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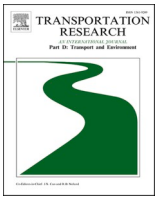

Can pedestrianization trigger gentrification? Analysis of Barcelona's sociodemographic changes following pedestrianization schemes☆

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ABSTRACT

Pedestrianization has become a widespread practice in cities promoting active mobility to achieve environmental and social goals. Some voices have, however, raised concerns around potential gentrification effects. This research tries to determine if pedestrianizations in Barcelona from 2012 to 2020 have set off gentrification-like sociodemographic changes. Mapping pedestrianized streets and using longitudinal sociodemographic data, we isolate the effect of pedestrianization on sociodemographic change at a small scale through adjusted Difference-in-Differences and Mixed Models. Results show that pedestrianized areas have experienced a higher-than-expected increase in residents migrating from the Global North and highly educated, and a higher-than-expected decrease in older residents. These changes align with literature's definition of gentrification, positioning pedestrianization schemes as relevant, though not singular, drivers of gentrification. This study advances existing literature by examining the role of pedestrianization in fueling population change and gentrification processes. It examines an understudied trigger of population change and addresses the inadvertent consequences of pedestrianization schemes while contributing to the debate on the social impacts of active mobility policies.

1. Introduction

Pedestrianized areas have become a staple of modern urban centers and have recently gained importance as tools for urban renovation and fighting against climate change. Pedestrianization schemes refer to the transformation of streets to prioritize pedestrians, restricting or banning access to motorized vehicles (Hussein, 2018). This process usually involves a significant physical change of the streetscape. However, the nature and significance of pedestrianized areas has changed over time. While during the later part of 20th century, pedestrianized areas were mainly conceived as means to valorize the historical heritage of city centers and as a catalyzer of economic activity in main commercial axes (Chiquetto, 1997; Martínez-Gutiérrez, 1991; Vialard and Ozbil Torun, 2019), in recent times they are used as part of a broader policy toolbox alongside other measures that aim to transform the built environment in order to

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attain sustainability goals, mainly through travel behavior change and public space. Their goal is no longer the *mise en valeur* of the city's heritage or increasing economic activity but facilitating and stressing the importance of active travel as a transport mode in our cities to achieve emissions, health-related objectives, and even social equity (Bertolini, 2020; De Nazelle et al., 2011; United Nations, 2017). This shift has also altered the scope of pedestrianized areas, which now extend beyond historic and commercial zones, reaching other parts of the city to ensure more equitable access to the benefits of pedestrianization. This approach also aims to mitigate the negative effects of over-centralizing services and public space quality in specific areas (Ajuntament de Barcelona, 2021; Tato-Camino, 2021; Ville de Paris, n.d.).

Despite becoming a widespread practice in urban design and mobility policy, pedestrianization has faced criticism from social movements and figures in the media and political spheres. Concerns have been raised about the potential for such interventions, aimed at improving public spaces, to contribute to gentrification (Elldér, 2024; Marquet et al., 2024a; Nello-Deakin, 2024; Roberts, 2019a, 2019b). By increasing the desirability of an area, pedestrianization could drive demand-side dynamics, such as attracting wealthier residents, and supply-side effects, such as rising property values, fueling gentrification processes.

Gentrification refers to the influx of middle-class residents in working class neighborhoods, displacing previous residents and changing the character of the neighborhood (Glass, 1964). Since the appearance of this concept in the 1960s it has been broadly studied across various fields, regions, and time periods. This has resulted in numerous definitions of gentrification, often leading to conceptual confusion and geographical differences in its interpretation. For example, scholars in the U.S. often emphasize the role of race in gentrification, with white newcomers displacing racialized working-class communities (Barton, 2016; Finio, 2022; Hwang and Sampson, 2014; Johnson et al, 2021), while in Southern Europe, studies have highlighted the presence of skilled immigrants from the Global North as a potential factor driving neighborhood gentrification (Anguelovski et al., 2017; Cocola-Gant and López-Gay, 2020; López-Gay et al., 2021; Mazorra-Rodríguez and López-Gay, 2024). Despite these contextual differences, most scholars agree on defining gentrification as 1) the entry of wealthier residents and 2) the displacement of more vulnerable previous residents until 3) the character of the neighborhood has changed (Finio, 2022; Grifith, 1996; Hammel, 2009; Hwang and Lin, 2016; Kennedy and Leonard, 2001; Lees et al, 2013; Smith, 1996).

With the turn of the century, gentrification was analyzed no longer as a sporadic, exceptional and local phenomenon; but rather as a generalized and planned strategy in neo-liberal urbanism implemented in many cities across the globe (both in the North and global South) in what Smith (2002) and other scholars called the *third wave of gentrification*. According to Smith, these gentrification strategies would be the result of a partnership between local public authorities and private global capital investments (Hackworth and Smith, 2001) and would spill over from the city center into other parts of the city (Smith, 2002). Public administrations would open new markets by including certain areas in regeneration plans and attracting investments seeking plusvalues with the expectation that that land would revalorize shortly (Dinio-López, 2023). But in this new wave, this public–private partnership would not only produce new housing, but also new places of production, consumption and recreation (Smith, 2002). This way, the city itself —or at least some neighborhoods that are perceived as desirable (Wyly and Hammel, 1999)- is turned into a merchandise; a product that has the capacity to create value and that is sold through a recognizable brand (Bonakdar and Audirac, 2019; Dinio-López, 2023; Vives-Miró, 2011). Urban spaces would be then seen as commodities available for global financial markets to use as assets, driving gentrification in the city.

Studies about gentrification have used a variety of qualitative and quantitative methods to measure it. Focusing on quantitative analysis, researchers have used multiple demographic, geographic, housing, and public space variables with the aim to quantify the potential or the degree to which an area has been gentrified. Some studies use certain variables first to determine if the area is at risk of being gentrified (Bunten et al., 2023; Ding et al., 2016; Freeman, 2005; Hammel and Wyly, 1996; Johnson et al., 2021), while others skip this step and directly try to quantify if it is being gentrified (Anguelovski et al, 2022; López-Gay et al, 2021; Mujahid et al., 2019). Most analysis are conducted using census data at the census area scale (Mujahid et al 2019; Bostic and Martin, 2003). Some common gentrification criteria include i) demographic data (age, origin, education, ethnicity, household composition), ii) socioeconomic status (employment rate, employment category, income, Gini coefficient) and iii) housing supply data (rent prices, selling prices, rate of touristic rentals). Finio (2022) offers an exhaustive review of most used variables to measure gentrification and suggests a classification of the literature in two main groups: studies trying to explain gentrification from the demand side (sociodemographic characteristics of the influx of newcomers), and studying gentrification from the supply side (the economic and housing conditions that make a neighborhood potentially gentrifiable).

1.1. Pathways between pedestrianization and gentrification

Even if the issue is starting to raise in the public debate, to date, not a lot of research has been devoted to understanding the consequences of pedestrianization on the social composition of the city. The few available studies seem to suggest three causal pathways by which pedestrianization could lead to gentrification.

First, a growing literature on commercial gentrification (Kirmizi, 2021, 2022; Liu and Bardaka, 2023; Özdemir and Selçuk, 2017; Wang et al, 2024) suggests that since pedestrianized areas attract a larger number of pedestrians (Robertson, 1994), and pedestrian footfall is a crucial determinant of retail turnover (Timmermans and Van der Waerden, 1992), pedestrianizations are likely to benefit commercial activities in the area (Hass-Klau, 1993; Soni and Soni, 2016). Sandahl and Lindh (1995) analyzed early Swedish pedestrianization schemes founding that they had improved the attractivity of the area and led to a slight increase in retail turnover and rent. Yim-Yiu (2011) found rent's increases in Hong Kong's pedestrianized street, while Yoshimura et al. (2022) have also found in Spanish cities that the pedestrianization of areas with high density of bars and restaurants are likely to increase their turnover. These changes could lead to some businesses suffering from raising rents and being replaced by international chains and a monoculture of restaurants

and bars (Özdemir and Selçuk, 2017), changing the character of the area's commerce (as in Glass' definition of sociodemographic gentrification).

Second, pedestrianizations could be linked to supply-side gentrification through higher housing prices. While consistent literature shows that walkability and pedestrian accessibility to amenities are linked to higher prices (Kato and Takizawa, 2021; Kim and Kim, 2020; Roper et al, 2021; Tong et al., 2023; Trichês Lucchesi et al., 2022; Yang et al, 2023; Yang et al, 2018), little has been studied around the impact of pedestrianization itself. This would be, however, theoretically possible and in line with literature proving that the built environment is an important factor determining housing prices (Kauko 2006; Li et al, 2021; Qiu et al, 2022): since pedestrianized areas offer a better quality of life, more residents would like to live nearby, with higher demand pushing prices up.

Finally, in recent times green gentrification literature have studied demand-side aspects related to analyzing the effects of new green infrastructure on sociodemographic composition (Anguelovski et al, 2022; Assaad and Jezzini, 2024; Droste and Gianoli, 2024; Kiani et al, 2023; Quinton and Nesbitt, 2024; Shokry et al, 2021; Triguero-Mas et al, 2022). These studies have explored how green amenities in vulnerable neighborhoods that could be conceived as a public policy to improve their residents' quality of life end up fueling the area's desirability and attracting a specific sociodemographic type of residents, raising issues of environmental justice (Anguelovski et al, 2017; Galiana-Martín, 2023; Gould and Lewis, 2016; Kim and Wu, 2021). Extending their arguments, pedestrianization could be acting in a similar fashion to green infrastructure development, inadvertently boosting the attractivity of an area and the associated demand.

While all these findings lead to think that pedestrianizations could involve both demand and supply side gentrification dynamics, little research has tried to isolate the impact of this kind of interventions to determine its effect on the city's sociodemographic composition.

1.2. Aim of the study

To fill this gap, this study sets to understand whether pedestrianizations can trigger sociodemographic changes that could be interpreted as gentrification using Barcelona as a study setting. Our main hypothesis expects that census areas in Barcelona that have received pedestrianization will have experienced a different sociodemographic evolution than those that had received no pedestrianization. Using a detailed log of all pedestrianizations undertaken in the city between 2012 and 2020 and combining it with fine-grained sociodemographic data from the city's municipal register of inhabitants, we follow a quasi-experimental logic to isolate the effect of pedestrianization on sociodemographic evolution at the census area level.

Since we observe this evolution over a brief period of time, we do not expect to perceive changes that fit perfectly into the definition of gentrification, but rather detect slight and growing changes that could be the sign of the beginning of future gentrification processes. A review of the variables most employed in literature and their interpretation let us to expect the following changes if gentrification was taking process: an increase in the proportion of residents with superior education and a decrease in those with lower education –both because of cultural capital and as a proxy for economic status– (Anguelovski et al., 2017; Freeman, 2005; Johnson et al., 2021), an increase in the proportion of immigrants from the Global North and a decrease of those with Spanish nationality or from other countries –as a sign of transnational gentrification– (Anguelovski et al., 2017; Cocola-Gant and Lopez-Gay, 2020; López-Gay et al., 2021; Mazorra-Rodríguez and López-Gay, 2024), a decrease in household size –because of newcomers' change in lifestyle– (López-Gay et al., 2021; Meligrana and Skaburskis, 2005) and a decrease of older residents in favor of young adults – driven by the emergence of commerce and services catering to younger populations, leading to symbolic displacement among the elderly– (Bostic and Martin, 2003; Ding et al., 2016; Johnson et al., 2021; Santos et al., 2024).

