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Isabel M. Martín-López
University of the Balearic Islands

Olalla García-Taibo
Universidad Pontificia Comillas (CESAG)

Pere Antoni Borràs
University of the Balearic Islands

social sciences

MDPI

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Understanding Factors Influencing Cycling Behaviour Among University Students and Staff: A Cross-Sectional Study

Isabel M. Martín-López [1], Olalla García-Taibo [2,3,*], Antoni Aguiló [4,5,6] and Pere Antoni Borràs [2,3]

[1] Department of Physical Activity and Sport Sciences, CESAG, Comillas Pontifical University, 07013 Palma de Mallorca, Spain
[2] Department of Pedagogy and Specific Didactics, Balearic Islands University, 07122 Palma de Mallorca, Spain
[3] Physical Activity and Sport Sciences Research Group (GICAFE), IRIE, Balearic Islands University, 07122 Palma de Mallorca, Spain
[4] Department of Nursing and Physiotherapy, Balearic Islands University, 07122 Palma de Mallorca, Spain; aaguilo@uib.es
[5] Health Research Institute of Balearic Islands (IdISBa), 07120 Palma de Mallorca, Spain
[6] Global Health and Lifestyles Research Group (EVES), IUNICS, Balearic Islands University, 07122 Palma de Mallorca, Spain
* Correspondence: olalla.garcia@uib.es

Abstract: Active commuting by bicycle offers health and environmental benefits, yet it remains uncommon among university populations. This study aimed to identify key factors influencing bicycle commuting among university students and staff based on cyclist typology and to assess the applicability of the Theory of Planned Behaviour (TPB) and socio-ecological models. A total of 305 students and 79 staff completed a questionnaire assessing sociodemographic, psychological, social, and environmental variables. Results revealed significant differences based on cyclist typology. Urban cyclists reported fewer perceived barriers (1.96 ± 0.59) and more advantages (3.61 ± 0.40) than non-cyclists (2.71 ± 0.56 and 3.26 ± 0.49, respectively; $p < 0.001$). While personal and psychological factors were most influential for non-cyclists, environmental aspects were more relevant for urban cyclists and cyclists. Multinomial logistic regression showed that for both cyclists and urban cyclists, bicycle ownership (OR = 0.098–0.104, $p < 0.001$) and intention to use (OR = 0.091–0.358, $p \leq 0.02$) were key predictors of cycling behaviour. Although gender was only a significant predictor for cyclists (OR = 3.41, $p = 0.003$), this variable did not influence urban cycling behaviour. These findings support using TPB and socio-ecological models to design targeted, multilevel interventions.

Keywords: active transportation; sustainable mobility; health behaviour; bicycle; barriers; enablers; higher education

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1. Introduction

Active commuting, primarily through walking or cycling, refers to the practice of commuting to work, school, or other destinations using non-motorized modes of transportation (Ogilvie et al. 2016). According to Laeremans et al. (2017), this practice may lead to increased levels of physical activity, which is largely responsible for the associated health benefits. Numerous studies have linked active commuting with a reduced risk of mortality, lower incidence of cardiovascular disease, cancer morbidity, type 2 diabetes, overweight, and obesity (Dinu et al. 2019; Oja et al. 2011; Kelly et al. 2014; Xu et al. 2022). Moreover, bicycle commuting has been associated with higher levels of perceived health and well-being (Page and Nilsson 2017), physical fitness (Henriques-Neto et al. 2020), workplace productivity (Ma and Ye 2019), as well as lower perceived stress (Chillón et al. 2017). Additionally, similar intensity levels and maximal oxygen consumption (VO_2 max) between users of conventional and electric bicycles (e-bikes) suggest comparable health benefits, irrespective of bicycle type (Riiser et al. 2022). Beyond individual health benefits, active commuting has broader benefits related to sustainability and public health. Specifically, bicycle commuting contributes to reducing the reliance on motorized transportation, thereby decreasing urban pollution and greenhouse gas emissions, aligning closely with global climate change mitigation efforts (Dinu et al. 2019; Wang et al. 2022). Consequently, promoting bicycle use has emerged as a key policy strategy aligned with the Sustainable Development Goals outlined in the 2030 Agenda (United Nations General Assembly 2015). Furthermore, the European Physical Activity Strategy for the World Health Organization (WHO) European Region 2016–2025 explicitly emphasizes reducing car traffic and increasing active transportation as one of its objectives to promote daily physical activity, which is fundamental for maintaining health and well-being for all adults in the European Region (WHO 2015).

However, despite existing evidence and policy efforts aimed at promoting cycling, the use of motorized vehicles for commuting to workplaces and universities has continued to rise significantly (Silva et al. 2011). In Spain, according to the Bicycle Barometer, only 3.5% of the population regularly uses a bicycle for daily transportation, underscoring the low prevalence of cycling for commuting purposes (GESOP 2019). This trend is particularly pronounced among university students and staff, underscoring the need to promote cycling as a means to enhance public health across all age groups (Chillón et al. 2016). Different interventions, such as educational programmes (Diniz et al. 2015), urban biking programmes (Adaros-Boye et al. 2021), smartphone apps to encourage sustainable transport (Bopp et al. 2018), and bicycle-sharing programmes (Molina-García et al. 2015), have shown promise in increasing bicycle commuting at the university. Nevertheless, successful promotion strategies require a comprehensive understanding of the behaviour, attitudes, and preferences of specific target groups (Michie et al. 2011).

