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**Gentrification, changes in the
physical environment and health in Porto:
an analysis of photographs and verbal data
from a photovoice study**

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Gentrification, changes in the physical environment and health in Porto: an analysis of photographs and verbal data from a photovoice study

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ABBREVIATIONS LIST

Sustainable Development Goals (SDGs)

Non Communicable Diseases (NCDs)

World Health Organization (WHO)

Sea Level Rise (SLR)

National Institute of Statistics - Portugal (INE)

Organisation for Economic Co-operation and Development (OECD)

Background: Gentrification is transforming urban environments with significant implications for residents' health. This study examines the health impact of gentrification-led changes in the urban physical environment in Porto, Portugal.

Methods: We conducted a deductive and integrated content analysis of 458 photographs and discussion transcriptions produced during a photovoice study with 16 participants from gentrifying, deprived non-gentrifying, and affluent areas. We did a descriptive quantitative analysis of photographs, and then qualitatively compared and cross-checked each analytical category and subcategory with the interview transcripts.

Results: All the analytical categories including in the coding matrix – pollution, green infrastructure, social infrastructure housing accommodation infrastructure, food environment, commerce and services, transport infrastructure, safety, crowding and building (except housing) were identified in both the pictures. Participants discussed how these aspects of the physical environment have changed, how those changes were affected by gentrification, and how they could be relevant to health. Green infrastructure was by far the most photographed aspect, while social infrastructure was portrayed by a negligible number of photos. Most categories were linked both to changes seen as beneficial for the city, including for health, and changes considered negative and unhealthy.

Discussion: The photographs taken by the participants, together with the transcripts of the sessions where they were discussed, suggest that gentrification changes the physical environment in meaningful ways, which may bring important consequences for health. However, some gentrification changes the physical environment in the ways that, in the long run, may also bring some benefit to the city, including the health of most inhabitants. This illuminates the contradictory nature of gentrification processes and their consequences.

Conclusion: This research highlights the complex relationship between gentrification, changes in the physical environment and public health, emphasising the need for balanced policies that promote equitable urban regeneration and sustainability.

Keywords: public health, urban health, photovoice, gentrification, social determinants of health, health inequalities.

Introdução: A gentrificação está a transformar os ambientes urbanos, com implicações significativas para a saúde dos residentes. Este estudo examina o impacto na saúde das mudanças no ambiente físico urbano decorrentes da gentrificação na cidade do Porto, Portugal.

Métodos: Foi realizada uma análise de conteúdo dedutiva e integrada de 458 fotografias e transcrições de discussões produzidas durante um estudo *photovoice* com 16 participantes de áreas gentrificadas, não gentrificadas e afluentes. Efetuou-se uma análise quantitativa descritiva das fotografias, seguida de uma comparação qualitativa e cruzamento de cada categoria analítica e subcategoria com as transcrições das entrevistas.

Resultados: Todas as categorias analíticas incluídas na matriz de codificação – poluição, infraestrutura verde, infraestrutura social, alojamento, ambiente alimentar, comércio e serviços, infraestrutura de transportes, segurança, superlotação e edifícios (exceto habitação) – foram identificadas nas fotografias. Os participantes discutiram como esses aspetos do ambiente físico mudaram, de que forma foram influenciados pela gentrificação e a sua relevância para a saúde. A infraestrutura verde foi o aspeto mais fotografado, enquanto a infraestrutura social foi pouco retratada. A maioria das categorias foi associada tanto a mudanças vistas como benéficas para a cidade e para a saúde, quanto a mudanças negativas e prejudiciais à saúde.

Discussão: As fotografias tiradas pelos participantes, juntamente com as transcrições das sessões de discussão, sugerem que a gentrificação altera significativamente o ambiente físico, com potenciais consequências importantes para a saúde. No entanto, algumas mudanças podem, a longo prazo, trazer benefícios para a cidade e para a saúde da maioria dos habitantes, destacando a natureza contraditória dos processos de gentrificação e os seus impactos.

Conclusão: Esta investigação sublinha a complexa relação entre gentrificação, mudanças no ambiente físico e saúde pública, enfatizando a necessidade de políticas equilibradas que promovam uma regeneração urbana equitativa e sustentável.

Palavras-chave: saúde pública, saúde urbana, *photovoice*, gentrificação, determinantes sociais da saúde, desigualdades em saúde.

INTRODUCTION

PART I: URBAN HEALTH

1.1. Urbanization and Public Health

Urbanization presents a major public health challenge in the 21st century. As urban populations grow at unprecedented rates, the inadequacies of basic infrastructure, coupled with social and economic inequities, exacerbate significant health disparities (Vlahov et al., 2007). The increasing proportion of the global population living in urban centres underscores the critical need to reconcile urban growth with the creation of healthy cities for all, a goal that lies at the heart of the future of global urban public health (Vlahov et al., 2009).

Cities are dynamic systems undergoing constant physical and social transformation, and the study of urban health examines how these urban characteristics impact population health (Galea & Vlahov, 2005). Indeed, the key to improving health equity lies in optimizing urban settings to promote health. When appropriately managed, urbanization can serve as a positive determinant of health. However, this rapid urbanization also introduces a host of challenges, such as unhealthy exposures, sedentary lifestyles, and an increasing burden of chronic and infectious diseases (Sarkar & Webster, 2017).

It is concerning to note that modifiable environmental risk factors are responsible for 12.6 million deaths annually, accounting for 23% of global deaths and 22% of the global disease burden in disability-adjusted life years. Particularly concerning is the fact that 26% of all deaths in children under five are attributable to these factors (Kampa & Castanas, 2008). In light of this, urban health not only focuses on the determinants of health and disease in urban areas but also on the urban context itself as a critical exposure of interest. By creating healthier environments, nearly one quarter of the global burden of disease could potentially be prevented. Essential components for good health include clean air, a stable climate, adequate water, sanitation, hygiene, safe use of chemicals, protection from radiation, healthy workplaces, sound agricultural practices, health-supportive cities, well-designed built environments, and preserved nature (WHO, 2024). The term physical environment refers to the naturally occurring features and built environments, including air pollution, climate and geological conditions, forests, parks,

water features, recreation and commercial facilities, and transportation systems (Galea & Vlahov, 2005; Ribeiro & Fecht, 2021).

Given the magnitude of the shift in how the majority of the world's population now lives, it is not surprising that this transition has significant health implications. Researchers, both in the popular press and academic literature, have long explored the effects of urban living on public health. The ubiquity of urban living promises to shape health both directly and indirectly by influencing what are typically considered risk factors or determinants of population health.

The complexity of causation and the diversity of mechanisms by which urban characteristics may affect health suggest that cross-disciplinary research is essential to enhance our understanding of the urban context's role in shaping population health (Galea & Vlahov, 2005). The epidemiological literature indicates moderate associations between neighbourhood influences and several health outcomes, including all-cause mortality, infant mortality, and the incidence of cardiovascular disease (Kawachi & Subramanian, 2007).

Thus, improving living conditions in cities—through enhancements in housing, employment, education, equality, the quality of the living environment, social support, and health services—is central to improving urban population health (Vlahov et al., 2007). Indeed, enhancing urban living conditions holds the greatest potential for reducing morbidity, mortality, and health disparities while also improving overall quality of life and well-being.

Consequently, achieving healthy urban environments and sustainable development are intrinsically linked. In wealthy and poor cities, unsustainable and unplanned development of urban housing, transport, and food systems, along with social and lifestyle factors, are drivers in the epidemic of non-communicable diseases (NCD), which are linked to risks and hazards such as air pollution, poor diet, physical inactivity, traffic injury and domestic injury (WHO, 2012).

There is now a strong consensus on the significant role that multiple, multilevel attributes of urban environments play in shaping lifestyle, health, and well-being. City planning decisions shape land uses and travel patterns, which in turn influence urban lifestyles and environmental exposures, and thus human health and environmental sustainability. Therefore, city planning policies influence urban lifestyles, health, and sustainability. There is an urgent need to build capacity for health-enhancing city planning policy and governance, particularly in low-income and middle-income countries.

The adverse effects of urbanization, such as pollution and congestion, shifts from fresh to processed foods, and a dearth of space for walking, cycling and exercise also combine to make cities epicentres of the NCD epidemic and drivers of climate change. As such, healthy and greener cities are essential for achieving the Sustainable Development Goals (SDGs) (Ramirez-Rubio et al., 2019). The health of urban environments is closely tied to multiple SDGs, including efforts to reduce air pollution (SDGs 3.9 and 11.6), combat NCDs and associated risks such as obesity (SDG 3.4), and ensure equitable access to public transport, with particular attention to women, children, persons with disabilities, and older individuals (SDG 11.2).

Furthermore, effective sanitation and waste management are crucial for safeguarding public health (SDGs 3.9 and 11.6), while promoting equity (SDG 10) remains a central tenet of sustainable urban development. Access to safe public and green spaces, especially for women, children, older persons, and persons with disabilities (SDG 11.7), is vital for fostering inclusive and healthy cities. Additionally, climate action, including enhancing climate resilience (SDG 13), is imperative to ensure that cities can adapt to and mitigate the impacts of climate change, ultimately supporting the health and well-being of urban populations (UNDP, 2024). In this era of rapid urbanization and significant demographic shifts, human health has emerged as a primary focus of sustainable development (Sarkar & Webster, 2017).

As cities continue to expand, leading to changes in environment, and society, these shifts have substantial impacts on health and have long been a significant concern for health policy in many countries (Shawky, 2018). Additionally, achieving health equity in urban

populations often depends on political decision-making (Mackenbach & McKee, 2015). With increasing concerns about the influence of context on health (Moore et al., 2018) have prompted calls for integrating population health considerations into urban planning as a vital goal. This integration is crucial to improving policy decisions, fostering healthier lifestyles, and mitigating major health risks (WHO, 2016; Vardoulakis et al., 2016).

While urban settings offer a wide variety of opportunities, jobs, and services, they also contribute to health inequalities due to their inherent diversity, segregation, and heterogeneous socioeconomic characteristics. The importance of place has become increasingly recognized in epidemiology and public health, with context playing a crucial role in designing and implementing effective public health interventions (Ribeiro, 2018).

Considering the unique characteristics of cities, such as population density and heterogeneity, make each city distinct. This complexity suggests that urban characteristics important in one city may not hold the same relevance in another, limiting the generalizability of findings on how urban living influences health (Vlahov, 2009). Nonetheless, understanding how urban environments influence health behaviours and outcomes in cities is of utmost importance (Yang et al., 2023).

In conclusion, as cities continue to grow and evolve, it is essential to proactively address the health implications of urbanization.

1.2. Key Determinants of Health in Urban Settings

Generally, the determinants of health encompass a wide range of factors, including biological, psychological, behavioural, social, economic, and environmental influences that collectively shape the health outcomes of individuals and populations (Detels et al., 2021). As previously mentioned, the impact of urban settings on population health has become increasingly significant as the global population shifts from rural to urban areas.

Furthermore, cities are not static; indeed, the dynamism of cities is one of their defining features. Considering health in urban environments fundamentally involves studying how different types of places affect health (Galea & Vlahov, 2005).

Ensuring public health requires more than merely addressing individual health status; it demands a comprehensive population health approach that rigorously considers and examines health determinants, particularly environmental determinants, which are especially critical in urban health research.

Table I illustrates the five key categories of environmental health determinants: the built environment, health behaviours, healthcare access and availability, the natural environment, and socioeconomic factors. These categories provide a framework for understanding how urban environments influence population health and highlight the critical areas for public health interventions in urban settings.

Table I Environmental Determinants of Health

Environmental Determinants				
Built environment	Health Behaviours	Availability and Access to Health	Natural environment	Socioeconomic Environment
Green Spaces Housing Mobility Safety Sanitation	Alcohol consumption Nutrition Physical activity Smoking	Hospital care Health insurance Oral care	Air pollutants Noise Soil Water quality	Education Employment Income Segregation Discrimination

**Adapted from the urban health index (WHO, 2014)*

Focusing on the urban context, multiple dimensions can influence the health of city populations such as physical environment, social environment and availability and access to health. These partitions and frameworks vary according to the author and are not consensual.

However, the study of the relationship between neighbourhood characteristics, both physical and social, and health outcomes has garnered increasing attention from the scientific community. Recent research has sought to analyse its impact on various aspects such as physical activity (Ribeiro et al., 2013, 2015), diet (Alves et al., 2013), mortality (Meijer et al., 2012), mental health (Gariepy et al., 2014; Xu et al., 2023), perinatal outcomes (Dadvand et al., 2012), and quality of life and well-being (Möttus et al., 2012).

1.3. Physical Environment and Health

This dissertation focuses on the physical transformations associated with gentrification and its impact on public health, with a particular emphasis on the physical environment, which is thus explored in more detail in this section.

The term physical environment refers to the naturally occurring features and built environments, including air pollution, climate and geological conditions, forests, parks, water features, recreation and commercial facilities, and transportation systems (Galea & Vlahov, 2005; Ribeiro & Fecht, 2021).

Key elements of the physical environment, such as air and water quality, noise pollution, exposure to hazardous substances, housing conditions, indoor environments, and access to open/green spaces and recreational areas, are all significant contributors to human health and well-being.

It may contribute to disparities in health risks, particularly when access to, or exposure to, the positive and negative attributes of the physical environment vary across different populations and places (Bastian et al., 2021).

As society increasingly recognizes the need to reconnect health with place, new policies have been developed to address complex contemporary challenges such as obesity, declining mental health, well-being, and social inequities (Morris & Saunders, 2017).

Furthermore, the growing awareness of the ecological impact on health outcomes has fuelled an emerging body of research in this area. Environmental conditions and characteristics, alongside individual factors, are increasingly recognized as influential in health inequalities, particularly in the distribution of chronic disease outcomes, mental health conditions, and health behaviours. For instance, exposure to environmental pollutants—both outdoor and indoor—may partially account for the prevalence of such diseases, making it crucial to implement effective interventions (Kim et al., 2013).

This environment can be categorized into main domains. While this division isn't entirely unanimous or universally agreed upon in the literature, the six points that will be discussed next are frequently mentioned and seem particularly relevant to this study (Galea & Vlahov, 2005). Each of the six domains will be examined in detail below: built environment, food environment, urban infrastructure, water and sanitation, access to green spaces, urban climate, and pollution.

a) Built Environment

The built environment influences physical and mental health (Janet et al., 2019). There is a growing recognition that the built environment plays a crucial role in the quality of care and can affect various important health outcomes (Elf et al., 2020; Wesz et al., 2023).

The human-built environment has been shown to influence both physical and mental health (Galea & Vlahov, 2005) and extensive scientific evidence supports the relationship between the built environment and various health conditions, including asthma and other respiratory conditions, injuries, psychological distress, and child development (Evans et al., 2000; Krieger & Higgins, 2002; Northridge et al., 2003; Paciência et al., 2022). Different aspects of the built environment are linked to specific health outcomes. For instance, features such as the density of development, mixed land uses, the scale of streets, aesthetic qualities of place, and connectivity of street networks may significantly affect physical activity levels (Handy et al., 2002; Ribeiro & Hoffmann, 2018). Low levels of physical activity, in turn, are a well-established risk factor for cardiovascular disease and all-cause mortality in urban areas (Diez-Roux, 2003; Pate et al., 1995).