Table 1
Sociodemographic evolution in Barcelona.

		2009	2023
Education			
	Low	39.0 %	18.1 %
	Medium	43.2 %	50.6 %
	High	17.8 %	31.3 %
Nationality			
	Spanish	84.4 %	78.6 %
	European / USA	4.9 %	8.9 %
	Other	10.7 %	12.5 %
Household size		2.54	2.53
Age groups			
	Under 18	15.8 %	15.6 %
	19 to 30	15.1 %	13.6 %
	31 to 64	49.6 %	49.4 %
	65 and above	19.5 %	21.4 %

Self-elaborated from Barcelona's register of inhabitants.

2. Methodology

2.1. Area of study

Barcelona is a Spanish city located by the Mediterranean Sea. With around 1,7 million people within the municipal term (IDESCAT, n.d), Barcelona is Spain's second most populated city, and the 5,8 million residents in its metropolitan region rank it as third in the European Union (EUROSTAT, 2024). Table 1 summarizes the sociodemographic composition of the city and its evolution from 2009 to 2023. The city's urban design is characterized by proximity and mix of uses (Ferrer-Ortiz et al., 2022; Vich et al., 2023) as well as its high population density. All of this results in a compact urban area with a high modal share of pedestrian trips (Observatori de la Mobilitat de Catalunya, 2023; Marquet and Miralles-Guasch, 2014, 2015).

The history of pedestrianization in contemporary Barcelona begins in the 1950 s and 1960 s, when a ban on cars was introduced in the historical center in the surroundings of the cathedral, the market, and other commercial areas (Santamaría-Hernández, 2017). Many parts of the historical center were further pedestrianized during the 1970 s and 1980 s, marked by the ban on cars on the iconic commercial axis of *Portal de l'Àngel* in 1973 (Miró, 2023). During the 1980 s, efforts to reduce car space in important transit axes spread outside the city center, with some peripherical streets noticeably reformed to give more space to pedestrians, such as *Avinguda Gaudí*, *Via Júlia* or *Rambla de Prim*. In the years 2000 s, the city center model was exported to other historical parts of the city, such as the *Vila de Gràcia* neighborhood, restricting car use without eliminating it (Ollés, 2006).

In 2016 the first pilot project of Superblocks (an urban design strategy aiming at creating new public spaces by enforcing a perimetral closure for traffic around certain blocks) starts in *Poblenou* neighborhood as a form of tactical urbanism, later exported to *Sant Antoni* neighborhood (Anguelovski et al., 2023; Orrego-Oñate et al., 2024). In the 2020s Superblocks evolved into Green Axis that are planned to cross the *Eixample* centric district (Ajuntament de Barcelona, 2021).

Sánchez-Aguilera and González-Pérez (2021) offer a thorough review of gentrification literature in Barcelona. Gentrification in Barcelona is usually linked to the change of paradigm in the city model with the Olympic Games of 1992, with a tighter partnership between the city council and the private sector to regenerate degraded parts of the city through large-scale projects and promote the international image of Barcelona as a global tourist destination and an advanced services economy (Casellas, 2006). These actions would be, then, an example of state-led gentrification mainly focused on the historical city and the littoral (Arbaci and Tapada-Berteli, 2012). López-Gay et al. (2021) depict the substitution processes that have taken place during the 2010 s in the city center and the historical area that were increasingly spilling onto adjacent neighborhoods. López-Gay et al. (2022) and Solana-Solana et al. (2020) dig further in in these substitution processes in the *Sant Antoni* neighborhood (where a Superblock was implemented in 2019), testifying vulnerable resident's moves to other parts of the city and an influx of new young, educated, and foreign-born residents.

2.2. Pedestrianization data

This study focuses on streets pedestrianized during the period 2012–2020. The data were obtained from a self-elaborated database from information of two different websites of the Barcelona City Council: i) Plànol BCN (Ajuntament de Barcelona, n.d.-a), an online viewer with spatial and transportation data, and ii) Superilles (Ajuntament de Barcelona, n.d.-b), a website with information regarding the Superblock project interventions. We considered a street as pedestrianized if it was classified in the Plànol BCN as a *Street with pedestrian priority* or a *Street without motorized vehicles*, or if it was part of a Superblock intervention. Afterwards, we confirmed the street was indeed pedestrianized through visual observation via Google Street View (GSV). Given that GSV storages street imagery from different years, we were able to manually assign to each street the year it had been pedestrianized. The use of GSV was the main factor in defining the lower bound of the 2012–2020 period, as street imagery is scarce for the years before 2012 and it did not allow to associate a specific year to each pedestrianization project. We did not analyze interventions undertaken after 2020 as there is not yet enough perspective to observe sociodemographic changes. Additionally, many different phenomena could have taken place in the city over 9 years, so to better isolate the effect of pedestrianization we decided to split the observations in two periods of analysis: 2012–2015 and 2016–2020. This way, we could ensure a sufficient number of observations in each period while focusing on more specific years. Table 2 summarizes the inclusion criteria followed during the database elaboration.

Once all pedestrianized streets were geolocated, these data were aggregated at the census area level (the smallest statistical unit in Spain, with Barcelona being divided in 1068 census areas). To do so, the total streets length within each census area was measured in ArcGIS Pro 3.2, as well as the pedestrianized streets length. Hence, the percentage of intervened street length was calculated for each census area. Moreover, each census area was assigned the period of the interventions that fell within it. In the case that one census area contained pedestrianizations belonging to two different periods, we chose to classify it according to the time on which the majority of the intervention had taken place.

Fig. 1 shows the distribution of pedestrianized streets across the city. The old city (district 1, *Ciutat Vella*) hosts several interventions, mainly carried out during the first period and in very turistified areas. The districts of *Sants-Montjuïc* (3) and *Gràcia* (6) received many pedestrianizations in both periods, mainly in historic parts of the district. *Eixample* (2) and *Sant Martí* (10) concentrate almost exclusively interventions of the second period and are home to the two Superblock tactical interventions (*Superilla de Sant Antoni* and *Superilla de Sant Martí*). All the remaining five districts of Barcelona have received at least one pedestrianization, even if they are scarcer. While the possibility of selection bias in the implementation of these schemes cannot be overlooked, pedestrianization efforts appear to be distributed across streets with diverse locations, designs, historical contexts, and levels of tourist activity.

Table 2
Inclusion criteria for pedestrianized streets.

Inclusion criteria:

1. Being classified as a street with pedestrian priority, a street without motorized vehicles or a Superblock project
2. Being pedestrianized between the years 2012 and 2020, both included
3. Having a minimum length of 3 blocks, or 2 blocks if it intersects with another pedestrianized street with a length of at least 2 blocks too
4. Representing a significant intervention; that is, reducing physical space for cars in the street layout or changing the construction materials of the street.

Significant interventions were classified in 4 types of pedestrianizations:

Type 1. Tactical urbanism. Small-scale, short-term interventions meant to inspire long-term change (Lydon and Garcia, 2015). In our case, they correspond with the pedestrianizations done under the Superblock program: interventions carried out with paint, plants and urban furniture.

Type 2. Levelled roads and sidewalks so that, even if construction materials still allow to difference them, they are at the same level and form a continuum.

(*continued on next page*)

Table 2 (*continued*)

	**Type 3. Unique platform streets**, where there is no differentiation between roads and sidewalks and different transport modes coexist.
	**Type 4. Other types of pedestrian streets**, such as those that have become green areas or that have substituted traffic lanes by vegetation.

Self-elaborated.

2.3. Sociodemographic data

Sociodemographic data at the census area level were obtained from the city's register of inhabitants, updated yearly and available at the Statistical Department of the Barcelona City Council website. Using data from official registers may rend difficult to differentiate between population displacement and neighborhood upscaling but is a common practice in gentrification studies and the most reliable source of objective sociodemographic change. To account for the sociodemographic situation before and after the intervention, data were obtained for the years 3-year-prior to the intervention period and 3-year-post, allowing enough time to observe changes and tendencies and reduce distortions from atypical years (i.e.: 2020 and the COVID pandemic). Hence, four different years were selected: 2009, 2013, 2018 and 2023 (Fig. 2). This is a short timespan to observe sociodemographic changes, but it is a widespread practice in literature (Finio, 2022) and it is the largest timespan possible, since data before 2009 was collected differently and incomparable. After reviewing the literature, all the relevant sociodemographic data (see section 1.2) available at the census area level for those four years were selected: age groups, education levels, household size and nationality. Lacking more disaggregated nationality data, we divided it in three categories: Spanish nationality, European (non-Spanish) or USA nationality (i.e.: Global North immigrants) and other nationality (i.e.: Global South immigrants). Definitions of sociodemographic variables can be found in Supplementary Material 1.

Since tourism is a well-documented driver of gentrification in Barcelona (Cocola-Gant and Lopez-Gay, 2020; Sánchez-Aguilera and González-Pérez, 2021), it was important to include it as a variable in our study to better isolate the effect of pedestrianization. To account for touristic pressure, unequally distributed throughout the city, an indicator of *Tourism Intensity* calculated by Barcelona

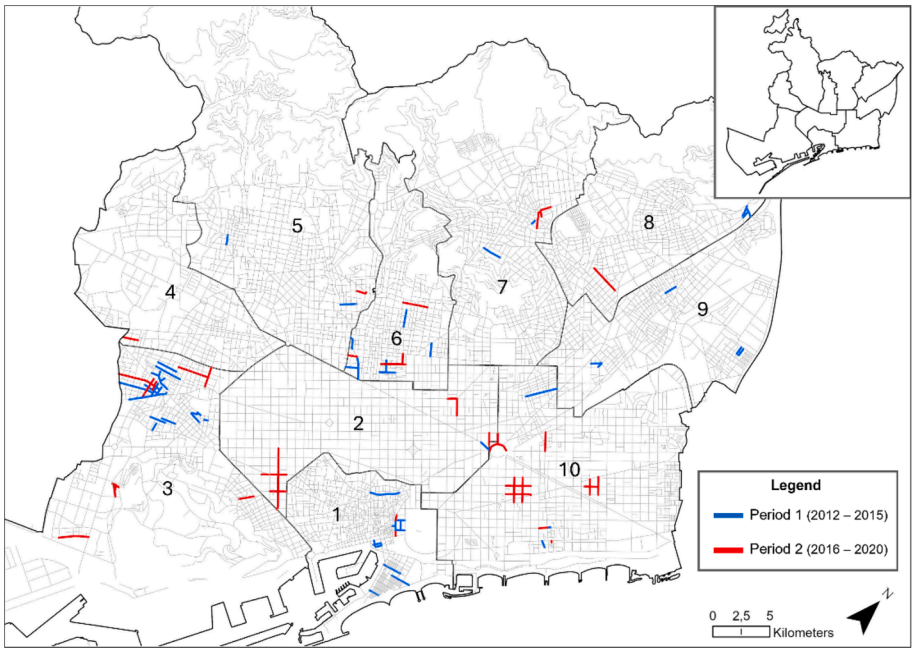

Fig. 1. Map of pedestrianized streets in Barcelona during 2012 – 2020. .
Source: self-elaboration

