



Sanmiguel-Rodríguez, A. (2023). Patterns of use of a bike-sharing system in a rural coastal town: the case of VaiBike. *Journal of Sport and Health Research*. 15(3):543-554. <https://doi.org/10.58727/jshr.94206>

Original

**PATRONES DE USO DE UN SISTEMA DE BICICLETAS
COMPARTIDAS EN UN MUNICIPIO COSTERO RURAL: EL CASO
DE VAIBIKE**

**PATTERNS OF USE OF A BIKE-SHARING SYSTEM IN A RURAL
COASTAL TOWN: THE CASE OF VAIBIKE**

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*Edited by: D.A.A. Scientific Section
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Received: 12/04/2022
Accepted: 07/07/2022



RESUMEN

En algunas ciudades europeas, se ha analizado el ambiente urbano para aumentar las opciones de movilidad, fomentar la práctica de actividad física (AF), mejorar el aire y reducir la congestión de tráfico mediante un sistema de bicicletas compartidas (BSS). Se ha diseñado un estudio cuantitativo y longitudinal con la recogida y análisis de datos del BSS de Vilagarcía de Arousa (Galicia, noroeste de España). Se contabilizó diariamente el número de usos del sistema de bicicletas VaiBike y se registraron un total de 59.998 observaciones (Hombres $n=42.411$; Mujeres $n=17.587$). Los hombres de 65 a 79 registraron una media superior a 50 minutos durante todos los días de la semana. En cambio, las mujeres ha sido mucho mayor la diferencia de uso entre los días de la semana y los fines de semana, especialmente en domingo llegando a superar en todas las franjas de edades los 40 minutos de media de uso. Se concluye que se podrían cumplir las recomendaciones de la OMS para la AF y salud, ya que los minutos de alquiler de las bicicletas del sistema son superiores a 30 minutos de media. Los hombres presentan mayor registro en el sistema y más media de uso que las mujeres, especialmente el grupo de edad de 65 a 79 años que se mantiene por encima de los 50 minutos todos los días de la semana y en todas las estaciones del año. En las mujeres los valores se sitúan en torno a la media hora durante todos los días de la semana y suben a más de 40 durante el domingo. Estos resultados pueden ser de utilidad para profesionales de la salud y administraciones públicas, pues conocerán cual es el perfil de los usuarios de bicicletas y sus patrones de uso de cara a mejorar el entorno urbano para incentivar la práctica de AF.

Palabras clave: Sistemas de bicicletas compartidas, Actividad Física, Salud Pública, Promoción de la Salud.

ABSTRACT

In some European cities, the urban environment has been analyzed to increase mobility options, encourage the practice of physical activity (PA), improve the air and reduce traffic congestion through a Bicycle-Sharing System (BSS). A quantitative and longitudinal study has been designed with the collection and analysis of data from the BSS of Vilagarcía de Arousa (Galicia, northwestern Spain). The number of uses of the VaiBike bicycle system was counted daily and a total of 59,998 observations were recorded (Men $n=42,411$; Women $n=17,587$). Men ages 65 to 79 logged an average of more than 50 minutes on all days of the week. On the other hand, the difference in use between weekdays and weekends has been much greater for women, especially on Sundays, exceeding 40 minutes of average use in all age groups. It is concluded that the WHO recommendations for PA and health could be met, since the minutes of renting the bicycles in the system are greater than 30 minutes on average. Men have more registration in the system and more average use than women, especially the age group of 65 to 79 years old, which stays above 50 minutes every day of the week and in all seasons of the year. In women, the values are around half an hour every day of the week and rise to more than 40 on Sunday. These results can be useful for health professionals and public administrations, since they will know the profile of bicycle users and their patterns of use in order to improve the urban environment to encourage the practice of PA.

Keywords: Bicycle Sharing Systems, Physical Activity, Public Health, Promotion Health.



INTRODUCTION

In some European cities, the urban environment has been analyzed to increase mobility options in a sustainable and ecological way, encourage the practice of physical activity (PA), improve the air and reduce traffic congestion through a Bicycle-Sharing System (BSS) (Boufidis et al., 2020; Chiariotti et al., 2018; D'Orso et al., 2020; Li et al., 2019; Kim, 2018; Ma et al., 2020; Sathishkumar, Park, y Cho, 2020; Sohrabi & Ermagun, 2021; Sun, Chen y Jiao, 2018). The existence of bike lanes, as well as the optimization of the system in order to minimize the time and maximize the probability of finding bicycles and spaces available to pick them up and deposit them respectively at the beginning and end of the journey, greatly favors success in any city (Lathia, Ahmed & Capra, 2012; Lin & Yang, 2011). Existing BSS are found in countries with relatively high percentages of people commuting by bicycle (DeMaio, 2004, 2009). In the Netherlands, more than 27% of all trips are made by bicycle, a figure that has remained relatively stable over the last decades and has even been surpassed by medium-sized cities, where the percentages are higher to 35% of trips (Martens, 2007).