A substantial body of literature also addresses the relationship between housing and health. Housing refurbishment and modifications, the provision of adequate heating, and improvements to ventilation and water supply have been associated with improved respiratory outcomes, quality of life, and mental health (Kingsley, 2003; Thomson et al., 2003); on the other hand, residing in disadvantaged housing was found to be a major risk factor for mortality (Ribeiro & Barros, 2020). The built environment also plays a crucial role in the prevention and containment of both chronic and infectious diseases. It can affect health both directly and indirectly, either through immediate, passive impacts (effects of indoor environmental quality, among others) or by influencing behaviours that can affect health, which may involve individuals' active participation, such as encouraging walking to increase physical activity (Pinter-Wollman et al., 2018).

These underscore the significant role of the built environment in shaping public health outcomes and the necessity of incorporating health considerations into urban planning and design.

b) Food environment

Food environments refer to the places where consumers engage with the food system to purchase and consume food, such as markets, restaurants, and cafeterias, and play a crucial role in shaping food availability, quality, safety, and affordability (Fanzo et al., 2021). In an urban context, these environments can undergo significant changes that affect these key factors, thereby influencing consumer behaviour, nutrition, and health outcomes. This is particularly important as diet and nutrition stand as leading causes of global morbidity and mortality (Westbury et al., 2021).

Moreover, the availability of healthy and unhealthy food options within neighbourhood environments can directly impact diet, nutrition, and health outcomes (Ribeiro et al., 2020; Westbury et al., 2021). Consequently, understanding these dynamics is essential for addressing the broader public health challenges associated with urban food environments.

c) Urban Infrastructure, water and sanitation

The urban infrastructure is a critical part of the physical environment and determines how a city provides water, disposes of garbage, and provides energy (Melosi, 2000).

Infrastructure systems have direct implications for how health and well-being evolve across urban–rural systems. Infrastructure systems have substantial and unequal impacts on different populations through mechanisms such as displacement, exposure to environmental risk, and access to essential services like water, and as a result are central to the question of social and environmental equity (Persall, 2021).

Indeed, water scarcity and water pollution are serious urban problems, particularly in low-income countries. The World Health Organization estimates that most urban populations in developing countries do not have access to proper sanitation (WHO, 1997).

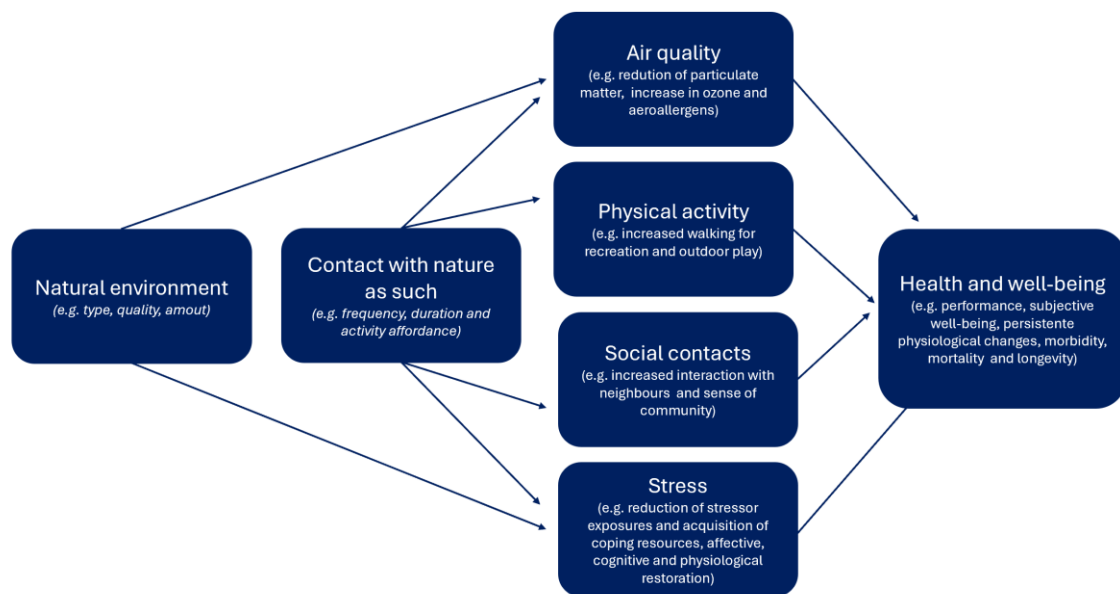
The relation between the urban infrastructure and health is shaped by different forces in established urban areas and in rapidly growing urban areas. In longstanding urban areas, the decline of an aging infrastructure, coupled with frequently declining municipal resources, may challenge cities' ability to continue to provide safe water and sanitation for urban residents. Breakdowns may increase, causing health problems related to water, sewage, or disposal of solid waste (Garrett, 2001), particularly it could contribute for spreading epidemics rapidly.

d) Access to green spaces

Transforming urban infrastructure to support quality of life and improve health outcomes for the expanding urban population is crucial. Urban green and blue spaces play a significant role in promoting health and well-being, addressing health inequities, and offering co-benefits for the environment, economy, and society (Hunter et al., 2023). An increasing body of literature demonstrates the relationship between green and blue spaces and various health outcomes, including physical health (Sampaio Costa et al., 2024; Browning et al., 2022), mental health (Ribeiro et al., 2024), and longevity (Takano

et al., 2002). The presence of these spaces is often an indicator of better health and quality of life.

However, access to green and blue spaces is not always equitable (Hoffmann et al., 2017), with certain population groups—particularly those already facing health-related challenges—being disproportionately disadvantaged in their ability to benefit from these environments (Hunter et al., 2023). Figure 1 outlines the health determinants and outcomes influenced by green spaces.



**Adapted from Nature and Health (Hartig et al., 2014)*

Figure 1 Influence of green spaces on public health

e) Urban Climate

Climate change has both direct and indirect effects on population health. Extreme temperatures and altered precipitation patterns contribute to heatwaves, cold spells, storms, droughts, wildfires, and floods, all of which directly impact health (WHO, 2008). Moreover, changes in climate can alter the distribution of vector-borne diseases and rodents. Indirectly, climate change can affect health by disrupting food sources, impairing food production methods, and reducing economic productivity (Haines et al., 2006).

Recent studies highlight the association between climate change and both physical and mental health outcomes (Macassa et al., 2022). Physically, climate change increases the risk of heat stress, injury, disease, and food supply disruptions. These impacts, in turn, affect community wellbeing by damaging the economic and social fabric of communities, disproportionately affecting socially vulnerable groups (Macassa et al., 2022). Mental health is also impacted by significant weather changes, which can induce psychophysical symptoms such as mood disturbances, irritability, anxiety, physical weakness, hypertension, headaches, hyperalgesia, and autonomic symptoms (Cianconi et al., 2020; Mazza et al., 2012), negative climate-related emotions and sleep disturbances (Ogunbode et al., 2021).

The combined effects of global warming and the expansion of the built environment are expected to intensify urban heat islands (UHIs), thereby amplifying the adverse effects on population health (lungman et al., 2023). Elevated heat exposure can lead to a range of direct health effects, such as syncope and heat exhaustion, while also exacerbating existing health conditions (Chen and Zhang, 2023). Non-optimal ambient temperatures are increasingly recognized as significant risk factors for mortality, particularly cardiovascular mortality (Davis et al., 2016). Additionally, relative humidity has been linked to both infectious and non-infectious pulmonary diseases (Tsao et al., 2023).

The health risks associated with urban heat are particularly pronounced among vulnerable populations, including socioeconomically disadvantaged and socially isolated elderly individuals.

f) Pollution

Environmental contaminants are significant contributors to human disease, impacting both climate change and public health, and leading to increased mortality and morbidity (Shetty et al., 2023). Human activities are a primary source of these pollutants, introducing contaminants into water, air, and soil through various means. The main pathways through which these pollutants enter the human body are inhalation, oral absorption, and ingestion.

While industrialization promotes economic development, it also introduces a considerable number of pollutants into the environment, posing serious health risks to exposed populations (Manisalidis et al., 2020). Environmental pollution remains a substantial global health risk, with traffic-related air pollutants, waste incineration, chemical industries and major natural events serving as major sources of contaminants. These pollutants include sulfur dioxide, carbon monoxide, nitrogen oxides, heavy metals, biological contaminants, ozone, and tobacco smoke. Once inhaled or ingested, these substances can disrupt bodily functions, leading to a range of health issues such as cancer, cardiovascular diseases, reproductive and prenatal disorders, central nervous system damage, and respiratory problems (Shetty et al., 2023).

Soil contamination is another critical issue, largely driven by anthropogenic activities such as industrial processes, wastewater discharge and oil spills. Chemicals introduced into the soil, whether through fertilizers, pesticides, or the leaching of untreated waste, pose significant health risks. Additionally, atmospheric deposition from industrial emissions, incomplete combustion, and nuclear activities further exacerbates soil pollution. The increasing production and consumption of plastics also contribute to this issue, as they degrade into carcinogenic and toxic additives such as bisphenol A, phthalates, dioxins, PAHs, among others (Shetty et al., 2023).

The global chemical industry is expanding at an alarming rate, growing by approximately 3.5% annually, and is projected to double by 2030. A significant proportion of this production occurs in low- and middle-income countries. However, the true burden of disease attributable to chemical pollution is likely undercounted, as only a small fraction of the thousands of manufactured chemicals in commerce have undergone adequate safety or toxicity testing. Particularly concerning are the inadequately documented effects of chemical pollution on developmental neurotoxicity, reproductive toxicity, and immunotoxicity (Fuller et al., 2022).

The combination of industrialization, urbanization, and the expansion of chemical manufacturing underscores the urgent need for comprehensive strategies to mitigate the health impacts of environmental pollution.

PART II: GENTRIFICATION AND URBAN TRANSFORMATION

2.1. Conceptualization and Typologies

Gentrification is a process of urban change characterized by capital investment in the built environment to cater to the demands of more affluent populations, often leading to the displacement of existing, lower-income residents (Lees et al., 2016; Cocola-Gant, 2016). This transformation is driven by the liberalization of the housing market, shifting the perception of housing from a basic shelter to an investment vehicle (Bone, 2014; Cole et al., 2016). As wealthier residents move into previously lower-income neighbourhoods, the area undergoes significant demographic, real estate, and cultural shifts, fostering new consumption practices. This process is closely associated with increased housing insecurity, displacement, and broader sociospatial changes, which can have profound and often negative impacts on health and social equity (Cole et al., 2021).

The concept of gentrification is increasingly relevant in understanding global urban dynamics, particularly as it intersects with the mobility of global middle classes and their interactions with local contexts and histories (Hayes & Zaban, 2020). Traditional notions of gentrification, often associated with high-income cities in Northern Europe and North America, may be insufficient to fully grasp its manifestations in the Global South and European periphery. In these contexts, the phenomenon may be more accurately described as transnational (Lemanski, 2014). This process reflects broader global trends in real estate accumulation, where transnational gentrifiers—whose spatial practices differ significantly from local urban classes—reshape urban spaces and their meanings (Cohen et al., 2015; Novy, 2018; Stock, 2006). The growing mobility and consumption patterns of higher-income transnational actors contribute to new forms of spatialized global inequalities, manifesting in local urban environments (Hayes & Zaban, 2020).

The impact of tourism further underscores these dynamics. Tourism growth, particularly in North Africa and Southern Europe, has significantly outpaced global economic growth, with the number of tourists doubling between 2003 and 2018 (UNWTO, 2019). This influx not only increases the quantity of visitors but also intensifies their impact on urban spaces.

Transnational gentrification, driven by neoliberal globalization and cultures of arbitrage, represents a new spatialization of global inequalities. This concept highlights the capacity of relatively privileged individuals from higher-income countries to appropriate urban spaces in lower-income regions, thereby exacerbating local disparities and contributing to displacement. This phenomenon is intertwined with colonial legacies and entrenched class hierarchies, illustrating how global financial practices and real estate investments create instability and vulnerability across different urban contexts (Hayes, 2014).

Indeed, this phenomenon has emerged as one of the most debated and complex concepts in the fields of housing, community development, urban studies, and public health over the past two decades (Brown-Saracino, 2017; Smith et al., 2020). Gentrification reshapes both the physical and social environments of cities, with profound impacts on the lives and health of their residents (Hayes et al., 2020; Lopez-Gay et al., 2021; Tulier et al., 2019).

A key aspect of gentrification is its association with increased housing insecurity. As revitalizing housing markets experience greater demand, commercial and residential rents often rise, contributing to housing unaffordability and displacement (Gibbons & Hyra, 2023). The upgrading of the housing stock in gentrifying neighbourhoods can lead to higher real estate prices and a reduction in affordable housing units, causing stress and anxiety among low-income residents, who may face the threat of displacement due to rising costs (Versey, 2022).

Gentrification extends beyond housing to encompass broader urban transformations, including urban greening, climate change adaptation, shifts in the retail landscape and food environment, and changes in the provision of services such as healthcare and education (Cole et al., 2021). These transformations can be conceptualized as exposures that affect health through various pathways, including alterations in housing stability, access to amenities, and the restructuring of spatialized social networks and neighbourhood safety (Cole, 2020).

While gentrification often leads to negative health outcomes for existing residents, the precise relationship between gentrification and health remains inadequately understood. There is a growing recognition of the need for further research employing diverse methodologies, including qualitative and participatory approaches, to better grasp the

complexities of gentrification's health impacts (Cole, 2020; Schnake-Mahl et al., 2020). Additionally, residents' perceptions of gentrification and neighbourhood change are important factors influencing their health and well-being (Lyanda et al., 2022).

Gentrification is not just a local phenomenon; it has become a global and transnational process, influenced by global capital flows and the mobility of a transnational middle and upper class, including lifestyle migrants, international students, and tourists from affluent countries (Aalbers, 2019; Cocola-Gant, 2016, 2018; Hayes et al., 2020; Sigler et al., 2016, 2020). In many cities, the loss of housing stock to the short-term rental market, rising housing costs, and cultural shifts driven by gentrification have displaced long-term residents while attracting transient, affluent populations (Cocola-Gant et al., 2020).

Gentrification is a complex phenomenon with varying nuances depending on the urban context in which it occurs. The literature identifies six types of gentrification, which may occur independently or simultaneously within the same city (Cole et al., 2021). Each type of gentrification is briefly described below.

a) Retail gentrification

Retail gentrification involves the transformation of retail markets alongside changes in neighbourhood social composition, where shifts in retail can either drive or result from gentrification (Hubbard, 2017). The type, density, and distribution of retail establishments play a crucial role in shaping health and health inequities, with both positive impacts, such as improved access to healthy food stores, and negative effects, such as an increased presence of harmful retailers like tobacco shops (Young-Wolff et al., 2014; Smith et al., 2017).

Moreover, while retail gentrification can enhance walkability and bring more supermarkets into gentrifying areas, these changes often do not equally benefit all residents. For instance, new healthy food outlets may be financially inaccessible to lower-income residents, creating disparities in access (Bilal et al., 2018; Caspi et al., 2012; Anguelovski, 2015).