1.1. Theoretical Approaches for Analyzing Cyclists' Behaviour

Previous research has identified the Theory of Planned Behaviour (TPB) by Ajzen (1991) and the socio-ecological construct by Bauman et al. (2008) as suitable frameworks for analyzing cyclist behaviour (Rowe et al. 2013; Acheampong 2017; Caballero et al. 2019; Milkovic and Stambuk 2015). Ajzen's theory posits that the best predictor of behaviour is the person's intention to perform or not perform the behaviour, which is influenced by attitudes towards the behaviour (shaped by personal beliefs, evaluations, and previous experiences), subjective norms (individual perceptions of social pressure to perform the behaviour and motivation to comply), and perceived behavioural control (the individual's belief about their capacity to perform the behaviour). The main advantage of TPB lies in its strong predictive capacity of individual-level intentions and its relative simplicity, facilitating clear identification and targeting of specific psychological determinants that influence cycling decisions (de Bruijn et al. 2009). Nevertheless, a limitation of TPB is that it overlooks broader contextual factors such as the social, environmental, and institutional contexts, which might substantially influence cycling behaviour (Götschi et al. 2017). On the other hand, socio-ecological models consider that behaviour is influenced by multiple dimensions of influence: personal, social and cultural, environmental, and institutional or policy-level factors (Sallis et al. 2015). Piatkowski and Bopp (2021) classified factors influencing bicycle use according to a socio-ecological model into personal factors (demographic, psychological, behavioural), social and cultural factors (such as social support and community norms), and environmental factors (physical infrastructure, natural environment, institutional policies).

This holistic perspective constitutes the primary advantage of socio-ecological models as it allows a comprehensive understanding of the complex interplay between individuals and their contexts, thus facilitating more robust intervention strategies.

1.2. Factors Influencing Bicycle Commuting

Taking into account the aforementioned theoretical approaches, multiple factors have been identified as determinants of bicycle commuting behaviour. At the personal level, these include sociodemographic characteristics (e.g., gender, age, race, marital status, socioeconomic status, having children, having one's own vehicle, educational level, and driver's licence), health-related factors (e.g., obesity, physical activity levels, physical fitness, perceived and actual health status), and psychological influences (e.g., intentions, attitudes towards cycling, sustainability beliefs, habits, perceived behavioural control, perception of benefits and barriers, cycling competence, and perceived risk) (Logan et al. 2023; Castro et al. 2010; Bhandal and Noonan 2022; Bauman et al. 2008; Castillo-Paredes et al. 2021; Goel et al. 2022; Kelarestaghi et al. 2019; Palma-Leal et al. 2023). Regarding social and cultural factors, previous studies highlighted the influence of social support, family and peer cycling habits, social status associated with cycling, parental attitudes, subjective norms, and community norms related to active commuting, as well as perceptions about car drivers and gender equality norms (Pearson et al. 2023). In terms of environmental factors, built environment characteristics (e.g., urban infrastructure, dedicated cycling infrastructure), natural environment factors (e.g., weather conditions, terrain orography, air pollution), and institutional factors related to the environment of the destination (e.g., travel distance, commuting time, incentives, urban planning, and transportation policies, as well as workplace, educational, health, and environmental policies) have been extensively documented as influential (Castro et al. 2010; Bauman et al. 2008; Kelarestaghi et al. 2019).

Furthermore, contextual events such as the COVID-19 pandemic have significantly impacted cycling behaviour globally, particularly due to the need for maintaining social distancing and avoiding crowded public transportation, prompting increased bicycle usage (Buehler and Pucher 2021). Additionally, the proliferation of e-bikes has facilitated bicycle commuting by reducing traditional barriers associated with travel distance, commuting time, physical fitness requirements, and topographical challenges. Nonetheless, the initial purchase cost remains a notable barrier to their wider adoption (Fishman and Cherry 2016).

Previous studies have indicated that factors influencing bicycle commuting may vary depending on the context, study population, and the specific type of bicycle use (Rowe et al. 2013; Castro et al. 2010; Félix et al. 2019). Therefore, effectively encouraging people to cycle or increase cycling frequency requires a clear understanding of these determinants (Damant-Sirois et al. 2014). Furthermore, previous research emphasized the importance of analyzing influencing factors according to different types of bicycle use rather than viewing them as a homogeneous group, as this approach provides more targeted and effective intervention results (Kroesen and Handy 2014). For instance, Fernández-Heredia et al. (2014) demonstrated that cyclist typology influenced perceptions of safety, acceptable commuting distances, and infrastructure preferences, enabling more targeted infrastructure interventions for potential cyclists with lower cycling skills or higher risk perceptions (Fernández-Heredia et al. 2014). Cyclist typology refers to the classification of cyclists into distinct groups based on characteristics such as cycling frequency, purposes for cycling, or experienced motivations and barriers (Cabral and Kim 2020). Several typologies have been proposed to better understand cyclist behaviour. For instance, Titze et al. (2007) categorized cyclists based on cycling frequency as regular or irregular cyclists, whereas Castro et al. (2010) and Rowe et al. (2013) classified cyclists according to the purpose of bicycle use, distinguishing among commuters, leisure cyclists, and competition cyclists.

