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Integrating climate change responses into age-friendly city domains: A theoretical review

This study focuses on older adults, who are disproportionately vulnerable to climate change due to their health, physical, and socioeconomic conditions. On the one hand, climate change has grown into the most challenging issue on the international agenda for the twenty-first century due to its adverse impacts. On the other hand, the global population has been ageing rapidly, especially in urban areas. The link between these two major concerns is unclear in theory and practice; hence, easy-to-use universal guidelines offering possible solutions for governments, institutions, and communities for irremediable impacts are an urgent necessity. Based on this imperative, this article presents climate change–responsive age-friendly city domains through a critical literature review. Seven domains are prioritized at various scales to represent the core planning areas of age-friendliness and climate-change resilience in urban areas: environmental safety, information and participation, health and social services on the city scale, surroundings and transportation on the neighbourhood scale, outdoor spaces and thermal comfort, and housing on the housing cluster scale. The interaction between these two concerns in the framework provided by this study contributes to raising awareness, building actions, and directing policies from a global perspective.

Keywords: climate change, age-friendly city, population ageing, sustainability, urban policy

1 Introduction

The impacts of climate change on cities have already been observed globally. According to recent findings, human-induced greenhouse gas (GHG) emissions are leading to the loss of icesheets and glaciers, rising sea levels, and increasing global temperatures. The increase in temperatures is causing changes in the climate system, such as more severe and frequent hot extremes, heavy precipitation, drought, and extreme weather events. Many of these changes are irreversible when past and potential future GHG emissions are considered (IPCC, 2021). Cities are the centres of dense and diverse populations, socioeconomic activities, government institutions, and structural investments (Hunt & Watkiss, 2011). Therefore, adapting settlements to changing climate systems and mitigating negative impacts has been the focus of recent urban strategies. Increasing resilience by fostering adaptive capacities, diminishing vulnerabilities, and eliminating risks has been one of the greatest priorities of local, national, and global institutions (Bulkeley & Tuts, 2013).

Demographic changes constitute the other side of these concerns because the population has been ageing globally (Palacios, 2002). This change has created new perspectives and challenges for urban planning and policies. The notion of age-friendliness underlines how cities can adapt to demographic change through urban planning. The World Health Organization (WHO) presented the determinants of age-friendliness of cities (WHO, 2007) to promote active ageing and health for older adults. This is the first and only international and legitimate guide. Active aging means allowing older adults to maintain their life in a place where they can meet their needs for as long as possible (Beard & Petitot, 2010). However, changing climate brings about extraordinary conditions that may affect older adults' health and consequently their ability to sustain an active urban life. Their medical, physical, financial, and social conditions make them more vulnerable to climate change (Gamble et al., 2013; Carnes et al., 2014).

These inequitable vulnerabilities have been pointed out in climate justice scholarship, highlighting the significance of the local engagement of those groups in climate action plans (Hughes & Hoffmann, 2020). In the transition of cities to a greener, more sustainable, and more resilient structure, the position of vulnerable groups and climate justice in the transition to post-carbon and adaptive societies and cities need to be discussed to empower these communities in the decision-making process and to reduce inequalities (Yang et al., 2021). Most age-friendly city approaches are restricted by business-as-usual conditions without climate change parameters in the framework (Wang et al., 2021). This limited perspective is a barrier to eliminating disproportionate vulnerabilities and pursuing climate justice. Therefore, this article provides new perspectives for transformation into climate-resilient age-friendly cities through a critical literature review. By linking climate change management actions and age-friendliness, this article provides a more inclusive and just framework for a specific social group that faces uneven impacts: older adults.

The study first presents the impacts of climate change on health with a focus on urban settlements to better understand the potential risks. It then discusses older adults' vulnerabilities and inequalities to highlight the need for climate justice, followed by an examination of urban adaptation and mitigation literature to describe strategies to mitigate the adverse impacts of climate change on older adults. The article criticizes age-friendly city determinants to define the gap between their current form and the desired climate resilience. Finally, it proposes new determinants for a more comprehensive approach that brings climate change and ageing concerns together and discusses the findings.

