Comparing Safety Perceptions and Active Mobility in Two Urban Settings: A Case Study

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Comparing Safety Perceptions and Active Mobility in Two Urban Settings: A Case Study

Perceived (un)safety significantly impacts urban quality of life, shaping mobility dynamics and public space use. This study examines differences in safety perceptions across two environments and analyzes variables influencing active transportation decisions (walking or cycling) within these contexts. Using surveys and systematic observation in neighborhoods of differing socio-economic levels, we also explore the relationship between built environment design, walkability, and safety. Residents in disadvantaged neighborhoods reported higher unsafety levels and greater disruption in mobility dynamics, with safety concerns playing a more prominent role in their decisions. These findings help clarify inconsistencies in literature regarding perceived unsafety and active mobility.

Keywords: Active transportation; walkability; urban mobility; safety perception; fear of crime; CPTED.

Introduction

Walkability is understood as "the extent to which the built environment is friendly to the presence of people who walk, live, shop, visit, enjoy, or spend time in an area" (Arellana et al. 2020: 184). Therefore, it is directly related to the perception of the immediate physical and social environment, such that if an environment is perceived as unfriendly, it will also be considered less walkable.

Intuitively, we can think that unsafe environments, or at least those perceived as such, will be spaces that people avoid, with potential negative consequences. If these spaces are in central or well-connected areas, or in areas necessarily used for day to day mobility needs, consequences at individual, community, and economic levels will be more relevant. For example, on an individual level, avoiding a street or area perceived as unsafe can increase travel time and distance to the destination and even deter

individuals from engaging in active transportation (i.e., walking or cycling) and lead them to opt for motorized transportation, thus missing out on the health benefits associated with active mobility (Mueller et al. 2015; Shamshiripour et al. 2020). In turn, a lower influx of pedestrians would reduce the incentive for new businesses to open or existing ones to remain, as they would seek strategic locations with higher pedestrian traffic (Grimaldi, Fernandez, and Carrasco 2019). A lower density of businesses would also have an economic impact on the neighborhood (Yoshimura et al. 2022).

This leads us to examine how perceptions of walkability and (un)safety vary among users of different urban environments (RQ1). Furthermore, we explore how users of these spaces differ in the factors influencing their decisions about active transportation (RQ2). This study contributes to the literature by providing evidence on differences in perceptions of (un)safety, walkability, and decision-making factors between two different environments. The following sections of the manuscript review the literature on perceptions of safety and walkability, describe the methodology employed, present the results, and discuss the findings in the context of prior research.

Literature Background

(Un)Safety Perception, Built Environment and Community Dynamics

Attitudes towards crime have been studied at both social and personal levels. This study focuses on the personal level, specifically the (un)safety perceptions also named as fear of crime. In the literature, fear of crime is typically categorized into emotional, cognitive, and behavioral dimensions (see Gerber, Hirtenlehner, and Jackson 2010). However, the conceptualization and terminology surrounding fear of crime have been debated for decades (Ferraro and Lagrange 1987; Hart, Chataway, and Mellberg 2022; Lorenc et al. 2014b). Researchers argue that existing measures often fail to capture the

emotional response to a perceived threat –fear- and instead reflect a generalized anxiety about victimization (Pohl and Buil-Gil 2024). In our study, we use the cognitive perspective, focusing specifically on the individual perception of (un)safety.

From an ecological perspective (Fernández-Ramírez 2008; Van Beek 2004), the physical and social characteristics of the environment are key factors in explaining variations in the perception of safety (Nalla and Ceccato 2020). Substantial evidence identifies specific aspects of urban design closely linked to the fear of crime, underscoring the spatial dependency of this phenomenon (Chen and Hedayati Marzbali 2024).

For instance, spaces that promote natural surveillance through effective lighting (Abenoza et al. 2018; Sundling and Ceccato 2022) and built environments with clear sightlines, such as transparent bus stop shelters or well-marked signage (Abenoza et al. 2018; Ceccato, Sundling, and Gliori 2024), tend to enhance people's sense of safety. This improvement may stem from the idea of "seeing and being seen" (Abenoza et al. 2018; Ceccato, Sundling, and Gliori 2024; Paul Cozens and Sun 2019; Sundling and Ceccato 2022). Conversely, neglected areas with visible graffiti, litter, or broken infrastructure can evoke feelings of unsafety, as they convey a lack of control and an atmosphere of vulnerability (Ceccato, Sundling, and Gliori 2024; Ceccato, Langefors, and Näsman 2023; Ceccato, Sundling, and Gliori 2024; Hedayati Marzbali et al. 2012).

