Are vital neighbourhoods socially privileged? Exploring the spatial relationship between urban vitality and urban vulnerability

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ABSTRACT

The built environment plays a key role in everyday wellbeing, as well-designed and accessible environments help fulfil people's daily needs and activities. Of special relevance is the urban vitality concept of Jane Jacobs, a core principle of local planning strategies worldwide, which is used as an indicator of street vibrancy and quality of life among city residents. However, the promotion of her ideas on dense, lively, and diverse neighbourhoods coexists with increasing urban inequalities. The present study aims to examine if, and how, vital places are related with different levels of social vulnerability. To do so, we use Exploratory Spatial Data Analysis (ESDA) of synthetic indicators of both vitality and vulnerability. Our results provide evidence of local associations between urban vitality and urban vulnerability, and identify four main scenarios that can be helpful for policy intervention. The findings of this study have the potential to guide

urban planning strategies to promote vital environments while preventing situations of social vulnerability.

Keywords:

Jane Jacobs, Built environment, Intra-urban inequalities, Spatial clustering, Barcelona.

1. Introduction

After decades of urban planning practices based on land use segregation, suburbanisation, and large-scale projects that implied a car-dependent mobility, we are experiencing a paradigm shift, within which proximity is undergoing a revival (Pozoukidou & Chatziyiannaki, 2021). In recent years, urban policies are promoting proximity dynamics by investing in accessibility and pedestrian-oriented developments, as they contribute to resolving some of our current urban challenges in environmental, social, and health terms (Solá & Vilhelmson, 2018). One of the main inspirations for the promotion of proximity environments would be the theoretical contributions of the American-Canadian urban theorist, Jane Jacobs (1916-2006), which focused on the street level and human activity, using a micro-scale perspective, which she termed as urban vitality.

Urban vitality describes a quality of urban environments that are full of street buoyancy, which are able to gather diverse types of people and activities at different times of the day. In her most celebrated book, *The Death and Life of Great American Cities* (1961), Jacobs theorised about the built environment characteristics that contributed to street *life*, and also those which discouraged human activity. Jacobs defined four main basic conditions for vitality: concentration, diversity, contact opportunity, and the need for buildings with different characteristics. *Concentration* is a prerequisite condition, as a certain level of densities - of population and activities - is needed to guarantee urban vitality. *Diversity* refers to having mixed-use spaces that can host diverse activities throughout the day, thus attracting people with

different needs and purposes. A human-scale urban design that promotes *contact opportunity* is another condition, as it boosts social interaction and the existence of the so-called "eyes on the street", an informal surveillance created by human co-presence that contributes to neighbourhood safety. Jacobs argued that vital neighbourhoods also need a certain level of social mixture, which was achieved by the presence of *buildings of different ages* that would offer diverse rent ranges, thus attracting people with different socioeconomic backgrounds. Added to these four conditions, Jacobs also mentioned two additional elements that are related to urban vitality: the *accessibility* of urban spaces, which should be walkable environments with a high coverage of public transit; and the presence of *border vacuums*, those elements and urban spaces that discourage human activity, such as large infrastructures.

In recent years, there has been a growing interest in understanding these theoretical conditions for urban vitality with an applied perspective (Shi et al., 2019). Using the frameworks of diverse disciplines and contexts, most previous works have characterised the built environment of today's cities according to the original principles of urban vitality of Jacobs (De Nadai et al., 2016; Delclòs-Alió & Miralles-Guasch, 2018; Kang et al., 2020; Lunecke & Mora, 2018; Sung et al., 2013). More recently, new contributions have aimed to revisit Jacobs theories, by taking into account current urban contexts, and then adapting her ideas of what contributes to vibrant city life today (Eom et al., 2022; Gómez-Varo et al., 2022a; Jiang et al., 2022; Yue et al., 2021; Ziya Paköz et al., 2022).

Urban vitality is widely considered as an indicator of good urbanism, as it has the potential to improve the quality of life (Braun & Malizia, 2015). This can be particularly relevant for urban policies aimed at vulnerable population groups, which can counteract their disadvantaged situations by benefitting from the Jacobs idea of dense, lively, diverse, and accessible neighbourhoods. However, some authors have pointed out that, in current urban areas, vital neighbourhoods can be privileging accommodated social groups, while pushing the

socioeconomic disadvantaged population aside (Connolly, 2018; Steil & Humm Delgado, 2019; Stein, 2019). This would implicate that planning for vitality could, paradoxically, encourage dynamics of exclusion, such as neighbourhood gentrification, for example. Therefore, knowing who is truly taking advantage of vital spaces, is of fundamental relevance for the deployment of urban policies with a social equity approach. In this sense, several studies have identified the existence of intra-urban inequalities in the distribution of these urban features, affecting deprived communities differently (Bartzokas-Tsiompras et al., 2020; Lowe et al., 2020). To date, however, the discussion on how urban conditions for urban vitality are related with urban social inequalities is relatively new (Gunn et al., 2022). Most of the studies on urban vitality have been based on a quantification of urban vitality, using measures of the built environment, whereas, studies of its relationship with urban social dynamics are scarce, with some recent exceptions (Anderson et al., 2017; Lan et al., 2020; Ma et al., 2022; Mouratidis & Poortinga, 2020). Thus, the main aim of this study is to address a key question: Does urban vitality spatially overlap with different levels of vulnerability?

One of the ways in which urban socioeconomic inequalities are expressed is through urban vulnerability (Antón-Alonso & Porcel, 2021), a concept that is gaining relevance within the research field of social disparities, poverty, and exclusion, particularly after the financial crisis of 2008 (Prada-Trigo, 2018) and the COVID-19 pandemic (Minguijon et al., 2022). Vulnerability, in a broad sense, refers to the inherent condition of the individual and collective existence, and highlights the exposition to the possibility of being damaged, together with a low capacity of defending against damaging impacts (United Nations, 2003, 2022). Under a social interpretation of vulnerability, Robert Castel's theories come to the forefront (1991, 1995). Castel argued that individuals can find themselves immersed in a dual process of disengagement, influenced by the relationship with paid work (i.e. having a stable job, a precarious job, or being unemployed), and social connections, which in turn can imply different levels of inclusion and can ultimately lead to social isolation. Within these two realms, individuals can find themselves at the extremes of

social integration, involving stable employment and strong inclusion, or social exclusion, characterized by an absence of a job and social isolation . Alternatively, individuals may occupy an intermediate position, that of social vulnerability, involving precarious employment and fragile inclusion. This intermediate stage, according to Castel, means that social vulnerability is an anteroom to social exclusion, therefore being relevant for policymaking as it implies the existence of potential opportunities for prevention (Castel, 1995).In addition, vulnerability can refer, not only to the social environment of individuals, but also to their physical environment, meaning that living spaces can have certain conditions of risk and disadvantage that could enable or strengthen unfavourable situations (Alguacil Gómez et al., 2014). One of the strategies to reduce social vulnerability is by means of well-equipped urban environments, that allow people to satisfy everyday needs and build community ties (Klinenberg, 2018). The built environment can shape people's access to daily activities, thus, determining the ability of certain social groups to participate fully in the society, and affecting both the quality of life of individuals and the equity and cohesion of the society (Tiznado-Aitken et al., 2018; Tsou et al., 2005).

