Environmental Research 251 (2024) 118550

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Review article

The Superblock model: A review of an innovative urban model for sustainability, liveability, health and well-being

Mark Nieuwenhuijsen [a,b,c,*], Audrey de Nazelle [d,e], Marta Cirach Pradas [a,b,c], Carolyn Daher [a], Angel M. Dzhambov [f,g,h,i], Cynthia Echave [j,k], Stefan Gössling [l,m], Tamara Iungman [a,b,c], Haneen Khreis [n], Nicolina Kirby [o,p], Sasha Khomenko [a,b,c], Ulrich Leth [q], Florian Lorenz [r], Vlatka Matkovic [s], Johannes Müller [t], Laia Palència [c,u,v], Evelise Pereira Barboza [a,b,c], Katherine Pérez [c,u,v], Lambed Tatah [n], Jernej Tiran [w], Cathryn Tonne [a,b,c], Natalie Mueller [a,b,c]

[a] Barcelona Institute for Global Health (ISGlobal), Doctor Aiguader 88, 08003, Barcelona, Spain
[b] Universitat Pompeu Fabra (UPF), Doctor Aiguader 88, 08003, Barcelona, Spain
[c] CIBER Epidemiolog'ıa y Salud Pu'blica (CIBERESP), Melchor Fernández Almagro, 3-5, 28029, Madrid, Spain
[d] Centre for Environmental Policy Imperial College London, London, United Kingdom
[e] MRC Centre for Environment and Health, School of Public Health, Imperial College London, London, United Kingdom
[f] Department of Hygiene, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria
[g] Research Group "Health and Quality of Life in a Green and Sustainable Environment", SRIPD, Medical University of Plovdiv, Plovdiv, Bulgaria
[h] Institute of Highway Engineering and Transport Planning, Graz University of Technology, Graz, Austria
[i] Environmental Health Division, Research Institute at Medical University of Plovdiv, Plovdiv, Bulgaria
[j] Architecture School La Salle University Ramon Llull, C. Quatre Camins 2, 08022, Barcelona, Spain
[k] Transfer and Knowledge Society, Department of Universities and Research, Generalitat de Catalunya, Via Laietana 2, 08003, Barcelona, Spain
[l] School of Business and Economics, Linnaeus University, 391 82, Kalmar, Sweden
[m] Western Norway Research Institute, 6851, Sogndal, Norway
[n] MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Cambridge, United Kingdom
[o] Research Institute for Sustainability, Helmholtz Centre Potsdam, Berliner Straße 130, 14467, Potsdam, Germany
[p] University of Stuttgart, HLRS, Nobelstraße 19, 70569, Stuttgart, Germany
[q] Research Unit of Transport Planning and Traffic Engineering, Institute of Transportation, TU Wien, Karlplatz 13, 1040, Wien, Austria
[r] LAUT - Landscape Architecture and Urban Transformation, Thurngasse 10/5, 1090, Wien, Austria
[s] Health and Environment Alliance (HEAL), Avenue des Arts 7/8, 1210, Brussels, Belgium
[t] Center for Energy, AIT Austrian Institute of Technology, Giefinggasse 4, 1210, Wien, Austria
[u] Agència de Salut Pública de Barcelona, Pl. Lesseps 1, 08023, Barcelona, Catalonia, Spain
[v] Institut d'Investigació Biomèdica Sant Pau (IIB SANT PAU), C. Sant Quintí 77, 08041, Barcelona, Catalonia, Spain
[w] Research Centre of the Slovenian Academy of Sciences and Arts, Anton Melik Geographical Institute, Novi trg 2, 1000, Ljubljana, Slovenia

ARTICLE INFO

Keywords:
Urban planning
Transport
Superblocks
Air pollution
Green space
Urban heat islands
Health
Well-being

ABSTRACT

Introduction: Current urban and transport planning practices have significant negative health, environmental, social and economic impacts in most cities. New urban development models and policies are needed to reduce these negative impacts. The Superblock model is one such innovative urban model that can significantly reduce these negative impacts through reshaping public spaces into more diverse uses such as increase in green space, infrastructure supporting social contacts and physical activity, and through prioritization of active mobility and public transport, thereby reducing air pollution, noise and urban heat island effects. This paper reviews key aspects of the Superblock model, its implementation and initial evaluations in Barcelona and the potential international uptake of the model in Europe and globally, focusing on environmental, climate, lifestyle, liveability and health aspects.

Methods: We used a narrative meta-review approach and PubMed and Google scholar databases were searched using specific terms.

Results: The implementation of the Super block model in Barcelona is slow, but with initial improvement in, for example, environmental, lifestyle, liveability and health indicators, although not so consistently. When applied

* Corresponding author. Barcelona Institute for Global Health (ISGlobal), Doctor Aiguader 88, 08003, Barcelona, Universitat Pompeu Fabra (UPF), CIBER, Spain.
E-mail address: mark.nieuwenhuijsen@isglobal.org (M. Nieuwenhuijsen).

https://doi.org/10.1016/j.envres.2024.118550
Received 29 December 2023; Received in revised form 14 February 2024; Accepted 23 February 2024
Available online 1 March 2024

on a large scale, the implementation of the Superblock model is not only likely to result in better environmental conditions, health and wellbeing, but can also contribute to the fight against the climate crisis. There is a need for further expansion of the program and further evaluation of its impacts and answers to related concerns, such as environmental equity and gentrification, traffic and related environmental exposure displacement. The implementation of the Superblock model gained a growing international reputation and variations of it are being planned or implemented in cities worldwide. Initial modelling exercises showed that it could be implemented in large parts of many cities.

Conclusion: The Superblock model is an innovative urban model that addresses environmental, climate, liveability and health concerns in cities. Adapted versions of the Barcelona Superblock model are being implemented in cities around Europe and further implementation, monitoring and evaluation are encouraged. The Superblock model can be considered an important public health intervention that will reduce mortality and morbidity and generate cost savings for health and other sectors.

1. Introduction

In Europe, more than 70% of the population lives in urban areas (Nabielek, et al., 2016). Adequate, reliable and efficient urban planning and transport systems are essential for cities to thrive. However, recent evidence suggests that current car-centric urban and transport planning practices can lead to increased exposure to air and noise pollution, urban heat islands, as well as green space scarcity and insufficient physical activity (Nieuwenhuijsen, 2020). These factors have significant detrimental effects on health, contributing to excess morbidity and premature mortality in cities like Barcelona (Mueller et al., 2017a; Mueller et al., 2017b; Iungman et al., 2021) and other European cities (Khomenko et al., 2021; Pereira Barboza et al., 2021; Iungman et al., 2023).

Urban models that recognize the role of public space as a public good, and allocate space for a variety of activities, can increase health benefits (Nieuwenhuijsen, 2021). Allocation and use of public space including streets, roads and parks, shape the distribution of environmental exposures and opportunities for social contact, access to nature and physical activity (Gössling, 2020; Nieuwenhuijsen, 2021). Hence, diversity in public space use can be conducive to healthier lifestyles. In Barcelona, one of the most densely populated and build up cities in Europe, the majority of public space is occupied by motorized vehicle infrastructure, parking and traffic, which increases negative environmental exposures and reduces opportunities for promoting health and well-being (Mueller et al., 2017a; Mueller et 2017b).

To address this, in May 2016 the government of the city of Barcelona approved the policy measure "Omplim de vida els carrers" (Let's fill the streets with life). This measure authorized the creation and implementation of the "Superilles" (in Catalan) or Superblock (in English) program in the city. The Superblock program proposed interventions in the public space to promote more diverse and people-centered land uses and provides more infrastructure to encourage walking and cycling. The interventions aim to reallocate space for active transport, reduce the presence and speed of motorized vehicles, increase green spaces and implement infrastructure for resting and social interaction that can improve safety, comfort, attractiveness and social cohesion. By reclaiming public space from road infrastructure, the Superblock program is currently one of the most viable strategies for the city to contribute to climate goals, including mitigation or adaptation and health.

1.1. The Superblocks in barcelona

The original Cerdà plan (Pla Cerdà) of 1855 for the extension of Barcelona is famous for its design including wide streets to promote air flowing - and health (Amati et al., 2023). Each block was originally intended to have an area of open space in the centre, aimed at catering to the health, leisure and commercial needs of the residents. But already by the 1920s, the centres of the housing blocks were filled-in with small constructions and garages. The streets were originally wide to allow for good air flow and further expansion of tramway lines, but by the 1960s and 1970s, were occupied by polluting motorized vehicles (Amati et al., 2023).

Barcelona is a compact and high density city (16000 people per km^2 -1.6 million in total in 2023), with little green space that is unevenly distributed across the city (Mueller et al., 2017a; Mueller et al., 2017b). Although only 1 out of 4 trips are taken by cars within Barcelona, over 60% of public space in streets (i.e., roads and parking lines) is dedicated to motorized vehicles, leading to the highest traffic density in Europe. This has led to high air pollution and noise levels that contribute to high premature mortality and morbidity (Mueller et al., 2017a; Mueller et al., 2017b, Khomenko et al., 2021; Iungman et al., 2021).

