



Urban vitality and seniors' outdoor rest time in Barcelona

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ABSTRACT

Immobility and lack of physical activity (PA) are global problems among seniors (≥ 65 years old). While being active is preferable to not doing physical activity, not leaving the house for long periods might increase mortality risk, lead to social isolation, depression, cognitive impairment, besides other health problems. However, going out of home, even to spend rest time outdoors could improve mental health, increase vitamin D intake, or provide opportunities in involvement in various experiences such as psychosocial, emotional, cultural, therapeutic, leisure or even PA since resting forms an essential part of PA for some seniors. Previous studies show that the characteristics of individuals as well as the physical environment and how seniors perceive it affect their outdoor behavior. Aiming to contribute to the literature which mostly focuses on the relationship between characteristics of the physical environment and seniors' PA, this study explores how a specific urban characteristic: urban vitality impacts seniors' outdoor rest while considering age and gender. To do so we used GPS-tracking and accelerometer data belonging to 253 seniors residing in Barcelona, in combination with a GIS-based urban vitality index and a questionnaire for sociodemographic data and neighborhood perceptions. Results show that seniors in Barcelona tend to rest rather than being active in more vital areas. However, results differ among age and gender groups that the probability of using vital areas for outdoor rest was especially higher among older senior men (≥ 75 years old). This study furthers our understanding of seniors' outdoor behavior, its relationship with the built environment and how this relationship varies among individual characteristics. Results might provide valuable insights for the design of vital urban spaces that can have positive contributions to seniors' lives while strengthening the community life by promoting social inclusion of all age and gender groups in urban life.

1. Introduction

Immobility and lack of physical activity (PA) are common issues for seniors (≥ 65 years old) around the globe (Azagba and Sharaf, 2014; Cunningham et al., 2020; Gomes et al., 2016; Schwanen and Páez, 2010). Older age, besides a series of causes, is often found to form a barrier to leave the home and this results in long hours spent indoors, often in front of screens, isolated (Jacobs et al., 2018; Rundek and Bennet, 2006). While the lack of PA is behind several noncommunicable diseases and a stark decrease in basic functions of everyday life (Knight, 2012), not leaving the home for extended periods of time might increase mortality risk (Jacobs et al., 2018), lead to social isolation, depression, cognitive impairment, besides other health problems (Petersen et al., 2015). Although being active is preferable to not doing

physical activity, going out of home even if it is to rest, provides numerous opportunities to individuals such as being involved in social life (Antoninetti and Garrett, 2012; Cao et al., 2019), improving mental health (Kerr et al., 2012a), increasing vitamin D intake (Bouillon, 2017), and facilitating engagement in experiences including “psychosocial, emotional, cognitive, cultural, leisure, therapeutic, recreational, volunteer” and even PA (Jacobs et al., 2018: p.106), since outdoor rest forms an essential part of PA for some seniors (Stahl et al., 2008). However, since most of the research to date has focused on PA, still not much is known about the drivers of outdoor rest among seniors.

According to socioecological model, characteristics of individuals and physical environment are among the factors that affect individuals' behavior (Bronfenbrenner, 1977). Gender and age are two individual characteristics that mostly show different associations with seniors' out-

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door behavior (Notthoff et al., 2017). Physical environment and how it is perceived also influence seniors' outdoor behavior (Akinci et al., 2021; Barnett et al., 2015; Joseph et al., 2006; Moniruzzaman et al., 2013). Certain characteristics of urban environments, such as vitality, is found to have positive associations with seniors' outdoor activity involvement (Author et al., 2015a). As Jacobs (1961) stated, no one enjoys watching an empty street but rather, "*people entertain themselves (...) by watching street activity* (p.35), *watching the traffic, watching the people on the busy sidewalks, watching each other*" (p.37) or, by watching urban vitality as its finest. In this regard, characteristics of urban built environments, especially the areas used for rest time, whether to sit and watch others pass by, or to have a break while doing PA, become even more important for seniors, as they have the capacity of promoting and extending outdoor active or rest time. Based on these perspectives, this study aims to examine whether urban vitality is associated with outdoor rest among seniors, while considering individual characteristics.