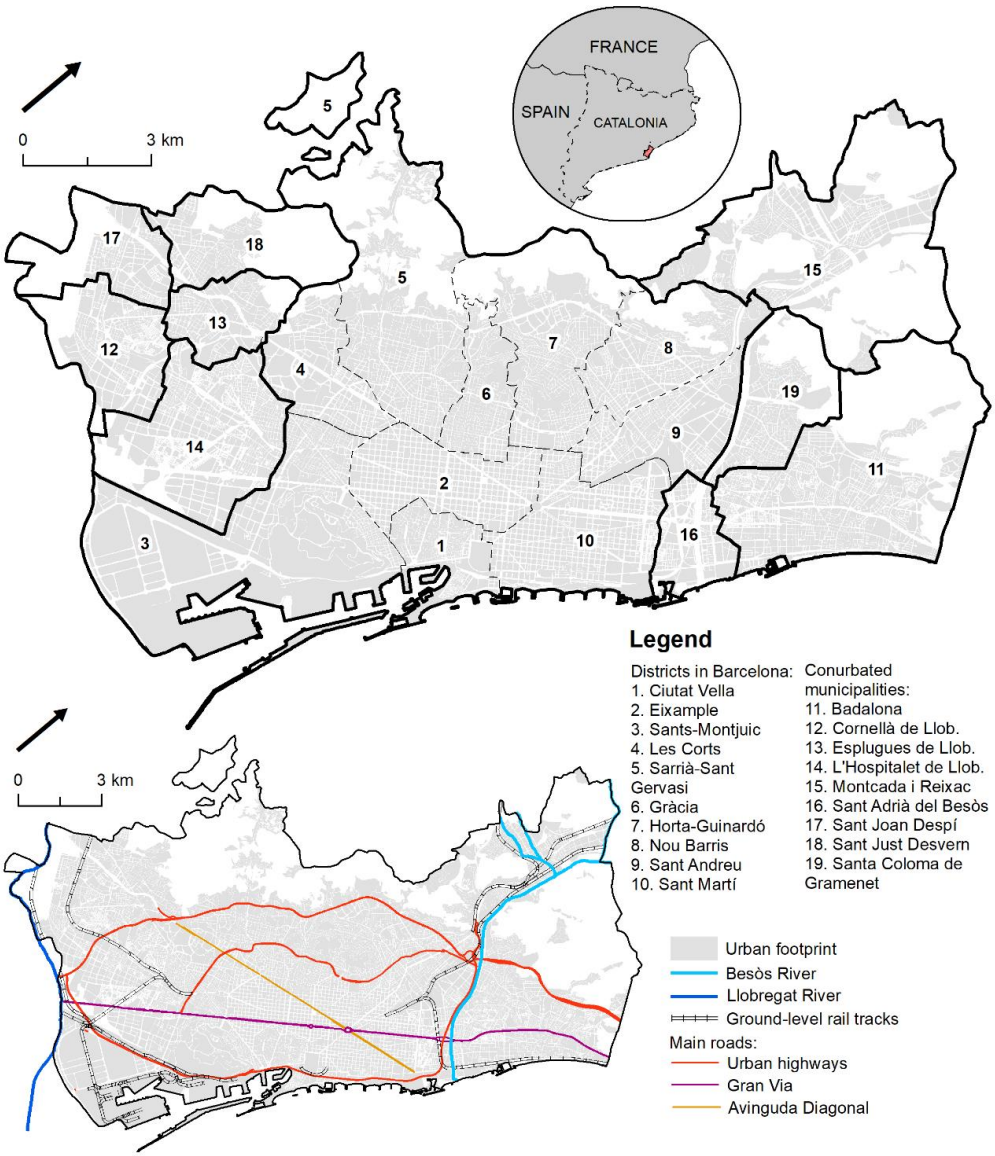
Therefore, it is important to identify in which urban contexts vulnerability and vitality are found, and to explore whether there does exist a link between them. With this goal, the aim of this paper is to explore the spatial relationship between urban vitality and urban vulnerability in the conurbation of Barcelona, Catalonia region, northeast Spain. With this study we aim to provide a deeper understanding of the spatial distribution of urban vitality in relation with social vulnerability, in order to inform urban practitioners, who work towards mitigating social inequalities, by means of designing and deploying spatial policies and interventions.

2. Methodology

2.1. Study area

This study focuses on the conurbation of Barcelona (Fig. 1), one of the largest metropolitan areas in Spain and in Southern Europe. Populated by approximately 2.5 million

inhabitants and with an extension of 190 km^2 (IDESCAT, 2021), the conurbation is composed by 10 municipalities, with the city of Barcelona at its centre (1.6 million inhabitants). This area is far from homogeneous, in terms of urban morphology and socioeconomic characteristics. Different historical milestones, economic developments, and urbanisation processes have led to a diversity of urban shapes, including historical towns, orthogonal expansions, high-rise and low-rise housing projects, or residential suburbanisation. Similarly, the metropolitan region is a socioeconomically heterogeneous mosaic that includes a population having diversity in socioeconomic status (SES). This area is covered by a public transportation system with a high frequency of service, composed of regional trains, subway and light rail systems, and interurban and urban bus services. As a reference for the analysis, we have divided up the area into 19 subareas of fairly comparable sizes, which correspond to the districts within the city of Barcelona, and the neighbouring municipalities.

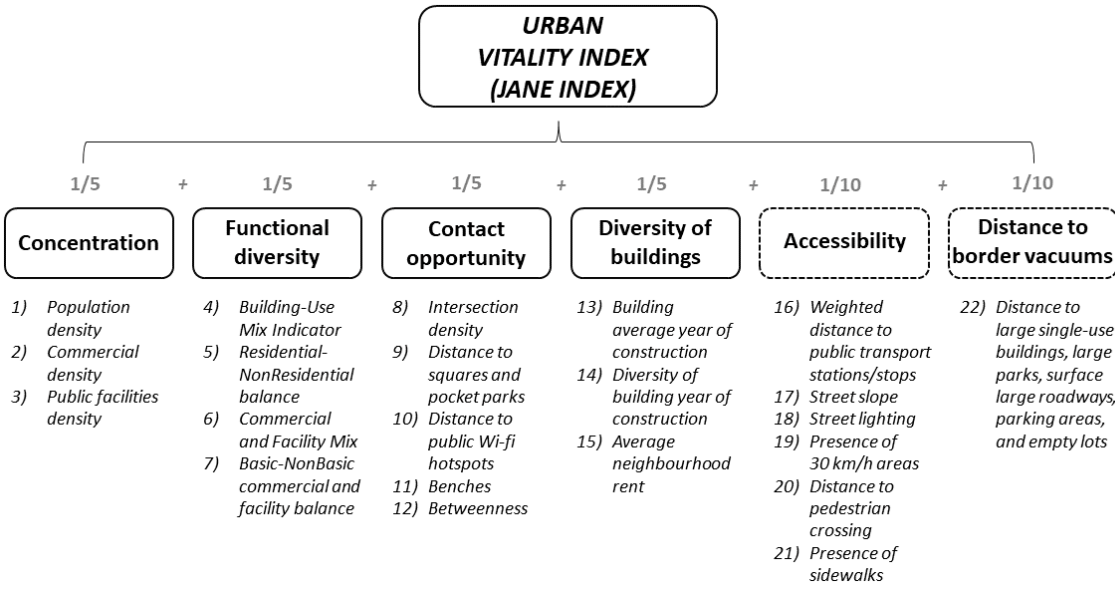


Source: own production.