2 Health impacts of climate change in urban settlements

More than half of the world's population lives in urban areas that are considered highly susceptible to climate stressors. Furthermore, older adults, who are highly vulnerable to climate impacts, are expected to form 22% of the population by 2050 (United Nations, 2022). Climate-related diseases, malnutrition, and deaths have already been observed globally. Over the past decade, respiratory diseases due to exposure to heat, cold, air pollution, and waterborne diseases after flood disasters can be linked to climatic variables. The projections reveal that anthropogenic climate change will increase the severity of the effects (IPCC, 2022).

Heat-related risks in cities are the most reported climate change exposure in the literature (Leyva et al., 2017) due to the urban heat island (UHI) effect, which intensifies the impacts of heatwaves, causing an increase in the risk of mortality and air quality–related health problems (Carnes et al., 2014). The high density of cities, heat-absorbing buildings and surfaces, limited airflow, and less natural and green space increase serious health risks in urban areas in particular during long heatwaves (Haines & Patz, 2004; Carnes et al., 2014; Xie et al., 2015). The frequency of extreme heat exceeding health thresholds is expected to increase in higher global warming scenarios; consequently, heat-related problems in urban settlements are projected to increase (IPCC, 2022).

Air pollution in urban areas is another detrimental effect addressed by much research. The latest IPCC report (2021) states that even in shallow GHG scenarios (SSP1-1.9) the air quality is below WHO standards, particularly in very polluted regions. In urban areas, emissions caused by economic activities, transportation, land-use changes, waste disposal, and energy demand reduce air quality, and limited airflow causes concentration of pollutants. Exposure to pollutants exacerbates respiratory and cardiovascular disorders such as asthma, heart attack, and cancer (Baja et al., 2010; Chang et al., 2022).

Sea level rise is a major threat to populations in coastal zones due to the risk of more frequent and severe coastal flooding and storm surges. Extreme climate events such as floods, storms, and heavy rain jeopardize not only natural and built environments but also inhabitants' lives. Moreover, floods can be linked to acute consequences such as waterborne diseases and epidemics due to contamination of drinking water (Gamble et al., 2013). The major reason for augmented risk in urban areas is increased impermeable surfaces that cause street flooding in heavy rain and land-use changes (Iqbal et al., 2022).

Because the organisms that cause diseases and epidemics are strongly sensitive to climatic variables, climate change will affect the pattern of infections (Thomas, 2020). As lately experienced globally, the COVID-19 pandemic caused the death of millions of people (WHO, 2022), especially those that have chronic diseases and are older (Centers for Disease Control and Prevention, 2022a). During the pandemic period, governments took serious precautions to prevent mass transmissions, such as lockdowns, surveillance, and quarantine. The capacity of the healthcare systems was also questioned even in developed countries (Oğur et al., 2021). Climate change is expected to increase the severity and frequency of these kinds of negative experiences locally and globally (IPCC, 2022).

3 Vulnerability and climate justice for older adults

Some regions have already experienced distinctive climate change impacts based on their level of exposure to geographic variables, their sensitivity based on social, economic, and structural susceptibility, and their adaptive capacity to accommodate these alterations and adjust their systems (McDermott-Levy et al., 2019; IPCC, 2021). Communities' ability to assemble, and to overcome and recover from climate change, is associated with their economic conditions, education, living environment, access to healthcare services, technology, information, household size, and people's ethnic groups, ages, and sexes (Lynn et al., 2011; Rhoades et al., 2018). Some social groups are more vulnerable and susceptible to any sudden shocks because of their health or economic conditions or social exclusion. They also have a lower adaptive capacity to changing conditions because they have limited access to information, financial resources, and technology. These socioeconomic inequalities and structural injustices are decisive in the severity of the consequences (Phelan et al., 2004).