2. Background

Urban vitality (Jacobs, 1961) or liveliness (Mehta, 2009), is a complex concept that has been defined in various ways in previous studies; "*the synergism of a sizeable number of varied and somewhat unique, commercial and experiential opportunities, and a relatively dense and socially heterogeneous pedestrian population, which animates certain city areas, almost continuously*" (Maas, 1984, p. 19), "*the extent to which a place feels alive or lively*" (Montgomery, 1998, p. 97), "*the capacity of an urban built environment to boost lively social activities*" (Yue et al., 2019, p. 11: 638) or "*24h a day street life*" (Sung et al., 2013, p. 165). These definitions were used in studies to spatially understand, assess, or optimize the functioning of complex urban systems. Among the multiple ways that vitality has been defined, one of the most insightful ones was that of Jane Jacobs (1961). According to her, the vitality of a place depends on various conditions including but not limited to, *a diverse land-use pattern; contact opportunity* granted by human-scaled blocks and sufficient street intersections that reduce walking distances and decrease traffic speed; *need for aged buildings* that enables diverse population groups to be present; *concentration* of people from all over the city; *accessibility* that enables places to be used actively 24 h, and properly controlled *border vacuums*, defined as infrastructures with a large footprint which reduce walking activity by preventing connections between places (Delclòs-Alió and Miralles-Guasch, 2018; Jacobs, 1961; Sung et al., 2013).

Numerous studies have focused on the relationship between built environment and seniors' outdoor behavior. Different types of urban spaces and micro-elements are found to increase seniors' PA at different scales, such as greenspaces (Author et al., 2019a; Carlson et al., 2012), or benches (Akinci et al., 2021; Ottoni et al., 2016) as some seniors find it difficult to walk more than 200 m without resting (Stahl et al., 2008). Only a few studies have explored seniors' PA in relation to vitality (Author et al., 2015a). In many studies, these relationships presented significant differences in terms of individual characteristics. Gender, for instance, was found to have significant associations with seniors' outdoor behavior in relation to built environment, as women being less involved in most outdoor activities (Notthoff et al., 2017; Rapp et al., 2018) and their activities are found less related with the characteristics of the built environment than their counterparts (Author et al., 2015a; Akinci et al., 2021; Ottoni et al., 2016). Seniors' age also presented differences in their outdoor behavior, since their physical possibilities or moving capacity (European Union, 2019; Kerr et al., 2012b) as well as the loneliness levels (Luhmann and Hawkey, 2016) change considerably among younger (< 75 years old) and older seniors (≥75 years old). These in turn could result in a higher need of social interaction or imply different relationships with the built environment.

Besides notable exceptions (Barnett et al., 2015; Cerin et al., 2016), most studies so far have explored built environment in relation to se-

niors' PA. While there are recent studies focusing on total outdoor time, some explored it regardless of PA levels in relation to seniors' driving status (Spinney et al., 2020), or some explored outdoor rest time (ORT) in relation to built environment characteristics but in middle-aged adults (Koohsari et al., 2020), and did not include urban vitality. There are few studies focused on seniors' outdoor rest but only explored space optimization or design (F. Peng, 2019; Z. Peng et al., 2020; Qingfen, 2018) and none of them focused on the vitality of the environment. Thus, to the best of our knowledge, this is the first study on the relationship between vital places and seniors' outdoor rest.

3. Method

3.1. Setting

This study was set in Barcelona Metropolitan Region, with a population of 1,620,343 (2018). More than one fifth of its population consists of seniors (Barcelona Estadística, 2018). Barcelona is located in the North-East coast of the Iberian Peninsula, and it is influenced by hot-summer Mediterranean climate, which mostly has mild temperatures during the year (maximum 35 °C and minimum -5 °C). The annual precipitation in the area is average and mainly takes place during fall and spring (European Environment Agency, 2012) which configures a friendly environment for outdoor activities with no frequent extreme climate events.