Fig. 1. Study area: the conurbation of Barcelona.

2.2. Data

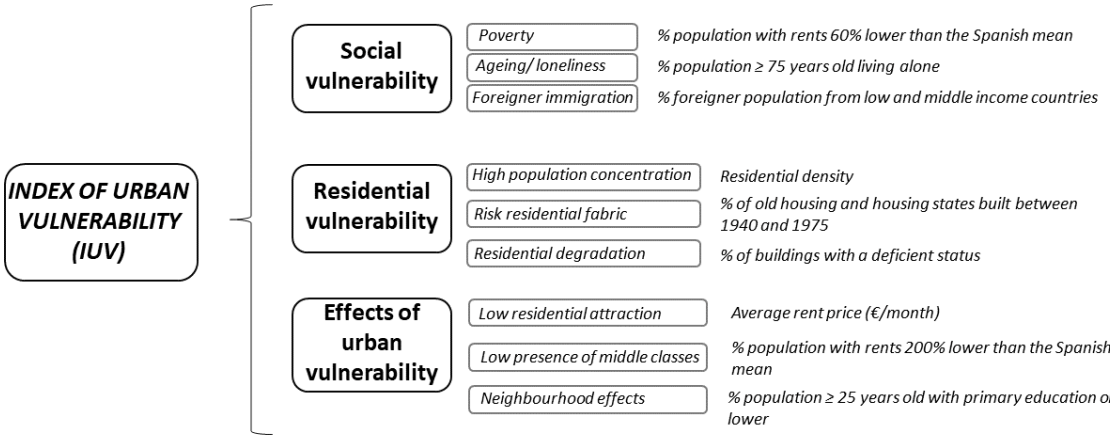
In order to analyse the conditions for urban vitality in the conurbation of Barcelona, we used the Jane index developed by Gómez-Varo et al. (2022). The Jane index is a synthetic indicator composed by 22 variables of the built environment, that measure the four main conditions for urban vitality that were theoretically described by Jane Jacobs (i.e. Concentration, Contact Opportunity, Functional Diversity, Building Diversity), as well as two accessory conditions (*Accessibility* and *Distance to Border Vacuums*) (Sung et al., 2015) within a 100 m x 100 m cell grid (Fig. 2).



Source: Own production based on Gómez-Varo et al., 2022.

Fig. 2. Schematic definition of the Jane Index.

For urban vulnerability, we use the Index of Urban Vulnerability (IUV), developed by the Institute of Regional and Metropolitan Studies of Barcelona (Antón-Alonso & Porcel, 2021). The IUV is a synthetic indicator that, following the theoretical insights of Alguacil et al. (2014), measures urban vulnerability with consideration of social and residential exclusion factors, and the effects that derive from them (Fig. 3). The data of this index come from diverse data sources, which mainly correspond to administrative records. The territorial units in which IUV is calculated are the Metropolitan Statistical Areas (MSA), which are similar to neighbourhoods and are currently considered as the sub-city territorial units of reference in the metropolitan area of Barcelona.



Source: Own production based on Antón-Alonso & Porcel (2021).

Fig. 3. Composition of the Index of Urban Vulnerability.

2.3. Analysis

Firstly, we conducted a descriptive analysis of the spatial distribution of both vitality and vulnerability in the study area. Then, we used spatial analysis techniques to examine how these two indicators interact in a space. The core of the analysis was based on Exploratory Spatial Data Analysis (ESDA) (Anselin, 1995). ESDA is a spatial analysis technique, that has been widely used in academic studies to help understand the geographical distribution of social issues with a clear spatial dimension, such as housing exclusion (A. Gutiérrez & Delclòs, 2016; Medina et al., 2020), the distribution of tourism accommodations (J. Gutiérrez et al., 2017; Lagonigro et al., 2020), the relationship between urban green and income (Gallego-Valadés et al., 2020), mobility indicators (De Silva et al., 2018; Lee et al., 2017), or health outcomes (Scarpone et al., 2020), among others.

Considering that the two studied variables had different spatial units and IUV was originally calculated at the Metropolitan Statistical Area level, we downscaled this to be displayed in a 100 m x 100 m grid; hence, it is possible to relate it to the urban vitality index.

The ESDA was divided into two steps. To begin the analysis process, a univariate analysis of spatial autocorrelation was conducted for each of the variables: urban vitality (JANE index)

and urban vulnerability (IUV). Firstly, we calculated the Global Moran Index (Moran, 1948) as an indicator of global spatial autocorrelation, that explains to what extent the analysed variables tend to display spatial grouping (positive spatial autocorrelation values, tending to 1), to present spatial dispersion (negative spatial autocorrelation values, tending to -1), or to be randomly distributed across space (autocorrelation values close to 0). The formula of the Global Moran Index is as follows:

$$I = (N \,/\, S_0) \sum_{i=1}^{N} \sum_{j=1}^{N} W_{ij} \, (X_i - \mu)(X_j - \mu) \,/\, \sum_{i=1}^{N} (X_i - \mu)^2$$

where N is the number of observations, *i* and *j* are the spatial units, μ is the mean of the variable X, *Wij* refers to the spatial weight of the adjacency matrix, and S_0 is the sum of the whole spatial weight ($S_0 = \sum_{i=1}^{N} \sum_{j=1}^{n} Wij$).

However, Global Moran's Index provides a general indicator, without considering the specific spatial distribution of autocorrelation. In order to look at the possible heterogeneity of the spatial distribution of urban vitality and urban vulnerability, we calculated Local Indicator of Spatial Association (LISA) maps (Anselin, 1995). LISA maps allow to identify areas with concentrations of high and low values of vitality and vulnerability, atypical values in a space, and those areas with a non-statistically significant association. The formula of LISA is as follows:

$$I_i = \frac{(X_i - \mu)}{m_0} \sum_{j=1}^{N} (X_j - \mu)$$

Where $m_0 = \sum_{i=1}^{N} (x_i - \mu)^2 / n$.