Older adults are one of the most vulnerable sub-groups (Chang et al., 2022; IPCC, 2022), with physical, economic, and social disadvantages that require serious consideration (Gamble et al., 2013; Carnes et al., 2014). Cities need to provide specific services and support for their wellbeing as well as to protect them from future risks (WHO, 2007). The climate-related mortality rate is higher in the older age group due to higher morbidity and pre-existing health disorders (Balbus & Malina, 2009). Furthermore, they are unable to readily react in an emergency such as a severe climate-related disaster like flooding (van Hoof et al., 2021). In addition to health impacts, this limits their lifestyles, prevents their participation in public life, and decreases their quality of life.

To promote active ageing for older adults, they need to engage in urban public life and regular physical activities "safely, independently, comfortably, regardless of age, income or ability level," also known as "ageing in place," which is a crucial concept for age-friendliness (WHO, 2002; Centers for Disease Control and Prevention, 2022b). Low-quality built environments and housing are major barriers to the wellbeing of older adults that increase both indoor and outdoor risks. For instance, an urban space with low outdoor thermal comfort due to its structural character discourages older adults from spending time outdoors even for their daily needs (Wang et al., 2021). Climate-related disaster risks may force people to leave their living environment. Such displacement may cause mental, psychological, or social complications and trauma (Gifford & Gifford, 2016). Therefore, it is important to integrate environmental aspects into urban studies addressing age and to discuss this issue from the perspectives of climate and social justice.

Although the older generation has greater responsibility for GHG emissions than the younger one, they are the ones most affected by these emissions-triggered impacts (Haq, 2021). Climate justice derives from environmental justice and focuses on the uneven distribution of climate change impacts at an international level (Gardiner, 2011; Mitchell & Chakraborty, 2014; Schlosberg & Collins, 2014), but it is inseparable from social justice. To reduce the susceptibility of the disadvantaged social group, older adults, justice implications should address spatial, social, and economic vulnerabilities in adaptation, mitigation, and transition policies (Brisley et al., 2012).

4 Methodology

The purpose of this article is to integrate climate change–responsive city and age-friendly city planning perspectives. On this basis, the methodology is formed as a critical review to provide responses to the main research questions:

1. What are the planning approaches for a climate-responsive urban space that considers older adults' specific needs?
2. To what extent does the age-friendly city guide cover climate responsiveness?
3. What are the domains that bring climate change management actions and age-friendliness together?

The research was carried out in three methodological steps. First, the impacts of climate change on older adults in urban space and potential mitigation approaches in the literature are reviewed to extract approaches to achieving a climate-responsive city. Second, the age-friendly city guide by WHO (2007) is examined from the perspective of climate change action. The WHO guideline is taken as the basis because it is the first and only legitimate regulation in age-friendly literature and is widely used. Third, scales and new domains are defined by bringing the two concepts together. Scaling is important for organizing planning interventions and developing urban policies because the needs of urban spaces and their planning procedures differ based on their scale. It also addresses the administrative level of the implementing agency. On the other hand, although all scales may overlap, some interventions should be decided through a top-down approach, which means they need to be organized from the upper level but others need to be planned at the bottom level. The differences between the scales are explained below.

The city scale refers to the size and scope of the entire city or urban area. It encompasses all the buildings, infrastructure, and natural features within the city limits, and it often extends beyond this to include the surrounding suburbs or rural areas that are influenced by the city. City-scale planning considers issues such as transportation, housing, economic development, and public services that affect the entire city.

The neighbourhood scale refers to a smaller geographic area within a city or town. It typically encompasses several city blocks or a specific community within the city. Neighbourhood scale planning focuses on the unique characteristics of the neighbourhood, such as its physical layout, architecture, and demographics, and it seeks to address issues such as transportation, public spaces, and social services that affect the quality of life in that area.

The housing cluster refers to a grouping of residential buildings within a neighbourhood or city. It includes apartment buildings, townhouses, or single-family homes that are clustered together in a particular area. It refers to a living area and facilities within 15 minutes' walking distance. Housing cluster planning focuses on issues such as density, affordability, and the provision of necessary services such as schools, parks, and public transportation. The goal is to create liveable, sustainable communities that meet the housing needs of residents while enhancing the overall quality of life.