Salvador Rueda and colleagues at the Urban Ecology Agency of Barcelona (BCNEcologia 2023 20 years of urban ecology agency in Barcelona) developed the Superblock model in the early 2000s to address these conditions based on the Cerdà Plan. The model is particularly suitable for any urban area with a grid-like system and sufficient population and facility densities, such as Barcelona. A Superblock consists of closing four road junctions in a grid of nine apartment blocks. This allowed for a proposal of 503 Superblocks in Barcelona (Fig. 1, Rueda, 2019). The Superblocks are created on the basis of a new road hierarchy that establishes a network of basic roads, where vehicles will circulate mainly (30 km/h) and a network of local roads with priority for people and cyclists (10 km/h). (BCNEcologia 2023 20 years of urban ecology agency in Barcelona). Under this scenario, 2 out of every 3 streets are pacified, i.e. allowing mainly only active transport and the incorporation of green space. Particularly in warmer climates, the greening of an area holds great significance, as it can considerably reduce the elevated temperatures associated with urban heat islands, and thereby reduce heat-related ill health outcomes, which contribute to premature mortality (Iungman et al., 2023).

Pilot areas of the Superblock model started as early as 2005 when BCNEcologia worked together with the Districts of Gracia and Sants Montjuic to intervene in these areas. Also, the urban interventions in la Ribera in the Born district in the 90's were a form of prototype of the superblock model (BCNEcologia 2023 20 years of urban ecology agency in Barcelona). The first three Superblocks were implemented between 2016 and 2019 under the city council "Omplim de vida els carrers" (Let's fill the streets with life) in Poblenou, Sant Antoni, and Horta. Poblenou (34,000 inhabitants in 2016) is a neighbourhood in the Santa Marti district in the north of the city and used to be very industrial: It is situated along the sea and benefited much from the regeneration of the area as part of the Barcelona Olympics (1992). Over the past 10 years in particularly, it has become a very popular area to live, partly because of its beach and lively Rambla de Poblenou. Sant Antoni (38,000 inhabitants in 2016) is a neighbourhood of the Eixample district, famous for its market which has recently been renovated. It is close to the old city centre. Horta (27,000 inhabitants in 2016) was an independent town that became part of Barcelona in 1904 and is situated in the west of the city towards the hills.

The implementation of first Superblock in the Poblenou neighbourhood of Barcelona received considerable resistance from the local population, due to the ad hoc manner it was implemented, lack of options of citizen participation, and because there were some concerns regarding

gentrification and governance (López et al., 2020; Zografos et al., 2020). Superblocks may lead to gentrification because of the improved quality of life in the area, which may increase rents and house prices. People living there may not be able to afford housing so are forced to move away. In later developments, the City Council changed the strategy, and citizen consultation and participation became one of the key phases of the Superblock implementation. Superblock implementation in Sant Antoni and Horta were better received after citizen participation and co-creation of the final intervention.

1.2. The implementation of the superblock model as green axes in eixample

The consultations by the city council around the Superblocks in Poblenou, Sant Antoni, and Horta combined with morphologic and mobility constraints led to a change to the original Superblock model concept for the Eixample district, with a reduction in the number of streets being pacified to 1 out of every 3 streets instead of 2 out of 3 streets (Fig. 2). It focused on implementation and was referred to, or rebranded, as Green Axes (i.e., "*Eixos Verds*" in Catalan (Magrinyà et al., 2023). The Eixample district is densely populated and suffers some of the highest air pollution levels in the city, partly because of excessive motorized traffic. Before the implementation the Barcelona City Council conducted a detailed analysis of the city: citizen flows and mobility, neighbourhood facilities, green spaces, building and social fabric in the Eixample district. This led to the development of a road hierarchy, resulting in the Green Axes approach whereby some streets are freed from motorized road traffic combined with the creation of a network of green streets and squares where pedestrians have priority.

According to the City Council, this has helped to create a new map of the city where citizens are the central players (Ajuntament de Barcelona). Twenty-one connected green axes were envisaged in the Eixample, with a total of 33 km of street and 21 new squares, which would provide a total of 3.9 ha of new public spaces. The Eixample neighbourhood would gain a total of 33.4 ha of new pedestrian areas and 6.6 ha of urban green areas.

The Green Axes plan for Barcelona aimed to change one third of the streets within the Eixample neighbourhood, by increasing the tree cover and the vegetation, adopting sustainable urban drainage systems, limiting motorized traffic, and providing a safer and more comfortable environment for pedestrians, cyclists, and other social activities in more sustainable and healthier environments (Fig. 2). These changes are greatest at the intersection of the streets, where former traffic junctions are becoming urban squares and gardens.

Magrinyà et al. (2023) provides the rationale behind the transformation, the implementation process and a more in-depth analysis. They showed a more interconnected green infrastructure system and significantly increase in accessibility to green areas as a result of the proposed changes. It creates a city of proximity, improve the well-being of the population, and builds more equitable neighbourhoods. As of 2023, of the original Green Axes plan for the Eixample neighbourhood, only four long streets have been transformed and pacified: Carrer Consell de Cent, Carrer Rocafort, Carrer Girona and Carrer Comte Borell.

Also, the original Superblock plan has become a political campaign that includes many other programmes to improve the city, including: pacification, traffic reduction and greening in major streets (such as Via Laietana, Meridiana, La Rambla), Green Axes, School protection (called"Protegim les escoles"), a new park (Les Glòries), the renovation of the area around a central train station (Sants estació), tram line connections, cycling lanes and Playable cities.

This paper reviews key aspects of the Superblock model, its implementation and initial evaluations in Barcelona, and the potential for international uptake in European or other cities internationally, focusing on environmental, climate, lifestyle, liveability and health aspects.

Results are presented in the form of a summary of findings of the different papers and follow the structure of a) evaluation of Superblock health impacts b) participation and equity issues; as well as c) health impacts assessments of the planned green corridors (i.e., Green Axes). The importance of the Superblock model for European and other cities as discussed in several papers is also presented. Findings are then discussed in regard to their importance for urban planning, the transferability of the concept, as well as research gaps.

2. Methods

Public governance issues are increasingly studied through mixed-method approaches that consider quantitative and qualitative evidence. Meta-reviews have been proposed by Wong et al. (2013), drawing on Greenhalgh et al. (2004), to "illuminate a heterogeneous topic area by highlighting the contrasting and complementary ways in which researchers have studied the same or a similar topic". Meta-narrative

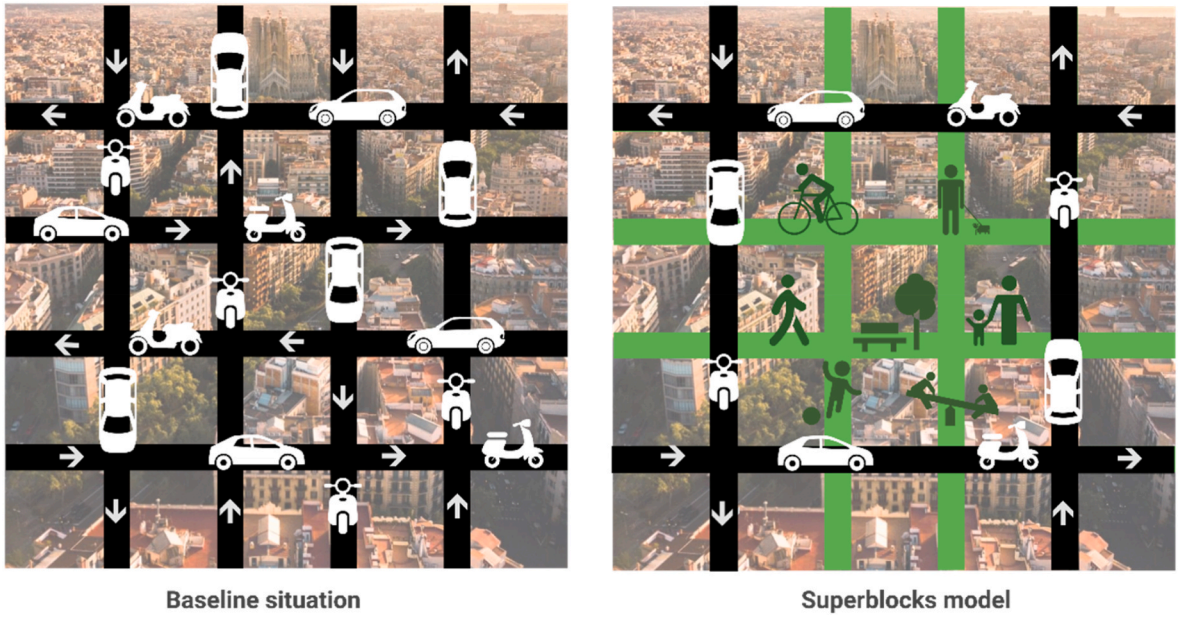

Fig. 1. Schematic scheme of a Super block model before (baseline) and after implementation.