The objective of bicycle commuting in the United States has a labor and business component. BSS tend to be located in central areas. This is mainly due to the compactness of urban development where cycling is ideal and they are concentrated in an urban environment, which offers a greater number of connections. It must be taken into account that the trips have been approximately 3 kilometers and 24 minutes, which makes the bicycle an ideal means of transport in the urban environment (DeMaio, 2004). Some authors (Castillo-Manzano & Sánchez-Braza, 2013; Chen, van Lierop and Ettema, 2020; Froehlich, Neumann & Oliver, 2009; Lathia et al., 2012; Lin & Yang, 2011; Liu, Jia & Cheng, 2012; Munkácsy & Monzón, 2017; Song et al., 2021; Sun et al., 2018; Wang et al., 2005; Webster & Cunningham, 2013) allude to the need to develop infrastructures and safe sports spaces in cities (bike lanes, bicycle parking or route planning) that can encourage PA in the urban environment. Caulfield (2014) pointed out positive associations with the promotion of cycling from the political sphere. That is, if the different governments and administrations try to adapt the city to the use of bicycles, building BSS, promoting routes, increasing safety, a favorable relationship is found between the

creation of infrastructures for bicycles and the levels of PA. Thus, BSS have a great dimension and relevance as a healthy and economical means of transport that favor a change of approach in the choice of journeys within the urban nucleus, in order to develop new policies that promote urban mobility and PA as a sustainable means of transport, encouraging healthy factors (Bourne et al., 2020; D'Orso et al., 2020; Frank & Engelke, 2001; Sanmiguel-Rodríguez, 2019, 2020, 2022; Sanmiguel-Rodríguez & Arufe Giráldez, 2019; Sathishkumar et al., 2020; Sohrabi & Ermagun, 2021; Sun et al., 2018).

On the other hand, The World Health Organization (WHO, 2018) defines PA as any movement produced by in the body, with the consequent consumption of energy. Likewise, the WHO planned PA guidelines valid for all people indicating the recommended levels of PA for three age groups: from 5 to 17 years, from 18 to 64 years and from 65 onwards. Therefore, for adults (18 to 64 years) and older people (65 years and older), the WHO recommends a minimum of 150 minutes per week of moderate aerobic PA, 75 minutes of vigorous aerobic PA, or an equivalent combination of both (Chodzko-Zajko, Schwingel & Romo-Pérez, 2012; WHO, 2010). Aerobic activity will be practiced in sessions of at least 10 minutes. The WHO has also pointed out that increasing aerobic activity to 300 minutes per week of moderate aerobic intensity or 150 minutes of vigorous aerobic intensity or a combination of both helps to obtain greater benefits (Chodzko-Zajko et al., 2012; WHO, 2010). According to the National Health Survey of 2017, 30.3% of men and 18.4% of women have a high level of PA. In men, in the group of 15 to 34 years, the high level of PA is higher, while in the group of 35 to 69 years, the percentage of men with a level of PA is moderate or low. Women ages 15 to 69 have a moderate or low level of PA (INE, 2017). However, there is an important limitation regarding the number of published references that address BSS in rural settings and that deal with health effects.

Thus, the objective that is intended to be achieved in this study has been to know the average time of use of the VaiBike bicycles according to gender, age, hours, days of the week, seasons of the year and compare that time with the PA recommendations established by the WHO.



METHODS

Design and sample

A quantitative and longitudinal study has been designed with the collection and analysis of data from the BSS of Vilagarcía de Arousa (Galicia, northwestern Spain) from the beginning of the service on July 17, 2009 until January 18, 2012. The sample consisted of a total of 3,268 users of the BSS of the Vilagarcía de Arousa City Council. The user's identification is associated with a numerical value, maintaining their anonymity at all times. The number of uses of the VaiBike was counted daily and a total of 59,998 observations were recorded (Men $n=42,411$; Women $n=17,587$). The data was provided and authorized by the municipality of Vilagarcía de Arousa. With regard to the conditions of use of the system, users of the service may make daily use of the bicycles within the following hours: between 9:30 a.m. and 10:30 p.m. in the months of May, June, July, August and September, and between 9:00 a.m. and 7:00 p.m. in the remaining months. On the other hand, the use of the bicycle is limited to 2 hours. In relation to the cost of using the service, two payment methods are established: 3 euros for temporary use of the service (from 1 to 31 days), or 12 euros for annual use. The variable studied was minutes of use, whose behavior was determined according to blocks of age and gender. From this information, other variables have been derived that were also the object of study, which have been: the journeys between the five stations and the minutes of use (calculated from the start and end dates of the journeys). The date of birth was coded as day/month/year, so it was decided to decode the age according to a numerical value through an Excel spreadsheet formula so that the statistical program SPSS would identify it correctly.