The second step of the ESDA was to analyse the spatial relationship between urban vitality and vulnerability. To do so, we conducted a bivariate analysis of spatial correlation, operationalised as the bivariate version of both Global Moran's Index and LISA maps.

LISA maps, both in univariate and bivariate spatial autocorrelation, classify spatial units in four cluster groups. When there is a positive relationship, we find 1) *High-High* group, corresponding to cells with high values of one variable next to cells with high values of the same variable (in univariate analysis) or the second variable (in bivariate analysis), and 2) *Low-Low* group, corresponding to cells with low values of one variable next to cells with low values of the same variable (in univariate analysis) or the second variable (in bivariate analysis). In the case of negative relationships, we find 3) *High-Low* group, corresponding to cells with high values of one variable next to cells of low values of the same variable (in univariate analysis) or the second variable (in bivariate analysis), and 4) *Low-High* group, corresponding to cells with low values of one variable next to cells with high values of the same variable (in univariate analysis) or the second variable (in bivariate analysis).

In order to define the extent of spatial relationships we used the Queen contiguity criteria, where neighbours are all the elements with shared borders and vertices (Anselin, 2005). Geoda© software (version 1.20) was used for the ESDA analysis. GeoDa© provides a p-value that informs about the statistical significance of Moran's indicators, with a confidence level of 95% (p=0.05). Finally, maps were created in ESRI ArcMap©.

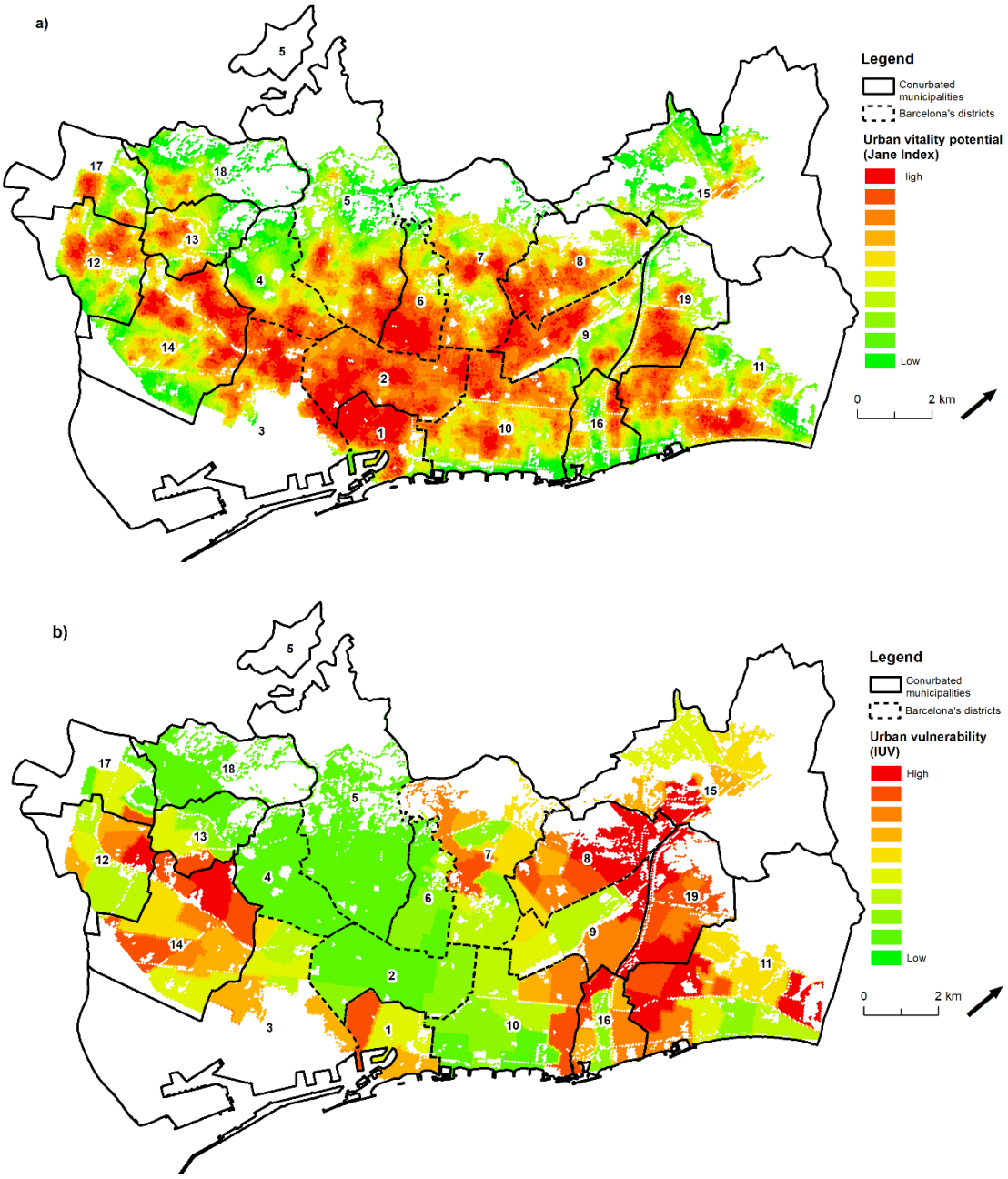
3. Results

3.1. The spatial distribution of urban vitality and vulnerability

Urban vitality in the conurbation of Barcelona generally follows a polycentric distribution (Fig. 4a). There is a main core in the central parts of the municipality of Barcelona, that extends to more peripheral parts of the city, and to the northern, compact, and dense neighbourhoods of the contiguous municipality of *L'Hospitalet de Llobregat* (14). In addition, there are also other vital cores which are found in compact and central areas of the rest of the municipalities in the conurbation, for example, in *Badalona* (11), *Cornellà de Llobregat* (12), *Esplugues de Llobregat* (13), *Montcada i Reixac* (15), or in *Sant Adrià del Besòs* (16). Otherwise,

non-vital areas are mainly found in the outskirts of the urban area, for example, in the northern part of the conurbation, next to large roads and natural limits, such as the Collserola mountain, the vicinities of Besòs and Llobregat rivers, and on the seafront, with the exception of the seafront areas of the city of *Badalona* and a portion of *Ciutat Vella* district in Barcelona.

By contrast, urban vulnerability presents a more marked linear pattern, with two main corridors of high levels of urban vulnerability in peripheral areas. These are situated in contiguous municipalities (*L'Hospitalet de Llobregat* (14), *Cornellà de Llobregat* (12), *Santa Coloma de Gramanet* (19), *Sant Adrià de Besòs* (16), *Badalona* (11) and *Montcada i Reixac* (15)), with some exceptions within the city of Barcelona (in the historical district of *Ciutat Vella*) and in the outskirts northern-western districts (*Horta-Guinardó* (7), *Nou Barris* (8), *Sant Andreu* (9)) (Fig. 4b). Differently, lower levels of urban vulnerability are found in central areas of the city of Barcelona, following the trace of one of its main avenues, *the Avinguda Diagonal*, until the northern-westerns districts (such as *Sarrià-Sant Gervasi* (5), *Les Corts* (4)), *Sant Joan Despí* (17), and northern neighbourhoods of *Esplugues de Llobregat* (13).