Barcelona is usually defined as a compact, walkable, and vital city (Delclòs-Alió et al., 2020; Author et al., 2015b; Delclòs-Alió and Miralles-Guasch, 2018). Despite having a low ratio of greenspace per inhabitant compared to other European cities (18m² including peri-urban forest of Collserola), small parks, streets, boulevards, and plazas with trees often compensate the need of spaces for outdoor activities (Author et al., 2019b; Baró et al., 2014). Not only Barcelona has a dense and homogeneous distribution of street trees (98.4/1000 inhabitants), but also of resting places such as public benches (16.9/1000 inhabitants). Thus, both in terms of climate conditions and the provision of urban spaces and micro-elements, Barcelona is a city where people can enjoy outdoor activities throughout the year.

3.2. Sample

Participants were recruited within the RecerCaixa Project ("*Ciudad, calidad de vida y movilidad activa en la tercera edad. Un análisis metodológico a través de Tracking Living Labs*") during June.2016 and June.2017. They were contacted through 39 senior day-centers located across the metropolitan area, which was then followed by snowball (chain-referral) sampling technique with voluntary seniors from participants' social circles. Participants were required to be 65 years old or above and not to have specific mobility impairments. After being informed written and orally about the study, and provided with research protocol and instructions, 269 participants provided informed consent. Confidentiality was ensured by using random identification numbers.

Considering that seniors' outdoor behavior in relation to the built environment present differences according to their individual characteristics, we classified our sample by age [younger (< 75 years old), and older (≥75 years old) seniors] and gender.

This study was approved by the Ethics Committee on Animal and Human Experimentation at Universitat Autònoma de Barcelona (UAB; CEEAH-3656).

3.3. Data collection

Participants were asked to wear a GPS device (QStarz BT-Q1000X; QStarz International Co., Ltd., Taiwan, R.O.C.) and a wrist-worn accelerometer (Actigraph GT3X+; ActiGraph LLC, Pensacola, Florida USA) to collect data regarding their outdoor behavior for seven days.

Data extracted from both devices were aggregated into 15 s intervals using the Physical Activity Location Measurement System (PALMS) v.R4 (Jankowska et al., 2015). Additionally, participants were asked to fill in a questionnaire with data regarding their age, gender, self-reported health, and the characteristics of their residential neighborhood. As such, they could state their perception on the presence and quality of sidewalks, benches, trees, along with their assessments on cleanliness, noise, and traffic conditions in their neighborhoods (See Appendix A Supplementary material for survey questions about neighborhood perception).

3.4. Measurements and key definitions

In order to characterize urban vitality, we used the previously validated “JANE vitality index” (Delclòs-Alió and Miralles-Guasch, 2018). The JANE index considers vitality as the combination of six urban conditions mentioned by Jane Jacobs (1961): diversity, contact opportunity, need for aged buildings, concentration, accessibility, and distance from border vacuums (Delclòs-Alió and Miralles-Guasch, 2018). When calculating JANE index, building-use mix and residential-nonresidential ratio was considered for the diversity condition. Contact opportunity included block size and street width. Need for aged buildings consisted of mean year of construction and its standard deviation. Concentration consisted of population density, housing density, and building density. Accessibility was calculated as the distance to the closest public transport stop. Finally, distance from border vacuums considered the distance from large infrastructures and large single-use buildings. The index was calculated for 100×100 m cells across the city, and we used z-scores of each value to obtain comparable indicators. We considered that some variables such as housing density or land-use mix could have positive effects, while some others such as large blocks or proximity to border vacuums, could negatively affect urban vitality. The scores either with negative or positive values derived from six urban variables were integrated into the final JANE index (See Delclòs-Alió and Miralles-Guasch, 2018 for more information about the calculation).

We defined total outdoor time (TOT) as the time spent in any activity that takes place outdoors (excluding in-vehicle ones), regardless of PA levels. However, ORT only includes the time spent resting outdoors, with no PA involvement. Thus, TOT includes both ORT and time spent in outdoor activities with PA engagement.