Thus, the aim of this study was to identify the key factors influencing bicycle commuting among university students and staff based on cyclist typology (non-cyclists, recreational or competitive cyclists, and urban cyclists). Additionally, this study examined the applicability of the socio-ecological framework and Ajzen's TPB in the university context.

2. Materials and Methods

2.1. Study Design

This observational cross-sectional study was part of a broader initiative to promote active transportation, conducted by the Office of Healthy and Sustainable University at [University of Balearic Islands] during the 2020–2021 academic year. This initiative included an analysis of the factors influencing active commuting to university, the present study on bicycle use, and the implementation and evaluation of a three-month intervention that promoted cycling through gamification strategies and incentives.

2.2. Sample and Ethical Considerations

A non-probabilistic convenience sampling approach was employed. The final sample consisted of 384 participants, including 305 students (52% female, 48% male; mean age = 21.46 ± 5.48 years) and 79 university staff members (53% female, 47% male; mean age = 37.33 ± 9.54 years). The study received approval from the Ethics Committee of the University of the Balearic Islands on 11 February 2021 (Approval Code: 172CER20). All participants voluntarily agreed to participate and provided signed informed consent before completing the questionnaire.

2.3. Data Collection

Participants were recruited through both online and in-person channels. Following the recommendations of Sevil-Serrano et al. (2020) for programme dissemination, an informational brochure and poster were designed, featuring a recognizable icon representing the bicycle promotion initiative. These materials were distributed via the university's newsletter, website, and social media platforms. Additionally, during European Mobility Week, an information booth was set up alongside a bicycle exhibition. Several professors also contributed by dedicating 20 min of their lectures to explaining the study and encouraging voluntary participation. To maximize recruitment, an incentive-based strategy suggested by Bopp et al. (2019) was implemented, whereby participants who completed the questionnaire were entered into a raffle to win a folding bicycle.

2.4. Instruments and Procedure

Before completing the questionnaire, hosted on Google Forms, all participants reviewed an informational sheet and signed an informed consent form. Those recruited online signed the consent electronically, while those recruited in person provided written consent. The questionnaire took approximately 15–20 min to complete. It included sociodemographic variables (gender, age, university role, residential environment, and ownership of a car or bicycle); commuting mode, assessed using the Modes of Commuting to University Questionnaire (MODU) (Palma-Leal et al. 2020); barriers to active commuting, measured with the Barriers to Active Commuting University Scale (Palma-Leal et al. 2021); and additional sections on bicycle use type, frequency, and influencing factors and barriers. Since no validated questionnaire focusing exclusively on cycling behaviour was available, relevant questions were adapted from the Barometer of Bicycle Use in Spain (GESOP 2019) and previous studies (Herrera-Guzmán 2005; Rondinella et al. 2012). To ensure clarity and improve the questionnaire's quality, a pre-test was conducted with 10 university staff members and students. Participants provided feedback on question comprehension and relevance, leading to minor refinements in wording and structure. However, reliability analyses were not performed at this stage due to the small sample size of the pre-test and its primary aim being the improvement of item clarity and questionnaire comprehension rather than quantitative psychometric validation. The study variables analyzed to address the research objectives were as follows:

2.4.1. Type of Bicycle Use

Measured with the question: "Currently, how do you use your bicycle?" (GESOP 2019), with four response options: as a means of transportation, for exercise and sports, for recreational purposes, or not at all. Based on responses, participants were classified into three groups: non-cyclists, urban cyclists (using a bicycle as a means of transport), and other cyclists (using a bicycle for any purpose other than transportation).

2.4.2. Bicycle Usage Frequency

Assessed through the question: "In the past 12 months, how often have you used a bicycle?" with six response options: almost daily, 3–4 times per week, 1–2 times per week, only on weekends, occasionally (monthly), or not at all (GESOP 2019; Rondinella et al. 2012).

2.4.3. Perceived Cycling Competence

Assessed with the question: "Do you consider yourself capable of cycling correctly?" (GESOP 2019), with a dichotomous (yes/no) response option.

2.4.4. Intention to Use a Bicycle

Measured with the question: "Do you intend to use a bicycle as a means of transportation?" with a dichotomous (yes/no) response option (Herrera-Guzmán 2005).

2.4.5. Social Support

Measured with the question: "Do you feel supported by your family and/or friends to use a bicycle as a means of transportation?" with a dichotomous (yes/no) response option.

2.4.6. Peers and Family Bicycle Usage

Measured with the question: "Do any of your family members or friends regularly use a bicycle for transportation?" with a dichotomous (yes/no) response option.

2.4.7. Perceived Barriers and Benefits of Bicycle Use

Two sets of questions were adapted from the Barometer of Bicycle Use in Spain (Chillón et al. 2016). One included 12 items assessing barriers to cycling, and the other included 9 items evaluating perceived benefits. Responses were recorded using a 4-point Likert scale from the Barriers to Active Commuting University Scale (Palma-Leal et al. 2020): 1 (strongly disagree), 2 (somewhat disagree), 3 (somewhat agree), and 4 (strongly agree).