5 Mitigating adverse impacts of climate change for older adults

Urban areas are the foci of social, economic, and cultural activities. On the one hand, they produce certain activity patterns that contribute GHG emissions. On the other hand, urban areas are exposed to the highest climate-related risks. This combination places cities in a significant role in leading climate change actions through urban planning and design tools (Rosenzweig et al., 2010). In tackling the adverse impacts of climate change, urban settlements offer effective opportunities to decrease emissions through (renewable) energy, (sustainable) building, (public and green) transportation, and (reduce-reuse-recycle-dispose) waste management strategies, and to increase resilience through (green and grey) infrastructure, (public) service, and (inclusive) governance enhancements. The solutions vary among technological, social, and nature-based or all-integrated considerations (Lin et al., 2021).

Individual solutions such as air conditioning seem practical; however, they increase energy dependency and cost, which is not a proper remedy. For more equally distributed benefits among society and efficiency, multi-scaled urban planning measures are better (Milan & Creutzig, 2015). Building and surface materials, light, the geometry of settlements, and greenery are addressed in relation to the most frequently reported health threat: heatwaves intensified by the UHI effect. Materials with a higher albedo effect, light-coloured paint, or green roofs and facades reduce the heating of surfaces (Milan & Creutzig, 2015; Francis & Jensen, 2017). Streets aligned with the direction of the wind (wind corridors) also contribute to passive cooling and provide cleaner air (Ren et al., 2018). Accessible and continuing green axes are also effective solutions not only for cooling (by providing shade) but also for spreading nature-based solutions across the city by integrating ecology into spatial planning. Green and blue infrastructure as a nature-based solution also helps increase air quality by functioning as carbon sinks, eliminate flooding by providing more permeable surfaces that allow runoff water to be absorbed, and improve the urban ecosystem (Scott et al., 2016; Depietri & McPhearson, 2017; Frantzeskaki et al., 2019).

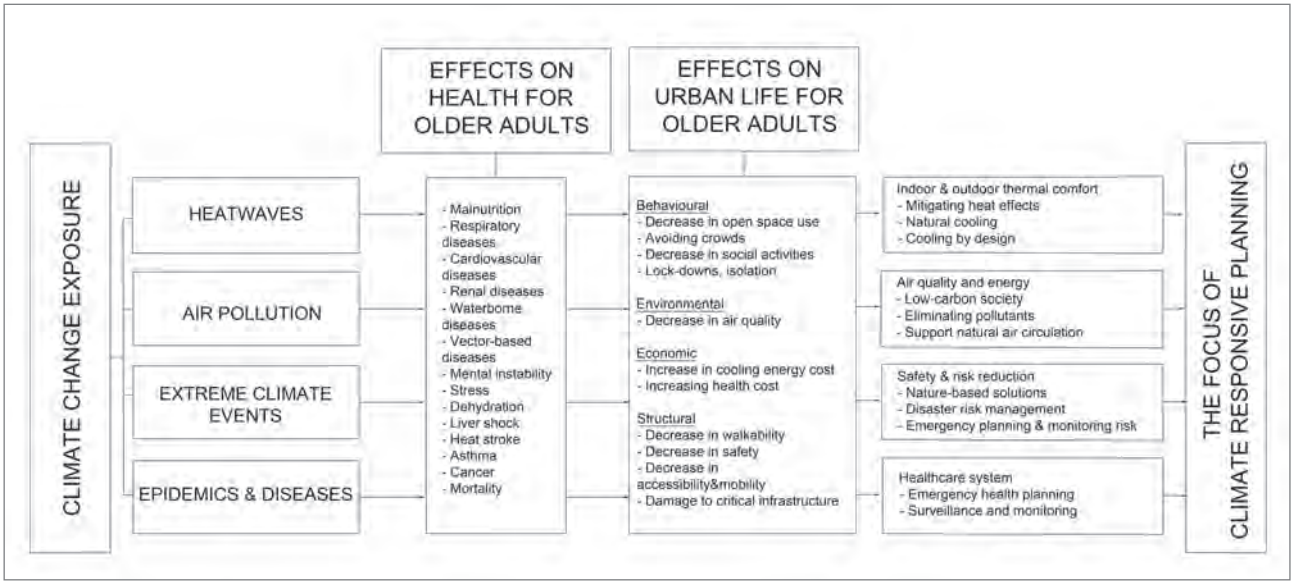

Figure 1: Climate change exposure and the focus of approaches in the built environment for older adults (illustration: authors, based on a literature review).