We calculated participants' exposure to urban vitality based on (1) their daily trips using their GPS-tracks and (2) their residential neighborhood. Calculating the vitality that participants encountered in their daily trips provides a better account of their exposure to urban vitality than just using a fixed residential-based buffer. Furthermore, combining a track-based exposure with a residential-based one can help overcome the neighborhood averaging effect as described by Kim and Kwan (2021). Thus, *track-based vitality* was calculated by juxtaposing participants' outdoor GPS points to the vitality index calculated at 100×100 m cells. Each outdoor point was assigned the vitality value from the corresponding cell. *Residence-based vitality* expresses the average vitality values around the residence and was calculated by averaging the vitality index of cells intersecting a 650 m network-buffer around participants' home addresses. We settled on a 650 m network-buffer (approximately 10–15 min walk for seniors) based on previous research (Marquet and Miralles-Guasch, 2014; Prins et al., 2014). In addition, we also calculated neighborhood walkability for the 650 m residential network-buffer, as follows (Frank et al., 2010):

$$\begin{aligned} \text{Neighborhood walkability} &= [(2 \times z - \text{intersection density}) \\ &+ (z - \text{net residential density}) \\ &+ (z - \text{retail floor area ratio}) \\ &+ (z - \text{land - use mix})] \end{aligned}$$

All calculations were conducted with ArcGIS 10.5 (ESRI, Redlands, CA).

3.5. Data management

Participants provided a total of 2368 days of data and over 12 million GPS and accelerometer datapoints. Considering that the focus of the study was on outdoor rest, we eliminated in-vehicle and indoor datapoints based on Signal to Noise Ratio provided by the GPS receiver, while keeping only outdoor pedestrian datapoints belonging to valid days of participation ($n = 1,309,888$ datapoints, corresponding to 942 valid user-days, recorded by 253 participants). Valid days included at least four wearing days and ten hours of device wear-time. Then we coded datapoints as Active = 0 and Resting = 1, and created a database with all the available data based on user-days.

3.6. Statistical analysis

First, we used descriptive statistics and bivariate analysis at user-day level to explore the association between average outdoor time (minutes) -total outdoor time (TOT) and outdoor rest time (ORT)- and vitality levels, individual and neighborhood characteristics, and neighborhood perceptions. For a better interpretation of the results and comparison between groups, we categorized both vitality variables in tertiles for descriptive analysis. One-way ANOVA tests were used to flag significant associations.

Second, we used a mixed effects logistic regression model with user ID as a random effect to fully examine the relationship between vitality and probability of resting rather than being active when spending time outdoors. We have tested the multicollinearity of explanatory variables before the model specifications. The model was adjusted by age, gender, perceived health, and self-reported neighborhood perceptions. In order to account for the residential effect fallacy (Chaix et al., 2017), we also included the residence-based vitality and walkability in the models. We included two vitality variables as continuous variables in the model. Finally, considering the individual differences in seniors' outdoor behavior, we created three interaction terms between age and track-based vitality, age and gender, and age, gender and track-based vitality. By using these, we calculated the adjusted predictive probabilities of outdoor rest at each representative value of age, gender and track-based vitality, using the Stata 15 (StataCorp LLC, Texas, USA) margins command. These actions allowed us to estimate the odds of finding a resting datapoint at different levels of vitality and stratifying by age and gender, while controlling for the rest of the covariates.

4. Results

4.1. Descriptive results

Descriptive statistics of the study sample, perception of neighborhood characteristics, total outdoor time (TOT) and outdoor rest time (ORT) are presented in Table 1. Participants presented an average of 279.9 min of TOT out of which 201 min were ORT. Overall, they spent 72% of their daily outdoor time resting. We observed statistically significant differences in all variables (p -value < 0.05). Average TOT and ORT among younger seniors (< 75) (287.4 min and 203.7 min, respectively) and women (292.6 min and 219.2 min, respectively) were higher than their counterparts. In terms of the ratio of ORT/TOT, older

Table 1

Descriptive statistics of the study sample, neighborhood characteristics, neighborhood perceptions, vitality and outdoor time.