Source: Own production.

1. Ciutat Vella, 2. Eixample, 3. Sants-Montjuïc, 4. Les Corts, 5. Sarrià-Sant Gervasi, 6. Gràcia, 7. Horta-Guinardó, 8. Nou Barris, 9. Sant Andreu, 10. Sant Martí, 11. Badalona, 12. Cornellà de Llobregat, 13. Sant Feliu de Llobregat, 14. L'Hospitalet de Llobregat, 15. Montcada i Reixac, 16. Sant Adrià del Besòs, 17. Sant Joan Despí, 18. Sant Just Desvern, 19. Santa Coloma de Gramanet.

Fig. 4. Urban vitality (JANE index) (a) and urban vulnerability (IUV Index) (b) in the conurbation of Barcelona.

The distribution of urban vitality in the conurbation of Barcelona presents a strong positive tendency towards spatial grouping, as shown by the Global Moran's Index results (Moran's I = 0,985) (Table 1). More vital areas tend to be located near other areas with similar

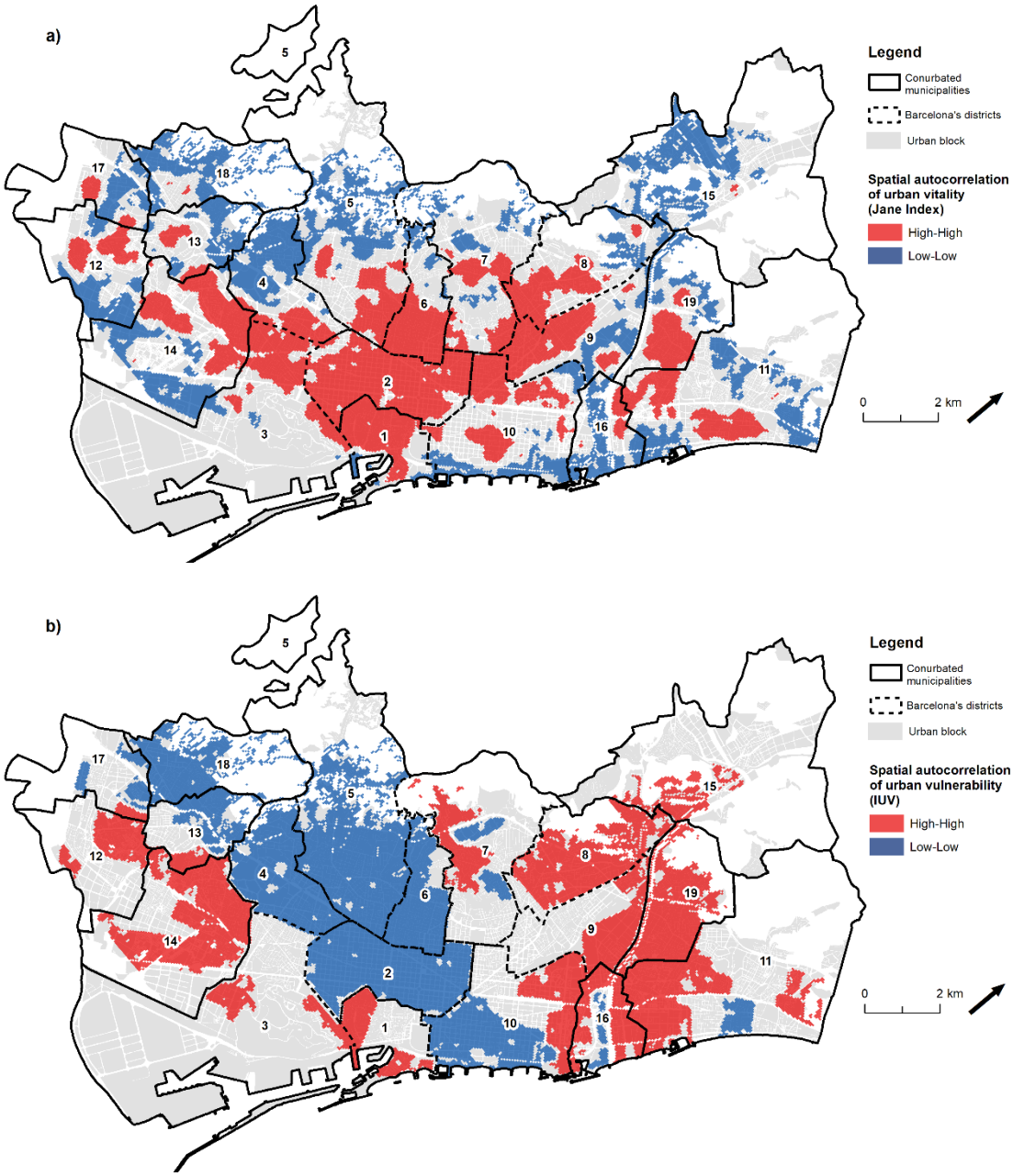
characteristics. Equally, areas with the low values of vitality are also found in close proximity to each other. In a similar way, urban vulnerability also presents a positive tendency to concentrate in a space (Moran's I = 0,971).

Table 1 Spatial autocorrelation of urban vitality and urban vulnerability, univariate and bivariate Global Moran's Index.

Urban vitality (JANE index)	0,985*
Urban vulnerability (IUV)	0,971*
Urban vitality – Urban vulnerability (Bivariate)	-0.004

*Statistically significant (p<0.01). Source: Own production.

However, these relationships are not equally distributed in a space, as shown in LISA maps. Fig. 5 shows the distribution of the four types of spatial clusters of both vitality and vulnerability. Urban vitality and vulnerability present different spatial autocorrelation patterns within the study area. On the one hand, vitality (*High-High* values) is mainly concentrated in compact, high-density areas, that are mostly located in the central city and some peripheral enclaves, whereas absence of vitality (*Low-Low* values) is relegated to the city administrative limits, those both bordering with the mountains (in the northwest) and industrial areas (on both sides of the city).



Source: Own production.

1. Ciutat Vella, 2. Eixample, 3. Sants-Montjuïc, 4. Les Corts, 5. Sarrià-Sant Gervasi, 6. Gràcia, 7. Horta-Guinardó, 8. Nou Barris, 9. Sant Andreu, 10. Sant Martí, 11. Badalona, 12. Cornellà de Llobregat, 13. Sant Feliu de Llobregat, 14. L'Hospitalet de Llobregat, 15. Montcada i Reixac, 16. Sant Adrià del Besòs, 17. Sant Joan Despí, 18. Sant Just Desvern, 19. Santa Coloma de Gramanet.

Fig. 5. Univariate spatial autocorrelation of Urban vitality (JANE index) (a) and urban vulnerability (IUV Index) (b) in the conurbation of Barcelona.

