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REVIEW PAPER

Active Commuting and Sustainable Mobility in Spanish Cities: Systematic Review

Alberto Sanmiguel-Rodríguez[1,2] and Víctor Arufe Giráldez[3]

[1]University Camilo José Cela, Faculty of Language and Education, Madrid, Spain, [2]Nebrija University, Faculty of Language and Education, Madrid, Spain, [3]University of Coruña, Faculty of Education, A Coruna, Spain

Abstract

The General Assembly of the United Nations established 17 sustainable development goals in its 2030 agenda, and urban mobility is in the sights of political authorities to empower sustainable cities and communities. This work consists of a review of the literature published within the Spanish context concerning public bicycle systems and urban mobility. To select studies, a search was carried out with different descriptors in the main Spanish and international databases, namely Scopus (Elsevier), Web of Science (WoS), and Dialnet. Some of the analysed works examine the efficacy of public bicycle systems as an efficient and sustainable alternative in cities; other works study the impact on individual and public health of shared bicycle schemes via increased physical activity engagement. Likewise, infrastructure and facilities for cyclists are also analysed as they favour perceptions amongst the population of greater road safety within their environment. Bicycle-share systems can help to maintain healthy habits amongst the population. Better infrastructure, technology and appropriate policies can favour the use of these systems.

Keywords: *Urban transport, public health, public transport, bike-sharing systems, physical activity*

Introduction

Healthy lifestyles have emerged as an important topic in contemporary society. Given this circumstance, governments and institutions promote the revitalization of public spaces, which encourages engagement in physical activity and the development of human interrelationships (Braçe, 2016; Curto et al., 2016). Thus, an active lifestyle, including walking or cycling, has become a key factor in reducing the impact of chronic diseases, obesity and/or coronary problems linked to human behaviour, such as those produced by a lack of physical exercise. In the same way, when such activities are used as a means of transport, they favour a less-congested urban environment and reduce greenhouse gas emissions, which cause climate change. All of this has a positive effect on human health (Anaya & Castro, 2012; Curto et al., 2016; Sanmiguel-Rodríguez, 2015, 2019, 2020; Seguí, Mateu, Ruiz, & Martínez, 2016). The field of study relating to urban mobility and active transport in cities has emerged as a relevant research area. The growing interest in environmental care has produced a sociological change in large sectors of society, which now prefer to walk or use non-polluting means of transport, such as bicycles (Herranz, 2015; Zozaya, 2016, 2017). Similarly, the increasing rise of fuel use makes the bicycle an ideal means of transport with regards to the sustainability of the urban environment (Pellicer-Chenoll et al., 2020). Given the enormous fuel consumption in Spain, where there is a high external dependence on oil, encouraging cleaner cities is crucial (Herranz, 2015).

At the international level, the 2030 Agenda of the United Nations (UN) opted to establish objectives for sustainable development, addressing the need to establish changes in urban mobility (UN, 2015).

In a review (Anaya & Castro, 2012) on bike-sharing systems in Spain, a detailed analysis of the different systems existing in 2011 was presented. In Spain, 196 systems had been implemented. According to the city profile, 51% of the systems are located in urban centres of less than 50,000 inhabitants; 21% are found in cities of 50,000 to 100,000 inhabitants, 24% in cities of between 100,000 and 500,000 inhabitants, and 4% in

Correspondence:

A. Sanmiguel-Rodríguez
University Camilo José Cela, Faculty of Language and Education, Urb. Villafranca del Castillo, 28692 Madrid, Spain
E-mail: asrgz2014@gmail.com

centres made up of more than 500,000 inhabitants. However, most of the Spanish cities that have bike-sharing systems are poorly equipped with bicycle infrastructure. According to Castillo-Manzano, López-Valpuesta, and Sánchez-Braza (2016), a strategy that has started to achieve good results in the promotion of bicycle use, along with the construction of bicycle lanes and availability of bicycle parking, is the implementation of public shared bikes systems that coexist with the private use of bicycles; Their findings showed that the average duration of trips on private bicycles was higher than those made using public bicycles; however, there is a complementary relationship between the two modes of transport in regards to distance. Following on from this research, the results of another study (Braun et al., 2016; Curto et al., 2016) showed that the modal competition between cycling and public transport, through the presence of more public transport stops and better cycling infrastructure and stations for bicycles, is associated with greater active displacement within the urban environment.

Other international studies (Eren & Uz, 2020) have addressed the need for a comprehensive review of the factors affecting bike-sharing demand to bridge the gaps by deepening the knowledge on weather, built environment and land use, public transportation, station level, socio-demographic effects, temporal factors, and safety.