Variables		# of userdays with ORT	Average ORT (minutes)	# of userdays with TOT	Average TOT (minutes)	ORT/TOT ratio (%)	p value
Total		942	201.0	949	279.9	72%	
Age							
	<75	454	203.7	460	287.4	71%	0,000 **
	≥75	488	198.5	489	272.7	73%	0,001 **
Gender							
	Men	427	179.1	430	264.4	68%	0,000 **
	Women	515	219.2	519	292.6	75%	0,001 **
Health							
	Bad	27	164.6	27	205.7	80%	0,000 **
	Regular	233	209.1	235	278.0	75%	0,001 **
	Good	682	199.7	687	283.4	70%	0,005 **
Track-based Vitality							
	Low	259	237.1	260	332.2	71%	0,001 **
	Moderate	248	172.2	250	241.0	71%	0,000 **
	High	246	178.5	249	245.3	73%	0,002 **
Residence-based Vitality							
	Low	257	257.5	257	337.3	76%	0,001 **
	Moderate	254	184.1	255	268.9	68%	0,001 **
	High	242	145.1	247	212.3	68%	0,000 **
Neighborhood Walkability							
	Low	326	269.4	326	349.8	77%	0,001 **
	Moderate	316	153.9	322	226.5	68%	0,001 **
	High	300	176.3	301	261.2	67%	0,001 **
Neighborhood Perceptions							
Presence of enough sidewalks	Yes (Y)	839	189.8	846	268.2	71%	0,000 **
	No (N)	103	292.1	103	375.2	78%	0,001 **
Sidewalks with good conditions	(Y)	615	183.7	622	259.6	71%	0,000 **
	(N)	292	240.8	292	327.4	74%	0,001 **
Presence of elements on sidewalks which prevent walking	(Y)	387	225.9	389	308.8	73%	0,001 **
	(N)	538	183.8	543	257.3	71%	0,000 **
Presence of enough benches	(Y)	590	189.7	596	269.4	70%	0,000 **
	(N)	336	223.9	337	299.0	75%	0,001 **
Presence of steep streets which make walking difficult	(Y)	210	215.4	210	284.6	76%	0,001 **
	(N)	691	186.9	698	268.4	70%	0,000 **
Presence of different paths reaching the same destination	(Y)	672	183.1	679	256.3	71%	0,000 **
	(N)	235	227.8	235	316.2	72%	0,001 **
Presence of enough trees	(Y)	747	188.5	752	266.7	71%	0,000 **
	(N)	188	253.8	190	337.3	75%	0,001 **
Presence of good conditioned buildings	(Y)	857	205.1	864	283.6	72%	0,000 **
	(N)	54	197.4	54	300.4	66%	0,003 **
Clean neighborhood	(Y)	620	198.0	622	268.3	74%	0,000 **
	(N)	299	215.3	304	311.8	69%	0,001 **
Noisy neighborhood	(Y)	336	172.2	342	248.4	69%	0,001 **
	(N)	565	225.0	566	304.9	74%	0,000 **
Presence of traffic on streets	(Y)	687	178.5	694	252.2	71%	0,000 **
	(N)	255	261.8	255	355.0	74%	0,001 **

** Significant p value < 0,01.

seniors (≥75) (73%) and women (75%) devoted a larger share of their outdoor time resting than their counterparts ($p < 0.01$). Participants who reported bad health status showed a larger share of ORT (80%), although they had the lowest TOT (205.7 min) and ORT (164.6 min). Regarding track-based and residence-based vitality, TOT and ORT was higher in low vital areas and neighborhoods, however, the ratio of ORT/TOT was higher in high vitality areas.

Participants' outdoor behavior also differed based on how they perceived their neighborhoods. ORT was higher among those who considered their neighborhoods to lack sufficient and well-preserved sidewalks, not having enough trees and benches, that there were barriers on the sidewalks which prevent walking, and that streets were steep around their residences. ORT was also higher among those who considered their neighborhoods to be quiet, that they lack different paths to reach the same destination and that there was no traffic on the streets.