Social measures revolve around building communication and information channels to inform socially excluded populations. Using multiple media options to reach people that lack internet access maximizes the effect (Brisley et al., 2012). Early warning systems are possible practices that prevent deaths from heatwaves or flooding by allowing reliable communication and information. Another critical point is the effectiveness of the healthcare services in an emergency and sudden shock. In enhancing the healthcare system, surveillance and monitoring of climate change impacts on older adults' health make possible flexible, rapid, and efficient responses (Bambrick et al., 2011). Figure 1 presents the key solutions adopted from the literature for climate-change impact management in built environments for older adults.

Although age-friendly cities have addressed multi-level challenges for the wellbeing and health of ageing communities, climate change remains an environmental barrier that should be eliminated. Available age-friendly guidelines mostly overlook the effects of climate change (Krawchenko et al., 2016). Therefore, extending the age-friendly city framework by adopting climate change responses is a necessity to provide healthy, safe, and inclusive living spaces against the health threats brought about by the actual global crises.

6 The extended framework: climate--responsive age-friendly cities

The proposed framework examines and extends the WHO Age-Friendly City checklist, which is described under eight domains (WHO, 2007). The "outdoor spaces and buildings" domain needs greater emphasis on thermal comfort, emission concerns, and climate-related disasters, and it should have a multi-scale perspective. Therefore, this domain is reconceptualized into three categories, each representing a different scale: environmental safety, surroundings, and outdoor spaces and thermal comfort. The "transportation" domain remained, but it is enhanced with greater emphasis on sustainable mobility. The "housing" domain requires more focus on energy and thermal comfort concerns. The "social participation", "civic participation and employment", and "communication and information" domains need to present climate-related awareness and actions. They are brought together and represented by a more comprehensive domain: "information and participation". The "respect and social inclusion" and "community support and health services" domains lack emergency actions and preparation for any unforeseeable health event. Thus, they are merged and renamed "health and social services", containing city-wide service preparation for uncertain climate events. Figure 2 shows a detailed understanding of a "climate-responsive age-friendly city", developed in this study through a critical review of literature on multiple scales: city, neighbourhood, and housing cluster.

The city scale focuses on three dimensions: environmental safety, information and participation, and health and social services, which need to be addressed at the city level in policies and strategies. Environmental safety is a critical issue in terms of being prepared for unexpected weather events and sudden natural shocks due to the limited capacity of older adults to respond. Therefore, their access to early warning and information systems is highly critical for preparing and protecting themselves (van Hoof et al., 2021). For such a communication

Figure 2: Theoretical framework of the climate-responsive age-friendly city (illustration: authors, based on a literature review).

system, risk needs to be monitored. Stormwater management through nature-based solutions – green infrastructure and permeable pavements – provides a safe and sustainable living environment throughout the city (Jayasooriya & Ng, 2014). Rapid urbanization – especially in developing countries – escalates health problems associated with waste disposal. Hence, sustainability, preserving resources, reducing waste, increasing recycling, and maintaining hygiene are crucial points in waste management (Giusti, 2009).

Information and participation serve to inform older adults about policies, emergency actions, events, and the planning process. An age-friendly city is not possible without being represented by the older adults themselves and not being informed about planning practices and policies. Older adults need to receive information through multiple channels, such as the internet, TV, radio, and printed booklets (Bukov et al., 2002). They also need to find room to make their voices heard. The climate-responsive age-friendly city needs to start its policies by creating public awareness.