Procedure, data analysis and ethical aspects

In the first place, the City Council of Vilagarcía de Arousa was contacted in order to obtain an anonymized database of the system and the consent for the transfer of data was signed. Afterwards, the data extracted from the system was collected and statistically analyzed using the SPSS program from IBM version 21.0. A significance value of $p < 0.05$ has been established in the hypothesis contrast tests; SPSS 21.0 and ANOVA were used for statistical analysis. Next, descriptive data such as means or standard deviations were calculated and finally

comparisons of means were made through the t-test, in the case of two independent samples, and the analysis of variance when the comparisons were made between more than two independent samples.

All procedures performed in this manuscript were performed in accordance with ethical research standards. The informed consent of the administration that governs the BSS was obtained.

RESULTS

The results of this study have shown that both men and women have used the VaiBike bicycles for more minutes during the weekends. Men aged 65 to 79 years were the ones who recorded the highest average use of the system, maintaining a similar average every day of the week with an average greater than 50 minutes, although with a tendency to be slightly higher during the weekends (Figures 1 and 3 and tables 1 and 2). For their part, women have shown a much greater difference in use between weekdays and weekends, especially on Sundays, exceeding 40 minutes of average use in all age groups (Figures 2 and 4 and Tables 1 and 2).

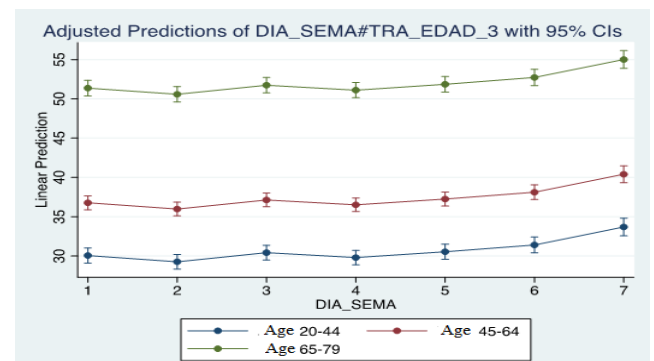


Figure 1. Minutes of use in the male gender by age groups and days of the week

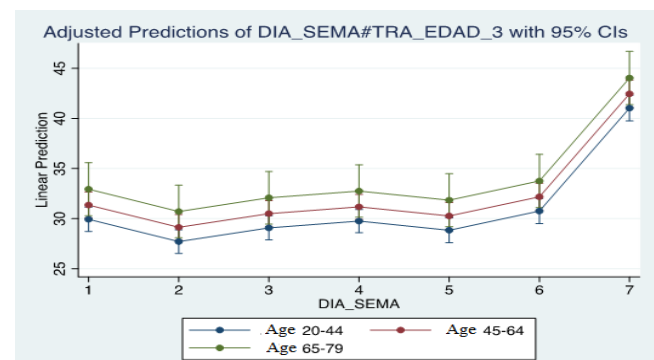


Figure 2. Minutes of use in the female gender by age groups and days of the week

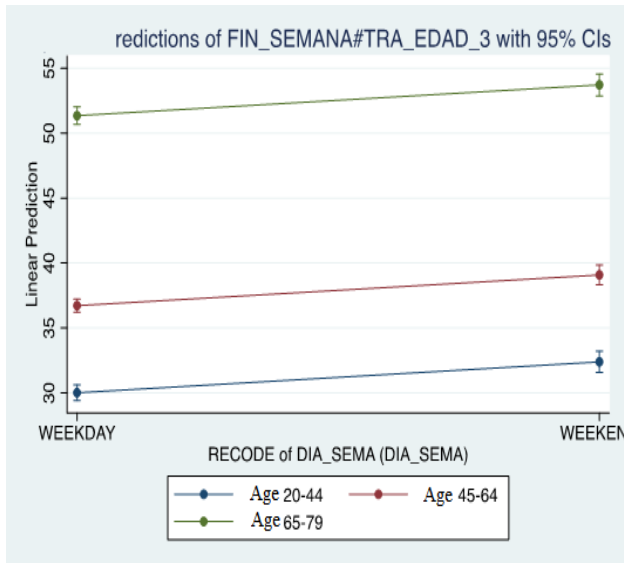


Figure 3. Minutes of use in the male gender by age groups and weekly periods

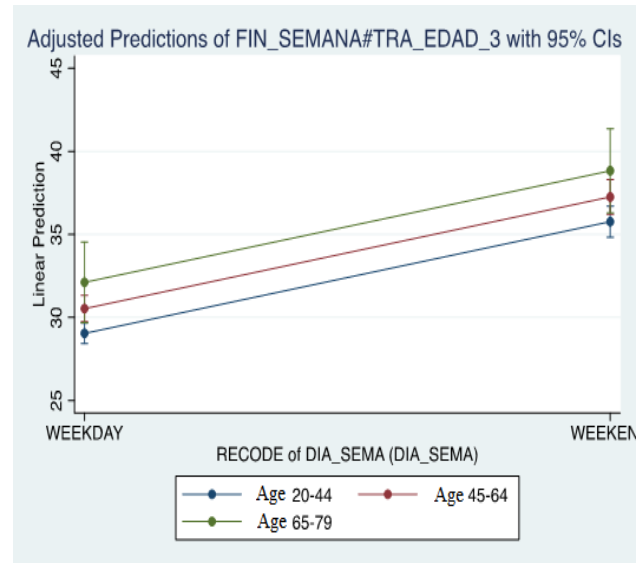