4.2. Regressions and adjusted predictive probabilities

In logistic regression we observed statistically significant associations with the probability of resting rather than being active when outdoors, and most of the independent variables (Table 2). Compared with younger participants, older participants ($b = 0.453$; $p < 0.01$) were more likely to rest rather than being active while they were outdoors. Similarly, men were more likely to spend their outdoor time resting rather than being active compared with women ($b = -0.292$; $p < 0.01$). Perceived regular health was related with higher possibility of resting rather than being active when outdoors ($b = 0.365$; $p < 0.01$). When moving through the city, participants were more likely to rest rather than being active in those areas that scored higher in the vitality index ($b = 0.135$; $p < 0.01$). In contrast, residence-based vitality and walkability did not show statistically significant rela-

Table 2

Mixed effect logistic regression relating vitality, individual and neighborhood characteristics and neighborhood perceptions, and probability of resting vs. being active when outdoors.

Fixed effects	B	p	CI (95%)	
Age				
<75.	= ref			
≥75	0,453	0.000 **	0,250	0,655
Gender				
Men	= ref			
Women	-0,292	0.003 **	-0,482	-0,103
Perceived Health				
Good	= ref			
Regular	0,365	0.000 **	0,194	0,535
Bad	0,350	0.162	-0,140	0,840
Track-based vitality	0,135	0.000 **	0,109	0,161
Residence-based vitality	-0,312	0.066	-0,645	0,020
Neighborhood Walkability	-0,028	0.150	-0,067	0,010
Neighborhood Perceptions				
Presence of enough sidewalks	0,324	0.012 *	0,073	0,575
Sidewalks with good conditions	0,201	0.025 *	0,025	0,377
Presence of elements on sidewalks which prevent walking	-0,211	0.010 *	-0,371	-0,051
Presence of enough benches	-0,013	0.874	-0,173	0,147
Presence of steep streets which make walking difficult	-0,142	0.145	-0,334	0,049
Presence of different paths reaching the same destination	-0,185	0.031 *	-0,353	-0,017
Presence of enough trees	0,006	0.946	-0,180	0,192
Presence of good conditioned buildings	-0,146	0.473	-0,543	0,252
Clean neighborhood	-0,673	0.000 **	-0,832	-0,513
Noisy neighborhood	0,218	0.004 **	0,068	0,369
Presence of traffic on streets	0,089	0.328	-0,089	0,266
Age (≥ 75) x Track-based vitality	-0,086	0.000 **	-0,128	-0,045
Age (≥ 75) x Gender (Men)	0,188	0.198	-0,098	0,474
Age (≥ 75) x Gender (Men) x Track-based vitality	0,431	0.000 **	0,371	0,491

Outdoor points are labelled as Active = 0 Resting = 1.

B: Coefficient estimate, p: p-value, CI: Confidence Interval.

* Significant p-value < 0.05.

** Significant p-value < 0.01

relationship with the probability of resting rather than being active when outdoors ($p = 0.066$ and 0.150 respectively).

Regarding neighborhood characteristics, participants' probability of resting rather than being active when outdoors was higher when they perceived having enough ($b = 0.324$; $p < 0.05$) and well-conditioned sidewalks ($b = 0.201$; $p < 0.05$) and presence of noise in their neighborhoods ($b = 0.218$; $p < 0.01$). While perceived presence of elements which prevent walking on the sidewalks ($b = -0.211$; $p < 0.05$), presence of different ways to reach the same destination in the neighborhood ($b = -0.185$; $p < 0.05$) or perceiving the neighborhood to be clean ($b = -0.673$; $p < 0.01$) were related with lower probabilities of resting rather than being active when outdoors.

Next, we used post-estimated adjusted predictive probabilities to observe the effect of the interactions between gender and age at predicting the possibility of resting rather than being active when outdoors (Fig. 1). The difference between age groups' tendencies to rest rather than being active when outdoors and its relations with vital environments was even more visible. In general, for all participants, being exposed to more vital environments entailed a higher probability of resting rather than being active when outdoors. This trend, however, was not homogenic across age and gender groups. When the environment was more vital, older men's probability of resting rather than being active while they were outdoors was much higher than their younger and women counterparts. This was especially acute when compared to older women. Among younger seniors alone, the vitality of the environment had a slightly stronger effect on women's tendency to rest rather than being active when outdoors.