Bike-sharing systems have recently become a key issue in urban mobility and in related research activity. Due to their relative novelty, most scholars focus on the characteristics of the supply side without taking demand into account. Data on this subject has not yet been analysed in detail as most of the systems have only recently been introduced (Munkácsy & Monzón, 2017). Ferrando, Anaya and González (2010) pointed out that the approach to implementation of bicycle systems in Spain is currently under development. The data obtained have shown a series of trends that characterize Spanish public bicycle systems. For example, it is noted that there are many types of systems and that the evolution of those that are perceived as successful is usually towards automation. It has also been noted that these systems are successfully implemented not only in medium and large cities but that small cities can also implement systems adapted to their context, which are capable of producing good results. In a survey carried out by Curto et al. (2016) in Barcelona, travellers' favourable perceptions towards public bicycles were reported. Further, the most important facilitators for using bicycle-sharing systems were reported as follows: avoiding bicycle theft and vandalism, and maintaining the low cost of the system. According to Braçe (2016), public bicycle programmes have begun to receive increasing attention in recent years due to the great interest of urban planners in developing and improving active transport systems in the urban environment. These measures would help reduce dependence on private vehicles and encourage non-motorized journeys, thus maintaining the three pillars of sustainable development: environmental, economic, and social (Braçe, 2016; Castillo-Manzano et al., 2016; Morales, 2011; Norveto, 2010). As a result, bike-sharing systems have experienced relevance and popularity in European countries and around the world (Castillo-Manzano et al., 2015; Faghih-Imani, Hampshire, Marla, & Eluru, 2017). Furthermore, bicycle infrastructure has also been shown to be an extremely important element in sustainable mobility strategies in the urban sphere (Ballester & Peiró, 2008; Braun et al., 2016; Luque, 2016; Morales, 2010, 2011; Munkácsy & Monzón, 2017; Norveto, 2010; Seguí et al., 2016; Zozaya, 2016, 2017) and as part of strategies targeting less polluted environments. It fits in with research into the design of urban spaces and how this influences health, improving understanding of the physical and social elements that condition people's lives (Anaya & Castro, 2012; Ballester & Peiró, 2008; Braun et al., 2016; Curto et al., 2016; Herranz, 2015; Munkácsy & Monzón 2017).

Thus, it was decided to review bicycle systems found in the Spanish context, given that the climatic characteristics of this country favour the practice of physical activity and outdoor cycling. Also, many planning policies are being developed in Spain within the urban environment to promote less congested traffic environments whilst also favouring public health. Simultaneously, these active means of transport (walking or cycling) favour a less congested urban environment, reducing greenhouse gas emissions. This also has a positive effect on human health (Anaya & Castro, 2012; Curto et al., 2016). The choice of this environment for the study of urban mobility relating to bicycle use is because Spain enjoys situational, climatic, and topographic characteristics that favour outdoor sports throughout the year.

This work aims to review the literature published in recent years concerning Spanish bike-sharing systems. Specifically, the objectives that our article aims to address are as follows:

a) Compile research studies conducted on public bicycle systems and better understand the status of issues relevant to this research field within the Spanish context.

b) Classify the main lines of research developed around the subject.

c) Document the background of investigations relating to current public bicycle systems for future investigations.

Methods

This article's development was based on the realization of a bibliographic review based on the search and analysis of information relating to bike-sharing systems within the Spanish context. This type of review is called an "overview" (Grant & Booth, 2009), through which an update of all the macro information published on a specific topic is established. Its main advantage is the ability to analyse a large amount of information published in recent years and clarify different subtopics related to researchers' main topic. To carry out this review, the parameters and recommendations set by the PRISMA Declaration were used, complying with the analysis of that declaration's 27 items (Moher, Liberati, Tetzlaff, & Altman, 2009). Different search descriptors were used, among which the following keywords are highlighted: shared bicycles, public bicycles, bicycle systems, physical activity and bicycles, active transport and public health and bicycles. Works published up until 2020 were included. The inclusion criteria used were as follows:

a) Scientific articles published within the Spanish context up until December 20, 2020;

b) Addressing any type of research related to bicycle systems and urban mobility in the Spanish context incorporating quantitative, non-experimental, descriptive, prospective, longitudinal, cross-sectional and/or case studies;

c) Published in English or Spanish.

After the application of these criteria, a total of 181 documents on the subject, published in English and/or Spanish up until December 2020, were included. The work schedule for

the information search consisted of four distinct phases:

• 1st Phase: Search and selection of the aforementioned descriptors using the UNESCO Thesaurus.

• 2nd Phase: Search carried out using general search engines and in the following databases using the inclusion criteria described above: Scopus, Web of Science, and Dialnet.

• 3rd Phase: Analysis of the content of articles and classification according to themes.

• 4th Phase: Categorization of the articles and preparation of the manuscript. It should be noted that, in general, attempts were made to use the article itself as a reference. However, in some cases, due to the difficulty accessing the content of some articles, the corresponding abstracts were analysed and evaluated.

The work schedule for the information search consisted of five differentiated stages. These are described next and can also be observed in the flow diagram, which provides a graphical representation of the process in Figure 1.