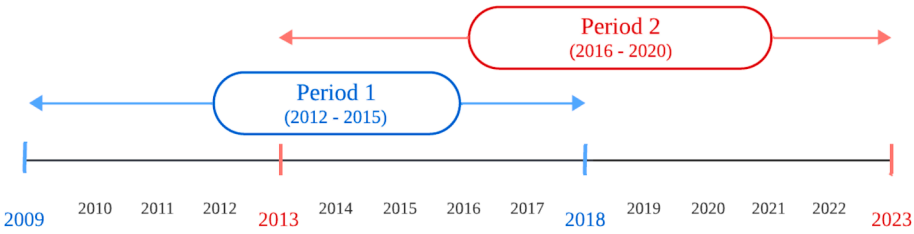

Fig. 2. Pedestrianization periods and pre-intervention and post-intervention time points. .
Source: self-elaboration

Regional (Ajuntament de Barcelona, 2020) was obtained from Barcelona's Open Data portal. This indicator gathers three different levels of tourism intensity (low, medium and high), depending on the number of touristic accommodations (hotels, hostels or Airbnb listings), food and beverage establishments, clothing stores, *souvenir* shops and touristic attractions. For each census area, we calculated the percentage of its area that experienced medium or high tourism intensity (Fig. 3).

Finally, two long-format databases (one for each period) were created with Barcelona's census areas as observations adding pedestrianization-related and sociodemographic-related variables. The treatment is a dichotomic variable (0/1) indicating whether the census area has received some pedestrianization (hence, in Period 1 database, census areas pedestrianized during Period 2 are not considered treated yet).

2.4. Methods

Since sociodemographic changes are complex to capture and the physical changes of the city difficult to isolate as a causal factor, two similar but different methods are combined: the Difference-in-Differences (DiD) approach and the Mixed Models. The complementary use of both techniques enriches the analysis, the first offering robustness and the second paying more attention to nuances. If DiD results shared significancy and were consistent in direction with those derived from the Mixed Models, it would strengthen their validity and reliability. Furthermore, Mixed Models could uncover significant insights that might remain undetected by the DiD approach.

Adjusted DiD is a statistical technique that attempts to simulate an experimental research design using observational longitudinal data. The idea is to divide observations into two groups: treatment group (the one that has received the effect of some type of intervention, in this case pedestrianization) and control group (the one that has not received the effect). It assumes that, without this intervention, the difference between both groups would stay constant over time. This way, DiD allows to estimate the treatment effect

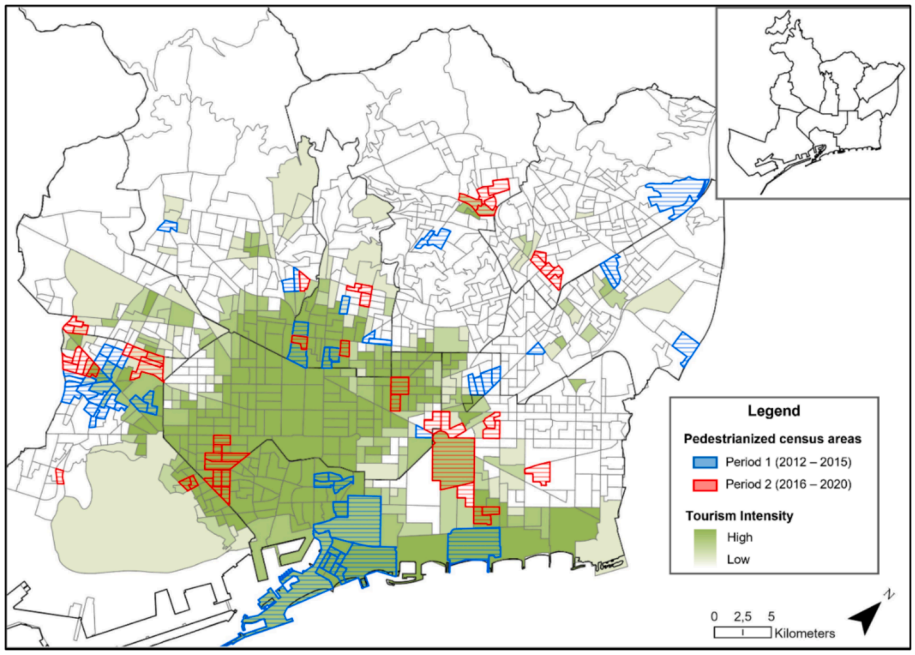

Fig. 3. Pedestrianized census areas and areas with high and medium tourism intensity. .
Source: self-elaboration

on a certain outcome (in this case, the sociodemographic variables) for the treated group, removing selection biases. Several authors have successfully used DiD with similar purposes (Marquet et al., 2024b; Wang et al., 2024; Yeganeh et al., 2024; Yoshimura et al., 2022). In this case, adjusted DiD will allow us to distinguish the effect of pedestrianization on the evolution of certain sociodemographic variables, while controlling touristic intensity (measured as the percentage of the census area that falls in a medium or high intensity area). We performed the adjusted DiD analysis to each one of the periods and each one of the outcomes separately, comparing the sociodemographic data three years before and three years after the interventions. We calculated the adjusted DiD with R's package *did* (Callaway and Sant'Anna, 2021) with the following formula, with Treatment marking pedestrianization (0/1) and Post indicating pre (0) and post (1) treatment.

$$Y = \beta_0 + \beta_1 \text{Treatment} + \beta_2 Post + \beta_3 TourismIntensity + \beta_4 Treatment * Post + \epsilon$$

The other technique employed was Mixed Models, a form of lineal regression models, to analyze observations that are not independent, such as longitudinal data or nested data. They combine both fixed and random effects and are hence indicated for observations that are independent (such as the different census areas) but also related (the different time points for one census area). Mixed Models are a common technique in longitudinal studies (Molenberghs and Verbeke, 2001). In this study, the independent variable is the interaction term between the Treatment (0/1) and the Year (the four time points: 2009, 2013, 2018 and 2023), with the dependent variable being each one of the sociodemographic variables. We have included Tourism Intensity as a control variable, but also the base values (year 2009) for all the sociodemographic variables, to take into consideration that these variables are not independent from each other but that they rather depict a census area when combined all together. A Mixed Model was run in *Stata* for each outcome (Y) and each period, with the following formula (for census area *j* in year *i*):

$$Y_{ij} = \beta_0 + \beta_1 Treatment_{ij} + \beta_2 Year_{ij} + \beta_3 TourismIntensity_{ij} + \beta_4 Loweducation2009_{ij} + \beta_5 Higheducation2009_{ij} + \ldots + \beta_{10} 65y.o.2009_{ij} + \beta_{11} Treatment_{ij} * Year_{ij} + u_i + \epsilon_{ij}$$

Two additional approaches of Mixed Models were computed. First, one for tourism intensity, grouping the two periods and dividing the data by the level of tourism intensity (low vs. medium–high), in an attempt to compare if the effects of pedestrianization are the same in touristified and non-touristified areas of the city. Secondly, another for different pedestrianization types, grouping the two periods and creating two datasets: i) one comparing Type 2 pedestrianizations with non-intervened areas and ii) another comparing Type 3 pedestrianizations with non-intervened areas. The goal was to analyze if different types of pedestrianizations could affect differently the sociodemographic composition. Interventions of Type 1 and 4 had to be excluded because the sample was too small to provide statistical meaning.

3. Results

3.1. Adjusted DiD

We run one adjusted DiD model for each sociodemographic outcome and for each period of interventions. In Period 1 (2012 – 2015), only two outcomes had a significantly different evolution in treatment and control groups: the percentage of people with European or USA nationality and the percentage of people between 31 and 64 years old. No outcome had a significantly different evolution in Period 2 (2016 – 2020). Fig. 4 shows the different evolution over the years of these two outcomes for Period 1, with Counterfactual being the expected evolution of intervened census areas if they had not been intervened. As visible, in 2009 the percentage of people coming from European countries (other than Spain) and the USA was already higher in areas that would lately be intervened that in the rest of the city (control group). However, even if an increase in this percentage was notable by 2018 across all census areas, it was much more pronounced in the census areas intervened during 2012 – 2015 (as noted by the difference between the treatment and counterfactual lines), with these areas widening their pre-existing gap. At the same time, while Barcelona as a whole experienced a slight decline of people aged 31 – 64 y.o. between 2009 and 2018, census areas with pedestrianizations experienced a notable increase in the percentage of inhabitants of this age group.

3.2. Mixed Models

A Mixed Model was run for each outcome and each period (full results can be found in Supplementary Material 2). Period 1 (Fig. 6) showed more significant differences and with a stronger effect, while Period 2 (Fig. 7) showed minor changes. Fig. 5 summarizes the significant effects of treatment in the outcome variables. The main effects of pedestrianization over sociodemographic change are among education level and nationality. Our models found that in both studied periods a significant increase in the education level appeared in pedestrianized areas. While both the treatment and control groups presented a similar share (23 %) in 2009, by 2023 a 2-point gap had opened, with pedestrianized areas having more highly educated residents (Figs. 6 and 7). At the same time, pedestrianized areas also received a stronger than expected lowering in the number of low-educated people (Fig. 6).

Looking at nationality changes, these are only noticeable in Period 1 (Fig. 6), but highly significant. The percentage of foreigners from European countries (other than Spain) and the USA increased across the city, but this dynamic was even stronger in areas that had received a pedestrianization. While on average, the share of foreigners from European or USA origin in a census area in Barcelona had increased by 50 %, that number was of 81 % in areas that had received a pedestrianization. The share of foreigners from other countries also increased in pedestrianized areas after the interventions (6 % increase), but this increase was smaller than the city average (18 %).

Finally, changes in age groups are minor and only partially significant, although still relevant. Period 2 interventions (Fig. 7) opened small gaps in the youngest age groups, with pedestrianized areas seemingly attracting a higher share of residents aged 18 years old or under and a lower share of those between 19 and 30 years old. The percentage of residents between 31 and 64 years old increased in the treatment group both after first and second period interventions, while the percentage of those aged 65 years or above decreased in the treatment group.

The consistency of results for key variables (such as the share of Europeans and Americans and residents aged 31–64 y.o.) across both adjusted DiD and Mixed Models underscores robust trends and reassures confidence in the validity of these findings. The subtler effects revealed by Mixed Models (such as for education groups and residents with other nationality) still provide valuable and valid insights into the potential broader effects of pedestrianization, even if they require more cautious interpretation.