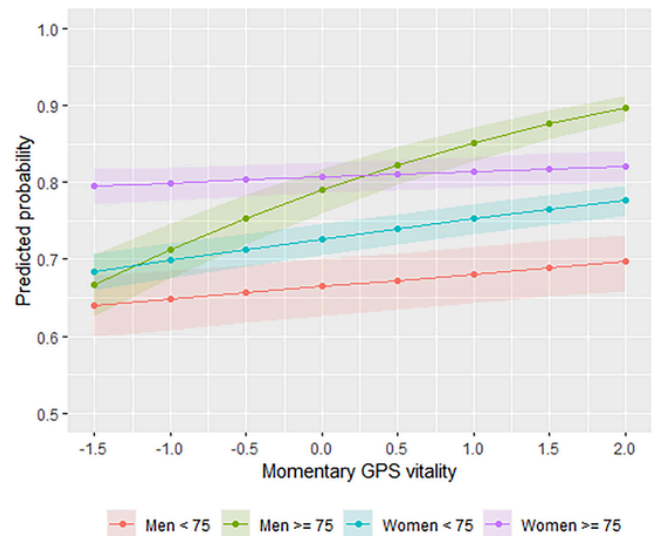


Fig. 1. Predictive probabilities of the interactions between vitality, gender and age at predicting outdoor rest.

5. Discussion and conclusion

In this paper we explored the relationship between seniors' outdoor rest and vitality of urban places using tracking data. Urban vitality was measured with the previously validated JANE vitality index. Outdoor rest data was collected by accelerometers and GPS devices, and sociodemographic data and neighborhood perceptions were obtained from a questionnaire. Results validated the hypothesis that seniors in Barcelona had a higher tendency to rest rather than being active in vital areas when they were outdoors. There are two plausible explanations for this result, although the motives of seniors' outdoor resting behavior are unknown. On the one hand, urban vitality itself could have attracted seniors, as Jacobs (1961) and Mehta (2009) suggest, and they might have chosen specifically these high vital areas to rest in order to watch more people and things happening around them. Since more people on the streets could mean more opportunities for social contact, this could also be correlated with the increased loneliness levels among seniors, especially after the age of 75 (Luhmann and Hawkey, 2016). On the other hand, our sample of seniors might have wanted to walk when they were outdoors, but due to the presence of many people or things happening around (urban vitality), they perhaps felt "unsafe" and needed to sit down somewhere to rest. Considering the increased levels of fear-of-fall among this age group especially after the age of 75 (Todd and Skelton, 2004), vitality or the presence of many other pedestrians around, might have negatively impacted seniors' walking and compelled them to take a necessary rest somewhere.

These two ideas could also be used to explain the differences in our results among two age groups, that older seniors' probability of resting rather than being active when outdoors was much higher compared to their younger counterparts. Additionally, compared to the rest of the participants, the probability of resting rather than being active when outdoors had a much stronger association with vitality for older men. From a gender and age perspective this could be related to the fact that even in older ages, due to traditional work division, women are mostly in charge of house-errands or taking care of their spouses and/or grandchildren (Author et al., 2019c; Azevedo et al., 2007; Rapp et al., 2018; Tarrant, 2010). As previous studies also found, characteristics and conditions of the built environment is more determinant in men's outdoor behavior (Author et al., 2015a) -except non-leisure trips which are mostly taken by women even in older ages (Boschmann and Brady, 2013; Mercado and Páez, 2009; Notthoff et al., 2017). Thus, senior women in our sample perhaps continued conducting these outdoor house-errands or caring tasks and rested wherever possible, regardless

of the characteristics of the environment. Our results are in line with previous literature regarding the existence of a gender gap and the resulting gendered influence of the built environment in outdoor behaviors. For the first time, we were also able to show that the vitality of urban spaces also has a gender and age effect on outdoor rest.