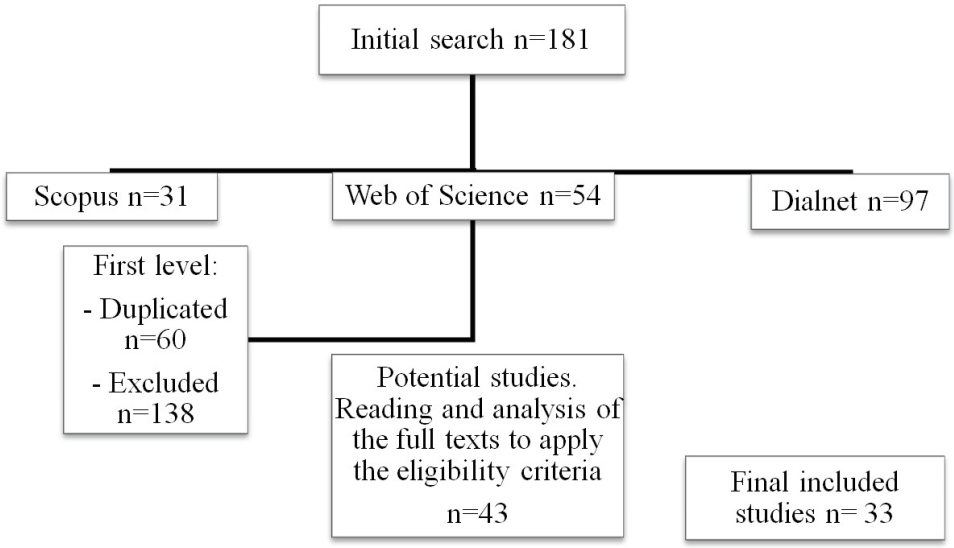

FIGURE 1. Flow diagram of the systematic search process

The research was carried out by dividing it into five large blocks of content to try to answer the different issues that we believe to be most important. The first section will deal with the current state of Spanish bicycle systems. In the second section, we will analyse the importance of cycling infrastructure, accessibility and facilities within bicycle sharing systems in the urban environment as a means of favouring active policies within the Spanish population. In the third, studies addressing the importance of road safety and new technologies within the Spanish system of public bicycles will be addressed and the social impact that it has on its population. The fourth point relates to the benefits of bicycle-sharing systems as a means of promoting healthy habits within urban environments, as well as the educational vision that different professionals and students have about cycling as an active means of transport. Finally, in the fifth section, we will attempt to explore whether correct political planning within the urban environment can favour healthy practices and the use of public bicycle schemes, with reference being made to the sustainable mobility and ecology offered by these systems.

Results

Once the flow chart of the systematic review of Bike-sharing systems and urban mobility in Spain was made, the result was 33 publications. All of them were included in the process of categorization by subject, which produced five categories of analysis of the scientific literature. The results of the systematic review carried out are detailed below, specifying the publications that belong to each of the five categories analysed (Table 1).

Table 1. Synthesis of the studies found on Bike-sharing systems and urban mobility in the Spanish context

Authors	Article title	The purpose of the study	Results and conclusions
Research on urban mobility and public bicycle systems			
Álvarez-Valdés et al., 2016	Optimizing the level of service quality of a bike-sharing system	Distribution of bicycles among stations	Computational results using real data from the bike-sharing system in Palma de Mallorca are reported
Brey et al., 2017	"I want to ride my bicycle": delimiting cyclist typologies	The aim of determining whether different typologies of cyclists exist depending on the type of bicycle for urban commuting (public bicycle/private bicycle)	This study showed that users of public bicycles are predominantly male, young and use the public bicycle for subsistence trips due to its easy intermodality; while private bicycle riders are mainly females who regularly make "non-subsistence" trips and prefer a more flexible bicycle for their daily needs