Psychosocial and community indicators also play a role in shaping perceptions of safety. At the individual level, prior victimization experiences, especially initial ones, can heighten sensitivity to safety concerns (Brunton-Smith and Sturgis 2011). However, the evidence on this link is mixed, with some studies reporting inconclusive results (Lorenc et al. 2014a). On the other hand, a sense of belonging and positive perceptions

of the community are negatively associated with fear of crime, as are trust in law enforcement and public institutions (Sundling and Ceccato 2022).

At the community level, positive social interactions and active community engagement can foster a sense of informal social control, promoting collective efficacy and, in turn, improving safety perceptions (Brunton-Smith, Jackson, and Sutherland 2014). Traditionally, ethnic heterogeneity has been thought to increase feelings of unsafety, as it has often been linked to reduced social cohesion and trust within neighbourhoods (Taylor 1997; Koopmans and Schaeffer 2016). However, recent evidence suggests no direct connection between ethnic diversity and fear of crime, despite finding a correlation between diversity and lower social cohesion (Glas, Jennissen, and Engbersen 2021).

In summary, the evidence underscores that well-designed urban public spaces and thoughtfully managed community dynamics play a critical role in shaping perceptions of safety. Features such as effective lighting, clear sightlines, and maintained infrastructure, alongside positive social interactions and a sense of community belonging, collectively enhance individuals' feelings of security. Conversely, neglect of urban spaces or weak social cohesion can heighten fear of crime. These perceptions not only affect how people engage with public spaces but also have broader implications for their transportation choices and overall urban mobility patterns.

Perception of Unsafety and Active Transportation

The literature has repeatedly found a relationship between the built environment and active transportation behaviors. Urban design can either facilitate or hinder activities such as walking, cycling, and other type of physical activity, which influence

individuals' physical, mental, and social health (Berke et al. 2007; Grasser et al. 2013; Ho and Cheung 2011; Mueller et al. 2015; Rogers, Gardner, and Carlson 2013; Van Holle et al. 2012). In this regard, research over the past few decades on the walkability of urban environments suggests that those characterized by population density, a diversity of uses, and pedestrian-friendly design (e.g. maintenance, connectivity, presence of vegetation, etc.) facilitate active transportation and physical activity (Carr, Dunsiger, and Marcus 2010; Cervero and Kockelman 1997; Frank et al. 2005; Safizadeh et al. 2024). According to Subiza-Pérez and Vozmediano (2015), the definition of a walkable environment should also include psychosocial and community elements. In fact, research has established the importance of the social landscape (Millstein et al. 2013), neighborhood satisfaction, trust among neighbors, social ties (Cleland, Timperio, and Crawford 2008; Franzini et al. 2010), and social support (Brown et al. 2007) in promoting walking.

The perception of unsafety related to vehicular traffic can also impact physical activity in public spaces and the dynamics of active transportation (Hong and Chen 2014; Loukaitou-Sideris 2006). This claim is supported by empirical evidence (Brown et al. 2014; Foster, Giles-Corti, and Knuiman 2010; Hong and Chen 2014). Zenk et al. (2009) noted that perceptions of unsafety might influence walking more than official crime rates do. However, other studies downplay the relationship between perceived unsafety and physical activity (Bracy et al. 2014), and in some countries, this relationship may not be found or may not be as apparent (Van Holle et al. 2012). These findings highlight the need for research in various geographical and cultural contexts.

The Current Study

We conducted an empirical study in a mid-sized urban area in Spain (population approximately 350,000) to explore the relationship between perceptions of walkability and safety (or lack thereof). The study also examined factors influencing active transportation decisions in two distinct environments, each with unique physical and community characteristics. We selected two different environments in order to identify the variables that potentially capture the contextual variability on (un)safety and walkability perception.

Our specific objectives were: (1) to systematically characterize the selected environments, (2) to compare users' perceptions of walkability and unsafety in both environments, and (3) to analyze how perceived unsafety are related to transportation behaviors and the use of urban spaces.

Method

The study design combined different observational methodologies: a) survey methodology and b) systematic observation methodology. To achieve the first objective, two members of the research team, as expert judges, evaluated the environmental characteristics of each of the environment using the systematic tools described in the next section. To meet objectives 2 and 3, we developed an *ad hoc* survey using validated questionnaires aimed at gathering users' perceptions of unsafety and walkability. The project received approval from the Human Research Ethics Committee of the university of the research team.