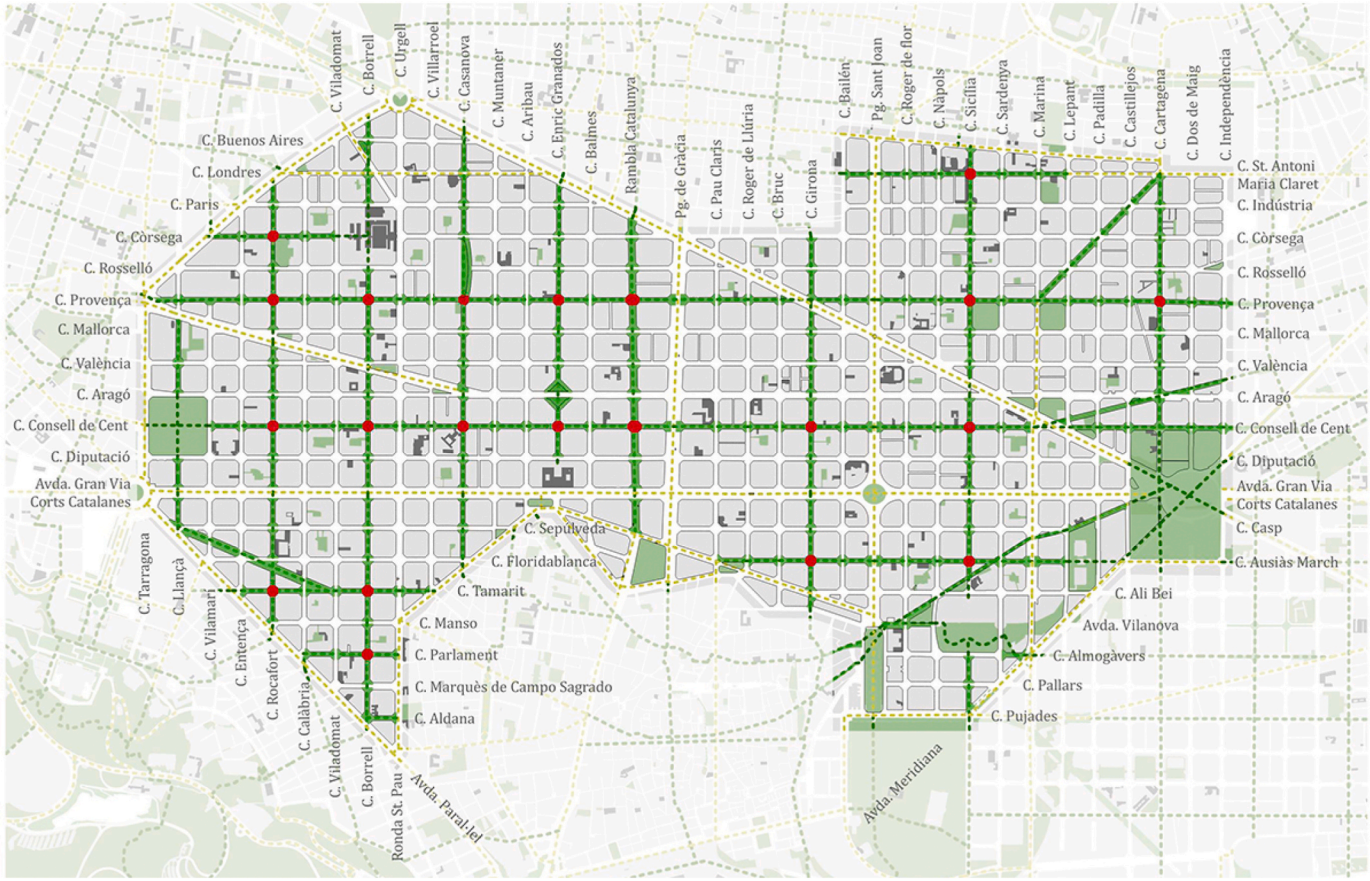

Fig. 2. The proposed Green axis plan in the Eixample district, Barcelona.

analyses in planning contexts have been conducted by for instance Hunter et al. (2019) and Cleland et al. (2020).

This paper presents a narrative meta-review of the urban Superblock model and implementation in Barcelona as Superblock program, and how its implementation has or will affect the environment, climate, equity and health. The work builds on earlier descriptive reviews (e.g. Scudellari et al., 2020, Staricco and Brovarone, 2022; Benavides et al., 2022; Amati et al., 2023). To identify articles, we went through the reference lists of the reviews and searched PubMed and Google scholar databases for "Superblocks", or "Superblock model" as well as the Catalan term *"Superilles"* and Spanish*"* *Supermanzanas"* in combination with and without "Barcelona'', "urban planning", "transport planning", "climate", "health" OR "equity" Additional searches were carried out for "Green Axes", as well as the Catalan term *"Eixos Verds"*), the planned green corridors to connect the Superblocks. We focused on implementation and evaluation studies and both measurement and modelling studies. We only searched for articles written in English, and for the period up to and including December 2023. The search resulted in 12, 500 records (mainly google scholar) with most articles referring in passing to Superblocks. We identified 15 studies and 16 publications which met the inclusion criteria and that provided relevant information (Table 1)Iterative searches for further papers based on the literature in the identified articles revealed no additional papers. We analyzed and summarised the results as a narrative review.

3. Results

We included and describe below 15 studies and 16 publications that were included with a mix of qualitative, measurement and modelling studies, with some focusing on the evaluation of the implementation of the Superblocks, mainly in Barcelona, and with others focusingon the potential implementation of the Superblocks in Barcelona or other cities (Table 1).

3.1. The evaluation of the Barcelona Superblock program

Initially, the Urban Ecology Agency of Barcelona evaluated all pilot areas using a sustainable urban indicators system which included mobility, public space, biodiversity and diversity of economic activities, proximity to services among others. However, no behavioural, environmental or health monitoring was included by the City Council after the implementation. After some criticism, the Barcelona City Council commissioned the Barcelona Public Health Agency to evaluate determinants of health and health effects of the Superblock program. The Agency proposed an evaluation called "Health in the Streets" to assess the potential environmental and health effects, with an equity perspective (Mehdipanah et 2019, Palència et al., 2020). It aimed to evaluate the three Superblocks (Poblenou, Sant Antoni, and Horta), using mixed methods, qualitative, quasi-experimental designs when possible, and health impact assessment (HIA) approaches.

The evaluation employed mixed methodologies including quantitative methods such as (a) In Sant Antoni, use of public space and physical activity levels using the validated System for Observing Play and Recreation in Communities (SOPARC); (b) In Horta, and Sant Antoni, pre–post traffic injury measures with a comparison group; in Horta: (c) a pre–post health survey of representative sample (1200 people) with questions about self-perceived health and quality of life, social support, mental health, mobility, physical activity, neighbourhood characteristics, and housing; (d) pre–post neighbourhood measurements, of particulate matter of less than 10 μm (PM10), particulate matter of less than 2.5 μm (PM2.5) and black carbon; nitrogen dioxide (NO2), (e) pre–post walkability measures using the Microscale Audit of Pedestrian

Table 1
Studies conducted in relation to the Superblocks.

Study	Type of study	Location	Tools	Results
Observational measurement studies				
Palencia et al., 2021	Before and after implementation study of perception, use, physical activity, air pollution and noise	Poblenou, Sant Antoni and Horta neighbourhoods, Barcelona, Spain	Mixed method Questionnaire for perception, Monitors for air pollution and noise Observation using SOPARC	Mixed results by neighbourhoods with better well-being and emotional health, some reduction in air pollution and noise, and changes in use and physical activity and perception
Puig-Ribera et al. (2022)	Observational study of physical activity and sedentary behaviour after implementation	Sant Antoni Superblock and comparison sid Fort Pienc Market Barcelona, Spain	Observation (SOPARC)	Some decrease in use and physical activity, particularly in elderly and teenagers after 1 year of implementation
Alsina-Pagès et al. (2021)	Measurement study of acoustics/ soundscape	Poblenou, Barcelona, Spain	Hush City App and audio clips	Some variation in soundscape throughout points in the neighbourhood
Qualitative studies				
Oscilowicz et al. (2020)	Observational study of perception and use of green spaces	Gentrified La Ribera and recently gentrifying Poblenou, Barcelona, Spain	Observational methods, surveys and interview	Increased use and access to green space may be shortlived because of possible (fear of) displacement
Zografos et al. (2020) Anguelovski et al. (2022)	Qualitative study of transformational land use planning linked with climate adaptation	Poblenou, Barcelona, Spain	In-depth semi structure interviews and reviews of plans and media	Transformational adaptation can be obstructed not only out of fear for the material and political effects of transformation per se, but also because of the message it conveys as concerns of who has the authority to decide for "the common good".
Anguelovski et al. (2023)	Qualitative study transformative planning and equity	Barcelona	Descriptive and review	Gentrification and equity are concerns to be addressed
López et al. (2020)	Qualitative case study mobility and climate	Barcelona	Description, review and critical analyses	The role of political power and institutional leadership has been key in societal acceptance and the achievement of tangible results. But there are also obstacles and drawbacks
Air quality modelling study				
Rodriguez-Rey et al. (2022)	Air pollution modelling study	Eixample area, Barcelona, Spain	Air dispersion model	Decrease of air pollution inside the Superblock/Ejes Verde and increase around it
Health impact assessment studies				
Mueller et al. (2020)	Health impact assessment study of 503 proposed Superblocks	Barcelona, Spain	Urban planning and transport health impact assessment tool (UTOPHIA)	Large reduction in premature mortality due due to reductions in air pollution, noise and heat and increase in green space and physical activity
Vidal Yañez et al. (2023)	Health impact assessment study of Ejes Verdes	Barcelona, Spain	Urban planning and transport health impact assessment tool (UTOPHIA)	A considerable reduction in poor mental health indicators (self-reported, drugs and professional visits)
Opbroek et al. (2023)	Health impact assessment study of Ejes Verdes	Barcelona, Spain	Urban planning and transport health impact assessment tool (UTOPHIA)	A considerable reduction in Total Difficulties and Hyperactivity/Inattention scores and considerable increase in (superior) working memory
Urban planning modelling studies				
Eggimann (2022)	Urban planning modelling study	18 cities worldwide	Geographical information systems and Network flow algorithm	Large part of street network (40%) suitable for Superblocks
Frey et al. (2020)	Urban planning modelling study	Vienna, Austria	Data driven approach	500 suitable Superblock site detected. Roadway space could be decreased and pedestrian space and green space increased
Müller et al. (2020)	Transport modelling study	Vienna, Austria	MATSim	Reduction in car trips and small modal shift with implementation Superblocks
Li and Wilson (2023)	Urban planning and air pollution modelling study	Los Angeles, USA	BenMap-CE	597 potential Superblocks sites identified with significant reduction in hospital admissions and economic savings