2.5. Data Analysis

Descriptive statistics were used to summarize the study variables and compare them based on cyclist typology. Mean and standard deviation (SD) were reported for continuous variables, while frequencies and proportions (%) were presented for categorical variables. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Since most continuous variables did not follow a normal distribution, the Kruskal–Wallis test was employed to compare differences across cyclist typologies. To examine associations between cyclist typology (dependent variable) and influencing factors (independent variables), a multinomial logistic regression model was conducted, using non-cyclists as the reference group. Odds ratios (OR) with 95% confidence intervals (CI) were reported.

3. Results

3.1. Cyclist Typology and Bicycle Usage Frequency

Respondents were categorized into three cyclist typologies based on their primary purpose for bicycle use: non-cyclists (no bicycle use), urban cyclists (bicycle use primarily for commuting), and cyclists (recreational or competitive). Approximately half of the sample consisted of non-cyclists, while among participants who reported using bicycles, a similar proportion identified as urban cyclists or cyclists (Table 1).

Table 1. Descriptive statistics of cyclist typology (n = 384).

Cyclist Typology	n	%
Non—cyclists	189	49.2%
Cyclists	104	27.1%
Urban cyclists	91	23.7%
Total	384	100%

Regarding bicycle usage frequency, nearly half of the respondents reported never or rarely using bicycles. Among active users, most participants cycled on a monthly basis, followed by smaller proportions who cycled several times per week, daily, weekly, or only on weekends (Table 2).

Table 2. Descriptive statistics of bicycle usage frequency (n = 384).

Frequency of Use	n	%
Never or rarely	169	44%
Monthly	97	25.3%
On weekends	18	4.7%
1–2 times per week	30	7.8%
3–4 times per week	37	9.6%
Daily or almost daily	33	8.6%
Total	384	100%

3.2. Perceived Barriers and Advantages of Bicycle Commuting by Cyclist Typology

Tables 3 and 4 summarize perceived barriers and advantages of bicycle commuting according to cyclist typology. Urban cyclists reported significantly fewer perceived barriers compared to cyclists and non-cyclists ($p < 0.001$). Conversely, urban cyclists perceived significantly greater overall advantages related to cycling compared to the other two groups ($p < 0.001$). When examining specific perceived barriers, significant differences emerged among cyclist typologies. Particularly, differences appeared regarding personal factors such as fitness level, cycling habits, general attitudes toward cycling, perceived risks associated with cycling, and preference for alternative transportation modes. Additionally, significant differences were observed in environmental factors, specifically travel distance and commuting time. However, no significant differences were observed among groups concerning barriers related to weather conditions or cycling infrastructure. In terms of perceived advantages, urban cyclists showed significantly more favourable perceptions about cycling in terms of speed, efficiency, comfort, and enjoyment compared to recreational/competitive cyclists and non-cyclists. Nonetheless, no significant differences were found between cyclist typologies regarding perceptions of cycling as an economical transport mode, nor regarding its health benefits, environmental benefits, or its utility for avoiding crowded public transportation.

Table 3. Comparison of perceived barriers to bicycle commuting by cyclist typology (n = 384).

Perceived Barriers	Total $\chi \pm$ SD	Non-Cyclists $\chi \pm$ SD	Cyclists $\chi \pm$ SD	Urban Cyclists $\chi \pm$ SD	p
1—I prefer the car or other means of transportation.	2.76 ± 1.05	3.19 ± 0.91	2.71 ± 0.89	1.93 ± 0.98	<0.001 *
2—I lack fitness.	1.95 ± 1.0	2.20 ± 1.04	1.88 ± 0.94	1.52 ± 0.81	<0.001 *
3—I take too long trips.	2.95 ± 1.04	3.06 ± 1.03	3.05 ± 1.01	2.6 ± 1.03	<0.001 *
4—I don't like it.	1.8 ± 0.99	2.21 ± 1.07	1.49 ± 0.74	1.29 ± 0.065	<0.001 *
5—I don't need it for the distances I travel.	2.47 ± 1.09	2.76 ± 1.03	2.54 ± 1.08	1.81 ± 0.93	<0.001 *
6—I lack the habit.	2.72 ± 1.17	3.22 ± 0.99	2.66 ± 1.08	1.77 ± 1.01	<0.001 *
7—The weather influences me.	2.94 ± 1.08	3.03 ± 1.06	2.97 ± 1.01	2.73 ± 1.16	0.10
8—It is not comfortable.	2.41 ± 1.04	2.74 ± 1.03	2.32 ± 0.92	1.84 ± 0.92	<0.001 *
9—I have no place to park it.	2.16 ± 1.13	2.25 ± 1.12	2.08 ± 1.10	2.07 ± 1.16	0.25
10—I lack time.	1.48 ± 1.11	2.73 ± 1.05	2.58 ± 1.09	1.84 ± 1.00	<0.001 *
11—The traffic is dangerous.	2.48 ± 1.06	2.70 ± 1.08	2.42 ± 0.99	2.09 ± 1.00	<0.001 *
12—The municipality is not adapted for cycling.	2.37 ± 1.1	2.40 ± 1.10	2.50 ± 1.05	2.71 ± 0.56	0.08
Total	2.45 ± 0.63	2.71 ± 0.56	2.43 ± 0.51	1.96 ± 0.59	<0.001 *

Notes. The Kruskal–Wallis test was used to assess statistical differences among groups, with significant values * ($p < 0.05$).