Environments, Procedure, and Participants

Two 600-meter street segments were selected for the study, each located in a different environment (see Figure 1) –environment 1 (hereafter E1) and environment 2 (hereafter E2). Representative images of these environments are shown in Figures 2 and 3. Two members of the research team systematically evaluated both environments. After completing the systematic observation, professional surveyors administered surveys to individuals walking along the selected street segments. To implement the survey designed by the research team, a survey company was contracted for the task. Gender and age criteria were applied to ensure a balanced sample, and respondents were confirmed to be neighborhood residents, ensuring they were familiar with and regularly used the area. Each survey took approximately 15 minutes to complete.

The sample included 226 participants, comprising 51.3% females and 48.7% males, with ages ranging from 18 to 96 years (M = 42.77, SD = 19.92). Table 1 presents the main characteristics of each sub-sample. While the sub-samples are similar in terms of economic independence, they differ significantly in ethnic composition, length of residence in the neighborhood, and professional activity.

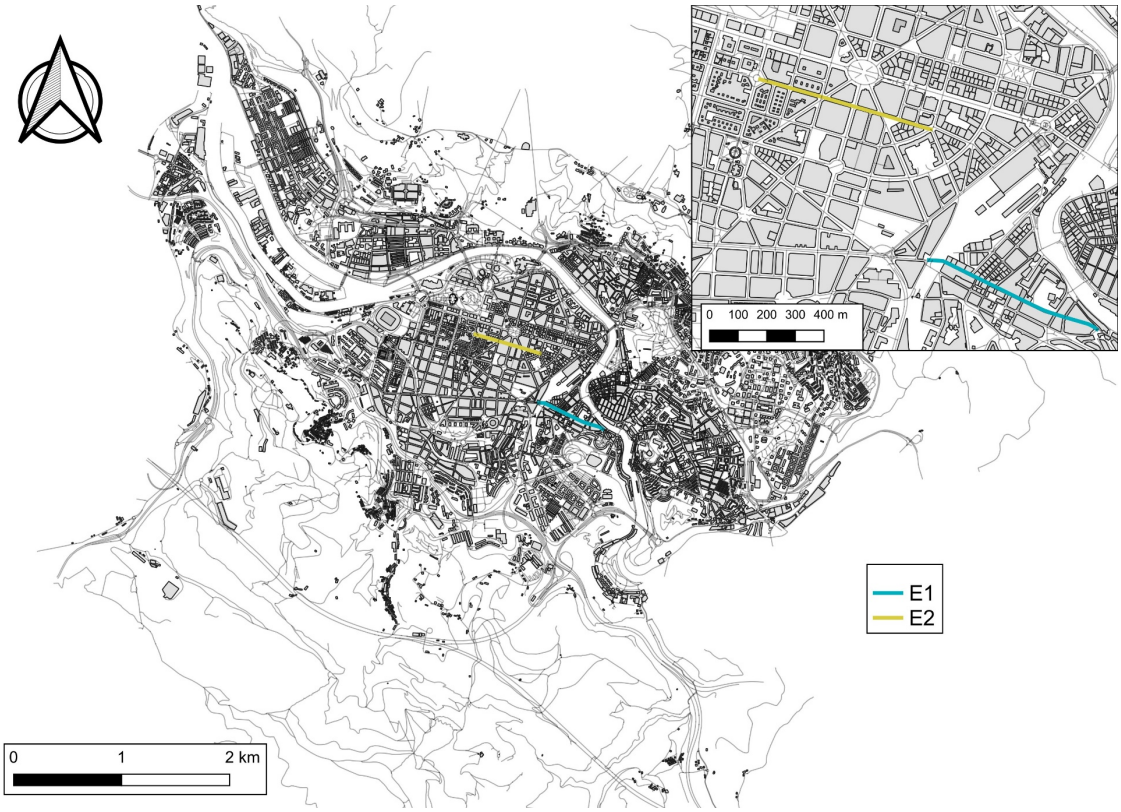

Figure 1. City map with zoom of the segments analyzed. Note: Own elaboration using data from © 2024 OpenStreetMap contributors.