Streetscapes (MAPS) tool; and (f) and health impact assessments (Mehdipanah et al., 2019; Biaani León-Gómez et al., 2020). Residents' perception of these effects were studied by using qualitative methods including a guerrilla ethnography, which combines ethnographic observation and semi-structured interviews (Sant Antoni, and Horta) and various focus groups according to different participant characteristics (Poblenou); and (Biaani León-Gómez et al., 2020).

3.2. *Results of the evaluation of the Superblocks in Poblenou, Sant Antoni and Horta*

The air pollution effects in the Superblock areas (Poblenou, Sant Antoni and Horta) varied according to the area with in Sant Antoni, a 25% reduction in NO_2 levels and a 17% reduction in PM10 levels and a decrease in noise levels. In Horta, no statistically significant changes were seen in pollutant levels. In Poblenou, citizens perceived a decrease in pollution, especially noise (Palencia et al., 2021)(Table 1).

In Sant Antoni there was a greater diversity of use and an increase in the use of space after implementation of the Superblock. In Horta, people felt somehow unsafe in streets that were not part of the Superblocks compared to streets that were. In Poblenou, changes were observed particularly for families with children who now used the new children's play areas and for office workers who now used the area for lunch breaks or after work gatherings. However, young people in Poblenou frequently thought that it was a space that was not designed for them, and older people did not use it because it felt as an isolated space, away from the main street (Palencia et al., 2021).

In general, the three Superblocks resulted in benefits in well-being and emotional health, better rest, less noise and air pollution and greater socialization. The areas became quieter, more comfortable and safer environments, which facilitated interaction between neighbours. (Palencia et al., 2021).

Puig-Ribera et al. (2022) described in more detail the use of the Sant Antoni Superblock by citizens. The study does not analyse the effect of the implementation of the Superblock, but focuses on the use after implementation, as the baseline evaluation is in the first week after implementation and not before implementation. They compared the physical activity and sedentary behaviour with a comparison site (Fort Pienc Market) in the first week after implementation and after one year, when the Superblock was fully integrated into citizens' daily life. They used the SOPARC tool and found that visits declined by 12% in the first three observation weeks, and by 17.6% after one year (mainly elderly people and teenagers). In the first week after implementation of the Superblock, 92.9% of citizens visited the Superblock walking, while 3.1% engaged in vigorous physical activity but after one year, citizens' walking decreased by 18.2% (from 2170 to 1930 citizens/hour) and vigorous activities decreased by 11%. The reductions were mainly in elderly and teenagers. They concluded that the Superblock implementation could be improved through targeted physical activity interventions and addressing any equity concerns.

In an interdisciplinary pilot study on urban planning and acoustics in the Poblenou Superblock, Alsina-Pagès et al. (2021) evaluated and recorded sound fragments of 15 people with the Hush City App application, to observe sounds along people's routes, observe the spaces arranged for people and perception of the soundscape by people. Also, acoustic technicians recorded 5-min long audio clips in gardens, pacified streets and Superblock boundary roads, where heavy motor traffic was still present. It provided baseline data for an on-going study. They stated that the Superblock core was associated with lower impact noise events such as birdsong, in contrast to the edges where higher impact traffic sounds were more frequently reported."

3.3. Participation and equity concerns

The implementation of the initial Superblock in Poblenou was not well received by many of the local residents and resulted in widespread protest and banners on apartment buildings against the intervention (Garfield, 2017). But there were also many people in favour such as the "Col·lectiu Superilla Poblenou" although there were not as notable and vocal. Some of the concerns were caused by the lack of information and participation in the process, and others by fear of gentrification.

Oscilowicz, et al. (2020) assessed perceptions and use of green play spaces in the two neighbourhoods of La Ribera and Poblenou of Barcelona, with different degrees of gentrification. They found that gentrification was associated with dissatisfaction of public space and less use by children and families and also lower levels of trust, increased delinquency and a greater sense of insecurity. They observed new place relations and attachment around green play spaces that were highly used by children and their families with early-stage gentrification. Yet, their research also showed a fear of displacement. They concluded that gentrification can provide short-term green benefits in terms of use and access, but possible long-term losses for socially vulnerable families in gentrifying neighbourhoods.

Zografos et al. (2020), and later Anguelovski et al. (2022), analyzed the Poblenou Superblock in the light of transformational land use planning linked with climate adaptation. They concluded that the key driver behind opposition to the Superblock were everyday political struggles for municipal authority, which resulted in clashing visions for the future city. They stated that urban transformation is as much about competitive urbanism and related short-term political gains, as it is about the importance of environmental and quality-of-life benefits that may result from the changes. They concluded that transformations can not only be obstructed by fear of change, but also about who decides the change. Anguelovski et al. (2023) also argue that questions about distributional and relational equity, including intersectional equity-driven, needs assessment and prioritization; spatialized local benefits or burdens; mobility justice goals; exclusion and green gentrification, together with procedural equity, including new models of participation, must be high on the agenda for transformative planning to achieve urban justice for all. They suggested that such transformative plans may also involve key trade-offs between addressing social and environmental vulnerabilities.

Finally, López et al. (2020) studied the Superblock model in relation to climate change and suggested that the role of political power and institutional leadership is key in societal acceptance and achieving results. To obtain reduction in private vehicle traffic more public transportation is needed to achieve broader positive socio-ecological effects. Also, if social inequality and justice are not taken into account, gentrification is possible.

3.4. Air quality modelling of the superblocks

In a recent air pollution modelling study, the Barcelona Supercomputing Centre estimated the effects of part of the Super block plan on air quality in Barcelona. Rodriguez-Rey et al. (2022) quantified the impact of part of the Superblocks in the Eixample area and the city-wide Low Emission Zone (LEZ). They found that traffic reduction measures are needed to see benefits in air quality and that the Superblocks or LEZ alone will not achieve benefits. Only inside the Superblock area they observed reductions in air pollution (±17%) but these were offset by increases around the area. An important limitation of the study that only a few Superblocks pilot areas were modelled, the model re-routed the motorized traffic around the pilot areas rather than assuming an overall reduction or "evaporation" in motorized traffic, although this second scenario is more likely to occur-as has been shown in previous studies in Barcelona (Nello Deakin, 2022).

3.5. Health impact assessment of the superblock model

Health impact assessments answer "what if" questions and are useful to demonstrate the potential health benefits or risks of proposed policies. A health impact assessment estimated that 667 premature deaths (95% CI: 235-1098) could be prevented annually, if all the originally proposed 503 Superblocks would be implemented (Mueller et al., 2020). These deaths could be prevented by reductions in NO_2 (291, 95% PI: 0–838), noise (163, 95% CI: 83–246) and heat (117, 95% CI: 101–137), and increases in green space (60, 95% CI: 0–119). Also, increases in physical activity would result in 36 preventable deaths (95% CI: 26–50). This is likely to be a large underestimation of the true increases of physical activity because no data were available on how people would use the new spaces and how this may change overall physical activity levels of the population, and hence these aspects were not included in the assessment. Overall, there would be an average increase in life expectancy for the Barcelona adult population of almost 200 days (95% CI: 99–297), and an annual economic impact of 1.7 billion EUR savings.