Table 4. Comparison of perceived advantages to bicycle commuting by cyclist typology (n = 384).

Perceived Advantages	Total $\chi \pm$ SD	Non-Cyclists $\chi \pm$ SD	Cyclists $\chi \pm$ SD	Urban Cyclists $\chi \pm$ SD	p
1—It is a fast means of transport	2.95 ± 0.83	2.77 ± 0.86	2.91 ± 0.76	3.37 ± 0.68	<0.001 *
2—Avoid traffic jams	3.43 ± 0.71	3.32 ± 0.75	3.42 ± 0.75	3.66 ± 0.52	<0.001 *
3—It is an efficient means of transport	3.27 ± 0.84	3.10 ± 0.85	3.23 ± 0.89	3.68 ± 0.59	<0.001 *
4—It is an economical means of transport	3.65 ± 0.67	3.63 ± 0.67	3.58 ± 0.77	3.78 ± 0.53	0.11
5—It is a pleasant means of transport	3.17 ± 0.90	2.89 ± 0.94	3.30 ± 0.82	3.59 ± 0.71	<0.001 *
6—It is a comfortable means of transport	2.62 ± 0.93	2.44 ± 0.94	2.56 ± 0.87	3.05 ± 0.85	<0.001 *
7—It is beneficial for my health	3.78 ± 0.55	3.74 ± 0.58	3.80 ± 0.61	3.84 ± 0.43	0.15
8—It is beneficial for the environment	3.87 ± 0.47	3.87 ± 0.44	3.84 ± 0.59	3.90 ± 0.40	0.73
9—Avoid crowed of people on public transport	3.58 ± 0.75	3.58 ± 0.78	3.53 ± 0.82	3.65 ± 0.57	0.88
Total	3.37 ± 0.50	3.26 ± 0.49	3.35 ± 0.53	3.61 ± 0.40	<0.001 *

Notes. The Kruskal–Wallis test was used to assess statistical differences among groups, with significant values * ($p < 0.05$).

3.3. Associations Between Cyclist Typology and Influencing Factors

Table 5 presents the results of the logistic regression analysis, comparing urban cyclists and cyclists versus non-cyclists. The results reveal several significant predictors. For both cyclist groups, bicycle usage frequency, ownership of a bicycle, and intention to use a bicycle were significantly associated with a higher likelihood of cycling, highlighting their central role in promoting bicycle commuting. Regarding gender, there was no significant difference found among urban cyclists compared to non-cyclists ($p = 0.99$). However, a significant difference was observed in the cyclist group (OR = 3.41, $p = 0.003$), indicating that being male was more strongly associated with bicycle use than with regular urban commuting. Conversely, residential environment, ownership of a motorized vehicle, cycling competence, social support, peer or family bicycle usage, perceived barriers, and perceived advantages did not yield significant differences in predicting cycling behaviour.

Table 5. Associations between cyclist typology and influencing factors.

Predictor	Urban Cyclists vs. Non-Cyclists OR (CI 95%)	*p*	Cyclists vs. Non-Cyclists OR (CI 95%)	*p*
Gender	1.021 (0.493–2.115)	0.99	3.414 (1.523–7.652)	0.003 *
Bicycle usage frequency	0.050 (0.009–0.262)	<0.001 *	0.041 (0.017–0.098)	<0.001 *
Residencial environment	0.366 (0.099–1.358)	0.13	0.441 (0.170–1.141)	0.09
Owner bicycle	0.104 (0.018–0.600)	0.011 *	0.098 (0.031–0.310)	<0.001 *
Owner motorized vehicle	4.613 (0.769–27.658)	0.09	2.152 (0.536–8.636)	0.28
Competence	0.825 (0.125–5.436)	0.84	0.936 (0. 279–3.139)	0.91
Intention to use	0.091 (0.022–0.382)	<0.001 *	0.358 (0.150–0.852)	0.02 *
Social support	0.721 (0.182–2.857)	0.64	0.82 (0.318–2.116)	0.68
Peers—family usage	0.839 (0.293–2.398	0.74	1.056 (0.469–2.377)	0.89
Perceived barriers	1.329 (0.448–3.945)	0.61	1.178 (0.481–2.884)	0.72
Perceived advantages	1.879 (0.574–6.148)	0.29	0.737 (0.292–1.86)	0.52

Notes. Multinomial logistic regression analysis comparing urban cyclists and cyclists with non-cyclists as the reference group. Results presented as odds ratios (OR) with 95% confidence intervals (CI). * Significant differences ($p < 0.05$).