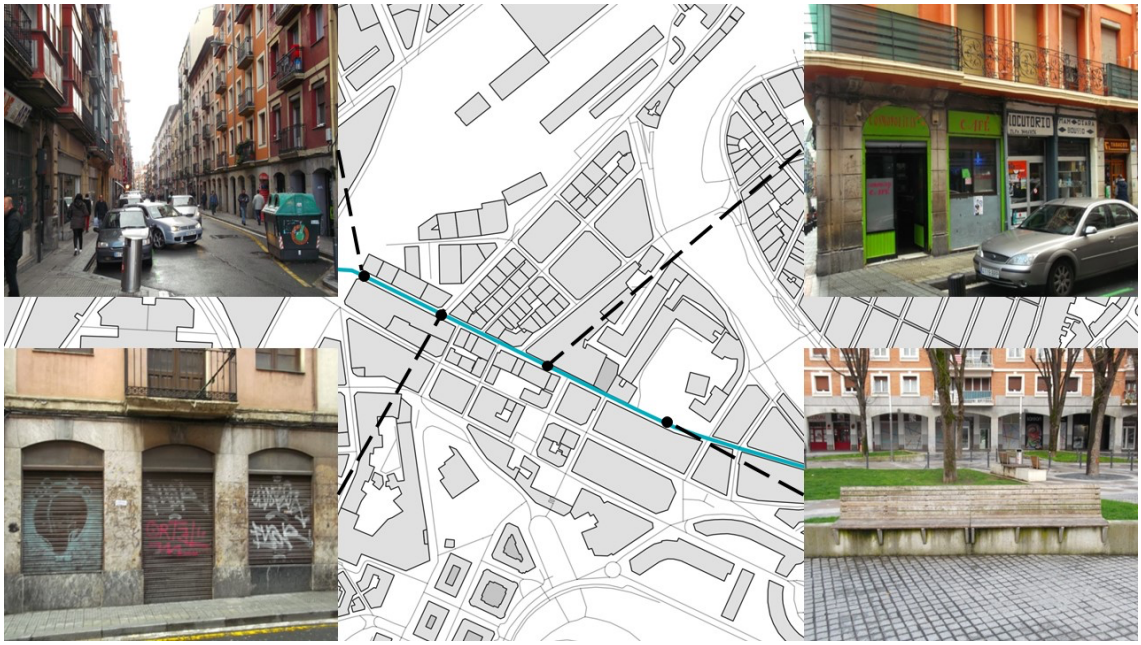

Figure 2. Street segment E1 with several photographs as examples. Note: Own elaboration using data from © 2024 OpenStreetMap contributors

Figure 3. Street segment E2 with several photographs as examples. Note: Own elaboration using data from © 2024 OpenStreetMap contributors.

Table 1. Socioeconomic data of the participants in Environment 1 (E1) and Environment 2 (E2)

Variables	E1	E2
N	113	113
Age (mean)	42.35 years	43.20 years
Gender	49.6% females 50.4% male	53.1% females 46.9% male
Ethnicity	68% Caucasian 11.5% Latino 4.4% African 7.1% Roma 1.8% Asian 15% Maghrebi	92.9% Caucasian 7.1% Latino - - - -
Time of Residence in the Neighborhood (mean)	18.98 years	27.07 years
Purchasing Power	50.4% low 25.7% medium-low 23.9% medium 0% medium-high 0% high	0.9% low 4.5% medium-low 75.9% medium 17.9% medium-high 0.9% high
Economic Independence	87.6% yes 12.4% no	77.9% yes 22.1% no
Current Professional Activity	2.7% student 29.2% works 40.7% unemployed 15.9% at home 11.5% retired	19.5% student 51.3% works 7.1% unemployed 10.6% at home 11.5% retired

Materials

Audit Tools

The systematic evaluation of the environment according to walkability criteria was conducted using the SPEDS, the Spanish adaptation of the Pedestrian Environment Data Scan (Ricci et al. 2011; Clifton, Livi Smith, and Rodriguez 2007). This tool groups its 41 items into the domains of Environment, Pedestrian Facilities, Road Attributes, and Pedestrian Surroundings. For this study, three brief scales were added: Aesthetics and Vegetative Elements (4 items), Positive Social Landscape (1 item), and Diverse Use of Space (4 items).

To assess the built and social environment features that might influence the perception of (un)safety among citizens, or conversely, fear of crime, we developed the Safe Urban Environment (SUE – EUS in its Spanish version: Espacio Urbano Seguro) audit tool (see supplementary material). Comprising 47 items across domains of Physical and Social Disorder (14 items), Ethnic Diversity (5 items), Crime-Encouraging Design (13 items), Security Elements (7 items), Maintenance (4 items), and Miscellaneous (4 items), each item records observed presence on a scale from 0 to 5.

Survey

To assess subjective perceptions of walkability, active transportation behaviors, and safety (or lack thereof), we designed a survey consisting of three sections. The first section gathered socio-demographic information. The second section included 7 of the 9 subscales from the ALPHA instrument, developed under the European project *Assessing Levels of Physical Activity* (Spittaels et al. 2010) which includes items to assess perceived neighborhood characteristics. These subscales evaluated perceived

neighborhood characteristics, including housing type, travel time to services, availability of walking and biking facilities, infrastructure condition, neighborhood safety, neighborhood pleasantness, and connectivity. The third section focused on active transportation, transportation decision-making, avoided areas, fear of crime, and neighborhood social cohesion, with all responses rated on a 1-4 scale.