On the other hand, two corridors of urban vulnerability (*High-High* values) are clearly distinguished in peripheral neighbourhoods of the conurbation. A first enclave is on the

southwestern side of the conurbation, mainly in the adjacent compact-dense neighbourhoods of the municipalities of *L'Hospitalet de Llobregat* (14), extending to most of the neighbouring city of *Cornellà de LLobregat* (12). A second enclave is found along the neighbouring areas of Besòs river, comprising the districts of *Nou Barris* (8) and *Sant Andreu* (9) of the city of Barcelona, and other adjacent municipalities, such as *Sant Adrià del Besòs* (16), *Badalona* (11), *Santa Coloma de Gramanet* (19), and *Montcada i Reixac* (15). Besides these two corridors, two isolated spots of urban vulnerability are found inside the city of Barcelona: one in the historical neighbourhoods of *Ciutat Vella* district (1), and another in the hilly and dense district of *Horta-Guinardó* (7). By contrast, clusters of low vulnerability (*Low-Low* values) are found both in central and more peripheral areas of the conurbation. Particularly, a linear pattern is identified, that follows the pattern of the *Avinguda Diagonal*, one of the main arteries of the city, forming a cone of low vulnerability that goes from the central neighbourhoods and extends to the northern-western periphery.

3.2. The relationship between urban vitality and vulnerability

Globally, there is no statistically significant spatial relationship between vitality and urban vulnerability (Bivariate Global Moran's I = - 0,004). However, the local version of Moran's indicator operationalised through LISA maps, shows a different picture (Fig. 6), resulting in four scenarios that are heterogeneously distributed across the studied area.

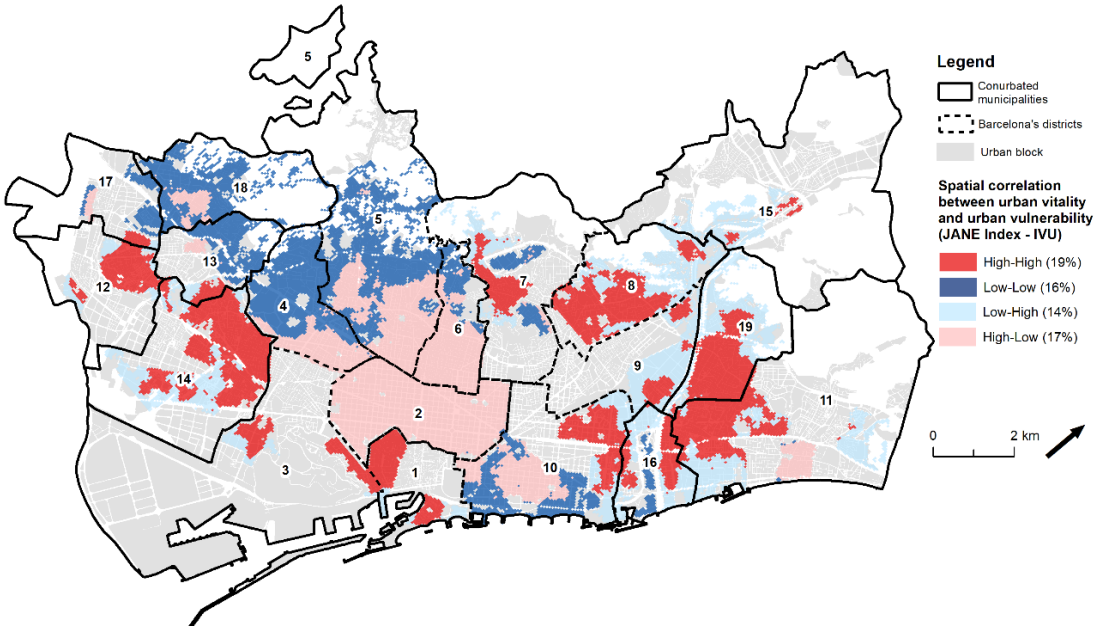


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Fig. 6. Bivariate spatial correlation of Urban vitality (JANE index) and urban vulnerability (IUV Index) in the conurbation of Barcelona.

Firstly, covering a 19% of the analysed territory, we found *High-High* clusters (high values of urban vitality overlapping high values of urban vulnerability) in two main enclaves, located in adjacent municipalities on both sides of the city of Barcelona. One is situated on the eastern side of Besòs River, in the southern neighbourhoods of *Santa Coloma de Gramanet* (19), neighbourhoods of *Sant Adrià del Besòs* (16), and *Badalona* (11). The other starts in the northern neighbourhoods of *L'Hospitalet de Llobregat* (14), extending to other neighbours of the city and to *Cornellà de Llobregat* (12). We also found isolated *High-High* clusters within the city of Barcelona, mostly in their north-eastern and eastern bordering neighbourhoods of *Nou Barris* (8)*, Sant Andreu* (9) and *Sant Martí* (10) in the hilly part of *Sants-Montjuïc* district close to an industrial area, and in specific neighbourhoods of the historical district of *Ciutat Vella* (1).

By contrast, *Low-Low* clusters are those areas that present low values both of vitality and vulnerability, and represent 16% of the studied area. They are mainly concentrated in the

north-western cone of the conurbation of Barcelona, comprising northern neighbourhoods of Barcelona, and northern areas above the northern ring road (*Ronda de Dalt*), in neighbourhoods of *Esplugues* (13), *Sant Just Desvern* (18), and *Sant Joan Despí* (17) municipalities. All of these areas are characterised by a concentrated wealthy population, and having urban forms with low density population and urban sprawl. We also found isolated spots of *Low-Low* clusters along the seafront of Barcelona, around the historical neighbourhood of *Sant Martí* (10) district.

A third group is formed by *Low-High* clusters which cover 14% of the conurbation, that are formed by areas with low values of vitality and high values of vulnerability, which are mainly situated on peripheral sides of the city. This is particularly true of the northern part of the eastern side of the city, close to Besòs river, and an isolated concentration in one neighbourhood of *L'Hospitalet de Llobregat* (14). This group is characterised by its proximity to multiple border vacuums, such as unmettaled roads and railway tracks, large infrastructures, or they have industrial areas within their proximities.

Finally, we find *High-Low* clusters, a group which corresponds to 17% of the conurbation, with high values of vitality and low values of vulnerability. These areas are located mainly in the city centre of Barcelona, drawing a pattern along *Avinguda Diagonal*, comprising neighbourhoods of the orthogonal urban expansion and historical towns of the north of Barcelona (in *Gràcia* (6) and *Sarrià-Sant Gervasi* (5) districts), bounded by the limit of one of the city's internal road rings, and in the seafront (*Poblenou* neighbourhood in *Sant Martí* (10) district). We also find a cluster of *High-Low* values in more distant municipalities, mainly in the historical cores, such as the northern peripheral municipalities of *Sant Just Desvern* (18) and *Esplugues de Llobregat* (13), close to the Collserola mountain, and along the seafront, with the historical town of *Badalona.*

4. Discussion

The main goal of our research was to examine the spatial relationship between urban vitality and urban vulnerability, using Barcelona as a case study. We found that urban vitality and urban vulnerability, at first, showed apparently unrelated spatial distributions. However, by means of ESDA techniques, we were able to detect and quantify statistically significant spatial associations between vitality and vulnerability in specific parts of the conurbation. The results of such associations were used in the identification of four different scenarios, which not only warrant specific interpretations, but at the same time have different implications that can help outline scenario-specific policy strategies.