Even if Fig. 1 showed that pedestrianization schemes were somehow evenly distributed across the city, the potential selection bias of these policies' location could influence these outcomes. To ensure the validity of our results and verify that the observed outcomes were not merely a reflection of pre-existing differences between treatment and control groups, we conducted a logistic binary model to assess whether baseline sociodemographic characteristics could predict pedestrianization (see Supplementary Material 3). The analysis revealed that census areas with smaller households and a younger population (ages 19–30 and 31–64) were more likely to undergo pedestrianization. All other variables remained statistically insignificant.

Finally, even if Tourism Intensity did not cancel out the effect of pedestrianization, it was indeed a significant control variable in

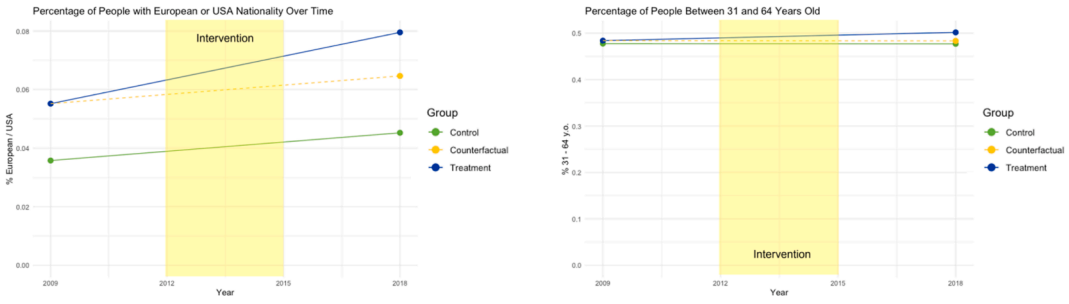

Fig. 4. DiD significant models Period 1. .
Source: self-elaboration

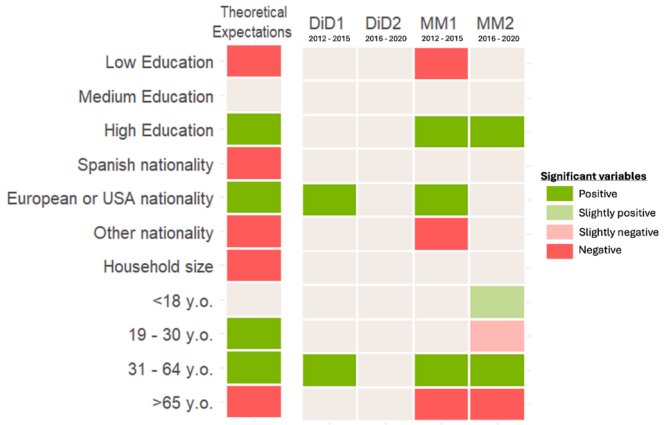

Fig. 5. Summary of DiD and Mixed Models' significances and signs. .
Source: self-elaboration

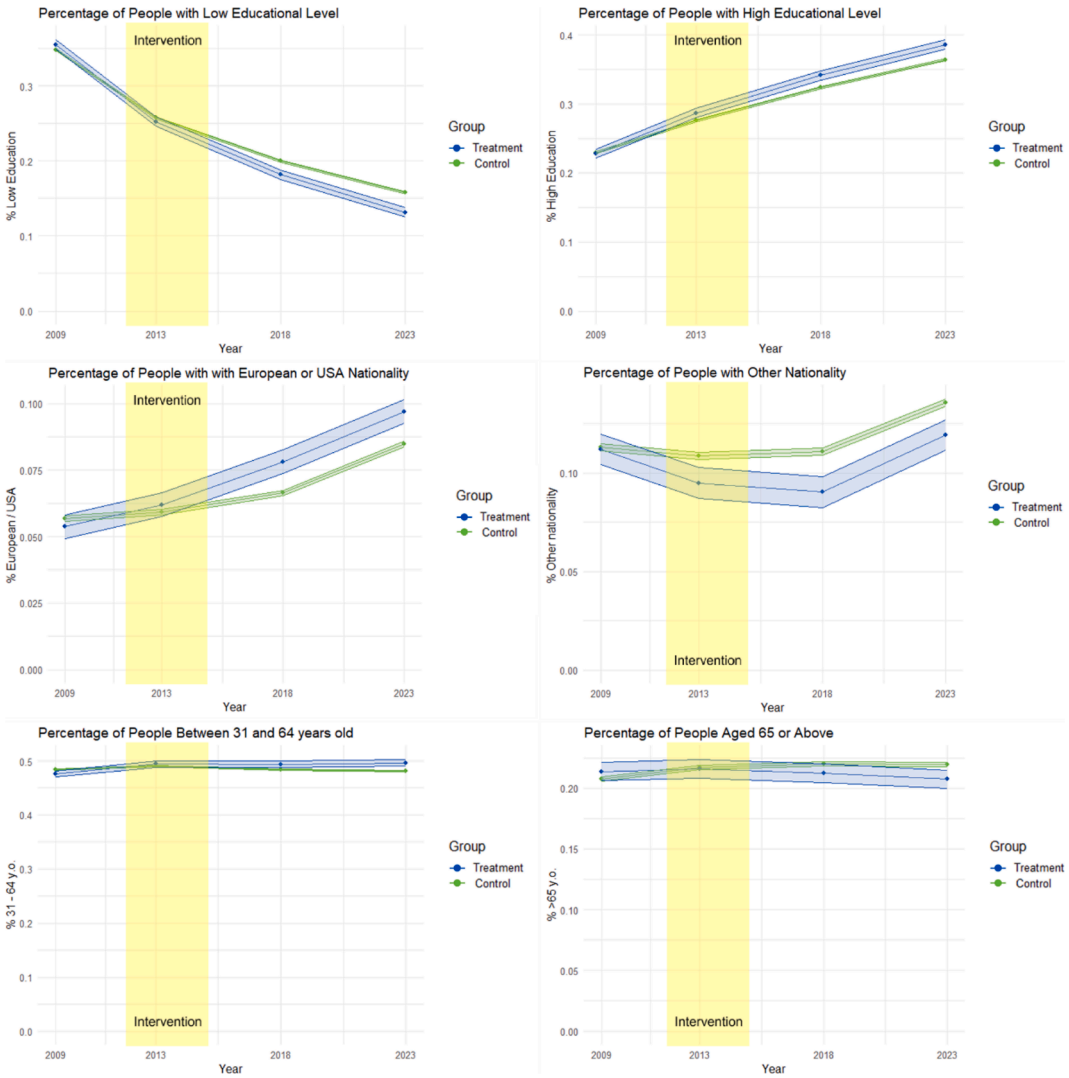

Fig. 6. Significant Mixed Models for Period 1. .
Source: self-elaboration

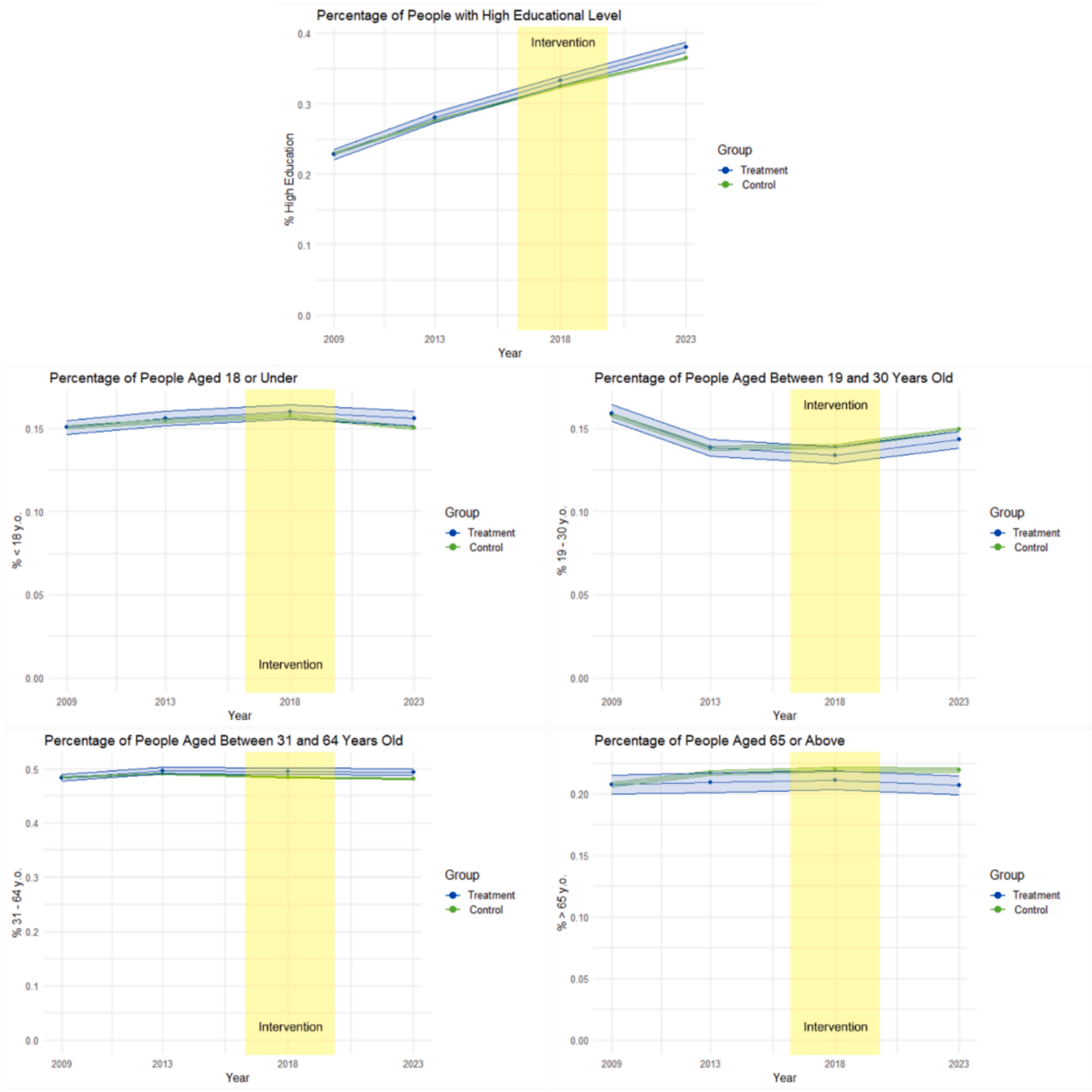

Fig. 7. Significant Mixed Models for Period 2. .
Source: self-elaboration

many of the Mixed Models in the expected direction: touristic intensity had a positive impact in the presence of the higher educated, foreigners (from Europe/USA and other countries) and those aged 31–64, and a negative impact on those aged 65 or older. However, the attempt to calculate models differentiating census areas not only by treatment but also tourism intensity yielded no significant results. At the same time, we ran some Mixed Models trying to compare treatment and control groups depending on the type of pedestrianization. Most of the results summarized in Fig. 8 are not surprising and agree with previous models, except for two differences. First, pedestrianizations of Type 2 seem to have no impact on the share of European and USA foreigners, in contrast with those of Type 3 and the general models that showed a clear effect. Second, Type 2 interventions seem to arise slight effects that are not visible in the general models nor in Type 3 models: levelling roads and sidewalks seems to mildly increase the share of residents with Spanish nationality and the size of the households.