Analysis

First, we obtained the proportions of the sociodemographic characteristics of the samples from each environment (see Table 1). Second, we conducted a narrative analysis of the data obtained through systematic observations (Tables 2 and Table 3). Finally, we performed a comparison of means (Student's t-test) to analyze differences between responses to the survey items. We reported Cohen's d (Cohen, 1988) as the effect size to aid in interpreting the differences between means. Additionally, we calculated 95% confidence intervals as a measure of uncertainty and reported p-values (Table 4 and Table 5).

Results

Narrative Analysis of Systematic Observation Tools

The main results of the evaluation of the segments concerning the design that promotes active transportation, using the SPEDS tool, can be seen in Table 2. Both segments have a similar structure, as they are single-lane streets with a significant presence of residential, commercial, and hospitality uses. Neither has infrastructure supporting

bicycle use. The social landscape is also similar in terms of activities, with movement, shopping, and a lack of sports practice being predominant.

The main differences between the two environments lie in their walkability. Environment 1 (E1) has very narrow and poorly maintained sidewalks and lacks traffic regulation elements, a situation opposite to that of Environment 2 (hereafter E2). There are also marked differences in the maintenance of roads and buildings; maintenance is high in E2 and low in E1. Additionally, the shops and businesses in E1 cater primarily to a multi-ethnic, lower-middle-class audience, while those in E2 cater to higher-income groups. Finally, the level of vegetation in E1 is very low, whereas in E2, the recreational areas feature green elements and trees are found along the street.

Table 2. Results of the systematic observation of the environments with SPEDS tool.

Units of analysis	E1	E2
General structure	Low traffic level roadway with two adjacent sidewalks.	Medium-high traffic level roadway with two adjacent sidewalks.
Main uses of Space	Extensive residential use (3-5 floors). Significant presence of stores, hotels and services (food, hairdressing, pharmacies...), of a certain ethnic character. Cultural and community uses: Museum of reproductions, a School, a Social Services unit and premises of various associations. Significant number of abandoned and poorly maintained premises.	Extensive residential use (>5 floors). Significant presence of stores, hotels, and services (banks, clothing and furniture chains, offices of liberal professionals...). No community uses are observed.
Urban facilities and recreational areas	Obvious lack of urban furniture. Presence of a square at one end of the analyzed segment. Very low level of vegetation.	Rest areas at various points along the segment with benches, fountains and vegetation.
Sidewalk condition and maintenance	Narrow sidewalks, poorly maintained, with cross slopes and insufficient curb cuts (50%). Absence of traffic regulation elements.	Wide and well-maintained sidewalks, lowered curbs, many traffic regulation elements and crossing aids (traffic circles, traffic lights, widening of sidewalks at intersections).
Social landscape	People running daily errands and chatting in the street. Significant ethnic heterogeneity.	People running everyday errands and chatting in the street. Ethnic diversity barely exists.

Regarding the socio-physical elements that can generate fear of crime, the results of the EUS tool application can be found in Table 3. E1 is a poorly connected environment, with low levels of maintenance, considerable deterioration, and a lack of green or attractive elements, making it a scenario prone to generating fear or insecurity. In E2, although connectivity can be a criminogenic factor and the green elements could generate feelings of fear, especially at night, in general, it is a well-designed, well-kept, and maintained space, more likely to generate a sense of security among citizens who walk through it.

Table 3. Results of the systematic observation of the environments with SUE tool.

Units of analysis	E1	E2
Physical disorder	High presence of graffiti and litter. Some evidence of vandalism and multiple abandoned premises.	Non-existent physical disorder.
Criminogenic potential	Little possibility of escape from dangerous situations (victim) and difficulty in fleeing and hiding (aggressor) due to low connectivity and access to other streets. Absence of elements that hinder natural surveillance.	Greater possibilities of anticipation (victim) and escape (aggressor) due to connection and accessibility to other streets and places. Presence of vegetation and urban furniture that would facilitate hiding and committing crimes; they make natural surveillance more difficult.
Elements of objective security	Large number of surveillance cameras, metal shutters in stores and homes. A private security guard (museum).	Absence of visible elements in/from the public space.