Urban vitality in Barcelona follows a polycentric pattern with diverse sub-centres of potential vitality spread throughout the territory, as previous studies have shown (Delclòs-Alió & Miralles-Guasch, 2018; Masip-Tresserra, 2016). These vital cores correspond to different urban types, particularly to historical towns with a compact urban form that have traditionally boosted proximity dynamics, together with orthogonal urban expansions that merged these diverse historical cores, and lately, high-rise housing estates that were mostly built in the second half of the 20th century to host a migrated workforce that established itself in the Barcelona area. They all have, as a common thread, a combination of urban density, mixed-use, and high levels of accessibility. By contrast, areas with low potential for vitality correspond to those situated in the limits of the city, close to ground-level large infrastructures (i.e. roads, rails, single-use large facilities), and to those sprawled residential developments presenting low levels of density. Moreover, the main contribution of the present study is that we evidence local associations between urban vitality and urban vulnerability which, in turn, helps in identifying four different scenarios for policy intervention.

The first scenario that we identified are *High vitality – High vulnerability* areas, covering 19% of the studied territory. Mostly located in the outskirts of the Barcelona city and in conurbated municipalities, they present diverse urban shapes such as historic towns, compact

urban forms, and high-rise housing projects. Most of these high-density neighbourhoods experimented a high-speed growth during the 1950 to 1970s, as they welcomed a working class population that was migrating to Barcelona (Domingo i Clota & Bonet i Casas, 1998). Originally built-up, and with many deficiencies, in some of these neighbourhoods, major urban renewal projects were implemented by the regional authorities during the first decade of the 2000s, that provided a general improvement in physical infrastructure, facilities, and accessibility (Mehdipanah et al., 2013). We also found a *High-High* scenario in the central core of Barcelona, in one of the neighbourhoods of *Ciutat Vella* district (*1*), an ancient neighbourhood of the medieval city of Barcelona, that since more than two decades ago has welcomed migrants coming from low and middle income countries. These *High-High* areas are the tangible evidence that a socioeconomically disadvantaged population can also enjoy vibrant environments with high levels of accessibility. These are the result of dense urban shapes, together with the effort of public policies, that provided well-equipped neighbourhoods. Therefore, in these contexts, urban vitality contributes to an improvement of the quality of life for the most vulnerable populations. However, there is a sustained latent risk of elitisation, precisely because of the intrinsic condition of vulnerability that characterises these areas. According to previous evidence, one of the common reported problematic is the displacement of low-income residents and gentrification processes, which in global cities such as Barcelona are the result of a combination of both local and international dynamics (Cocola-Gant & Lopez-Gay, 2020). More specifically, within the context of Barcelona, this displacement trend started in central-city areas as a consequence of the touristification of the historical town (López-Gay et al., 2021). Currently, this trend has extended to more peripheral neighborhoods as well (Antunes et al., 2020). Moreover, recent evidence highlights how the impact of tourist pressures, such as the increasing presence of tourist accommodation, results in a loss of diversity, thereby undermining the vitality of these areas (Gómez-Varo et al., 2023). Therefore, rather than focusing on physical and infrastructure improvements in these *High-High* scenarios, policymakers would do better by

focussing on urban policies that guarantee the liveability for the most vulnerable neighbourhoods. This could be achieved by, for example, implementing housing policies that promote the permanence of neighbours via, for instance, incrementing the minimum time extension of rental contracts (Nasarre-Aznar & Molina-Roig, 2017), or the creation of a competitive public housing rental market (Donat, 2017).

Secondly, *Low vitality – Low vulnerability* areas are found, representing 16% of the conurbation. This reality demonstrates that socially privileged areas do not necessarily correspond to the most vital urban spaces. In fact, it is quite the reverse and, precisely, certain areas where high-income groups live hold very low levels of street-life and diversity. They correspond to low-density residential neighbourhoods in the city outskirts, that lack daily life facilities, and have a low level of public transport accessibility. *Low-Low* areas in adjacent cities correspond to urban settlements, that have grown during the urban sprawl of the Barcelona Metropolitan Area (AMB) in the 1990-2000 period, which supposed a process of urban simplification, landscape homogenisation, and loss of urban diversity and complexity that had traditionally characterised the Mediterranean city (Munoz, 2003). However, we also find *Low-Low* concentrations inside Barcelona city, in certain seafront areas that have been affected by relatively recent urban renewal projects. Particularly, in *Vila Olímpica,* the residential area created for the Barcelona 1992 Olympic Games (Barcelona '92), and afterwards the *Forum* area that was created for the Universal Forum of Cultures Barcelona 2004 (a 141-day international cultural event) (Majoor, 2011). These findings support previous observations on how mega-event planning, by means of large-scale projects, have negative long-term impacts on both the built environment and the population (Müller, 2015), as evidenced here, in terms of the lack of street vitality, and the elitisation of certain city spaces. People living in these areas, particularly those in residential developments on the city outskirts, are usually the wealthier population, who are self-selecting to live in low density and/or low diversity environments. This residential choice is driven by life attitudes, as evidenced by previous research, and often results in high car

use and motorised lifestyles that have negative environmental and social costs (Scheiner & Holz-Rau, 2013). Therefore, urban policies on *Low-Low* neighbourhoods should be aimed at preventing their externalities, by promoting more dense and mixed developments, in terms of the diversity of uses and population (i.e. by means of housing or commercial policies), transport policies that favour space-efficient modes (active mobility and public transit) allowing car-free spaces, while also avoiding zoning and other urban policies that would encourage urban sprawl (Litman, 2015).