Health and social services are the most important features to be emphasized. In general, older adults visit and need health and social services more than other groups in society (Abbing, 2016). Therefore, accessibility, affordability, and availability of these services and a good surveillance system, especially in high-density cities, are fundamental requirements (Gutman, 2007; Quinn, 2008). Climate responsiveness needs emergency planning, which is critical for reaching older adults during sudden extreme events or other stresses. Identifying those requiring evacuation assistance before any extreme event will help build up an effective emergency plan (Balbus & Malina,

2009). Another problem older adults face is limited social networks due to retirement policies after age 65, which obligate people to leave their jobs and lose their social connections. Therefore, age-friendly environments must support and deliver social interactions and enhance engagement in the community of older adults (Khosravi et al., 2015) to reduce feelings of loneliness, isolation, and depression (Finlay & Kobayashi, 2018). The role of the living environment in this process is to deliver opportunities to engage the community through social urban environment design, community hubs and awareness, and events that create a social environment for all levels of society (Menec et al., 2011; Buffel, Phillipson & Scharf, 2012; Khosravi et al., 2015; Garner & Holland, 2020).

The neighbourhood scale has a supporting role for older adults through transportation facilities and a quality environment. Because people's mobility declines as they age, they tend to spend more time in their neighbourhood, meet their basic needs, and create a social environment (Bayar & Türkoğlu, 2021). Therefore, it addresses issues about "surroundings", which refers to the features of the settlement, and "transportation", which is about mobility within and beyond the neighbourhood.

Surroundings include a healthy ecosystem that provides fresh air and liveable settlements away from pollutants and makes it easy to meet daily basic needs and activities (Gitlin, 2003; Sugiyama & Thompson, 2007). Questioning how the neighbourhood is influenced by the facilities, structures, and infrastructure around it, this aspect highlights the location of settlements. Its closeness to pollution sources – for example, highways, industrial areas, construction areas, and waste disposal land – and higher exposure to pollutants such as NO_2, CO, SO_2, $PM_{2.5}$, and PM_{10}, is associated with a higher rate of respiratory diseases (Dong et al., 2012; Gong et al., 2012; Simoni et al., 2015). Moreover, the density of a settlement and streets' orientation regarding wind directions have a significant influence on the UHI effect, air quality, and solar radiation. Green infrastructure is an effective, affordable, and feasible strategy to enhance urban infrastructure, increase environmental and air quality, and integrate ecosystem (and ecosystem services) into settlements (Ren et al., 2018; Baldwin et al., 2020).

Transportation is key to older adults' mobility as well as social inclusion in the community (Grimaldi et al., 2016). It promotes sociability and accessibility to urban facilities, and it also enhances the mental wellbeing of older adults (Cvitkovich & Wister, 2001; Rosenbloom, 2009). Access to efficient public transport encourages older adults to retain their independence in daily life and commute to places where they can interact with the community; in doing so, they feel confident and active, helping prevent mental illnesses such as depression and loneliness (Metz, 2000; Rosenbloom, 2009; Holley-Moore & Creighton, 2015; Wong et al., 2017). Moreover, the affordability, safety, and accessibility of public transportation are the key factors encouraging older adults to use it (Broome et al., 2013; Wong et al., 2017). The frequency, efficiency, and availability of multiple transport modes provide connections to the city, allow people to travel independently, and foster the social inclusion and wellbeing of older adults (Cvitkovich & Wister, 2001; Rosenbloom, 2009; Aguiar & Macário, 2017). Sustainable, energy-efficient, and adequate design are the main principles of transportation facilities for promoting a healthier environment.

The housing cluster is the immediate environment for older adults to spend daily time. It plays an important role in older adults' life as they spend more time at home due to loss of physical activeness and their social network (Howden-Chapman et al., 1999); therefore, the housing structure needs to deliver multiple choices in an affordable range for all levels of society (Mulder, 2006).