4. Discussion

This study analyzed factors influencing bicycle commuting among university students and staff, categorizing participants based on cyclist typology: non-cyclists, cyclists, and urban cyclists. Most respondents reported not using a bicycle for commuting, which aligns with previous findings in Spain's general population (GESOP 2019) and within the university community (Chillón et al. 2016; Ribeiro et al. 2020). When comparing factors by cyclist typology, we found significant differences across personal, social, and environmental factors, highlighting the importance of tailoring interventions to specific cyclist profiles rather than applying generic strategies. Furthermore, our results reinforce the relevance of both Ajzen's TPB and socio-ecological models in understanding bicycle commuting.

4.1. Personal Factors Influencing Bicycle Commuting

Regarding sociodemographic characteristics, our results indicated that being male was significantly associated with a higher likelihood of being a cyclist (OR = 3.41, 95% CI = [1.52–7.65], $p = 0.003$). This finding aligns with previous studies indicating that men are more likely to use bicycles compared to women (Goel et al. 2022). However, this gender difference was not observed among urban cyclists in our study. This contrasts with findings from previous research suggesting that men are more frequently urban cyclists compared to women, as reported by Piatkowski and Bopp (2021) and Goel et al. (2022). Interestingly, Goel et al. (2022) also noted that in countries with high levels of cycling, women were equally as likely as men to commute by bicycle, highlighting the potential role of cultural and social factors in shaping cycling behaviour. Furthermore, various studies have identified gender-specific barriers that may contribute to the lower prevalence of bicycle commuting among women. For instance, Castillo-Paredes et al. (2021) found that female university students perceived more barriers to active commuting to university than male students. Likewise, Kelarestaghi et al. (2019) reported that men faced fewer barriers to cycling than women, particularly regarding risk perception, poor road conditions, and adverse weather. Similarly, Logan et al. (2023) indicated that women were more likely to be concerned about safety and a lack of confidence compared to men, even in areas with good cycling infrastructure. These findings suggest that perceived vulnerability and lack of confidence are key psychological barriers that disproportionately affect women. Therefore, addressing these barriers through educational interventions in universities (e.g., skills training, confidence-building workshops, or group cycling programmes) could be an effective strategy. For example, Adaros-Boye et al. (2021) implemented a theoretical-practical programme to promote urban cycling among university students, concluding that such interventions effectively increase bicycle use. Bicycle ownership emerged as one of the strongest personal predictors of bicycle commuting (OR = 0.10, 95% CI = [0.018–0.600], $p = 0.011$), reinforcing findings from previous research in university populations (Kelarestaghi et al. 2019). This suggests that simply having access to a bicycle is a critical enabler of cycling behaviour. However, ownership alone may not be sufficient. To convert ownership into regular use, supportive campus environments are needed. As Ribeiro et al. (2020) emphasize, the implementation of appropriate planning policies that provide a network of comfortable and safe facilities connecting the campus with residential areas, transportation hubs, and other key destinations is essential to increasing the number of people who commute by bicycle to the university. In this regard, investment in bicycle infrastructure, such as secure parking, bike lanes, and maintenance facilities, can complement individual-level factors and enhance the likelihood of commuting by bicycle.

4.2. Psychological Factors Influencing Bicycle Commuting

Regarding psychological influences, our results showed that urban cyclists had higher perceived competence, greater intention to commute by bicycle, more perceived advantages of bicycle commuting, and lower perceived barriers than non-cyclists. In terms of perceived competence, our results indicated that non-cyclists perceived themselves as less competent compared to those who regularly use bicycles. These results align with Bauman et al. (2008), who indicated that competence depends on experience and the frequency of transportation mode use. Indeed, bicycle use frequency itself was a strong predictor of cyclist typology (OR = 0.05, 95% CI = [0.009–0.262], $p < 0.001$). This finding highlights the role of habit formation in sustaining long-term cycling behaviour. Encouraging progressive increases in cycling frequency through behaviour change interventions (e.g., cycling challenges, incentives, and gradual exposure programmes) could effectively transition occasional users into regular cyclists. Additionally, our findings indicated that the intention to commute by bicycle was a predictor of this behaviour (OR = 0.05, 95% CI = [0.009–0.262], $p < 0.001$). This is consistent with Ajzen's TPB, which posits that intention is the primary predictor of behaviour (Ajzen 1991). According to this theory, intention is influenced by attitude toward the behaviour, subjective norms, and perceived behavioural control. Regarding attitudes toward bicycle commuting, we analyzed perceived barriers and advantages, finding that non-cyclists reported more barriers and fewer advantages compared to cyclists and urban cyclists, as also reported by Castro et al. (2010). The most prominent barriers among non-cyclists were both personal (e.g., preference for other means of transportation, lack of habit, perceived risk) and environmental (e.g., travel distance). In contrast, for cyclists and urban cyclists, environmental barriers (e.g., weather, lack of cycling infrastructure, and distance) were more significant. Prior studies have also identified these barriers as prevalent in the university community. For instance, Kaplan (2015) identified greater concerns about safety and inconvenience among non-cyclists. Various studies have also found that weather and road conditions influence this behaviour among university populations (Ribeiro et al. 2020; Kaplan 2015; Cerro-Herrero et al. 2018). These findings suggest that interventions must be tailored to the specific concerns of each group. For non-cyclists, strategies should focus on building confidence, addressing perceived risks, and reinforcing the short-term convenience and safety of cycling. For active cyclists, improving cycling conditions—through protected bike lanes, clear signage, and maintenance—may help reduce environmental disincentives and support sustained behaviour. Moreover, travel distance and time have been identified as significant barriers to active commuting in this context (Bopp et al. 2016; De Wet et al. 2021; Chillón et al. 2016), establishing a threshold distance of 2.6 km for walking and 5.1 km for cycling in university commuting. Similarly, De Wet et al. (2021) reported that among university students who cycled, only a small proportion travelled distances greater than 5 km (22%), while the majority cycled between 1 and 5 km (34%) or less than 1 km (40%). Furthermore, Castro et al. (2010) suggested a maximum efficient commuting distance of up to 7 km for conventional bicycles and up to 15 km for e-bikes. In this regard, Fishman and Cherry (2016) proposed that e-bikes could help mitigate barriers related to distance. However, high purchase costs and infrastructure limitations remain barriers to widespread adoption. Future research should investigate the role of e-bikes in university settings, particularly regarding their impact on cycling frequency, perceptions of convenience, and accessibility among diverse user groups. To address these barriers, universities could consider offering e-bike rental services. Molina-García et al. (2015) reported an increase in bicycle commuting to university following the implementation of a public bike-sharing programme.