3.6. Health impacts of the green axes

Vidal Yañez et al. (2023) conducted a health impact assessment of the Green Axes Plan and estimated an average increase of 5.67 % of green areas (range: 0.00%–15.77%) and 0.059 increase in Normalized Difference Vegetation index (NDVI) (range: 0.000 to 0.312), a measure of green space. They calculated that with full implementation of the Green Axes Plan, 31,353 (95%CI: 18,126–42,882) cases of self-perceived poor mental health (14.03% of total), 16,800 (95%CI: 6828–25,700) visits to mental health specialists (13.37% of total), 13,375 (95%CI: 6107–19,184) cases of antidepressant use (13.37% of total), and 9476 (95%CI: 802–16,391) cases of tranquilliser/sedative use (8.11% of total) could be prevented annually, corresponding to over 45 M € savings in mental health costs annually.

Also, Opbroek et al. (2023) performed a quantitative health impact assessment for Barcelona Green Axes Plan, but for children focusing on child behavioral and cognitive development outcomes. Based on expected green space increases, children's Total Difficulties and

Hyperactivity/Inattention scores were projected to decrease by 5% (95% CI: 0–15%) and 6% (95% CI: 0–17%). Working Memory and Superior Working Memory scores were expected to increase by 4% and 5%, respectively, while the Inattentiveness score could be reduced by 1%.

4. The superblock model in a european and international context

4.1. Applying the superblock model outside barcelona

The Superblock model has received international recognition and forms part of new scientific work on how and where to implement the Superblock model. For example, Eggimann (2022) developed a data-driven geospatial methodology for automatic detection of superblock potentials in 18 cities worldwide, with various shapes and sizes. In addition, the suitability of superblock potentials concerning traffic flow exposure was assessed with the help of a network flow algorithm. For some cities, over 40% of the street network was potentially suitable for integrating Superblocks, providing opportunities for city-scale transition towards more sustainable and liveable cities. They stated that a grid-like layout in cities is not a mandatory condition for high superblock potential, and that also cities with irregular street layouts can show high transformation potential as well.

Frey et al. (2020) also developed and applied a data-driven approach for detecting potential Superblocks sites in Vienna, considering urban morphological criteria. By intersecting the densely populated areas of Vienna with the main roads and the public transport network (tramway and bus) more than 700 superblock "candidates" were identified, of which over 500 were large enough to be considered suitable. For prioritising future implementation, indicators such as population density, public transport accessibility, access to public green, tree shading, and the spatial distribution of public space between pedestrians and cars were overlaid. An in-depth analysis of three potential Superblocks considering underground infrastructure showed that the roadway area could be reduced by 10 %, space for pedestrians could be increased by up to 30 %, more than 5 times as much green infrastructure and up to 7 times more trees could be fitted into the public space. Modelling the effects of a Superblock implementation in these three areas in Vienna by adding additional travel time to car trips starting or ending in the superblock, Frey et al. (2020) showed, that 3–14 % of the trips of the citizens would be affected directly: the mode share of car trips starting in the Superblock areas would decline by up to 60 %, while especially the public transport trips would increase.

Another approach to modelling the traffic impacts of the superblock was developed by Müller et al. (2023). They used the multi-agent traffic simulation MATSim to simulate traffic shifts of agents affected by the introduction of a superblock in Vienna. The study simulated multiple combinations of Superblocks to determine if more than one superblock has a stronger impact than a single one. The results show that the effect of multiple Superblocks is linear, with one superblock reducing the number of car trips by 100 per day. The modal shift of 0.5% from car to other modes is assumed to be very small and could be due to difficulties in properly modelling the lower attractiveness of cars and the higher attractiveness of active modes in a superblock.

Li and Wilson (2023) modelled the health benefits that would accrue from transforming 5, 10, 20, 30 and 50% of the residential neighbourhoods in the City of LA into Superblocks. They had five rules to guide the choice of arterial streets, candidate blocks and major bounding streets. After applying the first four rules of the LA Superblocks Model, they generated 950 Superblock candidates, but found that a subset of the candidates was either very small or did not contain sufficient interior road segments and ended up with a final list of 597 Superblocks. They performed a quantitative assessment of the air pollution using the BenMap-CE model and found significant reductions in hospital admissions and significant economic savings. Economic benefits indicated by annual values saved from hospital admissions increased the fastest when 5–10% of the residential areas were transformed and the rate gradually decreased afterwards and became less perceptible when 30–50% of the residential areas were transformed.

An ongoing Joint Programming Initiative Urban Europe funded project TuneOurBlock (TuneOurBlock, 2023) aims to identify implementation pathways and strategies for successful stakeholder engagement toward the expansion of the superblock concept as a policy and planning strategy for transformative urban adaptation. These strategies and stakeholder-specific methods are tested and evaluated in urban living labs in Vienna and Berlin. Part of the work is the modeling of Superblocks with the help of traffic simulations. Findings on traffic effects will then be integrated in discussions with stakeholders, using planning tools. An experts' survey has already been conducted to gather the insights of a diverse group of experts to validate the basic assumptions in regards to the Superblock concept. The panel of experts consisted of recognized academics and practitioners in urban development in the field of sustainable urban mobility and transformation, mainly from Europe. The findings resulted in a working, broad definition of the Superblock concept. Further, a municipal peer group of technical representatives from various European cities was created as a platform to exchange on recent developments on Superblocks and Superblock-like concepts. These and other representatives from fifteen European cities met to discuss the Superblocks during the first International Superblock Meeting, hosted by the City of Barcelona. From 22nd to March 25, 2023 (Barcelona meeting), politicians and technicians from Paris, London, Copenhagen, Berlin, Milan, Vienna, Rotterdam, Brussels, Ljubljana, Ghent, Lodz, Vitoria-Gasteiz. Valencia, Barcelona and Zurich attended the event and discussed recent developments in their cities, common challenges and possible solutions. A further meeting in Berlin will be held to expand on conclusions from the first meeting as well as discuss the more general notion of Superblock implementation pathways and strategies.

5. Discussion

The implementation of the Superblock model in Barcelona has been slow, but, where it has been implemented, improvements in, for example, environmental, lifestyle, liveability and health indicators have been shown, but not consistently. Simulation models have shown that, when applied on a large scale, the implementation of the Superblock model is likely to result in better environmental conditions, health and wellbeing, particularly inside the Superblocks, and to contribute to the fight against the climate crisis. Superblocks have also been controversial however, and real concerns over environmental equity and gentrification, traffic and related exposures' displacement have been raised, and need further investigation. The Superblock model has gained a growing international reputation and variations of it are now being planned or implemented in cities worldwide. An initial modelling exercise showed that it could be implemented in large parts of many cities in Europe. Despite the good intentions of the Superblock projects there are lessons that should be learned for subsequent implementations to avoid unintended consequences or limited impacts. Further research is urgently needed to evaluate the impacts of the implementation of the Superblocks to obtain a larger evidence base.

The implementation of the Superblocks in Barcelona has been slow and the implementation strategy changed due to citizen concerns and to changing political structures and authorities. In May 2023, the mayor Ada Colau-led local Barcelona government lost power and Jaume Collboni of the Catalan Socialist Party became the new mayor, which has left an uncertain future for the Barcelona Superblock program. During the election campaign Collboni campaigned against the Superblocks. The Superblock/Green Axes program was an important part of Colau's government election campaign, but did not appear to be a great vote winner for, and the elections seem to have been decided by other issues (Pauné and Moya, 2023). There were neither gains or losses in votes compared to the 4 years earlier in the areas within the new Green Axes,

indicating Colau lost more votes in areas that did not experience any neighbourhood changes.

Controversy and political backlash over car reduction strategies are not unique to the Barcelona Superblock experience. Previous studies have also documented dissent (Wild et al., 2018, Lambe et al., 2017; Field et al., 2018; Timmons et al., 2023). A recurring theme explaining such oppositions is concerns over negative impacts on local commerce, even though most research to date tends to show opposite outcomes (Volker and Handy, 2021). Public doubt or under-estimation of the scale of benefits expected from pro-environmental behaviour or from environmental changes have also been shown to play a role (Timmons et al., 2023). Experiencing change, however, has been shown to lead to better acceptance of interventions (Timmons et al., 2023), which seemed to be the case in Barcelona. In the absence of such occurrence where instead benefits are just communicated to members of the public, the "messenger" matters (Riley et al., 2021). The lack of trust in politicians and authorities may lead to further rejection of schemes (Timmons et al., 2023), which may also have had an impact in the case of Barcelona. Robust and independent research that is effectively communicated may thus be an important component of implementing such strategies. In Barcelona many more public consultations were organised where plans were explained and people could participate in the decision making, which improved the communication and acceptance.

In Barcelona, both simulations and before-after evaluations of impacts were carried out. The evaluation of the initial three Superblocks (Poblenou, Sant Antoni and Horta) showed some, but not consistent, lifestyle, environmental and health benefits. These evaluations are notoriously difficult to conduct though, and do not always show benefits because of the scale they are conducted. The simulations including health impact assessments showed large potential benefits, partly because they were done on a larger scale. Evaluations of active travel schemes such as London Low Traffic Neighbourhoods have also shown a tendency for health improvements such as increased physical activity, decrease traffic injuries, and reductions of air pollution (Aldred, 2019; Aldred and Goodman, 2020; Laverty et al., 2021; Yang et al., 2022).