Regarding neighborhood characteristics, perceiving sufficient and well-conditioned sidewalks, lack of obstacles when walking, and lack of different paths to reach the same destination were associated with higher probability of resting rather than being active when outdoors. Previous studies demonstrated that better sidewalk conditions would result in a higher volume of pedestrians (Rosso et al., 2021). However, this relationship was less significant for people between 65 and 75 years old, and it was no longer significant for people over 75 years old (Shigematsu et al., 2009). Thus, a plausible explanation could be that due to the presence of enough and good-conditioned sidewalks, or the lack of obstacles on the sidewalks in the analyzed neighborhoods, streets were used by many people (perhaps relatively younger people) and seniors either specifically preferred these vital areas to rest to be able to watch more people, or they took a *necessary rest* due to the “overcrowded” environment. Additionally, presence of more people might also bring along some “noise” to the neighborhood, which explains another result in our study that perceived noisy neighborhoods were related with higher possibility of resting rather than being active when outdoors. However, contrary to Jacobs (1961), traffic was not significantly associated with the probability of resting rather than being active when outdoors among this group of seniors. This could be due to the differences between the traffic volume in different neighborhoods of Barcelona, or how participants perceive it. Watching a large avenue with lots of cars passing at a time may not be as pleasant as watching the traffic on a one-way street. The perception of cleanliness at the neighborhood level was found associated with a lower possibility of resting rather than being active when outdoors, contrary to our expectations and also contrary to results from previous studies (Day, 2008) showing that clean environments are perceived as “safer” and thus, preferred more for outdoor activities. Finally, and again unexpectedly, the results did not show a significant association with the perception of enough benches in seniors' neighborhoods and the probability of resting rather than being active when outdoors. This could be explained by the gender gap or the domination of men in the use of urban micro-elements, as mentioned in a previous study in Barcelona that women do not prefer sitting on a bench if it is already occupied by a man (Ortiz et al., 2016). This gender gap was also demonstrated in a previous quantitative study which found positive relationship between the presence of benches in the neighborhood with only senior men's total outdoor time (Akinci et al., 2021).

To the best of our knowledge this is the first study to examine the relationship between seniors' outdoor rest and vitality of urban spaces. However, our study is not exempt from limitations. Neighborhood buffer selection might have caused bias in results and their interpretation, since not all seniors' outdoor spatial behavior and range are the same. Our results could be biased by different types of self-selection issues (Koohsari et al., 2015; O'Brien Cousins, 1997). First, the sample consists of people who are willing to take part in this study, so, they might have better health conditions and be more active than the “average” seniors in Barcelona. Second, related with residential self-selection issue, perhaps seniors in our sample who showed a higher probability to rest in vital areas may have chosen to live in vital neighborhoods and thus recorded more outdoor rest points coinciding with vital areas in their neighborhoods. Besides, the limitations of wrist-worn accelerometers could also be misleading due to their lower sensitivity in sedentary behavior compared to the hip-worn ones, although they are still considered trustworthy (>93–97%) in sedentary behavior studies (Montoye et al., 2016). While GPS provides high resolution spatiotemporal data, these devices also present technical limitations in terms of location accuracy as well as indoor-outdoor distinction (Duncan et al., 2013).

However, GPS devices have been found to be more accurate when combined with accelerometer data (Jankowska et al., 2015). Finally, in our study we focused on the probability of resting when being outdoors, regardless of the activity purpose. Future studies that combine device data with qualitative information could explore motivations and types of outdoor rest activities, and their relationship with urban vitality.

This study aimed to contribute to the literature by providing in depth information on seniors' outdoor rest and its relationship with vitality of urban spaces. With no doubt seniors should aim to have an active lifestyle and meet daily recommended PA levels for a healthier later life. However, it should also be considered that seniors' involvement in PA is significantly related with the possibility to rest (Akinci et al., 2021; Stahl et al., 2008). Thus, planning or designing outdoor rest areas may be of high importance for this demographic group. Our study showed that seniors in Barcelona tended to rest rather than being active when outdoors in high vital places. Urban designers and/or planners should consider placing public seats in these vital areas, which should be sufficient in number and appropriate in design for the usage of seniors whenever they want to have a rest, whether it be a *necessary* or a *leisure rest*.

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Declaration of interest

No declaration of interest was reported by the authors.

Uncited reference

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jtrangeo.2021.103241>.

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