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Authors	Article title	The purpose of the study	Results and conclusions
Research on urban mobility and public bicycle systems			
Castillo-Manzano & Sánchez-Braza, 2013	Managing a smart bicycle system when demand outstrips supply: the case of the university community in Seville	This paper analyses this experience in the university community, which represents one-third of system users	The people who are most satisfied with the system are those who use it for leisure and recreation activities, non-residents of the city, more environmentally aware people and those who have no alternative mode of transportation
Munkácsy & Monzón*, 2017	Potential User Profiles of Innovative Bike-Sharing Systems: The Case of BiciMAD (Madrid, Spain)*	The aim of this paper is the analysis of the evolution of bike-sharing and the exploration of how innovative technologies have changed bike-sharing systems for users and the identification of user (and non-user) profiles of the latest generation of bike-sharing based on an ex-ante case study on the BiciMAD	These authors showed that parking and inter-modality were the most relevant factors for BiciMAD users
Pellicer-Chenoll et al., 2020	Gender differences in bicycle sharing system usage in the city of Valencia	This study analysed the movements of men and women who use the BSS in the city of Valencia during weekdays	These authors showed that women use the BSS less than men in all the tested time slots. They also observed different network density and centrality for men and women. Finally, They found that women do not use the peripheral areas of the city at night
Rojas-Rueda et al., 2011	The health risks and benefits of cycling in urban environments compared with car use: health impact assessment study	To estimate the risks and benefits to health of travel by bicycle, using a bicycle-sharing scheme, compared with travel by car in an urban environment.	Public bicycle sharing initiatives, such as Bicing in Barcelona, have greater benefits than risks to health
Sanmiguel-Rodríguez*, 2019	Analysis of the ages, routes and minutes of use in the use of a shared bicycle system: the case of VaiBike in Vilagarcía de Arousa (Spain)*	This study is intended to categorize the ages of users of this system, as well as their frequency of use, the route characteristics, and average minutes of use of bicycles	Users' average age was 46 (men 49; women 38.7). The highest frequency of use begins and ends in the city centre. Men between 50 and 69 years old and women between 30 and 49 years old use bicycles the most. Coastal routes are the most popular in women. The average minutes of use in public bicycle trips were 36,1 (men 38,1; women 31,4).
Sanmiguel-Rodríguez*, 2020	Compliance with the recommendations for physical activity set by the WHO by public bicycle users in a Spanish municipality	To know if the users of the public bicycle sharing system of Vilagarcía de Arousa (Spain) comply with the recommendations of physical activity for health established by the WHO.	The results indicate that users of the Vaibike bicycle sharing system of Vilagarcía de Arousa comply with the minimum recommendations of physical activity given that the average number of minutes of use of bicycles is greater than 30 minutes.
Sanmiguel-Rodríguez & Arufe Giráldez, 2019	Impact of climate on a bike-sharing system. Minutes of use depending on the day of the week, month and season of the year	The objectives of this article are, firstly, to determine if the impact of climate, temperature and average rainfall on the use of shared bicycles; and, secondly, to analyse if the use of these bicycles is affected by the day of the week, month or season of the year	These authors found no significant differences in use concerning the day of the week. With respect to month, the data reveal a progressive increase in use from April to July, reaching a peak of 15.8% in September
Seguí et al.*, 2016	Bike-Sharing schemes and sustainable urban mobility. An analysis in the city of Palma (Mallorca, Balearic Islands)*	The article analyses public bicycle systems as an instrument to encourage bicycle trips within the framework of sustainable mobility policies	The analysis shows a low acceptance of the system, despite the more-than-notable increase in the number of cyclists in the city

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Authors	Article title	The purpose of the study	Results and conclusions
Research on urban mobility and public bicycle systems			
Accessibility, public spaces and infrastructure of bicycle systems and public facilities in the urban environment			
Braçe*, 2016	Study of the Effects of Urban Morphology on Physical Activity*	This article explores the association between urban design variables and physical activity, showing as the results obtained in a European Mediterranean area are consistent with the scientific literature	This author affirmed that in this environment, there is a relationship between urban sprawl, physical activity and use of transport-related physical activity (walking and cycling)
De Manuel, 2016	Sustainable urban mobility networks and the reactivation of the public space: Alcosa	This author has made a diagnosis about the relationship between a mobility model and public space occupancy.	There is a direct relationship between the use of public space and mobility model
Orzanco et al., 2018	Perception of psychosocial and environmental factors related to active displacement	The purpose of the present study was to determine the perception of individual factors and of the nearby environment, related in a special way to each of the two modalities of active transport, in a population sample of the adults living in the metropolitan area of Pamplona	People who spend less time walking to go from one place to another indicate lack of time as the reason that prevents them from carrying out some physical activity, while the group that uses the bicycle less for transport indicates a lack of enjoyment
Zozaya, 2016	La nueva infraestructura de la bicicleta en París y Barcelona: retos de su implantación e influencia de la trama urbana	This study showed that cycling infrastructure is an element of growing importance in the development of sustainable mobility strategies in urban areas	The hybrid nature of the bicycle as a means of transport, halfway between the pedestrian and the motorized vehicle, induces a rethink of the current configuration of urban roads and public spaces
Zozaya, 2017	Retos de la expansión de los sistemas de bicicletas públicas en las aglomeraciones urbanas metropolitanas	The creation of specific regulations and standards that would guarantee the compatibility of key elements among the different providers of these schemes is essential to ensure their success during the process of metropolitan integration	This study showed that bicycle systems can become a key element in the sustainable mobility strategy of cities
*Potential User Profiles of Innovative Bike-Sharing Systems: The Case of BiciMAD (Madrid, Spain); Munkácsy and Monzón			
Social factors, installation of bicycle systems, new technologies and road safety			
López & Monzó, 2014	Sistemas de bicicleta pública: vehículos inteligentes para ciudades sostenibles.	The article is part of the search for transport solutions	The article forms part of the search for transport solutions within what has been termed intelligent mobility and incorporates some type of communication and information technology
Morales, 2011	El Fomento del uso de la bicicleta en entornos educativos	The object of study of this work is to carry out a review bibliography of the evolution of the bicycle from its appearance to the culmination in different educational settings	This study showed the benefits of using this means of transport, both at an energy and environmental level
Osorio-Arjona & García-Palomares, 2017	New sources and challenges for urban mobility studies	In this article, the state of the art in these new data sources use for urban mobility analysis is implemented	To promote actions towards sustainable mobility, it is necessary to use dynamic information sources with high spatial and temporal detail that allow for efficient diagnoses of the mobility situation in our cities. Information and Communication Technologies and Big Data appear as new interactive sources that respond to these needs