Regarding perceived advantages of bicycle commuting, environmental and health benefits were the main perceived advantages among the majority of respondents, regardless of their cyclist typology, as indicated by Monzón et al. (2008). Additionally, avoiding crowded public transport, traffic jams, and saving money were also highlighted as advantages. In terms of reducing reliance on crowded public transport, this behaviour could have been influenced by the COVID-19 pandemic. As noted by Buehler and Pucher (2021), bicycle use increased as a means of transportation following the global pandemic. This shift underscores the potential for cycling as a resilient and adaptable mode of transportation in public health crises. Future studies should explore whether this trend is sustained post-pandemic and how it may influence long-term cycling behaviours in university settings. On the other hand, Damant-Sirois et al. (2014) pointed out that environmental reasons motivate almost all cyclists, and they also found that health, time efficiency, and low cost were important factors for cycling. Therefore, these advantages could be emphasized to encourage bicycle use within the university community. However, these authors also indicated that promoting health as a reason to cycle can inspire people to try cycling but is unlikely to increase frequency among current cyclists. In this regard, emphasizing financial and time-saving benefits—such as avoiding traffic jams—could be an effective strategy for promoting bicycle use, as these are also among the main perceived benefits according to previous studies (Bhandal and Noonan 2022).

4.3. Social Factors Influencing Bicycle Commuting

Social factors such as social support, peers, and family bicycle usage were not significant predictors in our regression model. Despite this, previous studies have identified influences such as the cycling behaviour of peers and family members, social status, social support, parental attitudes, and neighbourhood perceptions (Pearson et al. 2023). Thus, training programmes for students, staff, and interested family members, as well as promoting bicycle use through role models who commute by bicycle to the university, could be beneficial. Wilson et al. (2018) highlighted the importance of university–community interaction in fostering bicycle commuting. Given the impact of social norms and support, interventions aimed at increasing peer encouragement, campus-wide social campaigns, and mentorship programmes could be valuable. For instance, training workshops, staff-led cycling initiatives, and peer-support networks have successfully increased bicycle use in university settings (Adaros-Boye et al. 2021). Additionally, technological solutions such as mobile apps providing personalized travel plans, CO_2 savings, and economic benefits have demonstrated potential for behavioural change among university students (Sottile et al. 2021).

4.4. Environmental Factors Influencing Bicycle Commuting

Regarding environmental factors, Bauman et al. (2008) indicated that dedicated cycling infrastructure is a key determinant of bicycle use. In our results, among the barriers related to the environment, the most prominent for those who commuted by bicycle were that the municipality is not adapted for cycling and the lack of secure parking facilities. Similarly, Dufour (2010) reported that countries with high-quality cycling infrastructure had a greater modal share of cycling. International examples, such as the extensive bicycle lane networks in Copenhagen, Denmark, or Utrecht, Netherlands, demonstrate how comprehensive infrastructure investments coupled with strong public policies can effectively increase bicycle commuting at the city level, including in university contexts (Gössling 2013; Harms et al. 2016). Along the same lines, Kelarestaghi et al. (2019) indicated that solid bicycle infrastructure in university campuses, including the availability of bike lanes, secure parking, and other amenities, contributes positively to bicycle commuting. Conversely, the lack of such infrastructure is one of the main barriers for both regular and occasional cyclists, as well as for non-cyclists. Additionally, infrastructure designed to improve cyclists' comfort at their destination—such as lockers, showers, secure parking, and bicycle repair stations—also influences this behaviour. As highlighted by Wilson et al. (2018), promoting bicycle commuting within universities requires a multifaceted approach that includes high-quality cycling infrastructure, secure parking, integration with surrounding neighbourhoods, mobility planning, and ongoing monitoring of travel behaviours. Protected and illuminated cycle lanes, signage for cycling routes, quiet roads, end-of-journey facilities (e.g., changing rooms and showers), the possibility of bringing bicycles onto public transport, the absence of mandatory helmet laws, and specific cycling route maps have been identified as enabling measures for bicycle commuting (Pearson et al. 2023).