Indeed, the transformation of retail spaces driven by gentrification could focus more on the needs of tourists and younger consumers and potentially lead to older people feeling excluded (Jardim et al., 2024; Burns et al., 2012), which could lead to loneliness (Astell-Burt et al., 2022) and place alienation (Diaz-Parra & Jover, 2021) for them, with potential to make a neighbourhood a 'lonelygenic environment' (Feng & Astell-Burt, 2022).

b) Green gentrification

Green or environmental gentrification occurs when the improvement or construction of environmental amenities, such as parks, leads to the social and physical exclusion or displacement of long-term underprivileged residents (Gould & Lewis, 2017) due to the increase in housing prices in areas close to these spaces.

While greenspace availability is associated with various health benefits (Cole et al., 2019; Berry et al., 2017; Pearce et al., 2018) and reduced health inequalities (Mitchell et al., 2015), these advantages are often primarily experienced by residents of gentrifying neighbourhoods with higher education and income levels (Triguero-Mas et al., 2017).

In addition, new or improved parks may bring about increased greenspace police patrolling, changes in park usage, and decreased social interactions due to the displacement of long-term residents. These changes can negatively impact the health of underprivileged communities, who may rely more heavily on their nearby built and social environment (O'Callaghan-Gordo et al., 2018; Chen et al., 2020).

Furthermore, green gentrification can exacerbate environmental injustices. Environmental injustice refers to the inequitable and disproportionately heavy exposure of poor, minority, and disenfranchised populations to toxic chemicals and other environmental hazards. This form of injustice plays a significant role in contributing to disparities in health status across populations of differing ethnicity, race, and socioeconomic status.

For example, environmental injustice has been linked to disparities in the incidence and prevalence of various health conditions, including asthma (Maantay, 2007), obesity (Sturm, 2008), diabetes (Horowitz et al., 2004), lung cancer, and a range of mental health

and developmental problems (Schneiders et al., 2003). Moreover, children are particularly vulnerable to the adverse health impacts of environmental injustice, as evidenced by numerous studies (Landrigan et al., 2010). Thus, while initiatives like green gentrification may be intended to improve environmental conditions, they can also inadvertently reinforce or amplify existing health inequities across different social groups.

c) Climate gentrification

Global climate change presents significant risks to urban areas, which are home to over half of the world's population and are hubs of economic activity and infrastructure (Araos et al., 2016). Environmental stressors such as rising carbon dioxide levels, deforestation, global warming, urban heat islands (Galdies & Lau, 2020), ozone depletion (Barnes et al., 2019), and sea level rise (SLR) (Keenan et al., 2018) exacerbate these risks. Coastal cities are especially vulnerable to SLR, storm surges, and flooding, which impact property markets, residential choices, and the socioeconomic and demographic composition of neighbourhoods (Bryson, 2013).

The effects of climate change are increasingly evident in major cities, leading to the displacement of thousands of residents due to damage from hurricanes, floods, and fires. As cities rebuild with a focus on climate-resilient infrastructure (Kabisch et al, 2017), rising property values and new redevelopment projects often make it challenging for low-income residents and migrant communities (Anguelovski et al., 2019).

However, low-income communities, people of color, and migrant communities continue to face well-documented forms of climate injustice (Anguelovski et al., 2019). These populations have typically contributed the least to climate change while having the least access to environmental amenities, such as green space. Additionally, they are the most exposed to climate hazards and effects (Leichenko et al., 2008) and possess the fewest resources to adapt (Maantay & Maroko, 2009).

d) Tourism gentrification

Tourism gentrification refers to urban transformations driven by the needs and preferences of affluent visitors, characterized by the proliferation of corporate entertainment and tourism venues (Cocola-Gant, 2017, 2018, 2019). This type of gentrification is marked by an increase in short-term accommodations, rising housing prices, and shifts in retail and services to cater to tourists. It also leads to the emergence of a transient population and the displacement of long-term residents (Gotham, 2005).

For instance, Barcelona has experienced significant tourism-driven gentrification, particularly following the 1992 Olympic Games and the subsequent urban planning initiatives known as '*the Barcelona model*' (Degen & García, 2012). These developments, supported by administrative policies and major urban renewal projects, have led to a substantial rise in tourism in the city. The city's historical heritage, cultural dynamism, seashore, and academic institutions have further enhanced its attractiveness. Consequently, tourism's impact has extended beyond the tourism sector, affecting all city sectors and residents (López, 2015).

Moreover, the impact of tourism gentrification on health is not yet fully understood, but existing studies suggest several pathways through which it can adversely affect residents. These include environmental changes such as disruptions in mobility, the commodification of nighttime leisure, increased insecurity, and reduced access to public spaces; pollution, including air pollution; property speculation leading to eviction; and a decline in social networks and community identity (Gotham, 2005). These factors can contribute to increased stress, anxiety, depression, sleep deprivation, respiratory issues, and poor diet among residents (Marmion & Hindley, 2020; Godovykh & Ridderstaat, 2020).

e) Studentification

Studentification, or student-driven gentrification, occurs when academic institutions influence neighbourhood changes through direct investment or alterations in the housing

market for students (Moos et al., 2019). This process often results in increased living costs due to real estate investments by universities, which attract a higher proportion of privileged, college-aged residents (Ehlentz, 2016). Consequently, businesses and services in these areas shift to cater to this demographic, furthering the gentrification process (Moos et al., 2019; Dobbs, 2013).

Studentification can make it challenging for older residents to age in place, as these neighbourhoods become increasingly youthful. Older individuals may experience social or cultural exclusion, even if they are not physically displaced (Bailey, 2023; Powell, 2016).

While comprehensive empirical analysis of gentrification across the entire neighbourhood is lacking, there is evidence of early gentrification in areas served by university-sponsored schools, which have seen a demographic shift towards wealthier students (Pickren, 2012). Moreover, in some cases, the expansion of student housing has contributed to the displacement of underprivileged communities (Dobbs, 2013).

f) Health care gentrification

Health care gentrification refers to the process in which shifts in the type and spatial distribution of health care services increasingly favor wealthier residents, potentially excluding more vulnerable populations and leading to inequitable access to quality health care (Cole et al., 2021). This issue is closely tied to the growing emphasis on the private sector and also to the overloading of public healthcare systems. The strain on these systems is further exacerbated by the rising demand for care, driven by a growing and more floating urban population.

Moreover, this phenomenon mirrors the impact of academic institutions in the process of studentification, as for-profit real estate companies increasingly enter the healthcare market. These companies are not only managing healthcare services on a profit basis but are also engaging in direct real estate investments (Cole et al., 2021).

Health care gentrification also encompasses new challenges faced by health care providers in addressing the needs of patients from gentrifying areas. These include

difficulties in treating patients experiencing complex social environments and threats of displacement, as well as providing follow-up care to patients who have been physically displaced from their neighbourhoods. For example, a study highlighted increased hospitalization for mental health issues and greater reliance on emergency departments for mental health care among residents displaced from gentrifying neighbourhoods in New York City (Lim et al., 2017) left residents with no immediate health care options and forced the city to rely on additional ambulances to transport patients to neighbouring cities (Dahrouge et al., 2018).

Meanwhile, new health care facilities, such as urgent care clinics with minimal wait times, are usually established in wealthier parts of the cities demonstrating a trend where health care facilities are located based on profit potential rather than actual health care needs (Sumah et al., 2016).

Health care gentrification manifests differently depending on the health care system but maintaining equitable access to care (Blanchet et al., 2019) remains a challenge, exacerbated by reduced funding and the growing influence of the private sector in health care (Martinez et al., 2016).

2.2. The case of Porto

Porto, historic harbor town and commercial hub, is a city in Southern Europe that has undergone significant transformations, particularly since the 18th century, when its demographic and economic growth was driven by the wine trade and the influx of a British community that introduced new social practices (Fernandes et al., 2018). The 19th century saw further urban expansion with the advent of industrialization and the railway, reshaping the city's socio-spatial structure into a more complex configuration. This transformation was accompanied by the development of tourism infrastructure and a shift in the area's economic and cultural landscape (Fernandes et al., 2018).

In contemporary Porto, the wave of urban change mirrors these 19th-century dynamics, particularly in the functional transformation of the city center, although at a much faster pace. This functional gentrification is marked by the rapid growth of neo-traditional and

hybrid shops, which increasingly cater to temporary city users rather than residents. Between 2012 and 2017, nearly 40% of retail and service units in Porto's city center underwent some form of transformation, with a marked increase in fashionable and hybrid establishments combining multiple activities, such as shops that double as art galleries, cafes, or eco-product stores (Fernandes et al., 2018).

Porto's transformation must be understood within the broader context of transnational gentrification, a phenomenon increasingly evident in Portuguese and Spanish cities (Hayes et al., 2020). Transnational gentrification refers to urbanization driven by higher-income transnational migrants, often from Northern Europe and North America, who close rent gaps by investing in these cities. In the aftermath of the 2008–2009 financial crisis, Porto emerged as a hotspot for transnational gentrification, alongside its growing attractiveness as a tourism destination (Chamusca et al., 2019; Carvalho et al., 2019; Silva et al., 2023). The intensification of touristification and gentrification in Porto is exemplified by the dramatic rise in Airbnb-listed properties, which expanded from a single listing in 2009 to over 11,000 by May 2018, with most properties fully occupied for much of the year (Fernandes et al., 2018). This indicates the establishment of a new urban economy in Porto, where tourism, real estate, rental intermediation, low-paid maintenance jobs, and visitor-driven businesses play a central role.

Indeed, the ongoing gentrification in Porto, particularly the process referred to as 'touristic gentrification', is closely linked to the city's economic revitalization and the extensive rehabilitation and renovation of its built environment. This transformation has been significantly influenced by the classification of Porto's Historic Centre as a World Heritage site in 1996, the expansion of Francisco Sá Carneiro Airport, and the city's recognition as the European Best Destination in 2012, 2014, and 2017. These developments have contributed to a significant increase in tourism, leading to major changes, especially in the city centre, where accommodation capacity increased from 35.8 per 1,000 inhabitants in 2004 to 85.4 in 2017 (INE, 2018). The explosive growth of local accommodations, particularly those managed through digital platforms like Airbnb, has been particularly impactful (Chamusca et al., 2019). Moreover, the influx of post-secondary students, particularly through international exchange programs like Erasmus, has contributed to the homogenization of graduate and postgraduate education in Europe, further influencing the urban landscape (Carvalho et al., 2019).

Porto's specific experience of gentrification is shaped by the broader economic context of crisis and austerity measures, especially, between 2011 and 2014. During this time, several neoliberal housing policies were introduced, including the Golden Visa program, the Local Accommodation Legal Regime, and the Exceptional Urban Rehabilitation Regime (Antunes, 2019). The intensification of touristification in Porto has gone hand-in-hand with gentrification, rapidly reorganizing the social composition of the city (Barbosa & Lopes, 2019).

Recent studies have begun to focus on the impact of gentrification on Porto's resident population, particularly in terms of public health. Gentrification processes are transforming the physical, socioeconomic, and symbolic features of the city in contradictory ways, with both beneficial and harmful to health, having negative consequences particularly serious for vulnerable groups (Silva et al., 2023).

Gentrification has also been shown to have dual and disparate effects on the health and well-being of older adults (Silva et al., 2023). While some participants in studies acknowledge that changes in the physical environment due to gentrification can positively contribute to their well-being, others report a higher cost of living and increased vulnerability to mental health issues. Gentrification often leads to a shortage of affordable housing and weakens social cohesion, both of which are critical factors in the well-being of older adults (Santos et al., 2023).

The ongoing gentrification processes in Porto, and the difficulty in precisely describing how these processes impact health, highlight the complex relationship between urban change and public health, particularly for older adults. In Portugal, where retirement pensions are generally low and many older adults face multiple health issues (OECD/European Observatory on Health Systems and Policies, 2019), rising housing costs and other economic pressures may force difficult decisions that ultimately harm both mental and physical health.

PART III: QUALITATIVE AND VISUAL RESEARCH METHODOLOGIES

3.1. Qualitative Methods

The term 'qualitative research' gained prominence in the 1960s as a way to distinguish it from the then-dominant quantitative research methods, such as experimental work in social psychology, survey research in sociology and political science (Hammersley, 2013). Although qualitative data had been used previously, the development of specific quantitative methods was often driven by the need to replace earlier non-quantitative approaches that were deemed scientifically unsatisfactory. Qualitative research, therefore, encompasses a heterogeneous field that contrasts with quantitative methods.

Qualitative research is primarily defined by its flexible, inductive, and data-driven approach, which prioritizes the generation of descriptions and explanations over the testing of predefined hypotheses (Hammersley, 2013). This leads to a research design that is adaptive and open-ended, allowing for the creation of categories during data analysis that can accommodate multiple data items without initially being mutually exclusive. Researchers often rely on descriptions derived from observations, interviews, transcripts, and various documentary sources, including visual and online data.

An essential feature of qualitative research is its recognition of subjectivity. The influence of the researcher's personal and social characteristics on the data and analysis is acknowledged, and reflexivity is encouraged to enable readers to consider these effects (Hammersley, 2013). This opposes the notion that research should be entirely standardized and impersonal. Subjectivity is acknowledged in qualitative research, recognizing the influence of the researcher's characteristics on data and analysis as a potential source of insight. Reflexivity is encouraged to allow readers to assess these effects, opposing the idea that research should be entirely standardized and impersonal.

Qualitative studies typically focus on natural settings, investigating environments where people live and work or conducting interviews that resemble ordinary conversations. This approach contrasts with traditional quantitative methods that aim to control environments or standardize stimuli for comparability.

The contributions of qualitative research to epidemiology can be understood through two contrasting models: the enhancement model, which sees qualitative research as adding depth to traditional epidemiological studies by explaining unexpected results, generating hypotheses for quantitative testing, and aiding in the development of measures for social phenomena, and the epistemological model, which posits an equal relationship between qualitative and quantitative approaches, acknowledging the potential for challenge and tension between them (Popay et al., 1998).

While the enhancement model is more commonly accepted, framing qualitative and quantitative methodologies as complementary approaches suited to different research questions, qualitative methods are particularly valuable in epidemiological studies for offering insights into the meanings, beliefs, and attitudes of social actors, thus enabling a more nuanced analysis of human behaviour (Lloyd, 2000; Mays & Pope, 1995).

These methods are especially useful for exploring and mapping under-researched areas, giving voice to marginalized groups, providing detailed insights into people's experiences, and understanding the complexities of their beliefs and behaviours in ways that standardized quantitative approaches cannot. Moreover, qualitative research excels at exploring new questions and emerging theories through reflexive data collection, and in capturing the complexity, ambiguity, and gradual changes that are often missed by more static quantitative measures (Alderson, 2001).

3.2. Visual Data in Research

Image-based research methodologies, encompassing a broad range of visuals such as film, video, photographs, and cartoons, have been increasingly utilized within qualitative research across various fields, including sociology, anthropology, education, and health studies (Smith et al., 2016).

In public health research, photography has emerged as a valuable yet underutilized data source. While photographs have been predominantly used in fields like psychiatry and oncology to document patients' autobiographical narratives, their potential in public health remains largely untapped (Saita et al., 2018; Moretti et al., 2021). Photographs

serve as powerful tools for capturing conditions in specific places at particular moments, offering rich insights into the physical and social environmental contexts for health. They also enable systematic observation, useful for example in urban health to the observation of neighbourhoods, providing visual support in discussions with participants, such as city residents (Cannuscio et al., 2009).