Thirdly, *High vitality – Low vulnerability* areas are found, with high vitality and low vulnerability levels, and representing 17% of the conurbation, particularly, in neighbourhoods that used to be historical towns, and also in the orthogonal urban expansion, the *Eixample* (2) district, which at the beginning of the 20th century integrated many of these historical cores to form the city of Barcelona. These neighbourhoods present dense and compact urban forms with blocks and facilities at the ground floor level, and a high degree of accessibility to the city centre via public transport. The *High-Low* scenarios represent what some of the critical voices of Jacobs, in arguing that her idea on urban vitality, ultimately, was defending a middle-class way of life for relatively privileged neighbourhoods (Kirby, 2018; Stein, 2019). One plausible explanation of these *High-Low* areas could be their successful management, in terms of generators of quality of life. More recent voices, however, acknowledge that in the past few years, some of these areas have become physical and symbolic 'new touristic centres' of attraction, as they are seen as 'modern, alternative, and cool neighbourhoods', perceived as 'safe urban spaces with a creative and middle-class atmosphere', which have resulted in their being impacted by gentrification processes and, consequently, they have lost the traditional commerce (Lagonigro et al., 2020; Mansilla & Milano, 2019). Therefore, urban policies in *High-Low* scenarios now face the challenge of democratising vital spaces for a wider range of SES population. As physical infrastructure is well-equipped, efforts should be made in the social dimension, primarily, by promoting diversity of residents. Different urban policies can be implemented in this

commitment, including spatially targeted affordable housing policies, that guarantee the presence of low-rent population via such factors as social housing (Dawkins & Moeckel, 2016), regulations of the sharing of economic activities that have an impact on the everyday life of neighbourhoods (i.e. limiting the presence of short-term housing platforms) (Ferreri & Sanyal, 2018). Similarly, top-down urban policies that are willing to attract 'creative classes' into particular neighbourhoods, should be avoided in order to prevent their elitisation.

Finally, *Low vitality – High vulnerability* areas, representing 14% of the analysed territory, are mainly found in peripheral areas of conurbated municipalities. They correspond to areas that are located close to border vacuums, which present different types of monofunctional developments, such as industrial estates, informal residential settlements of self-constructed housing, or isolated residential high-rise housing projects. These areas have traditionally been neglected by urban policies partly because, paradoxically, in more disadvantaged neighbourhoods, the ability of local expenditure of their municipal administrations is smaller than in wealthier neighbourhoods (Nel·lo & AguadoMoralejo, 2021). Therefore, *Low-High* neighbourhoods probably are the scenarios that need to be given more priority attention by urban policies, which would need to address both physical (by creating mixed-used environments, or improving pedestrian and public transport accessibility) and social dimensions. For this commitment, some authors state the need to implement policies in a supra-municipal level that overcome the administrative limitations of more disadvantaged municipalities (Donat Muñoz, 2021). As an example, some cities are advocating to create mobility hubs at a metropolitan scale in areas where there is a general lack of infrastructure (Maciel Costa da Silva, 2021).

Despite the insights that are described in the previous paragraphs, our study has some limitations, that need to be taken into consideration in order to properly interpret the results, as well as to inform future studies. A first limitation relates to the use of synthetic indexes for

measuring two theoretical and widely discussed concepts, such as urban vitality and urban vulnerability. Although the construction of such indexes was based on an exhaustive review of the literature, other authors could argue the use of different indicators and weights for its calculation, particularly if it is intended to apply them in other urban contexts. A second limitation is related with the spatial unit that is used for the ESDA technique. As exhaustively highlighted by previous research, the so-called "modifiable areal unit problem (MAUP)" appears when data are aggregated in a determinate spatial unit (Jelinski & Wu, 1996). It was intended to minimise this problem, using a highly disaggregated spatial unit, the 100 m x 100 m grid in the Jane Index, however, the Urban Vulnerability Index is collected using a major spatial scale.

Finally, a third limitation is in the interpretation of the results. Although the ESDA allows to know where and how urban vitality and vulnerability are related, it is not possible to acknowledge the causality of these spatial relationships. Our results are focused on associations and, as such, the results provide solely a static image of the two phenomena which, indeed, are measured in different time period moments. In this sense, a natural progression of this work would be to explore the associations that are found in our study, but using a longitudinal design. This static perspective also hinders our understanding of how daily mobility and population fluctuations influence the interplay between urban vitality and vulnerability. While we may assume that individual's behaviour is linked to the residential built environment, it is possible that such interaction does not occur consistently in time. For instance, it may vary between weekdays and weekends, suggesting that people experience a different set of conditions elsewhere. Consequently, future studies should dedicate efforts to incorporate an examination of this relationship, taking into consideration the dynamic nature of the city. Furthermore, this was a purely quantitative examination of how urban vitality and vulnerability interact in space, but more in-depth knowledge could be gained by using a qualitative exploration of how residents perceive, and live in, different contexts.

5. Conclusion

In this study we aimed to provide quantifiable evidence to one of the critical issues in the current agenda for both urban research and practice, which is to understand to what extent urban environments that are accessible, comfortable, and attractive (i.e. vital environments) can be exclusively offered to those who are socially privileged. To do this, we used the theoretical framework of Jane Jacobs and her notion of urban vitality, which we explored against different levels of urban social vulnerability. We showed how in a dense, diverse, and generally lively Mediterranean city such as Barcelona, the most vital environments are, indeed, home to a population that is generally not socially vulnerable, as expected. However, we also identified different scenarios that add more room for interpretation and further study, which may be of particular interest to policymakers, not only in Barcelona, but also in global cities that share similar built environment traits, and that are working towards more liveable cities, while combating urban poverty, social exclusion, and intra-urban inequalities.

Taken together, the four presented scenarios strengthen the idea of (Gómez-Varo et al., 2022b) that urban vitality, rather than being a unique characteristic of certain types of neighbourhoods, can be found in widely different urban contexts presenting a diversity of built environments and sociodemographic circumstances. Hence, the evidence described in this paper has significant implications for the understanding of the principles of urban vitality as laid out by Jacobs, with a social perspective, as most of the research in this field has merely focused on the study of the built environment.

This research has also important implications for future practice. The proposed exploratory spatial analysis with the two synthetic indexes establishes a framework tool to detect different scenarios of intervention, contributing to a more accurate diagnosis for the design of tailor-made policies. In this sense, the replicability of the used methodology, as

another key contribution of the paper, could serve as a basis to study urban vitality and its socioeconomic correlates in other urban contexts around the world.

To conclude, this study has shown two main challenges facing future research that would analyse the relationship between urban vitality and vulnerability. Firstly, as long as longitudinal data at an infra-municipal level are available, it will be crucial to follow up the possible changes of a population's SES and built environment conditions. Secondly, evidence from this paper should also stimulate qualitative research to understand the everyday life of the different urban context. Only by addressing both challenges will we better informed to elaborate effective policies for the promotion of liveable and fair neighbourhoods.

Disclosure statement: The authors report there are no competing interests to declare.

Funding

Irene Gómez-Varo received funding from the Ministry of Education of Spain under the grant "Formación de Profesorado Universitario" (FPU18/02129); Oriol Marquet esearch was funded under a Ramón y Cajal postdoctoral fellowship (RYC2020-029441-I) granted by the Ministry of Science and Innovation, Government of Spain ; and Xavier Delclòs-Alió's research was funded under a Ramón y Cajal postdoctoral fellowship (RYC2021-031672-I) granted by the Ministry of Science and Innovation, Government of Spain (MCIN/AEI/10.13039/501100011033) and by the European Union (NextGenerationEU/PRTR). The research presented in this paper has been possible thanks to financial support received under the Project MICROMOV PID2019-104344RB-I00 from the Ministry of Science, Innovation and Universities of Spain.

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