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Authors	Article title	The purpose of the study	Results and conclusions
Research on urban mobility and public bicycle systems			
Reboreda et al., 2016	Cyclope: sistema tecnológico para mejorar la seguridad vial de bicicletas y ciclomotores	These authors have created a system aimed at the prevention of traffic accidents amongst cyclists and motorcyclists	The number of injuries sustained on the road in Spain has been maintained over time
Tironi, 2015	Éticas en el cuidado de los recursos urbanos: mantención y reparación en un sistema de bicicletas públicas	This study demonstrated the essential work that takes place behind the scenes by those who maintain and repair urban resources, such as bike sharing systems	
*Potential User Profiles of Innovative Bike-Sharing Systems: The Case of BiciMAD (Madrid, Spain); Munkácsy and Monzón *Perception of psychosocial and environmental factors related to active displacement; Orzanco et al.			
Planning policies in the urban environment and studies of sustainable mobility, environment and ecology			
Ballester & Peiró, 2008	Transport, environment and health	These authors review the negative impact of current transport forms on health in terms of traffic injuries, climate change, atmospheric contamination, noise, and interference with daily activities and exercise, such as impediments to walking or cycling.	Recommendations are made on the need to reduce the use of private cars and to develop segmented routes and areas of quiet traffic connected in the cities and among nearby towns to promote walking are cycling
Herranz, 2015	Un nuevo concepto para la ordenación del territorio	This study showed that public authorities often proceed in a contradictory manner when promoting active means of displacement	
Rojas, 2013	Transportation, Air Pollution And Physical Activities; an integrated health risk assessment programme of climate change and urban policies (TAPAS)	Active transport (walking, cycling or public transport) may have the capacity to reduce greenhouse gas emissions and climate change and may bring with them benefits for the environment and health	
*Study of the Effects of Urban Morphology on Physical Activity; Braçe *Potential User Profiles of Innovative Bike-Sharing Systems: The Case of BiciMAD (Madrid, Spain); Munkácsy and Monzón *Bike-Sharing schemes and sustainable urban mobility. An analysis in the city of Palma (Mallorca, Balearic Islands); Seguí et al.			
Healthy habits, benefits of the practice of physical activity and educational vision			
Chillón et al., 2017	Active commuting to school, positive health and stress in Spanish children	The objective was to analyse the association between active travel to school and variables of positive health and stress in Spanish children	Measures are necessary to encourage active travel to school due to the positive benefits it has on physical and emotional health, seen as a possibility of adequately channelling stress in Spanish children
Luque, 2016	La movilidad urbana sostenible una nueva razón para fomentar el uso de la bicicleta en el ámbito educativo	Encourage the use of bicycles, not only in our sessions but also as an excellent means of promoting "transportation to school"	
Mallada, 2012	El cicloturismo en el currículo de Educación Secundaria de Cantabria	This article is a review of the possibilities of the use of the bicycle and the realization of cycling activities within the framework of the educational curriculum of Cantabria (Spain)	
Mira & Tortosa, 2009	The bicycle as a means of sport and transport	Cycling can be the way for all of them to do the advisable daily sport and to reach a healthy and sustainable life, according to the basic competences of the Organic Law of Education (OLE) and the principles of the World Health Organization of Health (WHO)	
Moreno & Bernal 2016	Transporte activo y ciudad: propuesta interdisciplinaria para la educación física	This article showed an educational proposal focused on active transport (use of the bicycle to get to the school) and on the generation of critical awareness based on the experience of the city as an educational space-time	

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Authors	Article title	The purpose of the study	Results and conclusions
Research on urban mobility and public bicycle systems			
Rodríguez-López et al., 2013	Family factors influence active commuting to school in Spanish children	The objective was to analyse the association between parents' occupational activity and parents' mode of commuting to work with the mode of commuting of their children	Children whose parents did not work used to engage in higher levels of active commuting to school than those whose parents worked. Children whose parents used to commute actively to work used to engage in higher levels of active commuting to school than those whose parents used both passive modes of commuting to work.
Ruíz-Ariza et al., 2017	Active commuting to school influences on academic performance of Spanish adolescent girls	Active commuting has been associated with better health and cognitive performance	
Sanmiguel-Rodríguez, 2015	Ambiente urbano y bicicletas compartidas: efectos sobre la actividad física	The objective of the study was to analyse the uses of a public bike system according to user characteristics, as well as the time of use of bicycles, months, seasons and weather	Users of the bicycle sharing system are middle-aged. If we take into consideration gender, the service is more used by men than by women. Women show an earlier usage of the service compared to men
Villa-González, Ruíz & Chillón, 2016	Recommendations to implement quality interventions to promote active commuting to school	The objective of the current study is to propose different practical recommendations to increase the quality of the intervention programmes focused on promoting active commuting to school, based on previous intervention experiences with Spanish schoolchildren	These authors recommended increasing the dose of the interventions, provide proper guidance about the content of the intervention, and conducted several assessments across the intervention, in order to improve the quality of the interventions
Villescas et al., 2016	Towards a city in penny-farthing: The role of children as essential changemakers	The purpose of this study is to approach the essential role of children as changemakers in the city of Murcia (Spain)	
*Analysis of the ages, routes and minutes of use in the use of a shared bicycle system: the case of VaiBike in Vilagarcía de Arousa (Spain); Sanmiguel-Rodríguez			
*Compliance with the recommendations for physical activity set by the WHO by public bicycle users in a Spanish municipality; Sanmiguel-Rodríguez			

Legend: * - Repeated studies in the different categories

Discussion

We present below a synthesis of the main lines of research reviewed. After reading and analysing each of them, different degrees of development and evolution are indicated.