The air quality modelling study showed that some benefit on air quality in the areas of the proposed Superblocks could be expected, but also an increase in air pollution with bordering areas of the Superblocks, due to re-routed traffic (which were based on assumptions not facts), if other policies are not simultaneously implemented such mobility demand management or low emission zones. This is not necessarily fully supported with the very few measurement studies of impacts of car reduction strategies (Yang et al., 2022). However, as for most transport interventions, it is clear that a package of measures is required to effectively promote health, rather than policies in isolation (de Nazelle et al., 2011). The mixed results of the Barcelona implementation evaluation studies indicate that the current measures are not ambitious enough and that a more rapid and extensive implementation at the scale of the original Superblock model (i.e. 503 Superblocks), covering all parts of the city, is needed to obtain the full benefits that have been project by the environmental, health and economic impact study conducted by Mueller et al. (2020).

This should also be combined with other measures such as e.g. low emission zones (LEZs), increasing the cycling network and allowing for multimodality (e.g. taking the bike or electric scooter on the train), extend the tram line system, and generally ensuring high connectivity of public transport, setting a speed limit of 30 km/h on all roads, enforcing legal action on offenders, transformation and pacification of areas around schools, creation of new parks (e.g. Glories) and green networks (green avenues such as the Ramblas in Barcelona throughout the city), to obtain maximum benefits for the environment, climate, health and economy (Nieuwenhuijsen, 2023). Stimulating the local economy and retail sector, and reducing e-commerce is essential to create lively and sustainable neighbourhoods. Finally, improving urban planning and the public transport system serving the metropolitan area are essential to reduce the traffic flow in and out of Barcelona City, and maximize the potential of the metropolitan area and make it more sustainable, liveable and healthy. Such measures must be put in place with equity in mind throughout.

An important and fair criticism that has been raised with regards to Superblocks are issues of fairness and equity in both process and implementation. This has been identified in previous research as also contributing to opposition to neighbourhood schemes that aim at reducing car use or promoting active travel (Lambe et al., 2017; Timmons et al., 2023). As much as the perceived potential inequity of outcome, the lack of control and lack of meaningful consultation is often to blame in such instances (Timmons et al., 2023), as was also the case in Barcelona.

Meaningful consultation, and effective communication on benefits throughout the consultation process will help engage the public positively, including helping the silent majority voice potential favourable opinions of car reduction schemes (Timmons et al., 2023). Communication approaches should keep in mind that different individuals will have different interests and that messaging should be individually or group tailored and not be generic. Also it should take into account that positive framing and trust-worthy messengers will help engage (Riley et al., 2021).

The implementation of the Superblock model in Barcelona should not be seen in isolation in Europe as many cities in Europe implement new innovative urban models (e.g. 15-minute city, low traffic neighbourhoods, car free city), and measures that shift private car use to active and public transportation and increase green space in cities (Moreno et al., 2021; Nieuwenhuijsen, 2021; Yang et al., 2022). This is a trend that has been going on for a number of years and was accelerated during the COVID19 pandemic. The trend is to move away from outdated 20th century car-centric city models to 21st century people-centric city models that not only take into account mobility, but also sustainability, liveability as well as population and planetary health.

As has been shown by Eggimann (2022), Li and Wilson (2023) and the TuneOurBlock project (TuneOurBlock, 2023), the Superblock model can be, and already is, being applied to cities other than Barcelona, such as Berlin, Vienna, Bogota, etc. albeit perhaps on a less ambitious scale. Important for a successful implementation, as evidenced by the Barcelona experience, are the active participation and co-creation perspective together with the local population, and also adapting to local contexts, i.e. considering diversity of neighbourhoods. The Superblock model is likely to work best in high density neighbourhoods, where a large range of amenities, shops, employment and cultural opportunities are available, and the public space is appropriately used.

In the European policy context, new urban models and policies are being considered in various aspects of the European Green Deal. The EU has set an agendas and initiatives that aims at addressing the need for advancement in urban sustainability, climate neutrality and promoting well-being and Superblocks are well suited to deliver on this. Within those agendas, concrete funding for cities are available for ambitious implementation of projects that promote citizens' well-being and sustainability. For example, the Urban Agenda for the EU brings together the Commission, national ministries, city authorities and other stakeholders to promote better laws, easier access to funding and more knowledge sharing on issues relevant for cities. The Urban Agenda for the EU offers a new form of multilevel and multi-stakeholder cooperation with the aim of strengthening the urban dimension in EU policy (European Commission, 2023).

Another initiative that promotes sustainable and inclusive future is the New European Bauhaus is a creative and interdisciplinary initiative that connects the European Green Deal to our living spaces and experiences (European Commision, 2023b). Furthermore, the aim of EU Mission on Climate-Neutral and Smart Cities is to 1) deliver 100 climate-neutral and smart cities by 2030 and to 2) ensure that these cities act as experimentation and innovation hubs to enable all European cities to follow suit by 2050 (European Commision, 2023c). Cities have

accelerated urban transformations, moving from the concept of infrastructure for processes to the infrastructure for healthy living and contemplating physical space that achieve 'liveable communities' standards (Jevtic et al., 2022).

Finally, concerns like equity and gentrification, traffic displacement, house (rental) prices, and reduced retail sales should be addressed as they are often raised as objections to the Superblock development. Equity and gentrification, and related displacement of residents, are particularly concerns if Superblock implementation and related benefits only take place in selected neighbourhoods or urban areas and other areas, potentially already more marginalized, are left behind. Therefore, appropriate policies, that e.g. control real estate speculations, should be put in place to avoid displacement of residents and/or make sure that the whole city benefits by applying the transformation at scale. Displacement of, and increase in, motorized traffic to streets within the Superblocks that are not pacified, or to areas around the Superblocks, have been particular concerns. Recent study showed though that developments such as the Superblocks e.g. tactical urbanism or Low traffic neighbourhoods may actually not lead to displacement of traffic, but to so called evaporation of traffic because people cut out e.g. unnecessary journeys (Yang et al., 2022; Nello Deakin, 2022; Thomas and Aldred, 2024). A particular concern of the retail sector is that a reduction in car traffic (and car parking) may lead to reduction in sales, but actually the opposite may occur as was shown in a recent study looking at the impacts of pedestrianization in Spanish cities (Yoshimura et al., 2022).

The limitation of the work so far is the relatively small number of studies, and not always of good quality that have conducted so far in terms of evaluation of Superblocks, partly because not many have been implemented yet. Such evaluations are important to justify and inform policies and should always been part of new implementations. However, evaluations are notoriously difficult to conduct and very resource intensive, but also necessary. Further research should focus on a range of environmental, lifestyle, social, economic and health changes that may happen when new Superblocks are implemented to inform future policy making. There is a need for more longitudinal studies in Barcelona and other places where Superblocks are implemented. Early empirical measurement studies showed mixed results, which need to be refuted or confirmed by further studies.

In conclusion, the Superblock model is an innovative urban model that addresses environmental, climate, liveability and health concerns in cities. The initial evaluation of the model in Barcelona showed health and environmental benefits, but needs further expansion of the program and evaluation of its impacts and answers to related concerns, such as environmental equity and gentrification, traffic and related exposures' displacement and reduced retail sales. Adapted versions of the Barcelona Superblock model are being implemented in cities around Europe and further implementation, monitoring and evaluation are encouraged. The implementation of the Superblock model is coherent with and supports EU frameworks, policies and guidelines for sustainable transport planning, climate change action and living and working in a health promoting environment, such as the European Green Deal and the Mission on Climate Neutral and Smart Cities.

CRediT authorship contribution statement

Mark Nieuwenhuijsen: Writing – review & editing, Writing – original draft, Supervision, Methodology, Data curation, Conceptualization. **Audrey de Nazelle:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Marta Cirach Pradas:** Writing – review & editing, Supervision, Investigation. **Carolyn Daher:** Writing – review & editing, Supervision, Project administration, Investigation. **Angel M. Dzhambov:** Writing – review & editing, Supervision, Investigation. **Cynthia Echave:** Writing – review & editing, Validation, Supervision, Investigation. **Stefan Gössling:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Tamara Iungman:** Writing – review & editing, Investigation. **Haneen Khreis:** Writing – review & editing, Investigation. **Nicolina Kirby:** Writing – review & editing, Investigation. **Sasha Khomenko:** Writing – review & editing, Supervision, Methodology. **Ulrich Leth:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Florian Lorenz:** Writing – review & editing, Methodology. **Vlatka Matkovic:** Writing – review & editing, Investigation. **Johannes Müller:** Writing – review & editing, Methodology. **Laia Palència:** Writing – review & editing, Supervision, Investigation. **Evelise Pereira Barboza:** Writing – review & editing, Supervision, Methodology. **Katherine Pérez:** Writing – review & editing, Supervision, Investigation. **Lambed Tatah:** Writing – review & editing, Investigation. **Jernej Tiran:** Writing – review & editing, Supervision, Methodology. **Cathryn Tonne:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Natalie Mueller:** Writing – review & editing, Methodology, Investigation, Conceptualization.

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.

Data availability

No data was used for the research described in the article.