However, despite their utility, visual methods like photography pose ethical challenges, particularly concerning privacy, confidentiality, and anonymity, which necessitate careful and detailed consent procedures (Smith et al., 2016). Furthermore, the subjective nature of photography, such as the framing and perspective chosen by the photographer, introduces a tension between objectivity and subjectivity, which must be critically examined in research.

Photovoice studies, for example, often focus only on the images selected by participants for discussion, potentially overlooking other relevant data. Nonetheless, photographs alone can offer significant insights into the links between place and health, as well as the social processes that influence these relationships (Cannuscio et al., 2009).

The use of visual methods, supported by the increasing role of information and communication technology, has become an essential aspect of qualitative research, enriching our understanding of complex health issues (Cannuscio et al., 2009).

3.3. Photovoice as a Tool in Public Health

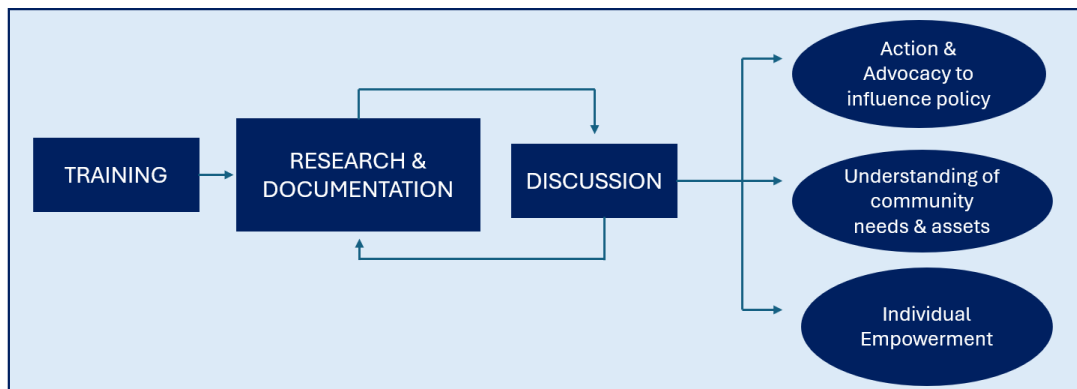
Photovoice, a participatory qualitative and visual research method, aims to achieve three primary goals: (1) enabling individuals to document and reflect on their community's strengths and concerns, (2) fostering critical dialogue and knowledge about key community issues through group discussions of photographs, and (3) influencing policymakers (Wang et al., 1997). This method is highly adaptable, making it suitable for various participatory objectives, different groups, and diverse public health issues. It is particularly empowering for marginalized groups, including women, workers, children, non-literate individuals, and those with stigmatized health conditions, as it leverages their unique insights and expertise about their communities (Sutton-Brown, 2014)

Despite its strengths, photovoice has several limitations. First, it introduces potential risks related to political sensitivity, as documenting and discussing community issues can be politically charged. Participants may engage in self-censorship to avoid negative repercussions, influenced by their awareness of potential consequences for themselves and their families. Second, personal judgment influences many stages of the process, including who uses the camera, what is photographed, and which images are selected for discussion. This subjectivity can affect the representation and interpretation of data, as not all material may be captured or analyzed. Third, the method can reproduce broader social stratifications through control over resources like money and editorial input, potentially impacting the representation of different voices (Wang et al., 1997).

Photovoice requires facilitators to be sensitive to ethical issues, power dynamics, and personal biases in photography. Facilitators should understand local contexts and approach their roles with humility and openness, especially when they are external to the community.

One of the approaches that can be used by facilitators is the pneumonic SHOWeD, the discussion facilitators would ask, (a) What do you see here? (b) What is really happening here? (c) How does this relate to our lives? (d) Why does this problem, concern or force exist? and (e) What can we do about it? This group discussion technique aims to support community empowerment (Freire, 1973; Catalani & Minkler, 2010).

Photo-elicitation encourages research interviews by placing photographs in front of informants and using those photographs as projective devices. The method involves a three-stage process for needs assessment: selecting photographs that reflect community needs, contextualizing these images through storytelling, and codifying issues, themes, or theories that emerge from discussions. This participatory approach helps ensure that the findings are rooted in the community's perspective and allows for both internal and external validation of the results. The photovoice impact model is illustrated in figure 2.



**Adapted from Catalani & Minkler, 2010*

Figure 2 Photovoice Impact Model

Ultimately, photovoice offers a dynamic and impactful way to engage communities in identifying and addressing their concerns, promoting dialogue, and influencing policy through the powerful medium of visual storytelling. It complements other needs assessment strategies and enhances the visibility of community issues, contributing to more informed and effective public health interventions.

OBJECTIVES

The main aim of the project is to investigate, from the perspective of city residents, how gentrification shapes the urban physical environment and may impact residents' health in Porto.

This broad objective is then divided into two specific objectives:

1. Identify how and which dimensions of the urban physical environment (e.g., pollution, green spaces) are perceived to change due to gentrification, using the photographs produced by the participants of a photovoice study about gentrification and health in Porto.
2. Understand how residents make sense of the changes in the neighborhood's physical environment and their impacts on residents' health, using the transcriptions of the group sessions where photographs were selected, presented and discussed under the same study.

Gentrification, physical environment and health: a combined analysis of the visual and textual materials of a Photovoice study conducted in Porto, Portugal

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Abstract

Background: Gentrification is transforming urban environments with significant implications for residents' health. This study examines the health impact of gentrification-led changes in the urban physical environment in Porto, Portugal.

Methods: We conducted a deductive and integrated content analysis of 458 photographs and discussion transcriptions produced during a photovoice study with 16 participants from gentrifying, deprived non-gentrifying, and affluent areas. We did a descriptive quantitative analysis of photographs, and then qualitatively compared and cross-checked each analytical category and subcategory with the interview transcripts.

Results: All the analytical categories including in the coding matrix – pollution, green infrastructure, social infrastructure housing accommodation infrastructure, food environment, commerce and services, transport infrastructure, safety, crowding and building (except housing) were identified in both the pictures. Participants discussed how these aspects of the physical environment have changed, how those changes were affected by gentrification, and how they could be relevant to health. Green infrastructure was by far the most photographed aspect, while social infrastructure was portrayed by a negligible number of photos. Most categories were linked both to changes seen as beneficial for the city, including for health, and changes considered negative and unhealthy.

Discussion: The photographs taken by the participants, together with the transcripts of the sessions where they were discussed, suggest that gentrification changes the physical environment in meaningful ways, which may bring important consequences for health. However, some gentrification changes the physical environment in the ways that, in the long run, may also bring some benefit to the city, including the health of most inhabitants. This illuminates the contradictory nature of gentrification processes and their consequences.

Conclusion: This research highlights the complex relationship between gentrification, changes in the physical environment and public health, emphasising the need for balanced policies that promote equitable urban regeneration and sustainability.

Keywords: public health, urban health, photovoice, gentrification, social determinants of health, health inequalities.

I. Introduction

Urban living profoundly influences health by directly shaping factors and indirectly affecting determinants of population health (Sarkar et al., 2017). Urban health focuses on understanding how living in cities impacts health outcomes, considering the urban environment itself as a key exposure. While other partitions exist (Macintyre et al., 1993), three broad categories help explain how city living affects health: the physical environment, the social environment, and the availability of and access to health (Galea & Vlahov, 2005). The term physical environment refers to the naturally occurring features and built environments, including air pollution, climate and geological conditions, forests, parks, water features, recreation and commercial facilities, and transportation systems (Galea & Vlahov, 2005; Ribeiro & Fecht, 2021). Features of the physical environment, such as air and water quality, noise pollution, exposure to hazardous substances, housing conditions, indoor environments, and access to open/green spaces and recreational areas, contribute to human health and influence our overall well-being (Schnake-Mahl et al., 2020).

The physical context is dynamic, undergoing multiple transformations driven by various factors, such as gentrification. The urban transformations driven by gentrification may contribute to health risks, particularly when access or exposure to the positive and negative attributes of the physical environment varies across populations and places, potentially leading to health disparities (Bastain et al., 2021). Gentrification poses challenges for families in accessing affordable, quality housing, food, services and transport access, leading to the relocation of the poorest residents and, consequently, a drastic change in the physical and socio-cultural characteristics of the neighbourhoods (Schnake-Mahl et al., 2020).

Gentrification can be understood as a set of processes of sociospatial change driven by investments in the built environment targeted to the preferences of affluent people (Gant, 2016). It involves the revitalisation of the physical environment, the displacement of former residents — particularly those with less economic resources — and the arrival of new, more affluent individuals into the gentrifying areas. Recent studies highlight Spanish and Portuguese cities, such as Barcelona (Cocola-Gant et al., 2020), Madrid, Lisbon (Cocola-Gant et al., 2021; Mendes, 2021), and Porto (Chamusca et al., 2019; Carvalho et al., 2019), as gentrification hotspots driven by tourism and other forms of transient mobility and real estate financialization, which are linked to international fluxes of capital and globalised consumption

and often facilitated and encourage by the state and its actors.

The available research suggests that gentrification-induced transformations can have both positive and negative impacts on health. Key aspects affected include changes in nutrition due to shifts in food availability and access, variations in housing quality and affordability, changes in green space availability, and modifications in access to local services, including health care, among others. These changes can lead to adverse effects on health (Santos, 2024; Silva et al., 2023). The health impacts of gentrification are distributed unevenly (Hwang & Ding, 2020). Urban inequalities exacerbate discrimination by limiting opportunities and creating unjust exposures based on race, ethnicity, age, gender, and sexuality. These social and physical disparities are closely linked to unequal environmental exposures, resulting in environmental injustices (Cole et al., 2021). In addition, older adults have a specific vulnerability since many have spent much of their adult lives living in the same neighbourhood, and their daily lives are usually circumscribed to their immediate neighbourhood due to retirement and/or reduced mobility (Torres, 2020).

In Porto, urban transformation has gone hand-in-hand with a growing influx of tourists and other types of short-term visitors and floating city users, such as students, digital nomads, and other individuals who reside temporarily in the city. (Chamusca et al., 2019). Beyond tourism, a relevant source of gentrification is linked to the influx of post-secondary students – referred to as *studentification* (Carvalho et al., 2019). These phenomena, especially the tourism boom, have had significant consequences. On the one hand, they have stimulated the rehabilitation and revitalization of the historic centre and local commerce. On the other hand, it has led to a sharp increase in housing values, mass evictions, pressure on residents, and the closure of local businesses and community spaces (Barbosa & Lopes, 2020).

The relationship between gentrification, the physical environment, and health is intricate and warrants comprehensive exploration. The physical environment's role as a determinant of health underscores the importance of understanding how urban transformations, driven by physical changes induced by the gentrification process, affect community well-being. Qualitative methods are useful for investigating the complex relationships between gentrification and public health, offering rich, contextual insights that quantitative approaches may overlook. These methods, characterized by their flexible nature, allow for rich

descriptions and explanations of phenomena (Hammersley, 2013). Visual methods, including the analysis of photography, film, video, and other visual artifacts, have become increasingly accepted and utilized across various disciplines such as sociology, psychology, geography, and health care (Pain, 2012).

In public health research, photography has emerged as a valuable yet underutilized data source, offering potential beyond its traditional use in fields like psychiatry and oncology (Saita et al., 2018; Moretti et al., 2021). Research by Cannuscio et al. (2009) has shown its value to reveal health-relevant features of the physical, as well as social, environment. These visual methods are especially effective in engaging participants who may not be accustomed to reflecting on their experiences, facilitating deeper reflection and richer data collection compared to verbal data alone. They are also valuable for systematic observation, such as in urban health studies where they can provide visual support in discussions with city residents (Cannuscio et al., 2009). As information and communication technology continues to advance, the integration of visual methods in qualitative research has become important for capturing the nuanced impacts of gentrification on health, ensuring that the data collected is both comprehensive and insightful (Cannuscio et al., 2009; Barbour, 2014).

One type of visual method is photovoice, which is useful for research in various areas including public health. Furthermore, photovoice stands out as a participatory research and visual method that empowers community members to document and reflect on their environment through photography (Budig et al., 2018). This type of methodology is growing in popularity in the health, education and social sciences as a research tool based on the core values of community-based participatory research (Glaw et al, 2017).

Photovoice projects typically produce a substantial number of photographs, capturing diverse aspects of the physical environment and the personal narratives of those experiencing gentrification. These images offer a powerful means of understanding how gentrification reshapes neighbourhoods and affects the daily lives of residents (Sutton-Brown, 2014).

Photos, when considered as standalone data rather than merely as elicitors, hold significant potential for uncovering nuanced perspectives (Glaw et al, 2017) and highlighting the subtle ways in which gentrification impacts the physical environment and, consequently, community

health. Thus, visual data can be considered integral to research, not just supplementary tools, which emphasizes the need for rigorous and comprehensive analysis of visual materials within academic inquiry (Harrison, 2002). Moreover, visual documentation, such as photos, can serve as compelling evidence in discussions about urban policy and planning, emphasizing the need to consider health impacts in the context of urban redevelopment. The increasing concern about the influence of context on health requests for the integration of population health into urban planning as an essential goal to improve related-policymaking decisions, to foster healthier lifestyles and to avoid major health risks. (Salgado et al, 2020)

Despite the potential of visual methods and photographs as valuable data points, existing research often focuses on either visual or textual analysis and photos that participants don't use for the discussion session are often discarded (Wang et al., 2020; Smith et al., 2022). This study aims to address this gap by conducting a combined and integrated analysis of the visual and textual material generated in a photovoice study on gentrification and health in Porto (Portugal). Specifically, it aims to assess the impact that the physical transformations associated with gentrification could have on public health.

2. Methods

2.1. Design and participants

The present study draws upon photos and transcriptions collected during a photovoice project conducted by the team within the EPIPorto cohort, which has been described in detail in a previous publication (Silva et al, 2023).

Briefly, we recruited participants from areas where gentrification processes are intense and from both deprived and affluent areas where they are mostly absent. All the participants took part in a prior training session on photography and were then given cameras to portray situations in which they believed there may be a relationship between gentrification and health in the city of Porto. Afterwards, we conducted three discussion sessions, one per group, with a total of 16 participants, including 7 men and 9 women, all residents in the city of Porto,

Portugal. The discussion sessions with participants from gentrifying, deprived non-gentrifying and affluent non-gentrifying areas took place on July 29th, October 17th and November 17th 2022, respectively.

2.2. Analysis of photographs and transcriptions

The photovoice study that generated the data which we used for this article only considered the photographs that the participants chose to discuss during the three discussion sessions, leaving out most of the photographs. Additionally, it did not specifically focus on changes in the physical environment but rather on broader neighbourhood transformations and health impacts. Like many photovoice studies, data analysis was focused on the session transcripts, while the photos were mostly used to elicit the views of participants and promote discussion. In contrast, the present study adopted an integrated approach, analysing all photographs taken by participants and the transcriptions of discussion sessions aiming to complement the analysis of the three discussions with the visual information extracted from the photos. This means that all the data generated by this study – the entirety of the photographs generated by participants and the integral transcripts of the three discussion sessions – were considered for detailed analysis.

For the analysis of the photographs and the transcriptions, a coding matrix was developed. Both the photographs and the transcripts from the photovoice discussion sessions were coded using this framework. This allowed us to compare both media and integrate the analysis of both later on. This matrix development was based on a literature review about the relationship between health, gentrification and changes in physical environment and lists the main physical signs of gentrification being organised in 10 broader categories each one with several subcategories. Table 1 presents the 10 categories and their respective subcategories.