Research on urban mobility and public bicycle systems

Concerning this first theme, several articles that analysed various aspects relating to bicycle systems in Spain are cited. Rojas-Rueda, Nazelle, Tainio, & Nieuwenhuijsen (2011) evidence a large degree of success in terms of the number of subscribers and the frequency of travel on shared bikes in Barcelona. Castillo-Manzano and Sánchez-Braza (2013) analysed the Sevici bicycle sharing system in the city of Seville. Surveys analysing the weather were administrated to students, professors, and administrative staff. They showed that the low levels of rainfall in Seville make it a favourable place for bicycle use as a sustainable mean of transport, although two factors could alter this aspect. The findings of Brey, Castillo-Manzano, and Castro-Nuño (2017) show that users of public bicycles in Seville are predominantly young men with a high level of education who use public bicycles to a great extent due to their greater inter-modality.

In contrast, women used the private bicycle as a means of regular transport and preferred it for their daily needs. The results of Pellicer-Chenoll et al. (2020) showed that women use public bicycles in the city of Valencia less than men do, and women do not use them in the peripheral areas of the city at night. Munkácsy and Monzón (2017) surveyed BiciMAD in Madrid, analysing the system`s uses (leisure, sport, tourism, work or school), topography, infrastructure and the challenges posed to the Madrid government when attempting to promote cycling. In another investigation (Seguí et al., 2016) carried out in Palma de Mallorca, the sustainability of the city's bicycle mobility over recent years was examined, together with increases in bike lanes and specific parking. According to Álvarez-Valdés et al. (2016), the quality of service is drastically

affected by imbalances in the distribution of bicycles between stations. BiciPalma has made it possible to improve the image of the bicycle in the city and to expand its use to other user groups who previously did not opt for this means of transport, for instance, to work. Sanmiguel-Rodríguez and Arufe Giráldez (2019) examined outcomes of the Vaibike system in Vilagarcía de Arousa in relation to age, gender, route taken, hours, weeks, and climatic variables, while another study (Sanmiguel-Rodríguez, 2019) indicated that women preferred journeys along the coast in this city. Further, its effect on meeting WHO's physical activity recommendations was identified (Sanmiguel-Rodríguez, 2020).

Accessibility, public spaces and infrastructure of bicycle systems and public facilities in the urban environment

According to the framework developed for this theme, many programmes exist to implement or promote increased citizen participation related to cycling in cities. However, each of these initiatives has the same essential purpose: to create a network of efficient and useful cycling paths that will enable bicycles to be used safely on main roads, incorporating the bicycle into the model of inter-modality of urban transport. There has been a progressive introduction of bike lanes, and many people have begun to take advantage of them to move around the city. Despite this, all structural modifications require a period of adaptation and, in reality, the network of cycling lanes is full of obstacles to the cyclist. Along these lines, Munkácsy and Monzón (2017) also showed that parking and inter-modality were the most relevant factors for BiciMAD users. Indeed, the designation of shared lanes on busy roads in the centre of Madrid was highly criticized by participants. To make the service qualitatively and quantitatively more attractive, the development of appropriate infrastructure must be encouraged by the local government. However, many people are more concerned about the flexible, economic, and ecological nature of cycling.

In another investigation (Zozaya, 2016), it has been shown that cycling infrastructure is an element of growing importance in the development of sustainable mobility strategies in urban areas. An increasing number of cities are encouraging the use of bicycles through various initiatives, including municipal bicycle rental systems. The hybrid nature of the bicycle as a means of transport, halfway between the pedestrian and the motorized vehicle, induces a rethink of the current configuration of urban roads and public spaces. Another study by Zozaya (2017) showed that bicycle systems can become a key element in the sustainable mobility strategy of cities. Also, the visibility of public bicycles and stations serves to publicize the commitment to sustainable mobility in the municipality, generating interest in the public regarding this means of transport, with the system even becoming incorporated into the "brand" and the attractiveness of the municipality. However, the decision to incorporate a public bicycle system in the city must take into account the difficulties involved in the implementation project, such as achieving the acceptance of citizens and demonstrated economic sustainability, which will depend on maintenance and replacement costs, obtaining significant revenues, and a commitment to the system of future administrations, amongst others. Although a public bike system will probably not become linked at a state and international level in the same way that the modern railway network has been, its scope for potential action within urban groups often exceeds the municipal perimeter in which many current initiatives operate. Thus, the creation of a standard is a necessary step if we want to guarantee the maximum utility of public bicycle systems in the metropolitan environment. Standardization would allow greater investment in bicycle systems based on initiatives at a local level with the certainty of being able to integrate them later on within a metropolitan network. It would also force different types of stations and vehicles to work together to find solutions, facilitating competition and innovation.