Subjective Perception of Environments, Safety, and Walkability

In line with the objective analysis, there are significant differences in the residents' perceptions in each of the environments. Residents of E1, compared to those of E2, perceive the condition of sidewalks and public spaces to be worse (M_{E1} = 1.40; M_{E2} = 3.13; t (224) = 19.61; $p < 0.001$; d = 2.63; 95 % CI [2.27 ; 2.98]) and view their neighborhood as less pleasant (M_{E1} = 2.3; M_{E2} = 3.29; t (224) = 17.85; $p < 0.001$; d = 2.38; 95 % CI [2.03 ; 2.71 They also expressed lower levels of satisfaction with living in the neighborhood (M_{E1} = 3.25; M_{E2} = 3.82; t (224) = 5.00; $p < 0.001$; d = 0.65; 95 % CI [0.38 ; 0.92]), identification with it (M_{E1} = 2.66; M_{E2} = 3.21; t (224) = 4.16; $p <$ 0.001; d = 0.55; 95 % CI [0.28 ; 0.82]), well-being from living there (M_{E1} = 2.63; M_{E2} = 3.58; t (224) = 8.31; $p < 0.001$; d = 1.11; 95 % CI [0.83 ; 1.39]) y and desire to stay (M_{E1} = 2.3; M_{E2} = 3.35; t (224) = 6.82; $p < 0.001$; d = 0.90; 95 % CI [0.63 ; 1.17]). However, residents of E1 reported a greater perception of unity and social cohesion among neighborhood residents (M_{E1} = 2.65; M_{E2} = 2.27; t (224) = 3.08; $p < 0.001$; d = 0.41; 95 % CI [0.15 ; 0.67]) and a higher level of acquaintance among them (M_{E1} = 2.81; M_{E2} = 2.09; t (224) = 5.83; $p < 0.001$; d = 0.78; 95 % CI [0.51; 1.05]).

Regarding safety perception, scores in both environments range from low to medium, with none exceeding 3 points on a 1-4 scale. As shown in Table 4, residents in the E1 neighborhood reported higher levels of perceived unsafety, greater fear of being victims of crime, and a greater perception of the presence of potential aggressors.

Table 4. Comparison between users of the two environments with respect to unsafety

Items per Domain	Mean E1	Mean E2	t	*d*	95 % CI
1.Perceived unsafety in the neighborhood [1-4] in relation to:					
Leaving bicycles on the street ***	3.33	2.41	6.12	0.81	[0.54; 1.08]
Crossing the street safely ***	2.17	1.63	4.02	0.53	[0.26; 0.79]
Going for a walk in traffic ***	1.97	1.50	3.77	0.49	[0.22; 0.75]
Cycling	2.47	2.46	0.59	-	-
High crime rate (day)***	2.27	1.35	6.85	0.92	[0.64; 1.19]
High crime rate (night)***	2.56	1.55	7.42	0.98	[0.7; 1.26]
2. Fear of being a victim of the indicated crime [1-4]					
Theft or robbery **	1.55	1.18	3.45	0.45	[0.19; 0.71]
Physical aggression **	1.42	1.09	3.47	0.46	[0.20; 0.72]
Sexual Assault	1.08	1.01	1.73	-	-
Verbal harassment or bullying ***	1.40	1.04	3.74	0.49	[0.22; 0.75]
3. Perceptions of potential aggressors [1-4]					
Presence of potential aggressors or thieves in the neighborhood ***	2.80	1.56	10.56	0.57	[0.3; 0.84]
People who could cause problems are from outside the neighborhood**	2.08	2.58	3.46	0.22	[-0.04; 0.48]

**$p < .001$; *** $p < .0001$; CI = Confidence Intervals

Comparison of Safety Perception in Active Transportation Behaviors and Urban Space Use Between Scenarios

Participants reported the elements they considered when engaging in active transportation behaviors, such as walking or cycling. They emphasized the importance of weather conditions, the pleasantness of the route, traffic safety, the time of day (day/night), and safety from potential crimes. As shown in Table 5, residents in the E1 neighborhood scored significantly higher than those in the E2 neighborhood on three of these factors: the relevance of traffic safety, safety from crime, and the time of day. No statistically significant differences were found between the groups for the remaining factors.

Table 5. Comparison between users of the two environments with respect to the elements considered in the decision-making process of active displacement.