Figure 4. Minutes of use in the female gender by age groups and weekly periods

Table 1. Minutes of use by age groups and days of the week by gender

Variable	Men					Women				
	Margin	Error Est	t	P valor	Delta-method (95% IC)	Margin	Error Est	t	P valor	Delta-method (95% IC)
Monday Age 20-44	30.0	0.48	61.77	<0.001	29.1-31.0	29.9	0.61	48.65	<0.001	28.7-31.1
Monday Age 45-64	36.7	0.45	81.12	<0.001	35.8-37.6	31.3	0.65	47.54	<0.001	30.0-32.6
Monday Age 65-79	51.3	0.50	100.83	<0.001	50.3-52.3	32.9	1.35	24.37	<0.001	30.2-35.5
Tuesday Age 20-44	29.2	0.48	60.87	<0.001	28.3-30.2	27.7	0.60	46.03	<0.001	26.5-28.8
Tuesday Age 45-64	35.9	0.44	80.45	<0.001	35.1-36.8	29.1	0.65	44.77	<0.001	27.8-30.4
Tuesday Age 65-79	50.5	0.50	100.58	<0.001	49.5-51.5	30.7	1.33	22.94	<0.001	28.0-33.3
Wednesday Age 20-44	30.4	0.48	63.38	<0.001	29.4-31.3	29.0	0.61	47.48	<0.001	27.8-30.2
Wednesday Age 45-64	37.1	0.44	83.57	<0.001	36.2-38.0	30.5	0.65	46.24	<0.001	29.2-31.7
Wednesday Age 65-79	51.7	0.50	103.02	<0.001	50.7-52.7	32.0	1.33	23.95	<0.001	29.4-34.7
Thursday Age 20-44	29.7	0.47	63.24	<0.001	28.8-30.7	29.7	0.58	50.65	<0.001	28.6-30.9
Thursday Age 45-64	36.5	0.43	83.37	<0.001	35.6-37.3	31.1	0.63	49.21	<0.001	29.9-32.4
Thursday Age 65-79	51.1	0.49	103.55	<0.001	50.1-52.0	32.7	1.33	24.52	<0.001	30.1-35.3
Friday Age 20-44	30.5	0.49	62.31	<0.001	29.5-31.4	28.8	0.63	45.49	<0.001	27.6-30.0
Friday Age 45-64	37.2	0.45	81.87	<0.001	36.3-38.1	30.2	0.68	44.46	<0.001	28.9-31.6
Friday Age 65-79	51.8	0.50	101.98	<0.001	50.8-52.8	31.8	1.34	23.65	<0.001	29.2-34.4
Saturday Age 20-44	31.4	0.51	61.24	<0.001	30.4-32.4	30.7	0.63	48.19	<0.001	29.5-32.0
Saturday Age 45-64	38.1	0.48	79.26	<0.001	37.1-39.0	32.1	0.68	46.97	<0.001	30.8-33.5
Saturday Age 65-79	52.7	0.52	100.15	<0.001	51.6-53.7	33.7	1.35	24.92	<0.001	31.1-36.4
Sunday Age 20-44	33.6	0.57	58.59	<0.001	32.5-34.8	41.0	0.65	62.87	<0.001	39.7-42.3
Sunday Age 45-64	40.4	0.55	73.19	<0.001	39.3-41.4	42.4	0.69	61.23	<0.001	41.0-43.8
Sunday Age 65-79	55.0	0.57	94.88	<0.001	53.8-56.1	44.0	1.35	32.48	<0.001	41.3-46.6