Orzanco, Guillén, Sainz, Redín, and Aguinaga (2018) show that the development of infrastructure that facilitate the mobility of pedestrians is associated with greater bicycle use for commuting. Following these conclusions, the results of another investigation (Braçe, 2016) have shown low-density urban areas, a lack of local services, a scarcity of public transport, and low-quality public spaces, reduce the likelihood of displacement through physical activity (walking and cycling) and increase dependence on private vehicles. In contrast, De Manuel, González and Donadei (2016) pointed out that there is a direct relationship between the use of public spaces and the mobility model in the Alcosa neighbourhood in Seville. To reactivate public spaces at the level of urban neighbourhoods, it is necessary to adapt the model of metropolitan mobility so that it favours alliances between public transport and active mobility. Doing so will encourage the reduction of public spaces for motor vehicles and improve pedestrian and bicycle accessibility, thereby activating the use of public spaces.

Social factors, installation of bicycle systems, new technologies and road safety

Regarding this theme, Osorio-Arjona and García-Palomares (2017) highlight that increasing demand for mobility in cities has led to an unsustainable dynamic both socially and environmentally. To promote actions towards sustainable mobility, it is necessary to use dynamic information sources with high spatial and temporal detail that allow for efficient diagnoses of the mobility situation in our cities. Information and Communication Technologies and Big Data appear as new interactive sources that respond to these needs. This article reviews the state of the art in using these new data sources for the analysis of urban mobility, comparing its usefulness with respect to traditional sources, classifying them, presenting the research topics they offer, and identifying challenges for the future. Other authors (López & Monzón 2014) point out the need to introduce greater inter-modality within public transport in the urban environment. Their article forms part of the search for transport solutions within what has been termed intelligent mobility, incorporating some type of communication and information technology. Bicycles as a means of transport was analysed and, in particular, how ICTs have enabled the development of public rental systems, which, in effect, have been equipped with some form of technological innovation. According to Munkácsy and Monzón (2017), smart technologies make it easy to use shared bike systems, since they allow location tracking, intelligent access, and the development of online applications. They enable the integration of bicycle-sharing systems within the urban transport system both from the user's (route planning, rates, etc.) and the operator's points of view. Other researchers (Reboreda et al., 2016) have created a system aimed at the prevention of traffic accidents amongst cyclists and motorcyclists. According to their study, the number of injuries sustained on the road in Spain has re-

mained steady over time. To address this, they have tried to introduce a technological system that helps improve road safety for cyclists.

In contrast, Orzanco et al. (2018) has revealed that perceptions of heavy traffic are more prevalent within populations that spend less time walking to move from one place to another. However, the development of infrastructure that facilitates the mobility of pedestrians is associated with greater bicycle use for travel. Another study (Tironi, 2015) demonstrates the essential work that takes place behind the scenes by those who maintain and repair urban resources, such as bike-sharing systems. This research makes us aware of those almost artisanal practices that, without much marketing, allow us to enjoy smart cities or sustainable transport systems. In contrast, Morales (2011) highlights the considerable social acceptance of the population to the use of bicycles as a means of ecological transport, showing the benefits of using this means of transport, both at an energy and environmental level.

Planning policies in the urban environment and studies of sustainable mobility, environment and ecology

The purpose of this theme is to analyse studies on policy and spaces, identifying predictive factors in the urban environment. Ballester and Peiró (2008) propose the development and maintenance of a public transport system that is faster, safer, cheaper and less polluting than private transport, which should be an important goal in current public policies. According to Rojas (2013), active transport policies can produce great benefits for the health of the population. These benefits are mainly associated with the increase in levels of physical activity. Munkácsy and Monzón (2017) point out that the European Union's transport policies, campaigns, and awareness-raising events are factors that influence the use of a non-polluting means of transport by members of society. According to these researchers, the BiciMAD system was not popular when it was inaugurated in July 2014 because there was no relevant public participation in the planning of the project, and it was not directly advertised before being presented, with only a few press releases being published. Although BiciMAD is considered a mobility management tool that is designed to be attractive to urban travellers, the local government or service provider did not directly approach the issue of public acceptance of the bicycle sharing system when developing it. According to Seguí et al. (2016), sustainable urban transport planning and the political decisions for its implementation are the result of a set of measures and interventions (dissuasive parking, traffic calming, car sharing, improvement of pedestrian areas and public transport or parking management) that can change and improve the habitability of cities.

Following these contributions, Herranz (2015) states that public authorities often proceed in a contradictory manner when promoting active means of displacement. Whilst communication is positive, the actions put into practice fail to offer an adequate response to social demands. Braçe (2016) states that there is also a relationship between urban morphology, physical activity, and the use of transport types that involve some physical activity, such as walking and cycling. These results should be useful for territorial and urban planners and managers when taking measures to avoid the increased dispersal of urban areas and the promotion of nuclei of centrality. These measures would help reduce dependence on private vehicles and encourage non-motorized journeys, thus maintaining the three pillars of sustainable development (environmental, economic, and social).

