’s tastes, desires, and demands.

Interest in inequalities in usage of BSSs has also increasing in recent years. Most of the reviewed studies showed similar outcomes to cycling in general, that is BSSs are used mostly by men, younger people, ethnic majorities, those with more income and higher educational levels, and those residing closer to BSS stations.

Ogilvie and Goodman (2012) examined inequalities in usage of a BSS in London, the first study of its kind found in the literature. Comparing BSS users with the general population and considering both personal and area-level characteristics, they were registered more by males, residents of more privileged areas and residents of more cycling prevalent areas. Also, people who were closer to BSS stations had more usage compared to others. They also found that people who live in poorer areas, and were registered with the BSS, use the system more compared to wealthier residents, probably due to lack of affordability, and storage, for having their own private bicycle. A study in Washington D.C revealed that most of the users of this BSS programme are from European ethnicity and with higher income levels (Buck, 2013).

Goodman and Cheshire (2014) showed that improved coverage of BSS in London over a three year period of extending the scheme to poorer areas increased the usage rates of this group of the population as well as women, however, the overall usage for these two groups was still less than people with higher-income levels and men, respectively. As expected, having local access to BSS stations plays an important role in their usage rates. Similarly, increasing the price of using BSS discouraged low-income people more than others, particularly as the price increased to more than using the bus. Another important barrier to BSS usage for lower income groups was the lack of a credit/debit card, which is necessary for using the programme. Following this, it could be possible that lack of mobile internet can play a role as a barrier for lower income populations.

Gavin et al. (2016) compared BSS users and non-users in areas within a 1.2-mile radius of BSS stations in three cities in the USA. They revealed that these systems are mostly used by younger males with European ethnicity who are affluent and educated. Evaluating the socio-demographic characteristics of BSS users in Lyon, France, Raux, Zoubir and Geyik (2017) found that the system is used mainly by men, who are younger and have higher social status. As expected, proximity to BSS stations affects BSS usage behaviour positively. Hosford et al. (2018) investigated the target market for BSS in Vancouver, Canada and found that the system is used mainly by men who are employed, educated and have higher income levels.

A study by Barbour, Zhang and Mannering (2019) shows that socio-demographic characteristics such as age, gender, income levels, household composition, and car ownership affect BSS usage significantly. They also found that having lower body mass index (BMI)[[2]](#footnote-2) and BSS usage are positively associated. Winters, Hosford and Javaheri (2019) attempted to identify the characteristics of users who made 20 or more trips per month of a BSS in Vancouver, Canada – these were termed “super-users”. Their findings illustrate that super-users are more likely to be young men residing close to BSS stations with an income level under $75,000. They also found that super-users have less opportunities to use other transportation modes. Nickkar et al. (2019) showed a considerable gender gap in Baltimore BSS users, where most of the users are male. They also found that women use BSS more for recreational purposes compared to men. Exploring a BSS in Washington D.C., and considering both registered members and casual users of the system, Kaviti, Venigalla and Lucas (2019) showed that registered users of BSS are mainly of European ethnicity and have higher income levels.

In contrast, the findings of some of the studies were not in line with the aforementioned research. Jahanshahi, van Wee and Kharazmi (2019) studied a BSS in Mashhad, Iran in a developing context and found that BSS is used mostly by the youth and students. Importantly, almost 80% of users did not have a car and most of the clients for this system were low-income people. Another striking point was the fact that women were banned from using BSS in Mashhad city, which lead to a 100% gender inequality of BSS usage due to this restrictive cycling policy. A study of a BSS in Minneapolis-St. Paul, USA revealed that BSS users who live in minority-concentrated and lower socio-economic status (SES) neighbourhoods use the programme more than others having accounted for station accessibility, proximity to bicycle infrastructure, and built environment. In addition, the system was used predominantly by men and younger people (Wang & Lindsey, 2019).

**Conclusions and recommendations**

The current study reviews inequalities in usage of bicycles to highlight differences in bicycle usage patterns among the population, considering their various socio-demographic characteristics and their different needs, desires, and bicycle usage behaviour.

The findings of this review reveal that bicycles are used more by younger people, men, people with higher income levels, well educated people, ethnic majorities, people who reside closer to bicycle infrastructure, people who reside closer to BSS stations, and those without disabilities. However, it is interesting to note that some studies, particularly those undertaken in different contexts, reveal that bicycle users are lower-income people, this highlights the danger of generalising outcomes and the need to consider context. Even though most of studies showed a similar profile of bicycle users, it is crucial to pay attention to context-based differences. There are context-specific issues which influence policy making in such environments. For instance, different traffic regulations, religious and cultural differences which, for example, may influence female cycling share, and different road safety records. Further research is required to investigate inequality in usage of bicycles in different geographical, economic, and socio-cultural contexts and compare them. This can help researchers to appreciate the differences and similarities, avoiding a “one size fits all” approach to policy making.

Inequality of bicycle usage could be an unavoidable fact and not necessarily a (fairness) problem due to different tastes, desires, and needs of population groups. Inequality in usage of bicycles can be the result of different characteristics of people and their desires, and/or result of inequitable bicycle services and facilities. The literature mainly focused on associations between bicycle usage and socio-demographic characteristics. However, the extent to which unequal usage of bicycles can be influenced by bicycling inequity is still not clearly understood. Obviously, equity in cycling is not limited to providing equitable cycling provisions considering measures such as accessibility. Furthermore, establishing equitable cycling policies, such as equitable cycling motivational strategies, and investment towards increasing usage of bicycles as a healthy and beneficial transportation mode is of paramount importance. In this regard, further research is required to explore the exact reasons for unequal bicycle usage of different population groups and to discuss policy implications in response to this new knowledge. Such studies can provide a better understanding of unequal usage of bicycles and help policy-makers to appropriately invest in equity in cycling.

Despite the socio-demographic differences, which can result in different bicycle usage, it is important that organisations operating BSS try to help reduce these inequalities in usage of bicycles by establishing some regulations in their planning and operation policies. In addition to improving equity in their systems by equitable distribution of the BSS stations and avoiding distributing them just in city centres or wealthier neighbourhoods, motivating population groups which are not interested in using BSS for their commuting, will help balance bicycle usage among different population groups, reduce the gaps between their usage, and result in better distribution of the benefits of cycling. For instance, implementing regulations which explicitly consider those with lower incomes, such as providing concessions for them, can help close the gap between them and more affluent populations in respect to usage of BSS. Improving the quality of shared bicycles can also help encourage groups of the population with more perceived risk such as women and elderly populations (assuming they are physically able) to use BSS. Governments also can play an important role by providing a safe cycling environment and infrastructure and establishing more cycling-oriented traffic regulations. In order to increase BSS usage among the population and avoid considerable unequal usage of this system it is important to consider the goal of these systems and identify the definition of success for them. Usually private businesses operate and lead BSSs where their success can be defined as more usage per bicycle, but not in an equal way nor in an equitable way. Therefore, it seems to be timely to explore the role for BSSs and the collaboration between governments and the private sector in order to provide BSS which consider equality of bicycle usage among the population, as well as more equity in its service.

**AUTHOR CONTRIBUTION STATEMENT**

Danial Jahanshahi completed the literature review and wrote the paper. Dr Subeh Chowdhury, Associate Professor Seosamh Costello, and Professor Bert van Wee reviewed the paper and provided editorial suggestions.

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1. Presenter [↑](#footnote-ref-1)
2. "Body Mass Index" (BMI) is the ratio of [human body weight](https://en.wikipedia.org/wiki/Human_body_weight) to squared height (Keys et al., 1972) [↑](#footnote-ref-2)