Elements considered [relevance 1-4]	Mean E1	Mean E2	t	*d*	95 % CI
Duration of the tour	1.99	1.90	0.79	-	-
Rush	2.20	2.18	0.23	-	-
Exercise	2.10	2.02	0.68	-	-
Atmospheric weather	2.72	2.77	0.39	-	-
Traffic status	2.18	2.12	0.39	-	-
Pleasant route	2.54	2.27	1.89	-	-
Traffic safety *	2.50	2.11	2.88	0.38	[0.12; 0.64]
Day/Night***	2.76	2.25	3.89	0.51	[0.24; 0.77]
Security in relation to the crime rate *	2.91	2.54	2.79	0.36	[0.10; 0.62]

*$p < .05$; **$p < .001$; *** $p < .0001$; CI = Confidence Intervals

Regarding the patterns of public space use that may be affected by safety perception, the avoidance of certain routes was generally low across the sample. However, residents of E1 reported higher avoidance of areas in their neighborhood compared to those in E2, both during the day ($M_{E1} = 1.32 > M_{E2} = 1$; t (224) = 3.945, $p < 0.001$; $d = 0.53$; 95 % CI [0.26; 0.79]) and at night ($M_{E1} = 1.73 > M_{E2} = 1.10$; t (224) = 5.149; $p < 0.001$; $d = 0.69$; 95 % CI [0.42; 0.96]). In terms of avoiding areas in the city as a whole, E1 residents avoided fewer places than E2 residents during the day ($M_{E1} = 1.08 > M_{E2} = 1.47$; t (224) = 3.437; $p < 0.001$; $d = 0.49$; 95 % CI [0.22; 0.75]) and at night ($M_{E1} = 1.14 > M_{E2} = 1.64$; t (224) = 4.157; $p < 0.001$; $d = 0.56$; 95 % CI [0.29; 0.83]).

Further exploration of the data indicates that E1 residents reported higher rates of avoiding areas within their own neighborhood compared to areas in the city as a whole, both during the day ($M_{neighborhood\text{-}day} = 1.32 > M_{city\text{-}day} = 1.08$; t(112) = 2.995; $p < 0.05$; $d = 0.36$; 95 % CI [0.16; 0.55]) and at night ($M_{neighborhood\text{-}night} = 1.73 > M_{city\text{-}night} = 1.14$; t(112) = 5.018; $p < 0.001$; $d = 0.61$; 95 % CI [0.41; 0.81]). Conversely, E2 residents showed less avoidance of areas within their neighborhood compared to the city as a whole, both during the day ($M_{neighborhood\text{-}day} = 1 < M_{city\text{-}day} = 1.47$; t(112) = 4.395; $p < 0.001$; $d = 0.59$; 95 % CI [0.39; 0.79]) and at night ($M_{neighborhood\text{-}night} = 1.10 > M_{city\text{-}night} = 1.64$; t(112) = 4.991; $p < 0.001$; $d = 0.64$; 95 % CI [0.44; 0.84]).

Discussion

The objectives of our study were to examine how perceptions of walkability and (un)safety differ among users of two urban environments (RQ1) and to explore how these perceptions affect the factors influencing decisions related to active transportation (RQ2). The findings reveal significant disparities in perceived safety and walkability

between residents of lower and higher socio-economic neighborhoods. In deteriorated environments, characterized by low maintenance and greater social vulnerability, residents report higher levels of perceived unsafety, which heavily influence their reliance on safety-related factors such as crime, traffic safety, and time of day when deciding on active transportation. Conversely, residents of higher socio-economic neighborhoods, perceiving their environments as safer, assign less weight to these factors.

This contrast highlights the relevance of urban design and maintenance in shaping individuals' perceptions of safety. Supporting this, our results show that residents in deteriorated environments consistently report higher rates of perceived unsafety compared to those in better-maintained areas with better environmental characteristics. These findings align with the principles of the Crime Prevention Through Environmental Design (CPTED) approach (Cozens 2002; Cozens and Sun 2019; Hedayati Marzbali et al. 2012). In particular, the second environment was characterized by open spaces, wide sidewalks, reduced curbs on roads, and overall good maintenance. Our results are consistent with previous research that links perception of safety and the immediate surroundings, both considering design and maintenance of the physical context and social dynamics (Chataway and Hart 2019; Kronkvist and Engström 2020; Skarlatidou, et al. 2023) and more specifically with studies finding an impact of physical and social disorder on feelings of unsafety among urban residents (Hodgkinson and Lunney 2021; Lee, Boateng, Kim, and Maher 2022; Winter, Johnson, and Obara 2021).

In this regard, our results contribute to the growing body of evidence supporting the use of CPTED, and particularly third-generation CPTED (Mihinjac and Saville 2019, Saville and Mihinjac 2022), for designing more liveable urban public spaces that

promote both safety and its perception, and the need to integrate crime prevention, sustainability and public health knowledge to do so. According to our results, broad paths and spaces, easily surveyable in natural way, good maintenance and greenery, and activities that allow positive social relations should be integrated in such systematic studies and can be recommended for practical application by policymakers and designers due to their coherence with up-to-date theory and empirical findings. However, there is still a lack of systematic analysis and evidence regarding which CPTED principles and strategies have the greatest impact on promoting perceived safety (Senna, Iglesias, and Matsunaga 2025), and future systematic research agenda is needed to expand our understanding and provide practitioners with more specific recommendations for designing and adequately maintaining urban public spaces that reduce fear.