In recent years, growing interest in environmental care has produced a sociological change in large sectors of society, which prefer to walk or use non-polluting means of transport such as bicycles (Herranz, 2015). According to Rojas (2013), active transport (walking, cycling, or public transport) may have the capacity to reduce greenhouse gas emissions and climate change and may bring with them benefits for the environment and health. Influencing these ideas, the study of Ballester and Peiró (2008) shows the negative impact on health that the current type of transport has in terms of traffic injuries, climate change, air pollution, noise, and interfering with daily activities and physical activity, for instance by making walking or cycling more difficult. These actions will help achieve a change in societal transport habits, a healthier population and a more sustainable environment. However, to promote active displacement, it will be necessary to reduce the use of private cars and develop quiet traffic spaces that connect cities and nearby towns.

Healthy habits, benefits of the practice of physical activity and educational vision

This area of investigation deals with aspects that include the benefits of bike systems and engagement in physical activity. Previous research (Sanmiguel-Rodríguez, 2015, 2019, 2020) has shown that bicycle systems are an active and sustainable means of transport that could help individuals fulfil the 2010 World Health Organization (WHO) recommendations for physical activity. According to Rodríguez-López et al. (2013), active transport between home and school can improve the health of school children and represent a significant percentage of their daily physical activity. Moreover, this practice has been associated with a better cardio-metabolic profile and improved general physical condition. In corroboration, Chillón, Villén, Pulido, and Ruíz (2017) indicate that the promotion of daily physical activity in young people, such as active displacement to school (walking or cycling), can have important health benefits. The results of this study showed that active displacement to school was inversely associated with stress. Likewise, in another study (Ruíz-Ariza, de la Torre, Suárez, & Martínez, 2017), it is shown that active displacement is defined as the act of going to the educational centre by means of transports that involve metabolic expenditure, such as walking or using a bike. The average daily time of active displacement in adolescents is 18 minutes, and it could increase total daily physical activity by 13%. Active displacement has been associated with better health and cognitive performance in Spanish girls in Secondary Education. Research by Villa-González, Ruíz and Chillón (2016) came to the same conclusions, in that it was observed that regular engagement in physical activity (walking or cycling) had numerous health benefits in young students, and that long-term engagement generated mental, academic, cognitive, psychological and social benefits for them.

Moreno and Bernal (2016) proposed that education should be focused on active transport and on generating critical awareness based on the characteristics of the city pertaining to space or time. They considered a community-focused pedagogical procedure that attends to interdisciplinary relationships and the collaborative generation of knowledge between all the parts to be indispensable. Luque (2016) reports that Spain is falling behind other European countries in the use

of this means of sustainable transport and states that schools should encourage the use of bicycles, not only in physical education classes but also as an excellent means to promote transportation to school. Teachers in general and physical education teachers, in particular, have one more reason to invite students and the rest of the educational community to use bicycles to promote sustainable mobility. Other authors (Mira & Tortosa 2009) highlight that professionals in physical education and sports have an ethical and moral obligation to promote bicycles as a means of physical activity, transportation, education, and health. Children travelling to school, teenagers travelling to college and adults travelling to work will find a means to meet recommended daily physical activity levels and achieve a healthy and sustainable lifestyle in accordance with the basic competences of the Organic Law of Education (LOE) and the principles of the WHO. Mallada (2012) found significant associations between the contents of physical education at secondary school, especially in the modules undertaken in nature, and the acquisition of basic competences. At the same time, bicycle use is promoted as a means of ecological transport and as a way to develop one's physical condition through play. Villescas et al. (2016) declare that children adapt easily to the reality presented to them and that education plays a decisive role in generating a transport model via the new streams of sustainable mobility and in accordance with a balanced lifestyle.

From the review of previous research, the following conclusions can be drawn:

1. The studies reviewed highlight a clear predominance of the sustainability of active transport, healthy mobility habits, and the benefits of engaging in physical activity.

2. Many studies indicate the great potential of bicycle systems, with studies on bicycle sharing systems and urban mobility in general gaining increased attention from international researchers due to its innovative nature. In addition, given the favourable climatic conditions, Spain is one of the countries with the most potential to encourage engagement in outdoor physical activity. This includes the use of bicycles or bicycle-sharing systems as an active means of transport throughout the entire year.

3. Active transportation to school is presented as a healthy habit and promotes improvements in students at academic, cognitive, social, and psychological levels. However, studies show that many young people do not practice physical activity on a regular basis and do not actively travel to their school or place of study.

4. The proper use of new technologies and advice from experts on the subject can help public bicycle systems to undergo major developments and be integrated successfully within the urban environment.

5. Regarding spaces and policies in the urban environment, several studies show a clear positive correlation between the creation of infrastructure designed to favour the sustainability of the environment and perceived safety, with higher levels of physical activity. In addition, given the great benefits to public health, policies should focus on creating active means of transport (such as bicycle-sharing systems) in order to reduce the rates of obesity and engagement in sedentary behaviour amongst the Spanish population.

6. In general, we have detected few publications on urban mobility and bicycle-sharing systems in the Spanish context. This may be because public bicycle systems have begun to emerge during recent years. The present study intends to create more knowledge about bicycle systems and their application within the urban environment in order to favour less congested traffic and pollution environments.

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Conflict of Interest
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