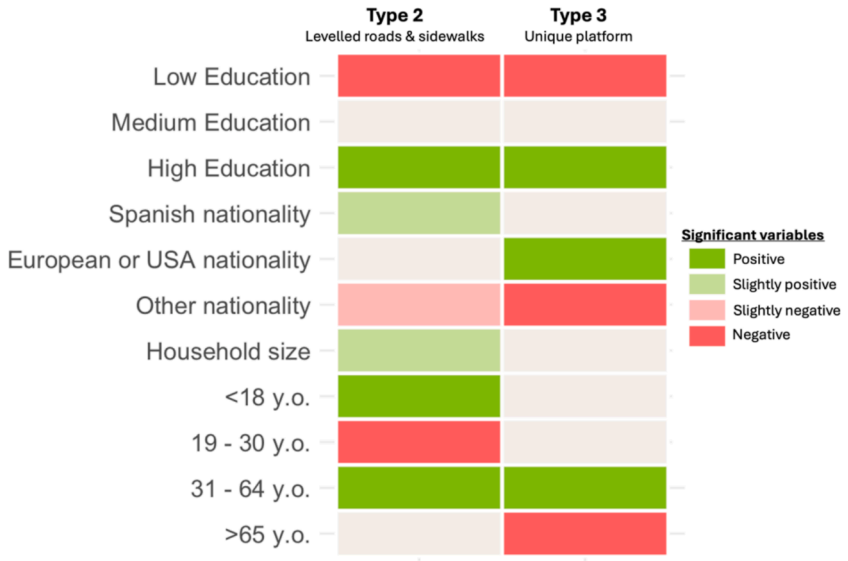

Fig. 8. Summary of Mixed Models' significances and signs depending on pedestrianization type.
Source: self-elaboration.

4. Discussion

Results from our analysis seem to confirm our hypothesis that pedestrianized census areas have experienced a sociodemographic evolution distinctive from those that have not received pedestrianization. As shown in Fig. 5, most of the sociodemographic variables presented the evolution we had expected after delving into literature: i) a decrease of the share of low-education residents and an increment of those with higher education, ii) an increase in migrants from the Global North and a decrease in those from the Global South, and iii) an increase in the share of 31–64 y.o. adults and a decrease of the elder. These trends are similar to the ones that the city experienced as a whole (as shown in Fig. 1), but they were significantly stronger in pedestrianized areas. However, some of the expected significant variables where not found to be significant at all, such as the share of residents with Spanish nationality or the average household size (both expected to decrease in pedestrianized areas). Age groups also behaved slightly different than expected, with residents $<$ 18 y.o. slightly increasing in the latter studied period and the younger adults (19–30 y.o.) slightly decreasing.

The results of the treatment-prediction model (Supplementary Material 3) support the validity of the pedestrianization effect on education and nationality groups while also introducing nuances regarding age groups. Since pedestrianization was more likely to occur in areas with a higher share of residents aged 31–64, the increase in this age group within the treatment areas may partly reflect pre-existing demographic patterns rather than being solely attributable to pedestrianization. However, the decline in older adults cannot be explained by pedestrianization occurring less frequently in already aging areas, suggesting that this change is a direct consequence of the intervention.

That being said, the post-pedestrianization demographic shifts align with the profile of gentrifier depicted by literature: a young or middle-aged adult −an age group combining higher income levels and greater residential mobility (Instituto Nacional de Estadística, n.d.-a; n.d.b)- with higher education (both because of cultural capital and as a proxy for economic status) migrating from the Global North. The decline in the share of residents over 65 y.o. has largely been depicted as a sign of gentrification by literature, as they move out of the neighborhood out of feelings of dispossession and nonbelonging (Atkinson, 2000; Henig, 1981; López et al., 2022). In our case, pedestrianization could act as a catalyzer of these feelings, as the elderly have the most negative feelings about pedestrianizing schemes in Barcelona, feeling that they create excessive street life and racket (Nello-Deakin et al., 2024).

As shown in the results, pedestrianizations carried out during the first period have triggered more profound sociodemographic processes than those of the second period. This is not due to the fact that we have more time perspective, since these differences are already obvious looking at the years 3-years-post-intervention (2018 and 2023, respectively). Pedestrianizations undertaken during 2012 – 2015 have yielded more significant and bigger population changes than those from the period 2016 – 2020. This could be due to three reasons: i) the consequences of the COVID pandemic in 2020, that could limit the arrival of newcomers (particularly foreigners) in the following years, curbing sociodemographic change; ii) a concentration of Period 1 schemes in the historical city, a neighborhood already highly pressured by tourism and gentrification (Cocola-Gant and Lopez-Gay, 2020; Sánchez-Ledesma et al., 2020); and iii) more profound differences in the nature of the pedestrianization schemes from the two periods (which also correspond to two different political parties governing at Barcelona's city council, see Marquet et al. (2024b)).

The aim of this paper was not to analyze gentrification processes in Barcelona, but rather to isolate the causal effect of pedestrianizations on them. Coming back to our research question, pedestrianization does seem to trigger a series of sociodemographic changes in the short-term that, if sustained in time, could fall within the gentrification definition. According to literature (see section 2.1), gentrification dynamics have been present in the city before the implementation of the pedestrianization schemes here analyzed,

and authors have pointed out multiple influential causes: overtourism, high-skilled international immigration, the Olympic Games, or the opening of new parks. Our models showed that tourism intensity was positively related to gentrification in Barcelona; however, it did not cancel out the effect of pedestrianization, which stood as a relevant factor contributing to gentrification on its own. We do not pretend to affirm that pedestrianization schemes are uniquely and directly responsible for gentrification. Gentrification was already present before our pedestrianization projects were undertaken and it is also present in non-pedestrianized areas. Nevertheless, pedestrianization seems to be, in the case of Barcelona, a relevant factor that, among others, can at least reinforce previously ongoing gentrification processes. It appears as an intervention in the built environment relevant enough to drive sociodemographic change, similarly to what green gentrification literature has found around the effects of opening new green spaces (Anguelovski et al., 2017; Droste and Gianoli, 2024; Triguero-Mas et al., 2022).

In a context of intercity competition to attract international investments and high-skilled workers, Barcelona has become a brand that tries to sell a product (Belloso, 2011; Ulldemolins, 2014). The city has tried to brand itself as a coastal, cultural and relaxed lifestyle city that allows for a work-life balance and an overall good quality of life, with architectural heritage and public space activities playing an important role in it (Balibrea, 2005; Barcelona International Welcome, 2024; Barcelona Turisme, 2009;Osácar-Marzal, 2020). Indeed, quality of life and lifestyle appear as some of the main reasons why skilled migrants choose to move to Barcelona (Cocola-Gant and Lopez-Gay, 2020; Pareja-Eastamay et al., 2009). Pedestrianization programs could reinforce this image of the city (even if it was not the original intention of the public policy or policymakers), differentiating Barcelona from other global cities (Harvey, 2001). Indeed, one of the main objectives of pedestrianization schemes was ameliorating quality of life by improving health (less emissions and noise and more active transport) and creating new public spaces for activities and social interaction (Ajuntament de Barcelona, 2021, 2022). Thus, pedestrianization could act as a tool of improvement of some areas, creating new spaces of living, production, consumption and recreation (Smith, 2002) that would contribute to the uniqueness of the Barcelona brand and become more desirable to wealthier newcomers. In fact, recent pedestrianization schemes in the city drew attention internationally, with one project being ranked by the media as one of the "coolest streets in the world" (Beard, 2024).

As previously commented, pedestrianization schemes, much like green infrastructure developments (Anguelovski et al., 2018), represent significant public investments in public space that enhance the desirability of the areas where they are implemented (Loughran, 2014). Within the framework of third-wave gentrification, which perceives urban spaces as being commodified by financial markets, such state-led interventions (intentionally or inadvertently) contribute to increasing their value as assets (García-Lamarca et al., 2022), ultimately driving gentrification. This phenomenon is not driven by the specific policy itself but by the broader economic and institutional framework in which it is embedded—one that positions the state as a market-opener, using public investments to make certain areas more appealing to private investors (Mezaroş et al., 2025). In cities like Barcelona, tourism amplifies these dynamics by increasing demand for short-term rentals, international investments, and high-value property markets. However, even in cities with lower tourism levels, pedestrianization schemes could trigger similar gentrification patterns if implemented within frameworks that encourage speculative real estate investments or lack robust housing protections. While the specifics may vary, with less international migration and more local middle-class presence, the impact on vulnerable residents remains significant. This underscores the need to understand how pedestrianization interacts with broader urban policies and economic structures, ensuring such initiatives prioritize inclusion and social equity rather than exacerbating existing inequalities.

Still, not all pedestrianization schemes are equal in form or goal, and not all of them have the same effects. Some pedestrianized streets in the historic center are part of greater beautification plans, some others attempt to create new public spaces, while others represent greening efforts to accompany new housing developments. In this paper, we did not focus on the goals of the schemes but rather on their implemented design. We found that streets where roads and sidewalks were leveled but still maintained distinct spaces for pedestrians and vehicles did not attract a higher proportion of Global North immigrants. In contrast, streets transformed into a single platform, along with all schemes considered together, showed the opposite trend. This could point to subtler pedestrianization projects also leading to subtler sociodemographic change, though further research needs to be done on this matter.

Finally, it is important to explore why certain variables, such as Spanish nationality and household size, were not found to change significantly after pedestrianization. The proportion of Global North immigrants increased in pedestrianized areas, seemingly at the expense of Global South immigrants, but not of those with Spanish nationality. This apparent stability in the Spanish population may be due to stronger community ties or housing tenure structures that resist gentrification pressures, though this requires further study. Household size, often expected to decrease in gentrification processes, also remained unchanged. This could be due to the study's short timeframe, cultural preferences for multigenerational living in Southern Europe, or rising housing costs that limit young individuals' ability to live independently.

5. Conclusions

This paper has aimed to determine if pedestrianization schemes could set off sociodemographic changes that fall within the definition of gentrification, in an effort to further understand the social outcomes of policies trying to improve pedestrian mobility. To do so, we have used two complementary methods (adjusted Difference-in-Differences and Mixed Models) attempting to isolate at the micro-level the effect of pedestrianization on sociodemographic changes in Barcelona. Our models showed that pedestrianized areas experienced a sociodemographic evolution proper of gentrification dynamics, incrementing more than the city average their proportion of residents migrating from the Global North and those with higher educational level and decreasing more than the city average the share of older adults. Thus, pedestrianization seems to be an intervention on public space relevant enough to spark or at least reinforce previous gentrification processes.