Table I Coding matrix for gentrification categories

Category	Subcategory	Description
Pollution	Noise pollution	Also known as environmental noise, refers to excessive unwanted or disruptive sound that interferes with normal activities, causing discomfort, annoyance, or adverse effects on health and the environment, thereby affecting the well-being of both existing and incoming populations. In urban contexts, sources of noise pollution include construction and demolition, commercial activities, heavy traffic, and elevated levels of noise associated with gatherings of people, both during the day and at night.
	Air pollution	Air pollution refers to the presence of harmful or excessive substances in the Earth's atmosphere, with potential repercussions for the well-being of populations. In urban contexts, the primary sources of air pollution are often associated with increased traffic and transportation, characterized by high vehicular traffic. Additionally, air pollution may result from construction and redevelopment activities, which can release airborne pollutants such as dust, construction-related emissions, and volatile organic compounds.
	Water pollution	Refers to the contamination of water bodies, including lakes, rivers, oceans, groundwater, and other aquatic systems, by harmful substances that adversely affect the quality of water and pose risks to human health, ecosystems, and the environment. In urban context the sources of pollution could be stormwater runoff, industrial and commercial activities, sewage, and wastewater.
	Litter pollution	Refers to the widespread accumulation of improperly discarded solid waste, including items such as plastic bottles, packaging, cigarette butts, and other debris, in public areas. In the context of gentrification, the reshaping of neighbourhoods through economic revitalization and demographic shifts can influence the patterns and consequences of litter pollution.

Category	Subcategory	Description
Social Infrastructure	Closing community centres and civil associations	Refers to the cessation or reduction of operations and services provided by communal spaces and organizations that historically served as vital hubs for social engagement, support, and community building.
	Open green spaces	Refers to accessible areas characterized by natural vegetation, grass, trees, and other greenery that serve as free public recreational, relaxation, and social interaction spaces. For example, these areas could include municipal gardens, parks, tree-lined areas within the city, among others.
	Street greenery	Refers to the intentional incorporation of natural elements such as trees, shrubs, and other vegetation within the urban streetscape – including roadsides, pedestrian areas, squares, and unused or underutilized spaces in cities.
	Reduction in brownfield sites	Refers to the deliberate decrease in the number or size of previously contaminated or underutilized areas within urban landscapes. This reduction is achieved through strategies such as site remediation, redevelopment, or adaptive reuse.
Green infrastructure	Restricted access green spaces	Refers to areas with natural elements like vegetation, greenery, and recreational amenities that have limited entry or use. These spaces may be subject to various constraints, such as exclusive memberships, entry fees, or physical barriers, affecting their accessibility to certain segments of the population.
Housing Accommodation infrastructure	On-going construction	Refers to the continuous and active process of building, renovating, or developing structures within a city or urban area. Examples of this persistent construction activity include the development of new residential properties, such as apartment complexes, condominiums, or housing units.

Category	Subcategory	Description
	Short-term rental	Refers to the practice of renting residential properties, such as apartments or houses, for brief periods, typically ranging from a few days to a few months. This form of lodging often occurs through online platforms or rental services, allowing property owners to lease their units to temporary occupants. This practice is facilitated by online platforms and rental services, such as Airbnb, enabling property owners to offer their spaces to transient occupants.
	Housing renewal/Upgrades	Refers to the process of revitalising and improving existing residential structures in urban areas and can involve a range of interventions, such as renovations, modernisations, and upgrades, with the aim of improving the quality, aesthetics, functionality, and visual appearance of housing units. In addition, can also include upgrading existing construction with, for example, energy-efficient features and technology to meet contemporary living standards.
	Green/climate friendly building practices	Refers to sustainable and environmentally conscious approaches in the construction and maintenance of buildings within urban areas. These practices aim to minimize the environmental impact of construction, enhance energy efficiency, and promote the overall well-being of both residents and the surrounding ecosystem. Regarding energy efficiency could be passive design strategies that maximize natural light, ventilation, and insulation to reduce the need for artificial heating or cooling and renewable energy such as solar panels or wind turbines to enhance energy efficiency and reduce reliance on non-renewable resources. In addition, sustainable materials and water efficiency strategies could also be included.
	Changes in housing density	Refers to alterations in the concentration and distribution of residential units in urban areas, often manifesting as the conversion of larger houses into smaller units and subdivision of properties, with impacts on affordability dynamics and housing market.

Category	Subcategory	Description
Food environment	Trendy food Markets	Refers to the evolving landscape of food-related establishments and markets in urban areas. Trendy food markets are characterized by a focus on unique, often artisanal, and high-quality, and culturally diverse food and beverage offerings.
	International restaurants	Refers to the evolving culinary landscape of urban areas undergoing gentrification. International restaurants are establishments that offer cuisine from diverse parts of the world, contributing to a rich tapestry of food options.
	Gourmet shops	Refers to the shops that are establishments that specialize in offering high-quality, often artisanal or specialty food products, emphasizing unique and upscale offerings. In this type of shops there is a focus on providing distinctive, and often locally sourced food products.
	Coffee shops	Refers to the evolving coffee culture and the presence of coffee establishments in urban area as coffee shops. These are social spaces that serve a variety of coffee-based beverages and often offer a relaxed atmosphere for community members to gather, study, work, or socialize.
	Green/healthy food	Refers to the changing landscape of nutritious and environmentally conscious food choices in urban areas. Green or healthy food options encompass a range of fresh, local, organic, and sustainably sourced products that contribute to a healthier diet and lifestyle, seeking nutritious and environmentally conscious choices.
	High-end restaurants and cafes	Refers to the transformation of culinary spaces in urban areas, high-end establishments, characterized by premium offerings, sophisticated dining experiences, and upscale atmospheres. These establishments are characterized by their emphasis on premium dining experiences, gourmet offerings, with chef-crafted menus.
	Closing traditional cafes and restaurants	These closures represent the displacement of long-established eateries, often with cultural or historical significance, contributing to the transformation of the culinary landscape. The closure of these establishments may lead to the loss of cultural heritage, as they are integral to the history and identity of the community.
	Terraces	The expansion of terraces, outdoor spaces commonly associated with cafes and restaurants that offers open-air places to enjoy meals.

Category	Subcategory	Description
Commerce and services	Closure of traditional shops	Refers to the displacement or closure of long-standing and often culturally significant businesses in a city affecting the livelihoods of owners and employees.
	Shops oriented to tourists	These are retail establishments strategically designed to tourists' needs and preferences. Such shops often offer a variety of souvenirs, local crafts, and goods that appeal to visitors.
	Private healthcare facilities	Refers to medical institutions that operate independently of government funding and are privately owned.
	Private educational facilities	Refers to educational institutions that operate independently and are not funded by the government.
	High-end stores	Refers to retail establishments that specialize in premium and luxury goods.
	Trendy/international stores and services	Refers to retail outlets and businesses that offer fashionable and globally inspired products or experiences.
	Sport facilities, wellness/fitness centres Day and night-time entertainment spaces	These are establishments focused on physical fitness, well-being, and sports-related activities. Examples of this type of establishment include gyms, spas, leisure centres, among other places. Refers to a variety of establishments where people gather for leisure and social interactions. These may include bars, pubs, nightclubs, discos, and similar venues that operate during different hours of the day, providing diverse entertainment options.
Transport infrastructure	Improvement in conventional transportation systems	Refers to enhancements made to traditional modes of public transportation, including buses, metro/subway systems, and trains.
	Investments in soft modes of transportation	Refers to financial allocations for the development and enhancement of alternative and eco-friendly transportation options. This includes the creation of bike lanes, introduction of scooter-sharing programs, and other initiatives aimed at promoting sustainable and accessible modes of transit.

Category	Subcategory	Description
	Presence of Tourist transportation	The presence of tourist transportation refers to the availability and visibility of transportation services designed to cater to tourists. This may include tour buses, sightseeing vehicles, or other modes of transport specifically tailored to the needs of visitors.
	Quality Sidewalks and Crosswalks	Represent well-maintained and pedestrian-friendly pathways and crossings that contribute to the safety and accessibility of pedestrians.
Physical signs of safety	Vandalism	Refers to the deliberate destruction or defacement of public or private property.
	Drug Consumption	Refers to the use of illicit substances or the misuse of legal drugs.
	Policing and surveillance	Refers to the enforcement of law and order as well as the monitoring of public spaces, considering, for example, surveillance cameras in public spaces and the reinforcement of the police presence, particularly at high-participated events.
	Alcohol consumption	Refers to the use of alcoholic beverages, considering, for example, levels of consumption in an urban context, the type of beverage consumed, among other factors.
Crowding	Crowding	Refers to the density of people in a particular area, often associated with public spaces.
Buildings (except housing)	On-going construction	The creation or renovation of commercial spaces attracts new businesses or services and infrastructure projects, such as road expansions, public transportation enhancements, or utility upgrades, contribute to the overall construction landscape.
	Building renewal/upgrades	Refer to the process of revitalizing and improving existing structures within urban areas. This involves making significant enhancements to the physical, functional, and aesthetic aspects of buildings, contributing to the overall transformation of a neighbourhood and may include renovations, modernizations, and aesthetic improvements.

For this analysis, criteria for the inclusion and exclusion of photographs were defined. All photographs taken by the participants were considered for inclusion. The exclusion criteria were as follows: photos of repeated locations by the same participant and photographs lacking sufficient quality for analysis. Afterwards, photographs were uploaded to the software *NVivo version 14* and were coded—based on the priori-defined matrix. Figure 1 shows an example of the photograph coding.

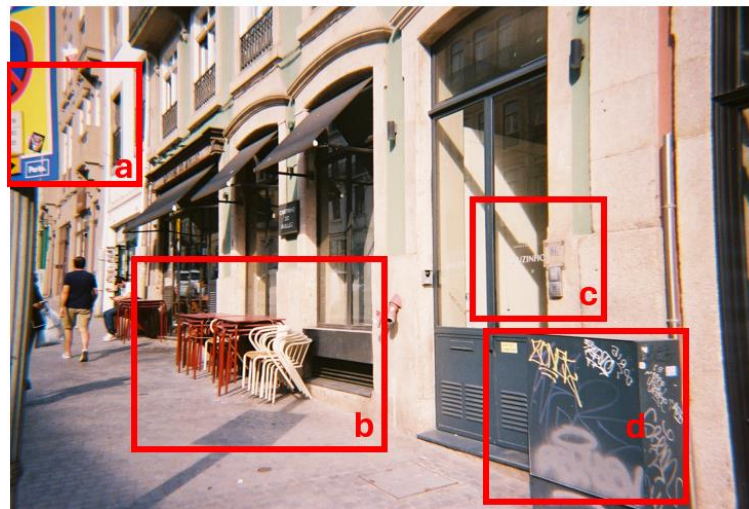


Fig. 1. Example of photo analysis of a gentrified area based on coding matrix. *Mouzinho da Silveira* Street, Oporto, Portugal. (a. Improvement in Conventional Transportation; b. Terraces; c. Short-term Rental; d. Vandalism)

The various elements of each photograph were analyzed, and one or more categories visible or inferable were identified, along with the co-occurrences of the most common subcategories. The analysis included categories that were directly observable in the photographs, as well as those that could be inferred from visual cues. Inferences were frequently made for subcategories that were not visually evident, such as air and noise pollution. For instance, the presence of construction sites was categorized as noise pollution, reflecting the likely presence of noise even if it was not explicitly visible in the images. This analysis allowed us to quantify the number of occurrences of each category, as well as quantitatively explore the co-occurrence of different categories in the same photograph.

The coding matrix was also used to systematically and qualitatively analyze the transcripts from the discussion sessions. The matrix's subcategories were used to code these transcripts. Thus, besides enabling the identification of the most frequently discussed categories and

subcategories, as well as the exploration of co-occurrences, our analysis allowed us to understand how participants made sense about each category and its implications for the city's inhabitants, including their health. In different words, the coding and analysis of both photographs and transcripts from the photovoice discussion sessions allowed us to integrate the analysis of both media, by comparing and cross-referencing the results from both processes. An integrated report of the qualitative analysis of both the photographs and transcripts will be presented, supported both by carefully selected images and excerpts from transcripts.

This approach allowed us to reach an understanding of the data informed both by what the photographs show when interrogated by our coding matrix and what our participants saw in them, as presented and discussed by them, including the issues and stories that were linked to them during the discussions. We believe this approach allowed us to reach a richer, more nuanced interpretation of both types of data and, consequently, a deeper perspective on the research topic.

3. Results

The results section is organized as follows: first, a descriptive analysis of the categorizations made in the photos taken by the participants and based on the established coding matrix will be presented. Following this, the results of the qualitative analysis of both photographs and transcripts will be presented in an integrated way. This presentation is organised according to the main categories of the analytical matrix. Finally, co-occurrences of categories in the pictures will be analysed. All participant names mentioned and cited throughout the article are fictional.

General descriptive quantitative analysis

A total of 16 participants were involved in the photovoice study, with their sociodemographic characteristics detailed in Table 2.

Table 2. Participants' socio-demographic characteristics

		Gentrifying areas (n=6)	Deprived non- gentrifying areas (n=4)	Affluent non- gentrifying areas (n=6)
Gender	Male	3	3	1
	Female	3	1	5
Age (Years)	50-59	1	0	0
	60-69	3	3	3
	70-79	2	1	2
	80-89	0	0	1
Completed education levels (ISCED,2011)	Early Childhood	1	0	0
	Primary	1	0	0
	Lower Secondary	2	0	1
	Upper Secondary	0	1	1
	Tertiary	2	3	4

From a total of 516 photos produced by participants, 58 were excluded according to the exclusion criteria previously established and presented in the methodology: place and categories repeated by the same participant (n=51); insufficient quality of the image (n=2); and impossibility of identifying any parameter related to health or gentrification in the photos (n=5). Based on the 458 photos analysed, the most common subcategories identified through the photo analysis were: street greenery, ongoing construction, terraces, crowding, and noise pollution. Most participants took photos of the most touristy locations and captured gentrified areas. Additionally, some of the locations chosen by participants for their photos were situated near their homes or workplaces, often outside typical tourist areas. Table 3 depicts the frequency of each category and sub-category.

Table 3. General quantitative description of photo analysis

Category	Number of times recognised	Sub-category	Number of times recognised
Green infrastructure	249	Street greenery	179
		Open green spaces	47
		Restricted access green spaces	23
Buildings	102	On-going construction	72
		Building renewal and upgrades	30
Pollution	94	Noise pollution	37
		Litter pollution	33
		Air pollution	14
		Water pollution	10
Food environment	86	Terraces	58
		International restaurants	7
		High-end restaurants	7
		Specialty coffee shops	5
		Trendy food markets	4
		Green and healthy food	3
		Gourmet shops	2
Transport infrastructure	73	Quality sidewalks and crosswalks	28
		Improvement in conventional transportation	24
		Presence of tourist transportation	14
		Investments in soft modes of transportation	7
Housing and accommodation infrastructure	50	Housing renewal and upgrades	28
		Short-term rental	13
		On-going construction	7
		Green and climate friendly building practices	2
Commerce and service	47	Shops oriented to tourists	23
		Day and night-time entertainment spaces	10
		Sport facilities, wellness, fitness centres	5
		High-end stores	5
		Trendy and international stores	2
		Closing traditional or local services	2
		Private healthcare facilities	0
		Private educational facilities	0
Crowding	43	Crowding	43
Physical signs of safety	32	Vandalism	32
		Policing and surveillance	0
		Drug consumption	0
		Alcohol consumption	0
Social infrastructure	5	Closing community centres and civil association	5

From the analysis based on the coding matrix for identifying changes in the physical environment related to gentrification processes, it was possible to identify the 10 categories previously established. Only five subcategories were not identified in the photos taken by the participants: private educational facilities, private healthcare facilities, alcohol and drug consumption, and policing & surveillance. Regarding these subcategories that were not identified in the photos, drug consumption was mentioned by one participant from the gentrified areas session.