**Table 2.** Minutes of use by age groups and weekly periods according to gender

Variable	Men					Women				
	Margin	Error Est	t	P valor	Delta-method (95% IC)	Margin	Error Est	t	P valor	(95% IC)
Week Age 20-44	30.0	0.30	96.91	<0.001	29.4-30.6	29.0	0.31	91.58	<0.001	28.4-29.6
Week Age 45-64	36.7	0.25	145.00	<0.001	36.2-37.2	30.5	0.40	76.31	<0.001	29.7-31.3
Weekend Age 20-44	51.3	0.34	150.04	<0.001	50.6-52.0	32.1	1.24	25.86	<0.001	29.6-34.5
Weekend Age 45-64	32.3	0.42	76.81	<0.001	31.5-33.2	35.7	0.47	75.21	<0.001	34.8-36.6
Weekend Age 65-79	39.0	0.38	101.43	<0.001	38.3-39.8	37.2	0.53	69.75	<0.001	36.2-38.2
	53.7	0.43	123.87	<0.001	52.8-54.5	38.8	1.28	30.17	<0.001	36.3-41.3

Additionally, the highest average number of minutes in the seasons of the year has been higher in the age group of 65 to 79 years with 54.1 in spring, 49.1 in summer, 46.9 in autumn and 55 minutes in winter respectively (Table 3). Comparing by age groups, it has been observed that the minutes of use of the VaiBike system have been greater during the spring months for all age groups (20-44, 45-64 and 65-79 years), and there are no differences between men and women, although the difference in minutes of use between weekdays and weekends were higher in women (Figures 5 and 6 and Table 3). In the results of minutes of use in the female gender by age groups and seasons of the year, the differences were not significant since the confidence intervals overlapped (Figure 6). Men, in all age groups, maintain similar values and always above 30 minutes of bicycle use regardless of the season of the year, although with a slight decrease during the autumn and winter months, being below 30 minutes in the age range from 20 to 44 years in autumn (27.7) and winter (28.8) as can be seen in Figure 5 and Table 3. On the other hand, for women, the average number of minutes of use is significantly lower during the autumn and winter months compared to the spring and summer months in all age groups, with the average number of minutes of use of the VaiBike being in the age from 65 to 79 years in autumn of 24.6 but in winter this group of women have registered the highest average with 46.5 minutes (Figure 6 and Table 3).

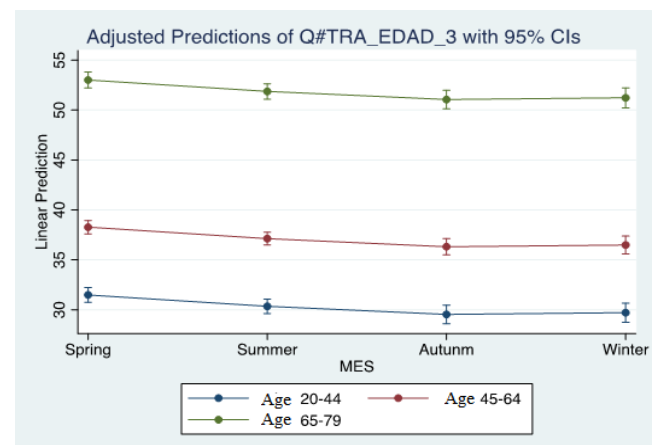
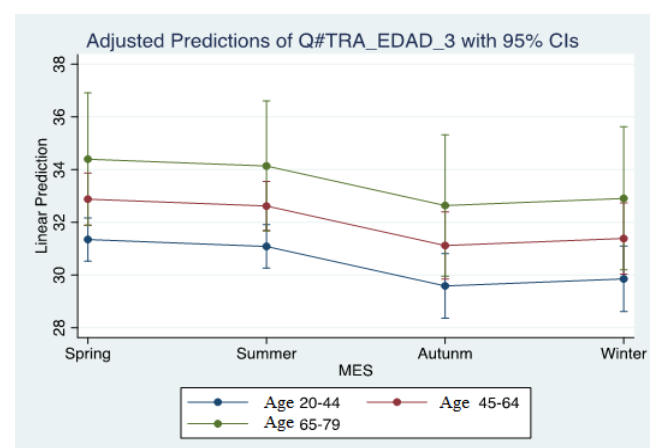
**Figure 5.** Minutes of use in the male gender by age groups and seasons of the year**Figure 6.** Minutes of use in the female gender by age groups and seasons of the year