The present research represents one of the first attempts to analyze the impact of real pedestrianization projects on

sociodemographic gentrification, opening the door to considering new variables in the relationship between transport policies and gentrification. The main strength of the paper relies on its micro approach: we did not intend to explore the big picture of gentrification in the city, but rather to look for slight sociodemographic changes in small spatial units during a brief period of time triggered by small-scale interventions. This analytical approach allows to better correspond specific population change patterns with specific physical transformations in the urban layout, making it easier to attribute the effect (sociodemographic change) to the treatment (pedestrianization). The results of this short-term approach are of relevance for policymakers, as they place nuances on the social effects of pedestrianization schemes and raise the issue of social justice in the outcomes of transport policies favoring active mobility. The issue is not to put pedestrianization policies to an end, but to further reflect on how they could interact with other policies and the broader development model of the city to foresee and prevent unwanted social consequences of their implementation. When implementing these schemes in areas experiencing gentrification or at risk of gentrification, it might be necessary to complement them with stronger policies, such as rent controls, investments in public housing or stricter business regulations, to effectively prevent displacement and protect vulnerable populations.

This study, however, is not without limitations. Measuring sociodemographic change at the microlevel is challenging in part because of lack of fine-grained data consistent through large periods of time. This limitation has prevented us from further assessing the parallel trends assumption for the DiD models, as well as incorporating income levels and housing prices in our analysis. Better quality data could allow for the use of more complex statistical models that could yield more robust results. Moreover, we have worked with stock data (which depicts the sociodemographic situation of a certain census area at a given time) and not with flow data (which depicts the characteristics of those who leave or move into a certain census area), rendering it difficult to quantify displacement (see Easton et al., 2020 on that matter). Our results could reflect a combination of residential mobility (population entries and exits) and changes within the in-situ population (such as residents aging or graduating). However, by controlling the baseline sociodemographic structure in our Mixed Models, we partially address this limitation. This approach helps us to isolate the observed sociodemographic changes and attribute them, at least in part, to residential movements. Additionally, relying on the city's register of inhabitants underestimates sociodemographic change by not considering unregistered residents, particularly in the case of migrants and temporal residents.

This study lays the groundwork for future research on the relationship between pedestrianization and gentrification, but many questions remain to be answered on the nature and implications of this relationship. Future studies should analyze larger periods of time to provide a stronger foundation for establishing causal relationships and to confirm that these short-term tendencies can become clear gentrification processes sustained in time. Furthermore, more research needs to be done addressing the variability in pedestrianization schemes, comparing different policy goals, contexts, and designs to verify if sociodemographic change is an unavoidable outcome of pedestrianization or if it is only present under certain policy designs.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT 3.5 in order to improve the language and readability of the paper. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

CRediT authorship contribution statement

Pablo Villar-Abeijón: Conceptualization, Methodology, Software, Validation, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **Carme Miralles-Guasch:** Conceptualization, Validation, Investigation, Resources, Writing – original draft, Supervision, Project administration, Funding acquisition. **Oriol Marquet:** Conceptualization, Methodology, Software, Validation, Investigation, Writing – original draft, Writing – review & editing, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trd.2025.104718.

Data availability

Data will be made available on request.

References

Ajuntament de Barcelona. (n.d.-a). Plànol BCN. Retrieved September 20th, 2024, from https://geoportal.barcelona.cat/planolBCN/en/.

Ajuntament de Barcelona. (n.d.-b). Superilles. Retrieved September 20th, 2024, from https://ajuntament.barcelona.cat/superilles/en.

Ajuntament de Barcelona. (2020). Diagnosi del pla de resiliència. On afecta la intensitat d'activitats turístiques a la població, al transport públic i als espais verds urbans de la ciutat? https://coneixement-eu.bcn.cat/widget/atles-resiliencia/docs/210729_ER_EP6_Pressio_Turistica_PDF%20final.pdf.

Ajuntament de Barcelona. (2021). Superilla Barcelona: model nous eixos verds. https://ajuntament.barcelona.cat/superilles/sites/default/files/model_eixos_verds_web.pdf.

Ajuntament de Barcelona. (2022). Pla de Mobilitat Urbana 2024. https://bcnroc.ajuntament.barcelona.cat/jspui/bitstream/11703/128157/1/Pla%20de%20Mobilitat%20Urbana_bcn_2024.pdf.

Anguelovski, I., Connolly, J.J.T., Cole, H., et al., 2022. Green gentrification in European and North American cities. Nat. Commun. 13, 3816. https://doi.org/10.1038/s41467-022-31572-1.

Anguelovski, I., Connolly, J.J., Garcia-Lamarca, M., Cole, H., Pearsall, H., 2018. New scholarly pathways on green gentrification: What does the urban 'green turn' mean and where is it going? Prog. Hum. Geogr. 43 (6), 1064–1086. https://doi.org/10.1177/0309132518803799.

Anguelovski, I., Connolly, J.J.T., Masip, L., Pearsall, H., 2017. Assessing green gentrification in historically disenfranchised neighborhoods: a longitudinal and spatial analysis of Barcelona. Urban Geogr. 39 (3), 458–491. https://doi.org/10.1080/02723638.2017.1349987.

Anguelovski, I., Honey-Rosés, J., Marquet, O., 2023. Equity concerns in transformative planning: Barcelona's Superblocks under scrutiny. Cities Health 7 (6), 950–958. https://doi.org/10.1080/23748834.2023.2207929.

Arbaci, S., Tapada-Berteli, T., 2012. Social inequality and urban regeneration in Barcelona city centre: reconsidering success. Eur. Urban Reg. Stud. 19 (3), 287–311. https://doi.org/10.1177/0969776412441110.

Assaad, R.H., Jezzini, Y., 2024. Green gentrification vulnerability index (GGVI): A novel approach for identifying at-risk communities and promoting environmental justice at the census-tract level. Cities 148, 104858. https://doi.org/10.1016/j.cities.2024.104858.

Atkinson, R., 2000. Measuring gentrification and displacement in Greater London. Urban Stud. 37 (1), 149–165. https://doi.org/10.1080/0042098002339.

Balibrea, M.P., 2005. Barcelona: del modelo a la marca. Arteleku-MACBA-Universidad Internacional De Andalucía. https://eprints.bbk.ac.uk/id/eprint/43858/1/43858.pdf.

Barcelona International Welcome. (2024). Barcelona International Community Day will once again gather international talent. Retrieved September 19th, 2024, from https://www.barcelona.cat/internationalwelcome/en/news/barcelona-international-community-day-will-once-again-gather-international-talent-1420830.

Barcelona Turisme. (2009). Pla Estratègic de Turisme de la ciutat de Barcelona. Diagnosi i estratégica. Retrieved September 19th, 2024, from https://www.diba.cat/documents/186930664/188093132/peturis_bcn_diagnosi_estrategica.pdf/ae944f47-f342-4a40-a314-a228b88a641c.

Barton, M., 2016. An exploration of the importance of the strategy used to identify gentrification. Urban Stud. 53 (1), 92–111. https://doi.org/10.1177/0042098014561723.

Beard, G. (2024, March 13). 30 coolest streets in the world right now. Time Out Worldwide. https://www.timeout.com/things-to-do/coolest-streets-in-the-world.

Belloso, J.C., 2011. In: The City Branding of Barcelona: A Success Story. City Branding. Palgrave Macmillan, London. https://doi.org/10.1057/9780230294790_15.

Bertolini, L., 2020. From "streets for traffic" to "streets for people": can street experiments transform urban mobility? Transp. Rev. 40 (6), 734–753. https://doi.org/10.1080/01441647.2020.1761907.

Bonakdar, A., Audirac, I., 2019. city branding and the link to urban planning: theories, practices, and challenges. J. Plan. Lit. 35 (2), 147–160. https://doi.org/10.1177/0885412219878879.

Bostic, R.W., Martin, R.W., 2003. Black Home-owners as a gentrifying force? Neighbourhood dynamics in the context of Minority home-ownership. Urban Stud. 40 (12), 2427–2449. https://doi.org/10.1080/0042098032000136147.

Bunten, D.M., Preis, B., Aron-Dine, S., 2023. Re-measuring gentrification. Urban Stud. 61 (1), 20–39. https://doi.org/10.1177/00420980231173846.

Callaway, B., Sant'Anna, P., 2021. did: Difference in Differences. R Package Version 2 (1), 2. https://bcallaway11.github.io/did/.

Casellas, Antònia. (2006). «Las limitaciones del "modelo Barcelona". Una lectura desde Urban Regime Analysis». Documents d'Anàlisi Geogràfica, 2006, Núm. 48, p. 61-81, https://raco.cat/index.php/DocumentsAnalisi/article/view/72653.

Chiquetto, S., 1997. The environmental impacts from the implementation of a pedestrianization scheme. Transp. Res. Part D: Transp. Environ. 2 (2), 133–146. https://doi.org/10.1016/s1361-9209(96)00016-8.

Cocola-Gant, A., Lopez-Gay, A., 2020. Transnational gentrification, tourism and the formation of 'foreign only' enclaves in Barcelona. Urban Stud. 57 (15), 3025–3043. https://doi.org/10.1177/0042098020916111.

De Nazelle, A., Nieuwenhuijsen, M.J., Antó, J.M., Brauer, M., Briggs, D., Braun-Fahrlander, C., Cavill, N., Cooper, A.R., Desqueyroux, H., Fruin, S., Hoek, G., Panis, L. I., Janssen, N., Jerrett, M., Joffe, M., Andersen, Z.J., van Kempen, E., Kingham, S., Kubesch, N., Lebret, E., 2011. Improving health through policies that promote active travel: A review of evidence to support integrated health impact assessment. Environ. Int. 37 (4), 766–777. https://doi.org/10.1016/j.envint.2011.02.003.

Ding, L., Hwang, J., Divringi, E., 2016. Gentrification and residential mobility in Philadelphia. Reg. Sci. Urban Econ. 61, 38–51. https://doi.org/10.1016/j.regsciurbeco.2016.09.004.

Dinio-López, J., 2023. El malestar de las ciudades. Arpa & Alfil Editores.

Droste, J., Gianoli, A., 2024. Green gentrification: a fuzzy-set qualitative comparative analysis of greened neighbourhoods in Berlin. J. Environ. Plan. Manag. 1–26. https://doi.org/10.1080/09640568.2024.2343059.

Easton, S., Lees, L., Hubbard, P., Tate, N., 2020. Measuring and mapping displacement: The problem of quantification in the battle against gentrification. Urban Stud. 57 (2), 286–306. https://doi.org/10.1177/0042098019851953.

Elldér, E., 2024. The 15-minute city dilemma? Balancing local accessibility and gentrification in Gothenburg, Sweden. Transp. Res. Part D: Transp. Environ. 135, 104360. https://doi.org/10.1016/j.trd.2024.104360.

EUROSTAT (2024). Where are the largest metropolitan regions in the EU? Retrieved June 18th, 2024, from https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240318-2.