4.5. Theoretical Implications

Our findings reinforce the applicability of both Ajzen's TPB and the socio-ecological model in understanding bicycle commuting behaviours (Ajzen 1991). TPB variables, particularly behavioural intention and perceived competence, significantly predicted commuting behaviour in our study. This aligns with Milkovic and Stambuk (2015), who found that all TPB variables were significant predictors of bicycle use among university students, with attitudes exerting the strongest influence. Similarly, Caballero et al. (2019) validated TPB among university students and staff, reporting significant correlations across all predictors. Regarding socio-ecological models, our findings suggest that personal, social, and environmental factors have varying influences depending on cyclist typology. This layered perspective highlights that bicycle commuting behaviour is shaped not only by individual intentions but also by broader contextual factors. Specifically, non-cyclists were more affected by personal and psychological barriers, whereas active cyclists emphasized environmental constraints. These findings align with previous research indicating that both psychosocial and environmental barriers play crucial roles, with environmental factors sometimes exerting greater influence (Molina-García et al. 2014). Cerro-Herrero et al. (2018) also reported that environmental and safety barriers scored slightly higher than psychosocial barriers, reinforcing the importance of context-specific analysis of perceived barriers. Therefore, combining TPB and socio-ecological models offers a robust framework for designing multilevel interventions sensitive to different cyclist profiles and their contextual determinants. Successful institutional initiatives, such as the 'U-MOB LIFE' project, have demonstrated that targeted actions such as enhancing campus bike lanes, improving and expanding bicycle parking facilities, providing mobile bicycle repair services, and establishing a bicycle loan system can enhance cycling uptake in university settings (U-MOB 2019). However, the effectiveness of these strategies depends not only on environmental improvements but also on how they engage behaviour change mechanisms. As Doğru et al. (2021) noted, success varies depending on the strategies used (Doğru et al. 2021). Scientific evidence suggests that interventions aimed at influencing and generating behaviour change are more effective and more likely to benefit individuals and communities when they are based on a health behaviour theory and utilize behaviour change techniques (Epton et al. 2013; Glanz et al. 2008; Sevil-Serrano et al. 2020). Therefore, universities should adopt comprehensive interventions that integrate infrastructure development, supportive policies, and behaviour-change strategies to enhance bicycle commuting.

4.6. Limitations and Future Research Directions

The non-probabilistic sampling method and limited sample size restrict the generalizability of the findings beyond the specific university context. Future research should include larger, more diverse samples across multiple institutions to enhance external validity. Additionally, self-reported data may introduce recall bias or social desirability bias, particularly regarding reported cycling frequency and perceived barriers. Using objective measures, such as GPS tracking or bike-sharing system data, could strengthen future analyses. Moreover, this study did not differentiate between conventional and e-bikes, despite emerging evidence suggesting that e-bikes may significantly influence cycling adoption (Pearson et al. 2023). Future research should explore the long-term impact of emerging mobility trends, such as the role of e-bikes and post-pandemic cycling habits, to further understand their influence on sustainable transport choices. Longitudinal studies would be beneficial to assess causal relationships and the long-term effectiveness of cycling interventions. Understanding how cycling behaviours evolve over time and whether certain factors (e.g., social influences, infrastructure improvements, policy changes) lead to sustained increases in bicycle commuting would provide valuable insights for designing more effective interventions. Lastly, one limitation of this study is that the regression models were not adjusted for potential confounding variables such as age, socioeconomic status, or distance to destination. Future studies should incorporate these variables to strengthen the validity of the findings.

Despite these limitations, this study stands out for its comprehensive approach and in-depth analysis of the factors influencing bicycle commuting among university populations. This focused perspective allows for a detailed exploration of key determinants, providing a solid foundation for designing interventions and policies that promote bicycle commuting while considering different cyclist typologies. Future research should build upon these findings to develop and evaluate targeted measures aimed at increasing bicycle commuting in university settings.

5. Conclusions

This study shows that active bicycle use remains limited within the university community and that commuting behaviour is shaped by an interplay of personal, social, and environmental factors, with some distinctions depending on cyclist typology. Urban cyclists reported fewer barriers and a more favourable perception of cycling advantages, particularly in terms of speed, efficiency, comfort, and enjoyment. Bicycle usage frequency, bicycle ownership, and the intention to use a bicycle emerged as strong predictors of commuting behaviour across all cyclist types. These findings underscore the importance of promoting this mode of transport, with strategies tailored to cyclist typology. Furthermore, the results support the applicability of both the TPB and the socio-ecological model in understanding cycling behaviour. Therefore, universities should implement holistic and theory-driven strategies that integrate infrastructure development, supportive policies, and context-specific behavioural interventions. These multilevel strategies, aligned with the needs and motivations of diverse cyclist profiles, can effectively foster a culture of active and sustainable commuting in academic settings.

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Abbreviations

The following abbreviations are used in this manuscript:

SDG	Sustainable Development Goals
WHO	World Health Organization
TPB	Theory of Planned Behaviour

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