To promote active ageing, outdoor spaces and thermal comfort pay attention to the climate perspective while responding to ageing needs. Ageing limits people to a certain environment due to physical and mental changes; therefore, the living environment is required to meet the needs of older adults within walking distance (Sundquist et al., 2011; Jun & Hur, 2015; Bayar & Türkoğlu, 2021). Accessible, adequate, safe, well-maintained, green, and serving basic urban needs are the fundamental features of supportive and walkable outdoor spaces for older adults (Jackie, 2013; Garner & Holland, 2020). The efficiency of outdoor spaces determines the daily routine, spending time outside of the home, sociability, independence, and most significantly mental wellbeing (Kim, 2010; Kloos & Townley, 2011; Astell-Burt et al., 2013; Thompson, 2013). From the urban design perspective, pavements should be free of barriers; however, climate impacts require pavements to be permeable to avoid any danger in the case of heavy rain. Green areas, parks, and green streets are important components of a cluster that both increase the ratio of permeable surfaces and provide shade to decrease the UHI effect. In addition to cooling centres, passive cooling measures (green walls and roofs, high-albedo surfaces, urban geometry, and wind corridors) decrease energy demand and support higher comfort both indoors and outdoors (Milan & Creutzig, 2015; Aram et al., 2019). The must-haves of the living environment are public toilets, shade, safety, and less traffic (McGarry & Morris, 2011; Dikken et al., 2020; Garner & Holland, 2020; Bayar & Türkoğlu, 2021).

Housing considers the qualifications of the house where older adults spent most of their time in terms of affordability, accessibility, comfort, design, and compatibility. The design of houses should meet the spatial needs of older adults such as barrier-free entrances, easy access to apartments, and lifting options (Burby & Rohe, 1990; Tinker, 1997). Another important issue from the climate change mitigation perspective is the energy used within the house, especially for heating and cooling. For example, using coal for heating causes multiple problems such as air pollution and GHG emissions, and it has a high risk for older adults (Kerimray et al., 2017). Renewable energy systems and energy-efficient design such as using high-albedo materials for the facade and roof to prevent overheating and aid insulation are both environmentally and budget-friendly (Milan & Creutzig, 2015).

7 Discussion

This article is based on the idea of developing a climate-responsive age-friendly city. The importance of this issue arises from two major situations that have been faced globally: the ageing population and climate change. The uneven distribution of climate stressors creates disproportionate impacts on cities and populations. Although cities act against climate change, the question of who will suffer more from climate stressors remains unanswered, which creates climate injustice in society. The social vulnerability of certain groups in society is associated with income level, sex, ethnicity, age, and civil society (Lynn et al., 2011). On the other hand, the vulnerability of those groups and injustice is either exacerbated or calmed by climate change actions and plans regarding the specific needs of the populations (Fothergill & Peek, 2004). Therefore, claiming that climate change actions need to be specified according to certain vulnerable groups, this study focuses on older adults' disproportionate vulnerability to climate change effects in urban areas (Antal & Bhutani, 2022). Scaling is the supportive argument of the bottom-up approach of this study. Three main scales that gradually affect older adults, but also directly from every perspective (the neighbourhood scale, the city scale, and the housing cluster) are linked to related climate actions, urban policies, and age-friendly topics.

The housing cluster is the immediate living environment for older adults and it is important due to depending on facilities and social life in a close setting. Time spent in the urban environment, emotional attachment to a place, local social networks, and feeling safe and secure in a familiar environment are the greatest supports for older adults as well as ageing in place (Buffel et al., 2012b). To support this, the cluster should provide a safe, comfortable, and affordable living environment in the face of climate change. Buildings are responsible for 30% of final energy consumption and 27% of total GHG emissions (IEA, 2022). Actions on promoting energy efficiency, using renewable energy, and increasing thermal comfort through material choice, housing design, and urban design contribute to the economy, the environment, and the wellbeing of older adults (Stephens & Allen, 2022; Wellecke et al., 2022)