Table 3. Frequency of uses and average minutes by age group and gender

Variable	All			Men			Women		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Minutes by age in spring									
All	19548	37.2	33.7	13509	39.5	34.9	6039	31.9	30.3
20-44 Age	8351	31.3	31.6	4437	31.2	32.9	3914	31.4	30.3
45-64 Age	7842	36.1	33.0	5907	37.4	33.8	1935	32.3	35.2
65-79 Age	3355	54.1	34.8	3165	55.0	34.5	190	39.3	35.2
Minutes by age in summer									
All	21775	36.6	33.1	15219	38.7	33.9	6556	31.8	30.6
20-44 Age	8340	31.6	31.9	4553	31.6	32.6	3787	31.5	30.9
45-64 Age	9401	35.7	32.6	6933	37.0	33.4	2468	32.3	29.9
65-79 Age	4034	49.1	33.8	3773	50.6	33.5	301	30.9	32.0
Minutes by age in autumn									
All	9942	36.7	32.7	7356	38.9	33.8	2586	30.3	28.3
20-44 Age	3090	28.4	30.8	1629	27.7	31.6	1461	29.3	28.1
45-64 Age	4758	37.5	33.0	3690	39.0	34.1	1068	32.0	28.5
65-79 Age	2094	46.9	32.5	2037	47.5	32.4	57	24.6	27.3
Minutes by age in winter									
All	8733	35.7	33.3	6327	37.8	34.5	2406	30.4	29.2
20-44 Age	3540	28.8	29.2	1958	28.8	30.4	1582	28.9	27.6
45-64 Age	3701	34.6	33.2	2914	35.2	33.7	787	32.7	31.4
65-79 Age	1492	55.0	35.2	1455	55.1	35.1	37	46.5	39.4

On the other hand, the results showed that the peaks at the start of more bicycle use occurred approximately between 9 a.m. and 1 p.m. and between 4 p.m. and 7 p.m., with 11 a.m. being the moment with the highest records of use with a peak of 12.2% of the total records of VaiBike use. These

levels, separated by gender, informed us that men used the bicycle more at 11 and 12 a.m. with values of 12.8% and 11.4%, respectively. Women obtained similar results with a peak at 11 and 12 a.m. with 10.8% and 10.5% respectively (Table 4).

Table 4. Recording of the hours of use of the system

Variable	All			Men			Women		
	HORA INICIO	%	Error Est	(95% IC)	%	Error Est	(95% IC)	%	Error Est
7:00	0.5	0.02	0.5-0.6	0.6	0.03	0.5-0.7	0.3	0.03	0.2-0.4
8:00	1.8	0.04	1.7-1.9	2.0	0.05	1.9-2.1	1.4	0.07	1.2-1.5
9:00	6.2	0.08	5.9-6.2	6.6	0.10	6.3-6.7	4.9	0.13	4.6-5.2
10:00	9.8	0.10	9.5-9.9	10.5	0.12	10.1-10.6	8.1	0.17	7.7-8.4
11:00	12.2	0.11	11.9-12.4	12.8	0.13	12.4-13.0	10.8	0.19	10.4-11.1
12:00	11.1	0.10	10.8-11.3	11.4	0.13	11.1-11.6	10.5	0.19	10.0-10.7
13:00	8.2	0.09	7.9-8.3	8.1	0.11	7.7-8.2	8.6	0.17	8.2-8.9
14:00	4.9	0.07	4.8-5.1	4.4	0.08	4.2-4.6	6.2	0.15	5.9-6.5
15:00	4.8	0.07	4.6-4.9	4.7	0.08	4.5-4.9	5.0	0.13	4.7-5.2
16:00	7.5	0.09	7.2-7.6	7.5	0.10	7.2-7.6	7.6	0.16	7.2-7.8
17:00	8.5	0.09	8.2-8.6	8.5	0.11	8.2-8.6	8.4	0.17	8.0-8.7
18:00	8.4	0.09	8.2-8.5	8.6	0.11	8.2-8.7	8.2	0.17	7.8-8.4
19:00	7.5	0.09	7.2-7.5	6.9	0.10	6.6-7.0	8.8	0.17	8.3-9.0
20:00	5.4	0.07	5.2-5.6	4.9	0.08	4.7-5.1	6.6	0.15	6.3-6.9
21:00	2.7	0.05	2.6-2.9	2.2	0.06	2.1-2.4	3.9	0.12	3.7-4.2
22:00	0.5	0.02	0.4-0.5	0.3	0.02	0.3-0.4	0.7	0.05	0.6-0.8