Green infrastructure

The green infrastructure category was divided into 3 specific subcategories according to the different types of green space: 3A – Open green spaces; 3B – Street greenery; 3C – Restricted access to green spaces. The general green spaces category was identified 249 times when analysing the photographs, 47 in the subcategory of open green spaces, 179 in street greenery, 23 in restricted access to green spaces. Different types of green spaces were mentioned by the participants, with the street greenery being the most mentioned and addressed by participants from the 3 different groups selected.

Residents of the city of Porto who participated in this study revealed the importance of the city's green spaces to them, particularly the city park, a large green area directly connected to a beach that allows for outdoor activities, sports, and socializing. City parks and gardens are referred as spaces that plays a beneficial role for their health.

On the other hand, regarding the studentification of the city, some participants mentioned that university students brought changes in the use of public space, such as sitting on the grass, something that residents were not accustomed to doing, as illustrated in figure 5.

'University students who study in our city use the garden to soak up the sun, to enjoy what the garden can actually offer us... which is, as our friend [referring to another participant in the discussion session] here also said, to oxygenate those lungs, even though they are very close to a high traffic area (...) I noticed that they also started to sit on the grass, something that never used to happen. But the residents sit on the bench, so they also began to enjoy a space that they didn't know how to use (...) They came, took advantage of the space we have, and showed us a way to use it. People started using it for the benefit of their own health.'

'Henrique', male, 64 years old, non-gentrifying deprived areas

From this perspective, these new students and some tourists are contributing to the promotion of healthier lifestyle habits in the city, even by setting an example. Sitting on the grass in public spaces used to be discouraged to avoid damaging the grass.



Fig. 5. Photograph by a participant from a deprived non-gentrifying area depicting a municipal garden with people enjoying this public green space.

Buildings (except housing)

The buildings (except housing) category was divided into 2 specific subcategories according to the different types of building: 10A – On-going construction; 10B – Building renewal/upgrades. The general buildings category was identified 102 times when analysing the photographs, 72 in the subcategory of on-going construction and 30 in building renewal/upgrades.

Buildings were widely identified in the photographs, as well as mentioned by the participants, in particular highlighting their need to maintain the city's infrastructure, but also seen as a process that has a negative impact on their lives, specially, during periods of rehabilitation work.

Indeed, the city is undergoing a rehabilitation of its infrastructure, and this has had a significant impact on life in the city, which is noisier, with more traffic due to restrictions on circulation associated with the rehabilitation works, both of which were considered to have negative health implications. However, it was recognized by the participants that this transformation driven by gentrification is giving the city a new lease of life and making it more pleasant and therefore better to live in. Figure 13 illustrates building renewal and upgrades in Porto downtown.

‘The city underwent an earthquake of reconstruction, let's say... There's a current here that... “let's rejuvenate all this”, which is a very good thing for me. And there's something I say: public health is better for me’.

‘Augusto’, male, 65 years old, gentrifying areas



Fig. 13 Photograph by a participant from a deprived non-gentrifying area depicting building renewal and upgrades.

Pollution

The pollution category was divided into 4 specific subcategories according to the different types of pollution: IA - Noise pollution; IB - Air pollution; IC - Water pollution; ID - Litter pollution. The general pollution category was identified 94 times when analysing the photographs, 14 in the subcategory of air pollution, 33 in litter pollution, 37 in noise pollution and 10 in water pollution. Different types of pollution were mentioned by the participants, with noise pollution being the most mentioned and addressed by participants from the 3 different groups selected.

Figure 2 represents one of the images discussed by the participants in the photovoice session, in which a large number of vehicles and traffic can be seen, as well as a crane and equipment for intervention works to extend the city's metro line, through which the noise that will result from both the traffic and the ongoing works can be perceived. On the other hand, in addition to the noise, both factors have contributed to generating atmospheric pollution and the consequent degradation of the city's air quality and environment.



Fig. 2 - Photograph by a participant from gentrifying area showing the noise pollution associated with the improvement in conventional transportation and the traffic intensity in the city.

Pollution was widely identified both in the photographs and in the discussion sessions with residents. The intense noise in the city, particularly associated with traffic and the city's modernisation and rehabilitation works, is perceived by the participants as something negative for their health, with particular emphasis on the impact on mental health and well-being.

'In the end, it's also in the area of mental health, I think. Because the people who are still there [touristic area of Porto] live with a lot of stress from the constant new noises, the wheels of suitcases, the noise from the bars.'

'Luísa', female, 62 years old, non-gentrifying affluent areas

'They [teams carrying out the construction works] didn't stop making noise, from a quarter past eight in the morning until six in the evening (...) imagine at home, me and people who, poor things, were much worse off than me, in poorer health, and older, others. And children. And sick people. And babies to breastfeed (...) related to the health issue, which, after two and a half months, I started to... maybe go off the deep end, because my family started to get worried. I started to get 'stressed'. But stressed in a way that I can't even describe. I needed... I needed psychiatric help.'

'Jorge', male, 66 years old, gentrifying areas

With regard to litter pollution, the participants had different points of view: on the one hand, some considered that the transformations and rehabilitations of the city had made it cleaner, more beautiful and more cosmopolitan. On the other hand, it was also mentioned that the high number of tourists has contributed to dirtier streets, more noise, particularly from bars and recreational spaces frequented by tourists, and all this has led to complaints from residents. About the presence and possible impact on their lives of litter and noise pollution, there were different positions among the various participants.

Another point highlighted was the high level of litter pollution on public roads and the contribution this waste makes to the proliferation of seagulls and pigeons, which is already a public health problem in the city (Faria, 2021). Figure 3 illustrates this situation in the downtown of Porto.

'The major infrastructures that changed the city of Porto. They've been important from then until now, and the city of Porto has improved a lot in terms of aesthetics, even in terms of hygiene, rubbish collection, all of that.'

'Isabel', female, 62 years old, non-gentrifying affluent areas



Fig. 3 - Photograph by a participant from gentrifying area showing litter pollution in downtown of Porto.

Food environment

The food environment category was divided into 7 specific subcategories according to the different types of food environment: 5A – Trendy food markets; 5B – International restaurants; 5C – Gourmet shops; 5D – Specialty coffee shops; 5E – Green/healthy food; 5F – High-end restaurants; 5G – Terraces. The food category was identified 86 times when analysing the photographs, 4 in the subcategory of trendy food markets, 7 in international restaurants, 2 in gourmet shops, 5 in speciality coffee shops, 3 in green/healthy food; 7 in high-end restaurants; 58 in terraces. Different types of food environment were mentioned by the participants, with terraces being the most photographed by the participants.

Concerns were expressed regarding the declining quality of new dining establishments and the potential adverse effects resulting from the loss of traditional gastronomy. The transformation and reorientation of commercial spaces towards a more international food offering have made it difficult for residents to access the traditional foods they are accustomed to. Residents noted that Portuguese food is increasingly being replaced by unhealthy international alternatives. The

rising prices of these international and gourmet restaurants render them inaccessible to some, leading to the disappearance of affordable establishments that offer traditional Portuguese cuisine within residents' cultural and gastronomic practices. As a result, these changes may have significant implications for the local population's diets and consequently for the overall health of residents.

'By reinventing our food, often with... in my view, with a total disaster of our typical dishes. So that would be a very negative aspect for our... for our health. Because, despite everything, we eat much healthier things than in the United States or Germany, don't we? Or anywhere else.'

'Joana', female, 51 years old, gentrifying area

Regarding terraces and as a result of the restrictions on indoor spaces due to the COVID-19 pandemic (but also as restaurant spaces with outdoor areas and views of the city, also sought after and oriented towards tourism) outdoor catering spaces have been greatly expanded in the city, which has limited pavements and pedestrian circulation areas. Terraces were described as an obstacle to pedestrian circulation. Participants recognise the benefits of enjoying these outdoor spaces, but also point out the negative impact they have on their daily lives. Figure 8 illustrates the situation above.

'The pavements are taken up with terraces. So we can't even walk, because the pedestrian space has been invaded. And this also has to do with mental health, I think. (...) The pedestrian space has been taken over by... terraces that are growing without... any rules.'

'Luísa', female, 62 years old, non-gentrifying affluent areas



Fig. 8. Photograph by a participant from a deprived non-gentrifying area depicting the difficulties residents face related to terraces.

Transport infrastructure

The transport infrastructure category was divided into 4 specific subcategories according to the different types of transport: 7A – Improvement in conventional transportation systems; 7B – Investments in soft modes of transportation; 7C – Presence of tourist transportation; 7D – Quality sidewalks and crosswalks.

The general transport category was identified 73 times when analysing the photographs, 24 in the subcategory of improvement in conventional transportation systems, 7 in investments in soft modes of transportation, 14 in presence of tourist transportation, 28 in quality sidewalks and crosswalks.

Different types of transport infrastructure were mentioned by the participants, with improvement in conventional transportation being the most mentioned in particular the new intermodal terminal of Campanhã (which has road space and access to the railway line), and the expansion and requalification works of the Porto metro.

The city's modernization and redevelopment efforts were prominently identified in the photos analysed, as well as in the transcripts of discussion sessions with residents. This point was linked to gentrification, particularly the city's transformation into a tourist destination, as well as with the aim of facilitating the movement of tourists and students between the various areas of the city.

The expansion (illustrated in figure 10) aims to make it easier to move around the city and to access neighbouring cities, such as *Vila Nova de Gaia* and *Matosinhos*, which also become more accessible to tourists.



Fig. 10. Photograph by a participant from a deprived non-gentrifying area depicting expansion work on Porto's metro network.

While participants acknowledged the immediate inconveniences of construction, such as noise and air pollution, they also recognized the long-term benefits of a modernized city, including reduced car traffic.

In addition to the noise (noise pollution), the dust resulting from the works (air pollution) and the logistical disruption to daily mobility, participants highlight inconveniences in the present during the works, but see them as something positive in the long term for the city. Most of them consider the disruption caused by the works to be a ‘necessary evil’ and that living in a modernised city also brings benefits to its residents.

‘And let them leave their cars on the outskirts, as they do in some cities. And that’s it. Mobility. Perhaps this will greatly improve health: fewer cars in the city, less pollution, less stress.’

‘Nuno’, male, 67 years old, non-gentrifying deprived areas

The significant presence of tourist transportation was mentioned by the participants and also identified in the photographs analysis. Figure 11 shows an example of this type of tourist-oriented transportation, a tuk-tuk conducting a guided tour of the city.



Fig. 11. Photograph by a participant from a gentrifying area depicting the presence of tourist transportation.

Moreover, according to a participant from gentrifying areas, the use of tourist transport options, such as tuk-tuks, poses potential public health risks due to the increased likelihood of accidents. These vehicles, often operated in congested urban areas with high pedestrian traffic, may lack the safety standards of conventional transportation, leading to a higher risk of injury

for both passengers and bystanders.

'But here they [tuk-tuk drivers] sometimes take four or six people. This, to tip over, which in the city they walk quite lightly, showing off and so on with their arms in the air and so on. Honestly, this could lead to problems one day. As it already has. In Gaia, there's already been a case where it overturned and the lady was badly injured'

'Rosa', female, 65 years old, gentrifying areas

Housing Accommodation Infrastructure

The housing accommodation infrastructure category was divided into 4 specific subcategories according to the different types of housing infrastructure: 4A – On-going construction; 4B – Short-term rental; 4C – Housing renewal/Upgrades; 4D – Green/climate friendly building practices. The general housing category was identified 50 times when analysing the photographs, 7 in the subcategory of on-going construction, 13 in short-term rental, 28 in housing renewal/upgrades, 2 in green/climate-friendly building practices. Different types of housing accommodation infrastructure were mentioned by the participants, with renewal and upgrades being the most mentioned and addressed by participants. Figure 6 shows the case of a building being built on a street in Porto.

Urban rehabilitation in Porto has also made the city centre inaccessible to families with children and individuals with lower incomes. The reconstruction efforts in the area, primarily focused on luxury housing, have contributed to this shift.

'And what is this reconstruction in that area? They're residential buildings, but they're for luxury housing.'

'Augusto', male, 65 years old, gentrifying area



Fig. 6. Photograph by a participant from a gentrifying area depicting rehabilitation and construction in the city.

‘Social geography has also changed, hasn't it? Because of that. The people who live in these very small spaces, they don't live the way I do, indoors, home, they live much more outside.’

‘Henrique’, male, 64 years old, non-gentrifying deprived areas

This shift has led to an increase in smaller family units, with larger families being pushed out of the city centre. However, some residents observe that the prevalence of smaller housing typologies attracts individuals whose lifestyles are less centered around the home and more focused on activities outside. Rather than being forced outside by cramped living conditions, these residents are drawn to such spaces because their lifestyle aligns with spending more time outside their homes.

On the other hand, the proliferation of local accommodation spaces and Airbnb were also mentioned and photographed (figure 7) by participants, suggesting this as a point that makes it difficult for families to remain living in the city, contributing to rising prices and leading to displacement.

'She [a person who used to live in Porto and moved to the outskirts] was moved to an area that was completely unknown to her, but she didn't continue to live in the city of Porto. Ehm... But the truth is that she... this really upset her. And someone who used to be a very happy person is now a very sad person.'

'Isabel', female, 62 years old, non-gentrifying affluent areas

'Local Accommodation. Now... They've taken over... These societies have taken over a lot of accommodation where families used to live, haven't they?'

'Nuno', male, 67 years old, non-gentrifying deprived areas



Fig. 7. Photograph by a participant from a non-gentrifying deprived area depicting a local accommodation space in Porto.

Commerce and services

The commerce and services category was divided into 8 specific subcategories according to the different types of commerce: 6A – Shops and services oriented to tourists; 6B – Private healthcare facilities; 6C – Private educational facilities; 6D – High-end stores; 6E – Trendy/international stores and services; 6F – Sport facilities, wellness/fitness centres; 6G – Day and night-time entertainment spaces; 6H – Closing local or traditional services.

The commerce category was identified 47 times when analysing the photographs, 23 in the subcategory of shops and services oriented to tourists, 5 in high-end stores, 2 in trendy/international stores and services; 5 in sports facilities, wellness/fitness centres, 10 in day and night-time entertainment spaces and 2 in closing local or traditional services. Private healthcare facilities and private educational facilities were not identified in the photos, neither mentioned by the participants in the discussion sessions.

In terms of commerce and services, some residents note that the services are oriented towards non-national consumers. They feel as though they no longer belong to the city.

'Of course we have... There are some places, I live there, where the prices are affordable, but there are others where it's affordable, but then it's exorbitant.'