It is well known that older adults spend most of their time in the neighbourhood they live in. Therefore, infrastructure, land use, and facilities have a significant impact on their wellbeing and independence. Efficient, affordable, accessible, and supportive public transportation increases their mobility and social interactivity while promoting their independent social activities (Booth et al., 2000; Khosravi et al., 2015). On the other hand, enhancing public transportation is a significant urban strategy in climate change mitigation and adaptation actions that also has positive impacts on older adults' health. Generating 33% of total urban GHG emissions, transportation is one of the major emission contributors and the fastest-growing sector in urban regions (OECD, 2020). Promoting reliable, comfortable, and accessible public transportation decreases the demand for automobiles, increases air quality, and eliminates traffic-induced air pollution (Sun et al., 2019). Industrial areas, highways, and waste-disposal areas are sources of both air pollution and emissions (Guttikunda et al., 2014) that should be located away from vulnerable groups' residential areas. Urban ventilation and integration of natural areas into urban settlements are other factors that affect not only air quality by hindering the accumulation of pollutants (Kurppa et al., 2018) but also by providing a natural cooling effect to eliminate the UHI effect (Gago et al., 2013).

The city scale revolves around factors that are concerns of society, systems, and government. Disseminating information and a well-functioning healthcare system are top priorities for coping with climate change and the ageing population due to older adults' dependency on healthcare services, which is expected to be increased by climate-related disasters and adverse health impacts. To develop a climate-responsive city, the increasing demand in an emergency should be considered to reduce the burden on the healthcare system. Because inequality in healthcare is associated with sociodemographic indicators such as poverty, education level, and lifestyle, enhancing the healthcare system should cover a more comprehensive perspective (Marmot & Bell, 2013). Local enhancements to support active ageing, a safe environment, and ageing in place contribute to the health and wellbeing of older adults and reduce the economic pressure on the healthcare system (Allen & Glasby, 2010; Darton, 2022). The WHO (2007) advises the integration of older adults into society and enhancing the participation of older adults into social activities to cope with isolation and loneliness. Creating an information network through com-

munities and policymakers is the greatest way to support this aim. Delivering the right information on campaigns, policies, and easy access to activities, and integrating older adults into volunteer work, are also essential to the quality of life, active ageing, and involvement in decision-making processes (Nazroo & Matthews, 2012). Disseminating information and warnings about climate change risks, precautions against disasters, and emerging impacts saves the lives of vulnerable people.

This study builds a bridge between the two most important challenges of the twenty-first century and provides a guide for future urban development. In addition, it can serve as a starting point for developing climate resilience so that cities can develop plans to address climate risks and vulnerabilities and ensure that they are inclusive of older adults. The three scales focus on different urban environments; however, they also connect with each other. To avoid overlap and repetition, spatial responses should be in line with policy planning regarding diversity in older adults. A limitation of this study is that the critical literature review is limited to English literature that is available online. Moreover, despite this study's comprehensive framework, it defines older adults as a homogenous group and does not focus on their specific needs based on sex, sociological background, or economic conditions.

Future studies need to test the domains on an empirical case study using both qualitative and quantitative research methods and support the theoretical framework with quantitative data analysis in the three scales of the study. Because the data on climate change mainly refer to the regional scale, the local data required by such a study need to be collected using specific methods. This framework can also be organized and evaluated for different city scales such as metropolitan cities or rural areas. Moreover, more detailed research can include the diverse identities and needs of older adults by focusing on heterogeneity.

8 Conclusion

Considering climate change exposure and its impacts on the health of older adults, urban planning strategies and actions need to focus on increasing indoor and outdoor thermal comfort and air quality, energy management, risk management, and safety on enhancing healthcare systems, and on integrating environmental concerns and solutions into urban settlements. This article has presented the importance of climate responsiveness while creating age-friendly cities from the perspective of climate and social justice. Population ageing and climate change are two inevitable and irreversible scenarios for the future of cities. Therefore, it is important to integrate these two dimensions into one to create more sustainable, resilient, and healthy cities. This study highlights the crucial domains for climate-responsive age-friendly cities through a critical review of the literature and provides a practical checklist for local governments.

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