We have also found that the perception of unsafety is an important factor related to active transportation (Safizadeh et al. 2024; Shamshiripour et al. 2020; Zenk et al. 2009; Saville and Mihinjac 2022), but its relevance varies depending on the socio-physical characteristics of the place of residence. Factors directly related to safety (time of day, traffic safety, and safety from crime) are relevant in the decision-making process for active transportation (Safizadeh et al. 2024). However, it was the residents of the lower socio-economic neighborhood who gave significantly more weight to these factors compared to residents of the higher socio-economic neighborhood. This finding may be key to understanding the inconsistent results regarding the relationship between fear and active transportation (Bracy et al. 2014; Van Holle et al. 2012): it may not be a conditioning factor for mobility in all contexts, but it is in those perceived as more dangerous. These results could constitute a first step towards designing a future Decision-Making Model for Active Transportation. Understanding the different factors

considered for active transportation and the relative weight of each could be useful for promoting physical activity and healthy living, as well as advancing projects for citizen-friendly cities that ensure options for sustainable mobility without citizens feeling the need to self-impose limitations on the use of public space.

In terms of avoidance patterns of certain places as a self-protection measure, residents of the lower socio-economic neighborhood avoided more places within their own neighborhood than in the city as a whole; a pattern that could be termed "endo-avoidance." That is, perceiving their own neighborhood as an unsafe and threatening environment, they responded behaviorally by avoiding certain places within the neighborhood, significantly limiting a normalized process of public space appropriation. In contrast to their perception of their own neighborhood, these residents see the city as a safer environment and therefore reduce their levels of avoidance within it. On the other hand, residents of the higher socio-economic neighborhood avoided some places in the city as a whole, but rarely within their own neighborhood; this could be termed "exo-avoidance," as they see their neighborhood as a safe environment that does not require them to avoid places or alter their mobility routines within it. The social representations of urban space included in Valera's and Guardia's (2014) model of unsafety perception could be useful for further exploring these differential patterns and examining other intervention measures. Similarly, an approach based on the likelihood of attitudes influencing decisions when evidence is ambiguous (in our case, regarding objective safety) could also shed light on the role of attitudinal predispositions towards the neighborhood in decision-making about transportation, in line with classic experimental works (Tetlock 1985).

These elements should be integrated into the previously mentioned systematic research agenda. And new research should expect to find disparate results depending on

whether the reference space being evaluated is one's own neighbourhood, or other neighbourhoods in the city, since other studies have also detected specific patterns when considering own neighbourhoods vs. other spaces (Roman et al. 2024). To account for the effect of familiar environments while systematically considering the impact of other factors, the use of virtual reality (as done by McClanahan et al. 2024) could be extremely helpful, allowing specific elements to be added to or remove from an environment that is already known by participants.

A number of limitations must be acknowledged in this study. First, the study was conducted in a very specific and limited geographical area, with two street segments for each neighborhood. Although each street was chosen as a representative space of the neighborhood in terms of design and use, future studies should address a larger number of segments per neighborhood, as well as a larger number of neighborhoods. Second, closely related to the above, the sample of subjects involved in this study is relatively small, making it advisable to replicate the findings with representative samples of residents from the analyzed neighborhoods. Finally, despite the relative independence between fear and objective crime rates, as previously discussed, having objective data on the incidence of different types of crimes in the analyzed segments would provide a more complete picture of safety in these areas, an objective we hope to achieve in future work.

Despite these limitations, the work presented contributes to expanding the evidence regarding the impact of both urban design and safety perception on active and healthy mobility. The 21st-century city faces significant challenges in various areas. One of them is to become an inclusive environment that guarantees well-being for its citizens. From an applied perspective, the hypotheses of San Juan and Vozmediano (2009) seem to be consolidating, suggesting that the implementation of measures

favoring the appropriation of urban space will increase the sense of safety. Additionally, an aesthetically pleasing environment will promote positive coexistence, reduce incivilities, and increase the sense of safety. Indeed, more cohesive, integrated neighborhoods with better environmental conditions will help reduce fear and its collateral effects on the quality of life. Walkable design, in turn, will promote sustainable and healthy mobility, especially important in socio-economically disadvantaged areas facing greater health challenges. This work aims to provide theoretical elements and specific prospective tools that contribute to analyzing and predicting some of the factors explaining active transportation in the city and the democratization of urban public space.

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