Acknowledgements

We acknowledge support from the Spanish Ministry of Science and Innovation and State Research Agency through the "Centro de Excelencia Severo Ochoa 2019–2023" Program (CEX2018-000806-S), and support from the Generalitat de Catalunya through the CERCA Program".

The SUPERBE project ("Potenziale von Superblock-Konzepten als Beitrag zur Planung energieeffizienter Stadtquartiere") has received funding from the Austrian research funding programme "Stadt der Zukunft". "Stadt der Zukunft" is a Funding Programme of the Republic of Austria, Federal Ministry for Transport, Innovation and Technology. The Austrian Research Promotion Agency (FFG) has been authorised for the Programme Management.

The TuneOurBlock project ("Transforming urban quarters to human scale environments: applying superblock concepts for different urban structures") has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875022. The authors also acknowledge financial support from the Slovenian Research and Innovation Agency (H6-8290) under agreement no. 1000-23-0618 and research core/project funding Geography of Slovenia (P6-0101).

Strategic research and innovation program for the development of Medical University – Plovdiv" № BG-RRP-2.004-0007-C01, Establishment of a network of research higher schools, National plan for recovery and resilience, financed by the European Union – NextGenerationEU.

Angel M. Dzhambov's and Mark J. Nieuwenhuijsen's time on this publication is partially supported by the "Strategic research and innovation program for the development of Medical University – Plovdiv" № BG-RRP-2.004-0007-C01, Establishment of a network of research higher schools, National plan for recovery and resilience, financed by the European Union – NextGenerationEU".

This project has received funding from the European Union's, Horizon Europe Framework Programme (HORIZON) under GA No 101094639 - THE URBAN BURDEN OF DISEASE ESTIMATION FOR POLICY MAKING (UBDPolicy).

A podcast about the Superblocks is available here: https://play.acast.com/s/streets-ahead/mark-nieuwenhuijsen-in-barcelona.

References

Ajuntament de Barcelona. Superblocks. https://ajuntament.barcelona.cat/superilles/en/ Accessed 28 January 2024.

Aldred, R., 2019. Built environment interventions to increase active travel: a critical review and discussion. Curr. Envir. Health Rpt. 6, 309–315.

Aldred, R., Goodman, A., 2020. Low Traffic Neighbourhoods, Car Use, and Active Travel: Evidence from the People and Places Survey of Outer London Active Travel Interventions. Findings, September.

Alsina-Pagès, R.M., Ginovart-Panisello, G.J., Freixes, M., Radicchi, A., 2021. A Soundwalk in the heart of Poblenou superblock in Barcelona: preliminary study of the acoustic events. Noise Mapp. 8 (1), 207–216.

Amati, M., Stevens, Q., Rueda, S., 2023. Taking Play Seriously in Urban Design: the Evolution of Barcelona's Superblocks, vol. 12063312231159229. Space and Culture.

Anguelovski, I., Honey-Rosés, J., Marquet, O., 2023. Equity Concerns in Transformative Planning: Barcelona's Superblocks under Scrutiny. Cities & Health, pp. 1–9.

Anguelovski, I., Zografos, C., Klause, K.A., Connolly, J.J., 2022. Urban transformational adaptation: contestation and struggles for authority in the pilot Barcelona superblock of Poblenou. In: Urban Resilience to the Climate Emergency: Unravelling the Transformative Potential of Institutional and Grassroots Initiatives. Springer International Publishing, Cham, pp. 65–91.

Barcelona meeting (2023). Accessed Feb 2, 2024. https://www.barcelona.cat/en/noticia/barcelona-superblock-international-meeting-22-to-25-march_1265393.

BCNEcologia 2023 20 years of urban ecology agency in Barcelona https://bcnroc.ajuntament.barcelona.cat/jspui/bitstream/11703/122999/3/BCNecologia_20%20years_ENG.pdf Accessed 5 October 2023.

Benavides, J., Usmani, S., Kioumourtzoglou, M.A., 2022. Scaling the Superblock model to city level in Barcelona? Learning from recent policy impact evaluations. Contesti. Città, territori, progetti (2), 79–94.

Biaani León-Gómez, B., Palència, L., Pérez, C., 2020. Methodological guide for the evaluation of the environmental and health effects of the Superblocks model in Barcelona. In: Salut as Carrers (Health in the Streets) Project. Agència de Salut Pública de Barcelona, Barcelona. https://www.aspb.cat/documents/english-aspb_salut-carrers-methodology-superblocks.

Cerdà I. General Theory of Urbanization 1867 Translated by Angela Kay Bunning 2018. Editor: Guallart Vicente, Institut d'Arquitectura Avançada de Catalunya.

Cleland, C.L., McComb, K., Kee, F., Jepson, R., Kelly, M.P., Milton, K., et al., 2020. Effects of 20 mph interventions on a range of public health outcomes: a meta-narrative evidence synthesis. J. Transport Health 17, 100633.

Eggimann, S., 2022. The potential of implementing Superblocks for multifunctional street use in cities. Nat. Sustain. 5 (5), 406–414.

European Commission, 2023. https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/urban-agenda-eu_en. (Accessed 6 December 2023).

European Commision, 2023b. https://new-european-bauhaus.europa.eu/index_en. (Accessed 6 December 2023).

European Commision, 2023c. https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en#what-are-eu-missions. (Accessed 6 December 2023).

Field, A., Wild, K., Woodward, A., Macmillan, A., Mackie, H., 2018. Encountering bikelash: experiences and lessons from New Zealand communities. J. Transport Health 11, 130–140.

Frey, H., et al., 2020. Potenziale von Superblock-Konzepten als Beitrag zur Planung energieeffizienter Stadtquartiere. SUPERBE, vol. 90. Wien. https://nachhaltigwirtschaften.at/resources/sdz_pdf/schriftenreihe-2020-42-superbe.pdfAccessed6Dec2023.

Garfield, L., 2017. Spain's Plan to Create Car-free 'superblocks' Is Facing Protests. https://www.businessinsider.com/barcelona-superblocks-protest-2017-1, 28 jan 2024.

Gössling, S., 2020. Why cities need to take road space from cars-and how this could be done. J. Urban Des. 25 (4), 443–448.

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., Kyriakidou, O., 2004. Diffusion of innovations in service organisations: systematic literature review and recommendations for future research. Milbank Q. 82, 581–629. https://doi.org/10.1111/j.0887-378X.2004.00325.x.

Hunter, R.F., Cleland, C., Cleary, A., Droomers, M., Wheeler, B.W., Sinnett, D., et al., 2019. Environmental, health, wellbeing, social and equity effects of urban green space interventions: a meta-narrative evidence synthesis. Environ. Int. 130, 104923.

Iungman, T., Khomenko, S., Nieuwenhuijsen, M., Barboza, E.P., Ambròs, A., Padilla, C. M., Mueller, N., 2021. The Impact of Urban and Transport Planning on Health: Assessment of the Attributable Mortality Burden in Madrid and Barcelona and its Distribution by Socioeconomic Status. Environmental Research, 110988.

Iungman, T., Cirach, M., Marando, F., Pereira Barboza, E., Khomenko, S., Masselot, P., Quijal-Zamorano, M., Mueller, N., Gasparrini, A., Urquiza, J., Heris, M., Thondoo, M., Nieuwenhuijsen, M., 2023. Cooling cities through urban green infrastructure: a health impact assessment of European cities. Lancet Jan 31. S0140-6736(22)02585-5.

Jevtic, M., Matkovic, V., Paut Kusturica, M., Bouland, C., 2022. Build healthier: post-COVID-19 urban requirements for healthy and sustainable living. Sustainability 14, 9274. https://doi.org/10.3390/su14159274.

Khomenko, S., Cirach, M., Pereira-Barboza, E., Mueller, N., Barrera-Gómez, J., Rojas-Rueda, D., de Hoogh, K., Hoek, G., Nieuwenhuijsen, M., 2021. Premature mortality due to air pollution in European cities: a health impact assessment. Lancet Planet. Health S2542–5196 (20), 30272-2.

Lambe, B., Murphy, N., Bauman, A., 2017. Smarter Travel, car restriction and reticence: understanding the process in Ireland's active travel towns. Case Studies on Transport Policy 5, 208–214.

Laverty, A.A., Aldred, R., Goodman, A., 2021. The impact of introducing low traffic neighbourhoods on road traffic injuries. In: Findings January, London, 2021.

Li, K., Wilson, J.P., 2023. Modeling the health benefits of superblocks across the city of los angeles. Appl. Sci. 13 (4), 2095.

López, I., Ortega, J., Pardo, M., 2020. Mobility infrastructures in cities and climate change: an analysis through the superblocks in Barcelona. Atmosphere 11 (4), 410.

Magrinyà, F., Mercadé-Aloy, J., Ruiz-Apilánez, B., 2023. Merging green and active transportation infrastructure towards an equitable accessibility to green areas: Barcelona green axes. Land 12 (4), 919.

Mehdipanah, R., Novoa, A.M., León-Gómez, B.B., López, M.J., Palència, L., Vasquez, H., et al., 2019. Effects of Superblocks on health and health inequities: a proposed evaluation framework. J. Epidemiol. Community Health 73 (7), 585–588.