'Joana', female, 51 years old, gentrifying area

'They're exaggerated [the prices] There you go, it's for outsiders, it's for those with money.'

'Susana', female, 61 years old, gentrifying area

'It's like I say, it's for the tourist.'

'Augusto', male, 65 years old, gentrifying area

Photographs and participant discussions revealed the significant presence of tourist-oriented

spaces in the city, which many residents perceive as contributing to a loss of local identity, people feel alienated from the city and have difficulty to access traditional services. This issue is illustrated in Figure 9. The decline of traditional commerce, already in motion due to the rise of large shopping centres and supermarkets on the periphery, has been exacerbated by retail gentrification, which has led to the replacement of locally oriented food products and stores with tourist-focused establishments. Retail gentrification was associated with replacement of iconic shops by generic stores catering to transnational customers and souvenir shops.

This shift is particularly detrimental to vulnerable groups, such as older adults with limited mobility, who may struggle to access food or become reliant on relatives for groceries. As convenient local shops disappear and the prices increase, these residents may reduce their physical activity and adopt more sedentary lifestyles, such as walking, which could have negative consequences for their health.

'People are sedentary at home, because they don't have the capacity, old people (...) to go to Norteshopping (...) This leads to... the mobility of people to get out of the house, and so on, and I think that this is also a component that matters for people's health. Or rather, it has a direct influence on people's health. People moving around. A person who doesn't leave the house and say, "Oh, my son's coming to bring me my food, my son's coming to bring me I don't know what." Why? Because he used to have a grocery store here, but he's gone (...) But you even had the capacity to go to the grocery store, but you don't have the capacity to go to a grocery store that's... which is the Continente [Portuguese supermarket], which is three or four kilometers away (...).'

'Augusto', male, 65 years old, gentrifying area



Fig. 9. Photograph by a participant from a deprived non-gentrifying area depicting the presence of tourist-oriented spaces.

Crowding

The crowding category has only 1 subcategory named “crowding”. This category was identified 43 times when analysing the photographs. Some participants in the study highlighted the need to adapt local health care to the new reality, namely by strengthening the response capacity of health centres.

According to the participants, streets and routes that are overcrowded due to an influx of tourists or increased population density from gentrification processes can hinder residents' ability to move freely and safely. This congestion discourages active forms of transportation, such as walking or cycling, which based on literature is already known that are essential for maintaining physical health and reducing the incidence of lifestyle-related diseases (Gualdi-Russo & Zaccagni, 2021). Moreover, overcrowded conditions can elevate stress levels, further impacting overall well-being. Figure 12 illustrates a photograph taken by a participant depicting tourists and a crowd in the historic centre of downtown Porto.



Fig. 12 Photograph by a participant from a deprived non-gentrifying area depicting tourists and a crowd in the historic centre of downtown Porto.

Residents noted a potential impact on healthcare delivery resulting from the city's touristification. On the one hand, the influx of people from different countries and regions may introduce diseases with low or previously non-existent prevalence, as well as contribute to the strain on local healthcare services due to the increased number of individuals requiring care.

'They may come from other countries where there are diseases that are not yet prevalent here (...) health centres, hospitals, etc., which end up being more crowded, to the detriment of all of them, ours.'

'Jorge', male, 66 years old, non-gentrifying deprived areas

On the other hand, crowding was also mentioned as beneficial in terms of the perception of safety in the city, helping some residents, for example, to enjoy the public space more and socialize, even at night.

'We encountered a crowd there, which is good, isn't it? It's good. (...) A few years ago, you couldn't go

down there. I remember going to have dinner in Baixa [the downtown area of Porto] with my wife and daughter and feeling afraid. (...) In Baixa*, you couldn't be there. Because there was no one.'*

'Henrique', male, 64 years old, non-gentrifying deprived area

Physical signs of safety

The physical signs of safety category was divided into 4 specific subcategories: 8A – Vandalism; 8B – Drug consumption; 8C – Policing and surveillance; 8D – Alcohol consumption. The general safety category was identified 32 times when analysing the photographs, all of them in the subcategory of vandalism. Signals of drug consumption, policing and surveillance and alcohol consumption were not visible in photos but were mentioned by some participants.

Some residents expressed discomfort with the influx of intense tourism and large crowds, viewing it as a factor contributing to increased inequality, insecurity, and even violence in the city. However, perspectives varied, with some stating that the city feels less safe now, while others claimed the opposite, noting that there hasn't been a noticeable increase in insecurity.

'Now with the police out on the streets, it's a bit better, but we had cases of rapes and stabbings a few months ago. Because the violence... it's getting worse.'

'Joana', female, 51 years old, gentrifying area

Social infrastructure

The social infrastructure category has only 1 subcategory named “closing community centres and civil associations”. This category was identified 5 times when analysing the photographs. The theme was briefly mentioned by some participants, both in terms of the closure of old spaces in the city and in terms of highlighting the ability of some to remain open in the city, such as the headquarters of a local association photographed by a participant as illustrated in figure 4.



Fig. 4 - Photograph by a participant from a gentrifying area showing a local association that remains open.

Participants argued that the ongoing gentrification processes in Porto are eroding the city's identity, leading to sociocultural displacement (Versey, 2022). The loss of a sense of place was perceived as detrimental to health. Local associations are also reported to be disappearing. This, in turn, is seen as erasing the city's identity, with adverse effects on mental health (Silva et al., 2023).

'The city is going to die, it's going to run out of people. So health will be gone.'

'Luísa', female, 62 years old, non-gentrifying affluent areas

Co-occurrence analysis

Presence of tourist transportation, improvement in conventional transportation and on-going construction are often co-identified in a photo with the presence of noise and air pollution. In addition, shops oriented to tourists and terraces are found in the same places where the presence of crowding.

Figure 14 illustrates the co-occurrence of subcategories such as improvement in conventional transportation, noise pollution, terraces and shops oriented to tourists.



Fig 14. Photograph by a participant from a gentrifying area used to illustrate co-occurrences.

Street greenery, the renovation and modernization of housing and the presence of terraces are often found together. This further suggests that the transformation of the city is also associated with green gentrification, where rehabilitation prioritizes a greater presence of

green spaces and street greenery. Similarly, in addition to associating terraces with the need for outdoor space arising from the restrictions imposed as part of the COVID-19 pandemic, the increase in the number of terraces in the city may also be associated with gentrification in order to create outdoor spaces for leisure and consumption in the city's restaurants.

4. Discussion

This study explored the complex relationships between gentrification, the urban physical environment, and public health by conducting a combined and integrated analysis of the visual and textual material generated in a photovoice study. Specifically, it focused on transformations in the physical environment, including the built environment, food environment, commerce and services, public urban infrastructure, access to green spaces, and pollution. All the ten categories related to aspects of the physical environment related to gentrification processes included in our codification matrix were identified in the photographs. The most common subcategories occurring in the images were street greenery, on-going construction, terraces, crowding and noise pollution. Only five subcategories were not identified in the photos taken by the participants: private educational facilities, private healthcare facilities, alcohol and drug consumption, and policing and surveillance.

Green spaces were significantly identified in the photographs but were comparatively less frequently mentioned by the participants. They noted their importance primarily for well-being and health and observed how students in the city have encouraged residents to make more use of these public spaces, such as sitting on the grass. However, some participants also pointed out that certain green spaces are poorly maintained and expressed a desire for their improvement. Existing literature extensively documents the importance of green spaces for health (Paciência et al., 2021; Ribeiro et al., 2024) with quality and accessibility sometimes linked to inequalities in use and access (Chen, 2022; Hoffmann et al., 2017). On the other hand, while not mentioned by participants or studied in Porto as of yet, the intense city redevelopment, which includes the creation of new green spaces, might be accompanied by efforts toward more sustainable urbanism. In a city already experiencing the effects of transnational gentrification, this could potentially involve "green gentrification," which may impact the physical environment and exacerbate environmental and climate injustice, and then influence the health of the population (Anguelovski et al., 2022). Future and more focused

studies on the city of Porto should explore this potential relationship. Specifically, it would be valuable to examine how these urban transformations align with Porto's climate transition policies and whether they may contribute to a phenomenon of green gentrification in the city.

Pollution was widely identified both in the photographs and in the discussion sessions with residents. The intense noise in the city, particularly associated with traffic and the city's modernisation and rehabilitation works, were perceived by the participants as something negative for their health, with particular emphasis on the impact on mental health and well-being. However, it was also seen by the participants as potentially beneficial for residents' health and quality of life, as the infrastructure became more pleasant and functional. Aligned with this result, a quantitative study conducted in Michigan (USA) found that, although air quality improved overall over a 40-year period, there was a lesser rate of improvement in gentrified areas (Hutchings et al., 2023). The harmful effects of noise (Krittanawong et al., 2023) and air pollution (Boogaard et al., 2023) on the physical and mental health are well-documented in epidemiological literature, with pollution being a crucial contextual determinant of health. Therefore, this finding underscores the need for local pollution monitoring in the city and health impact assessments in the context of ongoing gentrification processes.

Moreover, participants noted important changes in the transport infrastructure. While participants noted the short-term inconveniences of construction, such as noise and air pollution, the metro construction and the subsequent improvement in public transportation could reduce the number of cars in circulation, making the city less polluted and more pleasant, with positive impacts on residents' health and well-being. Such transportation infrastructure projects are somehow aligned with the concept of climate gentrification, which is also related to transit-oriented development (TOD) (Padeiro et al., 2019). Recent literature highlights that TOD-related projects often involve substantial investments that can alter spatial patterns and accessibility and can lead to gentrification and displacement of low-income residents. Although TOD is considered a critical approach for sustainable mobility and smart growth, concerns have been raised by analysts and community activists about its potential to induce gentrification and displace low-income groups (Padeiro et al., 2019). Therefore, although participants regarded the improvement of the transportation network as being motivated by the high international (especially tourist) attractiveness of Porto, and thus a result of touristification and

transnational gentrification processes, it may also contribute to reinforce gentrification. A comprehensive, evidence-based synthesis of the links between transit and gentrification is needed to inform policy and improve practice in Porto and other cities that may experience the same process. Additionally, mobility in cities is an aspect that influences the quality of life of their inhabitants. This mobility refers not only to public or private transport, but also to pedestrian movements. The creation of walkable urban environments contributes to the enjoyment of these spaces, makes pedestrian travel safer and, in this sense, will also contribute to people's health as it encourages healthy lifestyle habits such as walking, thus counteracting sedentary lifestyles (Ribeiro & Hoffmann, 2018; Sá et al., 2024).

Ongoing construction and short-term rentals were also frequently discussed, reflecting the city's shift towards luxury and tourist-oriented accommodations. This transformation has made the city centre increasingly inaccessible to larger families and lower-income residents, pushing them out in favour of smaller, higher-end units. While some residents appreciate the vibrant, outdoor-oriented lifestyle facilitated by these changes, the rise of short-term rentals and high housing costs has exacerbated displacement and affordability issues. These developments, which extend beyond the influx of affluent residents, are closely linked to the rise of platforms like Airbnb, which contribute to the withdrawal of rental housing from the market. This trend has significant social impacts, including the displacement of certain resident groups and the transformation of everyday life in cities where Airbnb is prevalent (Carvalho et al., 2019; Leoni & Parker, 2018). Indeed, increasing inequality within cities can drive up housing prices and the overall cost of living, thereby exacerbating segregation and limiting some residents' ability to fully participate in urban life (Versey, 2022). This transformation has also meant that large families with low and medium incomes have had to move to peripheral areas, creating disruption and a deterioration in well-being.

According to participants, crowding, resulting from the influx of tourists and increased population density, contributes to elevated stress levels and strains local healthcare services, potentially introducing diseases from tourists and exacerbating healthcare delivery issues. Conversely, some residents perceive crowding as enhancing safety and vibrancy in public spaces, allowing for more social interaction and a more secure environment, particularly in previously underpopulated areas. Some participants seemed to feel alienated from public spaces by the crowds, the high prices of stores and cafes, and their touristic orientation. They

may opt to avoid such areas, becoming semi-voluntarily excluded from them. This is a somewhat contradictory and unexpected result, but it reinforces the complexity of gentrification and its impacts: not only it generates paradoxical changes (Cole et al., 2021), it can also bring benefits and harms to different groups of residents (Schnake-Mahl et al., 2020).

Conflicting accounts were also observed regarding whether safety issues have increased or decreased in the city due to gentrification. Police records (INE, 2022) suggest that crime frequency in the city of Porto in the last 10 years has been stable and/or decreasing for some crime categories (e.g., theft by snatching and on public roads). Nevertheless, evidence suggests that perceptions of safety often do not align with actual crime rates, a trend that appears to be present in Porto (Zhang et al., 2021). However, a more detailed local analysis of crime data is necessary to confirm this.

According to participants, gentrification processes seem to be leading to the loss of traditional commerce and gastronomy, with local services and foods being replaced by tourist-oriented and international offerings. Diet is a key factor in human health, and the results indicate that gentrification-driven transformations in the city are impacting food access by complicating the availability of traditional local foods. The frequent opening, closing, and changing ownership of food retailers contribute to instability in local food environments, which can affect food access and health (Silva et al., 2023). Additionally, the commercial shift towards tourist-oriented establishments, international restaurants, and gourmet options is rendering food options increasingly inaccessible to economically deprived individuals (Caruso et al., 2022). This transformation could make it difficult for residents, particularly vulnerable groups like older adults, to maintain their usual dietary habits and access essential services, contributing to more sedentary lifestyles, and a decline in physical activity and overall health. Our results suggest that changes in retail coupled with crowding led some residents to feel excluded from the city, a situation that may lead to less healthy lifestyles and a deterioration in their overall health. Some groups, namely older people, become less mobile within the city, loses access to local and traditional services, and no longer identify with or feels safe in public spaces. Consequently, they tend to stay at home, adopting more sedentary routines, which reduces the physical activity associated with commuting and daily social interactions, increases feelings of loneliness, and potentially has a detrimental impact on both their physical and mental health.

Regarding subcategories that were not identified in the photos, drug consumption was mentioned by one participant from the gentrified areas session. In this case, it may not have been captured in the photographic analysis, since the photos taken by the participant who mentioned the topic of drug use are photos taken from a distance, where drug use is not perceptible, but something that, according to the explanation given, deserved the participant's attention. This could indicate that this phenomenon is not very visible in Porto, or it was not perceived by the large majority of participants as something linked to gentrification (despite being associated with gentrification processes according to the literature at least in certain geographical contexts (Schnake-Mahl et al., 2020; Smith et al., 2020)), or even as something that deserved their attention. Regarding private educational and healthcare facilities, changes in healthcare and the educative offer have been mostly identified in the north american context. They may not be as prominent in Porto, or participants might not have perceived them as related to gentrification or impacting health. Nevertheless, there is existing literature that links both to gentrification (Green et al., 2022). It is worthwhile to notice that, while globally widespread, gentrification processes have very specific local configurations (Aalbers, 2018; Hayes & Zaban, 2020).

In addition, according to our participants, older adults, certain minorities, and economically disadvantaged individuals, particularly families with children, are more vulnerable to certain negative aspects of gentrification, such as displacement, loss of place, erosion of social ties, and disruption in access to commerce and services. This aligns with the existing literature on the characterization of transnational gentrification (Lopez-Gay et al., 2021; Anguelovski et al., 2021) and also with a recent literature on gentrification in the city of Porto, focusing on the impact on the elderly (Santos et al., 2024).