Ferrer-Ortiz, C., Marquet, O., Mojica, L., Vich, G., 2022. Barcelona under the 15-Minute City Lens: Mapping the Accessibility and Proximity Potential Based on Pedestrian Travel Times. Smart Cities 5 (1), 146–161. https://doi.org/10.3390/smartcities5010010.

Finio, N., 2022. Measurement and Definition of Gentrification in Urban Studies and Planning. J. Plan. Lit. 37 (2), 249–264. https://doi.org/10.1177/08854122211051603.

Freeman, L., 2005. Displacement or Succession? Urban Aff. Rev. 40 (4), 463–491. https://doi.org/10.1177/1078087404273341.

Galiana-Martín, L. (2023). Mejora ambiental, movilidad social y desplazamiento residencial en el entorno de Madrid Río (2004-2019). Scripta Nova. Revista Electrónica De Geografía Y Ciencias Sociales, 27(3). DOI: 10.1344/sn2023.27.42419.

García-Lamarca, M., Anguelovski, I., Cole, H.V., Connolly, J.J., Pérez-del-Pulgar, C., Shokry, G., Triguero-Mas, M., 2022. Urban green grabbing: Residential real estate developers discourse and practice in gentrifying Global North neighborhoods. Geoforum 128, 1–10. https://doi.org/10.1016/j.geoforum.2021.11.016.

Glass, R.L., 1964. London: Aspects of Change, No. 3. MacGibbon & Kee.

Gould, K., Lewis, T., 2016. Green gentrification : Urban sustainability and the struggle for environmental justice. Taylor & Francis Group.

Grifith, J.M., 1996. Gentrification: Perspectives on the return to the central city. J. Plan. Lit. 11 (2), 241–255. https://doi.org/10.1177/088541229601100205.

Hackworth, J., Smith, N., 2001. The changing state of gentrification. Tijdchr. Econ. Soc. Geogr. 92 (4), 464–477. https://doi.org/10.1111/1467-9663.00172.

Hammel, D. (2009). Gentrification. In Elsevier eBooks (pp. 360–367). DOI: 10.1016/b978-008044910-4.01051-8.
Hammel, D.J., Wyly, E.K., 1996. A model for identifying gentrified areas with census data. Urban Geogr. 17 (3), 248–268. https://doi.org/10.2747/0272-3638.17.3.248.
Harvey, D., 2001. The art of rent: globalization and the commodification of culture. In: Harvey, D. (Ed.), Spaces of Capital. Routledge, pp. 394–411. https://doi.org/10.4324/9780203821695.
Hass-Klau, C., 1993. A review of the evidence from Germany and the UK. Transp. Policy 1 (1), 21–31. https://doi.org/10.1016/0967-070x(93)90004-7.
Henig, J.R., 1981. Gentrification and displacement of the elderly: An empirical analysis. Gerontologist 21 (1), 67–75. https://doi.org/10.1093/geront/21.1.67.
Hussein, N., 2018. The Pedestrianisation and Its Relation with Enhancing Walkability in Urban Spaces. J. Contemporary Urban Affairs 2 (1), 102–112. https://doi.org/10.25034/ijcua.2018.3666.
Hwang, J., Lin, J., 2016. What Have We Learned About the Causes of Recent Gentrification? Cityscape 18 (3), 9–26. http://www.jstor.org/stable/26328271.
Hwang, J., Sampson, R.J., 2014. Divergent Pathways of Gentrification: Racial Inequality and the Social Order of Renewal in Chicago Neighborhoods. Am. Sociol. Rev. 79 (4), 726–751. https://doi.org/10.1177/0003122414535774.
IDESCAT (n.d.). El municipi en xifres: Barcelona (Barcelonès). Retrieved June 18th, 2024, from https://www.idescat.cat/emex/?id=080193.
Instituto Nacional de Estadística (n.d.-a). Renta anual neta media. Renta por persona y unidad de consumo por edad y sexo. Retrieved September 5th, 2024, from https://www.ine.es/jaxiT3/Datos.htm?t=9942.
Instituto Nacional de Estadística (n.d.b). Variaciones residenciales interiores. Variación por provincia de procedencia, relación entre procedencia y destino y edad. Retrieved September 5th, 2024, from https://www.ine.es/jaxi/Datos.htm?tpx=53147.
Johnson, G.D., Checker, M., Larson, S., Kodali, H., 2021. A small area index of gentrification, applied to New York City. Int. J. Geogr. Inf. Sci. 36 (1), 137–157. https://doi.org/10.1080/13658816.2021.1931873.
Kato, H., Takizawa, A., 2021. Which Residential Clusters of Walkability Affect Future Population from the Perspective of Real Estate Prices in the Osaka Metropolitan Area? Sustainability 13 (23), 13413. https://doi.org/10.3390/su132313413.
Kauko, T., 2006. What makes a location attractive for the housing consumer? Preliminary findings from metropolitan Helsinki and Randstad Holland using the analytical hierarchy process. J. Hous. Built Environ. 159–176. https://doi.org/10.1007/s10901-006-9040-y.
Kennedy, M., Leonard, P., 2001. Dealing with neighborhood change. The Brookings Institution, Washington D C.
Kiani, B., Mamiya, H., Thierry, B., Firth, C., Fuller, D., Winters, M., Kestens, Y., 2023. The temporal sequence between gentrification and cycling infrastructure expansions in Montreal, Canada. Habitat Int. 139, 102899. https://doi.org/10.1016/j.habitatint.2023.102899.
Kim, E.J., Kim, H., 2020. Neighborhood Walkability and Housing Prices: A Correlation study. Sustainability 12 (2), 593. https://doi.org/10.3390/su12020593.
Kirmizi, M. (2021). The Mobility of Paris Residents and Retailers: Their Viewpoints on the Effects of the City's Pedestrianization. (hal-03481305v2).
Kim, S.K., Wu, L., 2021. Do the characteristics of new green space contribute to gentrification? Urban Studies 59 (2), 360–380. https://doi.org/10.1177/0042098021989951.
Kirmizi, M., 2022. Local Shopkeepers' Perspectives on an Attempt for Municipally-led Commercial Gentrification Via Pedestrianization. Planlama Dergisi 32 (3). https://doi.org/10.14744/planlama.2021.14238.
Lees, L., Slater, T., Wyly, E., 2013. Gentrification. In Routledge eBooks. https://doi.org/10.4324/9780203940877.
Li, H., Chen, P., Grant, R., 2021. Built environment, special economic zone, and housing prices in Shenzhen. China. Applied Geography 129, 102429. https://doi.org/10.1016/j.apgeog.2021.102429.
Liu, C., Bardaka, E., 2023. Transit-induced commercial gentrification: Causal inference through a difference-in-differences analysis of business microdata. Transp. Res. A Policy Pract. 175, 103758. https://doi.org/10.1016/j.tra.2023.103758.
López, P., Rodríguez, A.C., Escapa, S., 2022. Psychosocial effects of gentrification on elderly people in Barcelona from the perspective of bereavement. Emot. Space Soc. 43, 100880. https://doi.org/10.1016/j.emospa.2022.100880.
López-Gay, A., Ortiz-Guitart, A., Solana-Solana, M., 2022. Vivienda, cambio poblacional y desplazamiento en un barrio en proceso de gentrificación. El caso de Sant Antoni (Barcelona). Revista EURE - Revista De Estudios Urbano Regionales 48 (143). https://doi.org/10.7764/EURE.48.143.06.
López-Gay, A., Sales-Favà, J., Solana-Solana, M., Fernández, A., Peralta, A., 2021. El avance de la gentrificación en Barcelona y Madrid, 2011-2019: análisis socioespacial a partir de un índice de gentrificación. Estudios Geográficos 82 (291), e084.
Loughran, K., 2014. Parks for Profit: The High Line, Growth Machines, and the Uneven Development of Urban Public Spaces. City & Community 13 (1), 49–68. https://doi.org/10.1111/cico.12050.
Lydon, M., Garcia, A., 2015. Tactical urbanism. Short-term Action for Long-term Change. Island Press.
Marquet, O., Anguelovski, I., Nello-Deakin, S., Honey-Rosés, J., 2024a. Decoding the 15-Minute City Debate: Conspiracies, Backlash, and Dissent in Planning for Proximity. J. Am. Plann. Assoc. 1–9. https://doi.org/10.1080/01944363.2024.2346596.
Marquet, O., Fernández Núñez, M.-B., Maciejewska, M., 2024b. The political price of superblocks. Electoral outcomes of sustainable transport interventions in Barcelona. Environ. Int. 189, 108789. https://doi.org/10.1016/j.envint.2024.108789.
Marquet, O., Miralles-Guasch, C., 2014. Walking short distances. The socioeconomic drivers for the use of proximity in everyday mobility in Barcelona. Transp. Res. A Policy Pract. 70, 210–222. https://doi.org/10.1016/j.tra.2014.10.007.
Marquet, O., Miralles-Guasch, C., 2015. The Walkable city and the importance of the proximity environments for Barcelona's everyday mobility. Cities 42, 258–266. https://doi.org/10.1016/j.cities.2014.10.012.
Martínez-Gutiérrez, M., 1991. Los espacios peatonales comerciales. Descripción sistematizada de las distintas tipologías. Revista Urbanismo COAM 14, 12–19.
Mazorra-Rodríguez, Á., & López-Gay, A. (2024). Migración internacional cualificada y residentes temporales, ¿el avance definitivo de la gentrificación en El Raval? Papers, e3253. DOI: 10.5565/rev/papers.3253.
Meligrana, J., Skaburskis, A., 2005. Extent, Location and Profiles of Continuing Gentrification in Canadian Metropolitan Areas, 1981-2001. Urban Stud. 42 (9), 1569–1592. https://doi.org/10.1080/00420980500185462.
Mezaroş, M., Paccoud, A., & Lees, L. (2025). A 'gentrification regime' change: The fiscal roots of buy-to-let gentrification in Dudelange, Luxembourg. Urban Studies. DOI: 10.1177/00420980241303626.
Miró, D. (2023, September 9). Cuando el franquismo hacía "urbanismo táctico" en el Portal de l'Àngel. Ara. https://es.ara.cat/media/franquismo-urbanismo-tactico-portal-l-angel_129_4796936.html.
Molenberghs, G., Verbeke, G., 2001. A review on linear mixed models for longitudinal data, possibly subject to dropout. Stat. Model. 1 (4), 235–269. https://doi.org/10.1177/1471082x0100100402.
Mujahid, M.S., Sohn, E.K., Izenberg, J., Gao, X., Tulier, M.E., Lee, M.M., Yen, I.H., 2019. Gentrification and displacement in the San Francisco Bay Area: A comparison of measurement Approaches. Int. J. Environ. Res. Public Health 16 (12), 2246. https://doi.org/10.3390/ijerph16122246.
Nello-Deakin, S., 2024. "Winner" versus "loser" streets? Pedestrianisation and intra-neighbourhood equity. Journal of Urban Mobility 5, 100074. https://doi.org/10.1016/j.urbmob.2024.100074.
Nello-Deakin, S., Vallvé, C.S., Akinci, Z.S., 2024. Who's afraid of pedestrianisation? Residents' perceptions and preferences on street transformation. Habitat Int. 150, 103117. https://doi.org/10.1016/j.habitatint.2024.103117.
Observatori de la Mobilitat de Catalunya, 2023. Enquesta de Mobilitat en Dia Feiner 2022 (EMEF 2022). Resum Executiu. https://omc.cat/es/w/encuesta-emef.
Ollés, A. (2006, October 31). La peatonalización del centro de Gràcia reduce el tráfico en un 80%. El Periódico. https://www.elperiodico.com/es/barcelona/20061030/peatonalizacion-centro-gracia-reduce-trafico-5399863.
Orrego-Oñate, J., Núñez, M.F., Marquet, O., 2024. Diminishing returns of additional active travel infrastructure: Evaluating Barcelona's decade of sustainable transportation progress. Journal Of Urban Mobility 6, 100092. https://doi.org/10.1016/j.urbmob.2024.100092.
Osácar-Marzal, E., 2020. Barcelona: la imagen turística de la ciudad proyectada en las películas y series internacionales. Estudios Turísticos 220, 165–194.
Özdemir, D., Selçuk, İ., 2017. From pedestrianisation to commercial gentrification: The case of Kadiköy in Istanbul. Cities 65, 10–23. https://doi.org/10.1016/j.cities.2017.02.008.