DISCUSSION

Average minutes of system use and days of the week

The results of this study indicated that men between the ages of 65 and 79 were the ones who recorded the most average minutes of use on the VaiBike, exceeding 50 minutes of average use of the system. In contrast, women had an average of minutes highest on Sunday, exceeding 40 minutes of use on average in all age groups.

For Anaya and Castro (2012), the average duration of public bicycle loans is less than 30 minutes in 65% of cases. Börjesson and Eliasson (2012) reached similar results, indicating that the average duration had been in the range of 15-60 minutes, with an average of 29 minutes. For these authors (Anaya & Castro, 2012) 29% of the days of the year are weekends; therefore, if the percentage of loans that have been made on weekends is greater than 29% of the total annual loans, it means that a system is used more on weekends than on working days. In 56% of the systems, the percentage of trips on weekends does not exceed 29%, while in 44% the proportion of trips on weekends is greater. In another reference (Rojas-Rueda et al., 2011) it was pointed out that 68% of trips were made to commute to work or study center during the week with an average duration of 14.1 minutes, but the duration of use cycling is favored on weekends, where it increases to 17.8 minutes on average.

Likewise, the study carried out in London (Noland and Ishaque, 2006) has shown us that the OYbike system (UK) was used overwhelmingly as a means of daily transport, although they clarified that the longest journeys in duration occurred during weekends. Some authors have also reached these conclusions (Castillo-Manzano & Sánchez-Braza, 2013; Tin et al., 2010) who mentioned that BSS were used as a way of doing PA during free time. In Auckland, New Zealand, cycling volume was lower between weekdays compared to weekends and public holidays (Tin et al., 2012). Similarly, in Sydney, cycling time was higher on weekends than on other days (Pucher, Garrard & Greaves, 2011). Beecham and Wood (2014) showed that in London's Cycle Hire (UK) women tend to use the system more during weekends and on cycle routes.

Instead, Pucher et al. (2011) indicated that in the city of Melbourne (Australia), 39% of all bicycle trips

were to go to the workplace during weekdays, with a drop in recreational cycling during weekends. For Mateo-Babiano et al. (2016) shared bike trips in Brisbane (Australia) were shorter on weekends than on weekdays. Following these lines, Talavera-García, Romanillos and Arias-Molinares (2021) stated that on weekdays bicycle trips are distributed more equitably to their jobs, while on weekends the trips were mainly for leisure. Similar results were obtained by other studies (Ma et al., 2020; Song et al., 2021) that showed that the frequency of use of shared bicycles on weekdays was more frequent than during weekends. Li et al. (2019) showed that the use of bicycles has a greater effect on weekdays than on weekends and, unlike users over 40 years of age, younger users, especially those between 21 and 25 years of age, have a greater reduction in the frequency of use and the duration of the trips, being quite similar for men and women on weekends but during the week, however, the average duration of the trips of women was shorter than that of men. On the other hand, in the Bicing of Barcelona (Spain) Mondays were the most active; in contrast, Fridays were the days of the week with the fewest uses in the system (Froehlich et al., 2009).

Average minutes of use of the systems according to the months and seasons of the year

Men, in all age groups, maintain similar values of bicycle use regardless of the season of the year, although with a slight decrease during the autumn and winter months. In contrast, in women, the average number of minutes of use was significantly lower during the autumn and winter months compared to the spring and summer months in all age groups. Similar results were obtained by Talavera-García et al. (2021) who identified a higher demand for the BiciMAD in Madrid (Spain) between April and October, during the warm seasons, and a decrease during autumn and winter.

Kim (2018) stated that temperatures above 30°C have a different influence on different periods of time within a day. Especially, the scorching heat and non-working days affect the demand for hourly shared bikes differently. From spring to fall, except for mid-summer, the number of bike rentals was high and low in winter. Castillo-Manzano and Sánchez-Braza (2013) stated that the low levels of rainfall make Seville (Spain) a suitable place for the use of the bicycle as a sustainable and healthy means of



transport, although two factors could alter this aspect: the excessive heat at certain times of the year. Other authors (Tin et al., 2012) reflected that hot and sunny weather increases the volume of cycling in Auckland (New Zealand), while rainy and windy weather reduces the chances of cycling. Thus, the highest volume of cycling has occurred during the hottest months and has been lower in the coldest months, coinciding with summer and winter, respectively (Tin et al., 2012).