Moreno, C., Allam, Z., Chabaud, D., Gall, C., Pratlong, F., 2021. Introducing the "15-Minute City": sustainability, resilience and place identity in future post-pandemic cities. Smart Cities 4, 93–111.

Mueller, N., Rojas-Rueda, D., Basagaña, X., Cirach, M., Cole-Hunter, T., Dadvand, P., Donaire-Gonzalez, D., Foraster, M., Gascon, M., Martinez, D., Tonne, C., Triguero-Mas, M., Valentín, A., Nieuwenhuijsen, M., 2017a. Urban and transport planning related exposures and mortality: a health impact assessment for cities. Environ. Health Perspect. 125 (1), 89–96.

Mueller, N., Rojas-Rueda, D., Basagaña, X., Cirach, M., Cole-Hunter, T., Dadvand, P., Donaire-Gonzalez, D., Foraster, M., Gascon, M., Martinez, D., Tonne, C., Triguero-Mas, M., Valentín, A., Nieuwenhuijsen, M., 2017b. Health impacts related to urban and transport planning: a burden of disease assessment. Environ. Int. 107, 243–257.

Mueller, N., Rojas-Rueda, D., Khreis, H., Cirach, M., Andrés, D., Ballester, J., Bartoll, X., Daher, C., Deluca, A., Echave, C., Milà, C., Márquez, S., Palou, J., Pérez, K., Tonne, C., Stevenson, M., Rueda, S., Nieuwenhuijsen, M., 2020. Changing the urban design of cities for health: the superblock model. Environ. Int. 134, 105132.

Müller, J., Straub, M., Stubenschrott, M., Graser, A., 2023. Simulation of a full-scale implementation of superblocks in Vienna. In: 15th ITS European Congress. https://publications.ait.ac.at/de/publications/simulation-of-a-full-scale-implementation-of-superblocks-in-vienn.

Nabielek, K., Hamers, D., Evers, D., 2016. Cities in Europe - Facts and Figures on Cities and Urban Areas. PBL Netherlands Environmental Assessment, The Hague, Netherlands.

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., Leyden, K.M., Marshall, J.D., Matamala, J., Mellios, G., Mendez, M., Nassif, H., Ogilvie, D., Peiró, R., Pérez, K., Rabl, A., Ragettli, M., Rodríguez, D., Rojas, D., Ruiz, P., Sallis, J.F., Terwoert, J., Toussaint, J.F., Tuomisto, J., Zuurbier, M., Lebret, E., 2011. Improving health through policies that promote active travel: a review of evidence to support integrated health impact assessment. Environ Int. May 37 (4), 766–777.

Nello-Deakin, S., 2022. Exploring traffic evaporation: findings from tactical urbanism interventions in Barcelona. Case Studies on Transport Policy 10 (4), 2430–2442.

Nieuwenhuijsen, M.J., 2020. Urban and transport planning pathways to carbon neutral, liveable and healthy cities; A review of the current evidence. Environ. Int. 6, 105661.

Nieuwenhuijsen, M.J., 2021. New urban models for more sustainable, liveable and healthier cities post covid19; reducing air pollution, noise and heat island effects and increasing green space and physical activity. Environ. Int. Sep 6, 106850.

Nieuwenhuijsen M 2023 https://www.isglobal.org/en/healthisglobal/-/custom-blog-portlet/electric-cars-and-bikes-will-not-save-citi-1/4735173/0 Accessed June 24 2023.

Opbroek, J., Pereira Barboza, E., Nieuwenhuijsen, M., Dadvand, P., Mueller, N., 2023. Urban green spaces and behavioral and cognitive development in children: a health impact assessment of the Barcelona "Eixos Verds" Plan (Green Axis Plan). Environ. Res. 244, 117909.

Oscilowicz, E., Honey-Rosés, J., Anguelovski, I., Triguero-Mas, M., Cole, H., 2020. "Young Families and Children in Gentrifying Neighbourhoods: How Gentrification Reshapes Use and Perception of Green Play Spaces". Local Environment, pp. 1–22.

Palència, L., León-Gómez, B.B., Bartoll, X., Carrere, J., Díez, E., Font-Ribera, L., et al., 2020. Study protocol for the evaluation of the health effects of superblocks in Barcelona: the "salut als carrers"(health in the streets) project. Int. J. Environ. Res. Publ. Health 17 (8), 2956.

Palencia, Katherine Perez, Leon-Gomez, Brenda Biaani, Olabarria, Marta, , Maria Jose Lopez, Gomez, Anna, Mari-dell'Olmo, Marc, Rico, Marc, Puig-Ribera, Anna, Arumi-Prat, Ignasi, Cirera, Eva, Sola Serrabou, Marta, Anna, Codina, Marquez, Sandra, Cirach, Marta, Carrasco, Gloria, 2021. Report of results of the environmental and health effects of the Superblocks model in Barcelona. In: Salut Als Carrers (SAC) Project. Agència de Salut Pública de Barcelona, Barcelona. https://www.aspb.cat/wp-content/uploads/2021/10/English-ASPB_salut-carrers-resultsreport-Superblocks.pdf.

Pauné, M.M., Moya, F.J., 2023. Vuelco electoral en 5 calles de Barcelona que han sido polémicas esta mandato. (Accessed 25 June 2023).

Pereira Barboza, E., Cirach, M., Khomenko, S., Iungman, T., Mueller, N., Barrera-Gómez, J., Rojas-Rueda, D., Kondo, M., Nieuwenhuijsen, M., 2021. Green space and mortality in European cities: a health impact assessment study. Lancet Planet. Health 5 (10), e718–e730.

Puig-Ribera, A., Arumí-Prat, I., Cirera, E., Solà, M., Codina-Nadal, A., Palència, L., et al., 2022. Use of the Superblock model for promoting physical activity in Barcelona: a one-year observational comparative study. Arch. Publ. Health 80 (1), 1–12.

Riley, R., de Preux, L., Capella, P., 2021. How do we effectively communicate air pollution to change public attitudes and behaviours? A review. Sustain. Sci. 16, 2027–2047.

Rodriguez-Rey, D., Guevara, M., Linares, M.P., Casanovas, J., Armengol, J.M., Benavides, J., Soret, A., Jorba, O., Tena, C., García-Pando, C.P., 2022. To what extent the traffic restriction policies applied in Barcelona city can improve its air quality? Sci. Total Environ. 807 (Pt 2), 150743.

Rueda, Salvador, 2019. Superblocks for the design of new cities and renovation of existing ones: Barcelona's case. In: Integrating Human Health into Urban and Transport Planning. Springer, Cham, pp. 135–153.

Scudellari, Jacopo, Staricco, Luca, Brovarone, Elisabetta Vitale, 2020. Implementing the Supermanzana approach in Barcelona. Critical issues at local and urban level. J. Urban Des. 25 (6), 675–696.

Staricco, L., Brovarone, E.V., 2022. Livable neighborhoods for sustainable cities: insights from Barcelona. Transport. Res. Procedia 60, 354–361.

Thomas, A., Aldred, R., 2024. Changes in motor traffic in London's Low Traffic Neighbourhoods and boundary roads. Case Studies on Transport Policy, 101124.

Timmons, S., Andersson, Y., McGowan, F., Lunn, P., 2023. Using behavioural science to design and implement active travel infrastructure: a narrative review of evidence. Available at: SSRN. https://ssrn.com/abstract=4365989.

TuneOurBlock, 2023. https://jpi-urbaneurope.eu/project/tuneourblock. June21, 2023.

Vidal Yañez, D., Pereira Barboza, E., Cirach, M., Daher, C., Nieuwenhuijsen, M., Mueller, N., 2023. An urban green space intervention with benefits for mental health: a health impact assessment of the Barcelona "Eixos Verds" Plan. Environ. Int., 107880 https://doi.org/10.1016/j.envint.2023.107880. Epub ahead of print. PMID: 37002012.

Volker, J.M.B., Handy, S., 2021. Economic impacts on local businesses of investments in bicycle and pedestrian infrastructure: a review of the evidence. Transport Rev. 41 (4), 401–431.

Wild, K., Woodward, A., Field, A., Macmillan, A., 2018. Beyond 'bikelash': engaging with community opposition to cycle lanes. Mobilities 13 (4), 505–519.

Wong, G., Greenhalgh, T., Westhorp, G., et al., 2013. RAMESES publication standards: meta-narrative reviews. BMC Med. 11, 20. https://doi.org/10.1186/1741-7015-11-20.

Yang, X., McCoy, E., Hough, K., de Nazelle, A., 2022. Evaluation of low traffic neighbourhood (LTN) impacts on NO2 and traffic. Transport. Res. Transport Environ. 113, 103536.

Yoshimura, Y., Kumakoshi, Y., Fan, Y., Milardo, S., Koizumi, H., Santi, P., et al., 2022. Street pedestrianization in urban districts: economic impacts in Spanish cities. Cities 120, 103468.

Zografos, C., Klause, K.A., Connolly, J.J., Anguelovski, I., 2020. The everyday politics of urban transformational adaptation: struggles for authority and the Barcelona superblock project. Cities 99, 102613.