Pareja-Eastamay, M., Tumo-Garuz, J., Garcia-Ferrando, L, Pradel i Miquel, M. (2009). The magnetism of Barcelona: The View of Transnational Migrants. (Acre wp; N.° 7.2). AMIDSt, University of Amsterdam.
Qiu, W., Zhang, Z., Liu, X., Li, W., Li, X., Xu, X., Huang, X., 2022. Subjective or objective measures of street environment, which are more effective in explaining housing prices? Landsc. Urban Plan. 221, 104358. https://doi.org/10.1016/j.landurbplan.2022.104358.
Quinton, J., Nesbitt, L., 2024. Different names for the same thing? A systematic review of green, environmental, eco-, ecological, climate, carbon, and resilience gentrification. Cities 151, 105107. https://doi.org/10.1016/j.cities.2024.105107.
Roberts, D., 2019a. Barcelona wants to build 500 superblocks. Here's what it learned from the first ones. Vox. https://www.vox.com/energy-and-environment/2019/4/9/18273894/barcelona-urban-planning-superblocks-poblenou.
Roberts, D., 2019b. Barcelona is pushing out cars and putting in superblocks. Here are the 2 biggest challenges ahead. Vox. 10. https://www.vox.com/energy-and-environment/2019/4/10/18273895/traffic-barcelona-superblocks-gentrification.
Robertson, K.A., 1994. Pedestrian malls and skywalks: Traffic Separation Strategies in American Downtowns. Avebury, Aldershot.
Roper, J., Pettit, C., Ng, M. (2021). Understanding the Economic Value of Walkable Cities. In: Geertman, S.C.M., Pettit, C., Goodspeed, R., Staffans, A. (eds) Urban Informatics and Future Cities. The Urban Book Series. Springer, Cham. DOI: 10.1007/978-3-030-76059-5_15.
Sánchez-Aguilera, D., González-Pérez, J.M., 2021. Geographies of Gentrification in Barcelona. Tourism as a Driver of Social Change. In: Dominguez-Mujica, J., McGarrigle, J., Parreño-Castellano, J.M. (Eds.), International Residential Mobilities. Geographies of Tourism and Global Change. Springer, Cham. https://doi.org/10.1007/978-3-030-77466-0_13.
Sánchez-Ledesma, E., Vásquez-Vera, H., Sagarra, N., Peralta, A., Porthé, V., Díez, È., 2020. Perceived pathways between tourism gentrification and health: A participatory Photovoice study in the Gòtic neighborhood in Barcelona. Soc Sci Med 258, 113095. https://doi.org/10.1016/j.socscimed.2020.113095.
Sandahl, J., Lindh, C., 1995. Impact of improving the attractiveness of town centres. Transp. Policy 2 (1), 51–56. https://doi.org/10.1016/0967-070x(95)93246-u.
Santamaría-Hernández, C.G., 2017. El espacio público peatonal del distrito de Ciutat Vella. Dipòsit Digital De La Universitat De Barcelona. https://diposit.ub.edu/dspace/bitstream/2445/117867/2/01_TFM%20Carmen%20G.%20Santamaria%20Hernandez_TFM.pdf.
Santos, C.J., Henriques, A., Moreira, C., Ribeiro, A.I., 2024. Well-Being in a Gentrifying City: Results from the EPIPorto Cohort Study. Journal Of Urban Health. https://doi.org/10.1007/s11524-024-00921-4.
Shokry, G., Anguelovski, I., Connolly, J.J.T., Maroko, A., Pearsall, H., 2021. "They Didn't See It Coming": Green Resilience Planning and Vulnerability to Future Climate Gentrification. Hous. Policy Debate 32 (1), 211–245. https://doi.org/10.1080/10511482.2021.1944269.
Smith, N., 1996. The New Urban Frontier. Routledge. https://doi.org/10.4324/9780203975640.
Smith, N., 2002. New Globalism, New Urbanism: Gentrification as Global Urban Strategy. Antipode 34 (3), 427–450. https://doi.org/10.1111/1467-8330.00249.
Solana-Solana, A.M., Ortiz-Guitart, A., López-Gay, A., 2020. «Me están echando de mi casa». Repercusiones personales y sociales de la inseguridad residencial en Barcelona. Papers. Revista De Sociologia 1 (1), 1. https://doi.org/10.5565/rev/papers.2842.
Soni, N., Soni, N., 2016. Benefits of pedestrianization and warrants to pedestrianize an area. Land Use Policy 57, 139–150. https://doi.org/10.1016/j.landusepol.2016.05.009.
Tato-Camino, X. M. (2021). O modelo da cidade de Pontevedra: simplicidade e decisión, empatía coa contorno e a autonomía das persoas como eixos dun urbanismo centrado na recuperación do espazo público. In Agrelo-Costas, E., & Nogueira Pereira, M. X. (2021). Cidadanía e identidades: expresións políticas, económicas e culturais no século XXI. Universidade de Santiago de Compostela, Servizo de Publicacións e Intercambio Científico. DOI: 10.15304/9788418445415.
Timmermans, H. J. P., & Van der Waerden, P. J. H. J. (1992). Store performance, pedestrian movement, and parking facilities. In The attraction of retail locations: IGU-symposium, 5-8 August 1991. Part I (pp. 75-90). Michael Lassleben.
Tong, D., Shen, Y., Wang, X., Sun, Y., MacLachlan, I., Li, X., 2023. From Proximity to Quality: The Capitalization of Public Facilities into Housing Prices. Ann. Am. Assoc. Geogr. 113 (10), 2435–2455. https://doi.org/10.1080/24694452.2023.2227683.
Trichês Lucchesi, S., de Abreu e Silva, J., Larranaga, A. M., & Cybis, H. B. B. (2022). Walkability premium: evidence for low-income communities. Int. J. Sustain. Transport., 17(7), 727-739. DOI: 10.1080/15568318.2022.2090036.
Triguero-Mas, M., Anguelovski, I., Connolly, J.J.T., Martin, N., Matheney, A., Cole, H.V.S., Pérez-Del-Pulgar, C., García-Lamarca, M., Shokry, G., Argüelles, L., Conesa, D., Gallez, E., Sarzo, B., Beltrán, M.A., Máñez, J.L., Martínez-Minaya, J., Oscilowicz, E., Arcaya, M.C., Baró, F., 2022. Exploring green gentrification in 28 global North cities: the role of urban parks and other types of greenspaces. Environ. Res. Lett. 17 (10), 104035. https://doi.org/10.1088/1748-9326/ac9325.
Ulldemolins, J.R., 2014. Culture and authenticity in urban regeneration processes: Place branding in central Barcelona. Urban Stud. 51 (14), 3026–3045. https://doi.org/10.1177/0042098013515762.
United Nations. (2017). The new urban agenda (p. 30). Habitat III Secretariat. Retrieved June 4, 2024, from: https://habitat3.org/wp-content/uploads/NUA-English.pdf.
Vialard, A., Ozbil Torun, A., 2019. Pedestrianised Commercial Areas: from the Perspective of the Pedestrian and the Vehicle. Advance online publication, Beijing, China.
Vich, G., Gómez-Varo, I., Marquet, O., 2023. Measuring the 15-minute city in Barcelona. A geospatial three-method comparison. Resilient and Sustainable. Cities 39–60. https://doi.org/10.1016/b978-0-323-91718-6.00004-9.
Ville de Paris. (n.d.). Rues aux écoles: de nouvelles aires piétonnes. Retrieved June 14th, 2024, from: https://mairie18.paris.fr/pages/rues-aux-ecoles-de-nouvelles-aires-pietonnes-12767.
Vives-Miró, S. (2011). Producing a "Successful City": Neoliberal Urbanism and Gentrification in the Tourist City—The Case of Palma (Majorca). Urban Studies Research(1). DOI: 10.1155/2011/989676.
Wang, L., Zhou, J., Wang, P., et al., 2024. Green Gentrification and Urban Parks: Exploring the Complex Dynamics of Commercial Transformation. J. Knowl. Econ. https://doi.org/10.1007/s13132-024-02025-5.
Wyly, E.K., Hammel, D.J., 1999. Islands of decay in seas of renewal: Housing policy and the resurgence of gentrification. Hous. Policy Debate 10 (4), 711–771. https://doi.org/10.1080/10511482.1999.9521348.
Yang, Z., Li, X., Guo, Y., Qian, X., 2023. Understanding active transportation accessibility's impacts on polycentric and monocentric cities' housing price. Res. Transp. Econ. 98, 101282. https://doi.org/10.1016/j.retrec.2023.101282.
Yang, L., Wang, B., Zhou, J., Wang, X., 2018. Walking accessibility and property prices. Transp. Res. Part D: Transp. Environ. 62, 551–562. https://doi.org/10.1016/j.trd.2018.04.001.
Yeganeh, A., McCoy, A., Agee, P., Hankey, S., 2024. The role of new green construction in neighborhood change and gentrification. Cities 150, 105101. https://doi.org/10.1016/j.cities.2024.105101.
Yim-Yiu, C., 2011. The impact of a pedestrianisation scheme on retail rent: an empirical test in Hong Kong. J. Place Manag. Dev. 4 (3), 231–242. https://doi.org/10.1108/17538331111176057.
Yoshimura, Y., Kumakoshi, Y., Fan, Y., Milardo, S., Koizumi, H., Santi, P., Murillo Arias, J., Zheng, S., Ratti, C., 2022. Street pedestrianization in urban districts: Economic impacts in Spanish cities. Cities 120, 103468. https://doi.org/10.1016/j.cities.2021.103468.