This study presents several considerable strengths. Firstly, its innovative approach in photovoice research involves the analysis of all photographs taken by participants, not just those selected for discussion in the sessions. This method allowed for a more comprehensive visual analysis, offering richer information for the study by complementing residents' contributions in the transcripts with the results of a systematic analysis of the photographs. This contributes to existing research by providing new insights into how ongoing gentrification processes are reshaping the urban physical environment and health. In addition, as a beneficial impact on the community, participation in this study may have helped participants develop their awareness and interest in a pressing issue in the city, while also fostering greater

consciousness about their health. Finally, this research not only provides new insights into the effects of gentrification in Porto but may also be relevant for other cities undergoing transnational gentrification, particularly in Southern Europe.

However, we also acknowledge some limitations. First, our cohort consisted mostly of older adults, with all participants being over 50 years old. Including younger individuals could have provided valuable insights, as their perspectives on this issue may differ. Secondly, recruitment challenges led to an uneven gender distribution in two of our groups, which may have introduced unintended gender-related interactional effects. Finally, our sample did not include participants living in rented homes or those who experienced or were threatened by direct displacement. For future research, we recommend a more generationally representative sample to explore the perceptions of younger people regarding gentrification in Porto.

5. Conclusion

Our study highlights the complex relationship between physical transformation driven by gentrification and public health, through a photovoice in Porto. The integration of visual and textual analysis has illuminated how gentrification-driven transformations —ranging from infrastructural developments to shifts in local commerce — affect residents' health and well-being.

The study identified several public health impacts resulting from ongoing physical transformations caused by gentrification in Porto, including negative effects on mental health, changes in diet and physical activity, reduced access to food, and increased social isolation due to disruptions in commerce and services. Noise and air pollution from rehabilitation work have also affected residents' well-being. Of these, the most significant impact identified was on mental health. These results emphasize the need for more equitable and balanced approaches to urban development in Porto.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data availability

The transcripts that have been used are confidential and cannot be shared. Photos can be found in a public repository at the HUG project website at: <https://www.hug-project.com/photovoice>.

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CONCLUSION

Our study aimed to explore the complex relationship between physical transformation driven by gentrification and public health through analysing data generated by a photovoice project in Porto. By integrating visual and textual analysis, we have illuminated how gentrification-driven changes—ranging from infrastructural developments to shifts in local commerce—affect residents' health and well-being.

Key findings reveal that while certain physical environmental transformations, such as metro expansion and the improvement of green spaces, offer long-term benefits, they also generate immediate challenges, including pollution, displacement, and reduced access to traditional local services. These changes can negatively impact the health of vulnerable populations, particularly the elderly, by contributing to loneliness, isolation, and a sense of alienation.

The destruction of traditional commerce and dietary habits, combined with increased noise and air pollution associated with redevelopment projects, has significantly impacted residents' health. Overall, the most frequently identified health impacts within the photovoice project were related to mental health and well-being.

This research not only provides new insights into the effects of gentrification in Porto but may also be relevant for other cities undergoing transnational gentrification, particularly in Southern Europe. The ongoing physical transformations in Porto significantly impact the quality of life and well-being of its residents, underscoring the need for more equitable and balanced approaches to urban regeneration.

In conclusion, this study emphasizes that while gentrification can bring benefits, these are unevenly distributed. Therefore, it is essential to implement policies that protect residents' health and ensure that existing inequalities are not exacerbated.

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ANNEX

Opinion of the Ethics Committee of ISPUP



Parecer nº CE22210

A – Apresentação do pedido em apreciação

A Comissão de Ética do ISPUP recebeu no dia 18 de maio de 2022 o pedido de parecer sobre o projeto intitulado "Gentrificação e saúde no Porto - o ponto de vista dos participantes", formulado pelo Doutor José Pedro Silva, investigador responsável pelo projeto.

O projeto tem como objetivo estudar de que forma os moradores do Porto consideram, e sentem nas suas vidas, que os processos de gentrificação afetam a saúde na cidade; dar voz aos moradores no que diz respeito à forma como veem, e sentem, a relação entre a gentrificação e a saúde na cidade e, por último, promover a discussão e a reflexão públicas sobre os processos de gentrificação e as suas consequências para a saúde na cidade do Porto. O pedido submetido a esta Comissão de Ética foi instruído com os documentos obrigatórios para a submissão.

B – Identificação de questões com eventuais implicações éticas ou metodológicas

Após análise do projeto na reunião ordinária no mês de maio, todos os membros da Comissão concordaram que o projeto, na sua execução, contempla uma metodologia inovadora e respeita os necessários padrões éticos. As garantias de confidencialidade, integridade e conservação dos dados recolhidos devem respeitar integralmente as recomendações do Encarregado de Proteção de Dados do Instituto de Saúde Pública da Universidade do Porto (ISPUP).

C – Conclusão

Reconhecendo a relevância do projeto apresentado, e pressupondo que o investigador irá satisfazer e respeitar integralmente as recomendações do Encarregado de Proteção de Dados do Instituto de Saúde Pública da Universidade do Porto (ISPUP) em matéria de confidencialidade e proteção dos dados dos potenciais participantes, a Comissão de Ética do ISPUP deliberou, por unanimidade, dar parecer favorável à sua realização. Apenso a este parecer encontra-se a documentação que instrui o processo. O investigador deve comunicar os resultados, assim que o estudo esteja concluído.

Porto, 20 de junho de 2022

O Presidente da Comissão de Ética,

A handwritten signature in blue ink, appearing to read 'Amorim', is written over a light blue rectangular background.

Professor Doutor António Martins da Silva

Informed consent - photovoice

In accordance with the General Data Protection Regulation, the Declaration of Helsinki and the Oviedo Convention.

[Este MODELO destina-se a ser adaptado a cada caso concreto e os itens e sugestões nele contidos não esgotam os termos e possibilidades que cada investigador queira utilizar para o tornar mais claro. O documento deverá ser duplicado, um para o investigador guardar para provar que pediu e obteve consentimento perante eventuais auditorias; e outro para a pessoa que consente para que possa ler, revogar se assim o entender ou reclamar se verificar eventual incumprimento do garantido. A linguagem a utilizar deverá ser tão simples quanto possível, livre de termos técnicos (exceto quando os participantes forem profissionais de saúde) e globalmente adequada à literacia dos participantes a recrutar. Não esquecer de apagar, quando fizer o seu MODELO, todos os dizeres aqui vistos entre parêntesis retos. O número de páginas é atualizado automaticamente.]

CONSENTIMENTO INFORMADO PARA PARTICIPAÇÃO EM PROJETO DE INVESTIGAÇÃO E TRATAMENTO DE DADOS DE ACORDO COM O REGULAMENTO GERAL DE PROTEÇÃO DE DADOS, A DECLARAÇÃO DE HELSÍNQUIA E A CONVENÇÃO DE OVIEDO.

Por favor, leia com atenção a seguinte informação. Se achar que algo está incorreto ou pouco claro, não hesite em pedir mais informações através do e-mail: jose.pedro.silva@ispup.up.pt

Se aceitar participar neste estudo solicitamos que preste o seu consentimento, assinando o documento no final.

A participação no estudo é voluntária. Pode a qualquer altura cessar a sua participação, sem qualquer tipo de consequência, bastando para isso contactar o responsável através do e-mail acima.

1. INFORMAÇÃO SOBRE O PROJETO/ESTUDO

Título: Gentrificação e saúde no Porto – o ponto de vista dos residentes.

Entidade Responsável: Instituto de Saúde Pública da Universidade do Porto

Responsável Direto: José Pedro Silva jose.pedro.silva@ispup.up.pt

Descrição Geral do Projeto: O estudo “Gentrificação e saúde no Porto – o ponto de vista dos residentes” tem como objetivo aprofundar a compreensão das ligações entre a gentrificação e a saúde no Porto, a partir do ponto de vista das pessoas que vivem nessa cidade. Gentrificação é o nome que se dá à chegada a um determinado território (uma cidade, uma freguesia, um bairro...) de novas pessoas (novos habitantes, turistas, estudantes...) com mais poder económico do que os residentes mais antigos. Este é um processo que resulta em transformações importantes do território e das populações, o que pode implicar consequências para a saúde. Este estudo pretende conhecer melhor de que modo os portuenses consideram que a gentrificação, no Porto, pode afetar, ou afeta efetivamente, a sua saúde. Para isso, a equipa de investigação fará um conjunto de entrevistas com participantes na coorte EPIPorto, residentes em pontos da cidade onde a gentrificação se faz sentir com diferentes intensidades. Estamos, por isso, a convidá-lo para participar numa entrevista em que lhe serão colocadas perguntas sobre a sua opinião e a sua experiência pessoal relativamente à forma como a gentrificação pode afetar a saúde das pessoas. A entrevista será conduzida por um investigador do projeto e não deverá ultrapassar os 90 minutos. Ela será gravada (gravação de áudio) e depois transcrita e analisada.

Condições e financiamento: Estudo inserido no projeto HUG: os efeitos na saúde da gentrificação, da realocização e da insegurança residencial nas cidades: um estudo multi-coorte quase-experimental (PTDC/GES-OUT/1662/2020), coordenado pela Doutora Ana Isabel Ribeiro e financiado pela Fundação para a Ciência e Tecnologia. A sua participação no estudo é inteiramente voluntária. A participação não é recompensada, podendo haver apenas lugar ao pagamento de despesas com deslocações em transportes públicos. Se necessário, receberá uma declaração para efeito de justificação de falta ao trabalho. A recusa em participar não implica qualquer prejuízo para si. Designadamente, a recusa em participar neste estudo não tem qualquer consequência para a sua participação na coorte EPIPorto. Poderá igualmente retirar-se do estudo a qualquer momento, se assim entender. Este estudo foi objeto de um parecer favorável pela Comissão de Ética do Instituto de Saúde Pública da Universidade do Porto.

2. TRATAMENTO DE DADOS PESSOAIS

Objetivos do Projeto:

Este estudo pretende estudar como é que as pessoas do Porto consideram, e sentem, que os processos de gentrificação na cidade podem influenciar a sua saúde. Para isso, os investigadores precisam de contactar com moradores da cidade e recolher e registar a sua opinião sobre este tema.

Dados Pessoais:

Precisaremos de gravar a sua entrevista para a transcrevermos e analisarmos posteriormente.

Finalidade do tratamento:

Os dados recolhidos serão tratados de acordo com a legislação nacional e da UE aplicável e apenas serão usados pelos investigadores para os fins de investigação científica no âmbito do projeto Gentrificação e saúde no Porto – o ponto de vista dos residentes.

Responsável pelo Tratamento:

ISPUP – Instituto de Saúde Pública da Universidade do Porto, Rua das Taipas nº135, 4050-600 Porto, Portugal.

Conservação dos Dados Pessoais:

Os ficheiros áudio com os registos das entrevistas serão preservados até ao final do projeto, altura em que serão destruídos. Entretanto, serão transcritos por um transcritor externo que terá de respeitar a sua confidencialidade. As respetivas transcrições serão revistas pela equipa de investigação de modo a não permitirem a identificação das pessoas (por exemplo, substituindo quaisquer nomes referidos por pseudónimos) e preservadas por período indeterminado. Todos os dados serão guardados em formato digital em computadores do Instituto de Saúde Pública da Universidade do Porto e usados apenas para este estudo. O acesso aos dados só poderá ser feito pelas pessoas da equipa de investigação e, temporariamente, pelo transcritor dos registos áudio. Caso desista de participar no projeto, eliminaremos o registo áudio da sua entrevista, caso ele ainda não tenha sido destruído, e a transcrição da mesma, no caso de já existir.

Medidas de Proteção:

Todos os dados pessoais serão considerados confidenciais. Os registos áudio só serão conservados até ao final do projeto, momento em que serão destruídos. Até lá, serão mantidos em pastas encriptadas, em computadores do Instituto de Saúde Pública da Universidade do Porto. A sua transcrição será realizada por um transcritor externo que terá de assinar um acordo em que se compromete a manter sigilo sobre os mesmos, respeitar a sua confidencialidade e destruir todas as cópias dos ficheiros áudio e das transcrições que tenha em sua posse após o envio das segundas aos investigadores. Serão utilizados métodos seguros de transferência de ficheiros para realizar esta tarefa. O conteúdo das transcrições será anonimizado pela equipa de investigação e serão guardadas em computadores do Instituto de Saúde Pública da Universidade do Porto, em pastas encriptadas. Estes ficheiros serão identificados por um código que permitirá à equipa de investigação reidentificar os participantes, o que será necessário para destruir a transcrição em caso de desistência.

Partilha de Dados Pessoais:

Os ficheiros áudio serão transcritos por um transcritor externo ao projeto, nos termos descritos acima. Poderão ser reproduzidas pequenas partes das suas transcrições em publicações e apresentações científicas, mas sempre de forma a não identificar as pessoas.

Encarregado de Proteção de Dados:

Para quaisquer questões relativas ao tratamento de dados pessoais, contacte por favor, o nosso encarregado da proteção de dados através do endereço: dpo@ispup.up.pt

Direitos do Titular dos Dados:

Enquanto titular dos dados, a lei reconhece-lhe os seguintes direitos: Informação, Acesso, Retificação, Apagamento, Portabilidade e Limitação do tratamento. Para o exercício de algum dos seus direitos utilize o seguinte endereço de e-mail: jose.pedro.silva@ispup.up.pt.

A lei confere-lhe, igualmente, o direito de apresentação de queixas perante uma Autoridade europeia de supervisão, sendo que em Portugal a Autoridade competente é a Comissão Nacional de Proteção de Dados (www.cnpd.pt).

3. TERMO DE CONSENTIMENTO INFORMADO

- | | |
|--|---|
| 1. Li e compreendi a informação sobre o projeto, incluindo a identidade do Responsável, o tipo de dados que vai ser recolhido, o objetivo da recolha e do respetivo tratamento. | D |
| 2. Li e compreendi a informação sobre como os dados pessoais serão armazenados e durante quanto tempo, incluindo o que acontecerá aos meus dados no caso de desistir de participar no projeto. | D |

3. Foi-me dada a oportunidade de fazer perguntas e de esclarecer todas as dúvidas sobre este projeto. 4. Compreendo que posso desistir da participação no estudo em qualquer momento, sem necessitar de dar justificações e sem que sofra penalizações ou que questionem as minhas razões. 5. Percebi de que forma poderei comunicar a minha desistência, bem como exercer os meus direitos enquanto titular dos dados pessoais.	D D D
O Participante: Declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas previamente. Desta forma, aceito participar neste estudo e permito a utilização dos dados que forneço de forma voluntária. Nome: Assinatura: Data: / /	
SE NÃO FOR O PRÓPRIO A ASSINAR POR IDADE OU INCAPACIDADE (SE O MENOR TIVER DISCERNIMENTO DEVE TAMBÉM ASSINAR EM CIMA, SE CONSENTIR) Nome: Grau de parentesco ou tipo de representação: Assinatura:	

[Se não aplicável, eliminar esta linha↑]

ESTE DOCUMENTO É COMPOSTO DE **[3]** PÁGINAS
E É FEITO EM DUPLICADO: UMA VIA PARA **O/A**
INVESTIGADOR/A, OUTRA PARA A PESSOA QUE
CONSENTE.