Hours of use of BSS

The results of this study indicated that the peak hours of VaiBike use were in the morning between 9 a.m. and 1 p.m., with a peak at 11 a.m.. In another investigation (Castillo-Manzano & Sánchez-Braza, 2013) it was pointed out that in the Sevici system of Seville (Spain) the peak hours of the registration of uses were on weekdays from 7:30 a.m. to 9 a.m. and at 15 p.m. In terms of gender, 65% of system users were men and the remaining 35% women, with a joint average age of 24 years.

Talavera-Garcia et al. (2021) showed that the distribution of trips by users of the BiciMAD in Madrid (Spain) on weekdays had three peaks with a high percentage of trips: in the morning, in the afternoon and at night. On weekends and holidays, the distribution changes, not showing rush hour in the morning but with a notable increase in trips at midnight, probably associated with leisure activities. Thus, the hours of the day with the highest number of cyclists are the peak hours of 8-9 a.m. and 6-7 p.m.. In another study on BiciMAD (Munkácsy & Monzón, 2017), it was pointed out that bicycles can be an alternative to limited public transport at night, since the system is permanently available. Following these contributions, Froehlich et al. (2009) indicated that the availability of bicycles in the Bicing in Barcelona (Spain) had a drop around 7-8 a.m. due to the increase in their use, a slight increase in the availability of bicycles between 2 p.m. and 3 p.m. and progressively increases at 10 p.m. to 11 p.m. Börjesson and Eliasson (2012) noted that 86% of trips were weekday commutes to work, with a slightly higher share during the morning hours (7-9 a.m.) and a slightly lower share during the afternoon. Likewise, the maximum cycling volume in Auckland (New Zealand) has occurred between 7:00 – 8:00 a.m. and from 5-6 p.m. (Tin et al., 2012). These findings are almost identical to those of other

investigations (Chen et al., 2020; Li et al., 2012; Li et al. 2019; Liu et al., 2019) being the most frequent hours between 7-10 a.m. and from 4-8 p.m.. In contrast, for Kim (2018) the peaks of use during the days of the week appeared between 8 a.m. and 9 a.m. to go to work, but not on weekends, although, in general, bicycle rentals were more frequent due to night than in the morning or afternoon.

CONCLUSIONS

The WHO recommends in its guidelines for health and PA, a minimum of 150 minutes per week of moderate aerobic PA, which is equivalent to approximately 21 minutes, and/or 75 minutes of vigorous aerobic PA, which is equivalent to approximately 10 minutes diaries. Following these WHO recommendations, the data from this study show that the guidelines could be met in both men and women based on the minutes of use in all ages and in both genders. Thus, men have more observations of use in the system and more average use than women, especially the age group of 65 to 79 years, which remains above 50 minutes every day of the week and in all the seasons of the year with a maximum average of 55 on Sundays and 55.1 as a maximum value in the winter months. In women, the values are around half an hour every day of the week and rise to more than 40 minutes on average on Sundays, surely associated with leisure activities and free time. The age group of women from 65 to 79 years old obtained the highest average with a maximum average of 44.0 on Sundays and an average of 46.5 minutes in the winter months. For its part, between 11 a.m. and 12 p.m. was when the most uses of the system were recorded.

LIMITATIONS

However, all these data have to be taken with some caution because it has not been possible to measure the intensity of the trips, the actual journeys with the unevenness of the terrain of the locality, nor the effective minutes of use of the VaiBike bicycle rental.

One of the main limitations of this study is that it has not been possible to measure the exact routes with GPS or use pulse oximeters to measure Heart Rate (HR) in Vaibike users. Each ID could also be studied individually on a daily or weekly basis to find out how many of the 3,268 VaiBike users would meet the WHO recommendations. In this way, the results



could be more precise to identify and know if the recommendations indicated by the WHO for PA and health are being fulfilled.

In any case, these results can be very useful for managers, health professionals and public organisms or administrations, since they will know the profile of bicycle users and their patterns of use in order to improve the urban environment to encourage practice of PA among the population and develop healthy infrastructures and policies to combat sedentary habits in the population. It can also provide the managers of the different BSS with the peak hours of use of the system for a better optimization of the system so that there are always bicycles and spaces available at the stations.

ACKNOWLEDGEMENTS

There are no acknowledgements

CONFLICTS OF INTEREST

None declared

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