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AGE-FRIENDLY HOUSING MODELS AND FRAMEWORKS: A SYSTEMATIC REVIEW

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ABSTRACT

With the increase in the average age of the population worldwide, the demand for suitable housing solutions has also increased considerably. This systematic review focuses on the five most developed frameworks for age friendly housing which have been developed over the last two decades, how they have been shaped and how they are used in the context of property reuse and social housing development. Drawing on the WHO Age-Friendly Cities model, the Age-Friendly Ecosystem, the Smart Age-Friendly Ecosystem (SAfE), the Ageing Well Urban Planning Model, and the Concept of Age-Friendly Smart Ecologies (CASE), this study observes a shift from monocentric strategies to polycentric and ecosystem centrism models. The results demonstrate how, in the process of extending these frameworks, issues of technology, sustainability and community engagement remain at the core of creating age friendly places, along with the focus on environmental complexities. Meanwhile, this review analyzes the advantages and shortcomings of the frameworks and guidelines applicable to researchers, policymakers and practitioners dealing with urban planning and gerontology. The analysis addresses the question of how older adults can be accommodated through property reuse and social housing in a way that is sustainable and inclusive.

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1. Introduction

The global demographic shift towards an ageing population has profound implications for housing, urban planning, and social policy. Currently, approximately 771 million people are aged 65 years or older, and this number is projected to more than double to 1.6 billion by 2050 (United Nations (UN), 2024). This demographic transition necessitates a reimagining of housing and community design to support the well-being, independence, and social participation of older adults.

The concept of age-friendly housing has evolved significantly over the past few decades, moving beyond mere accessibility features to encompass several social, environmental, and technological considerations. As (Buffel & Phillipson, 2019) noted, the development of age-friendly communities is not just about adapting physical infrastructures but also about creating supportive social environments that enable active ageing.

This evolution is reflected in various models and frameworks that have emerged to guide age-friendly housing development. These range from the foundational World Health Organization's Age-Friendly Cities model (World Health Organizations, 2007) to more recent technology-integrated frameworks, such as the Smart Age-Friendly Ecosystem (SAfE) proposed by (Ramsden Marston &

Van Hoof, 2019). A notable example of successful implementation can be found in Medellín, Colombia, where "social urbanism" has demonstrated how inclusive urban design, focused on community participation and equitable resource distribution, can transform marginalized areas into vibrant, age-friendly communities (Meninato & Marinic, 2024).

Previous research in age-friendly housing has focused primarily on specific aspects of design and implementation, with varying degrees of emphasis on physical infrastructure, social connectivity, and technological integration. Early studies concentrated on basic accessibility and safety features, while more recent research has expanded to include smart home technologies, sustainable design, and social engagement considerations. Several scholars, including (van Hoof et al., 2021a), have highlighted the importance of moving beyond single-domain approaches to more comprehensive, integrated frameworks that address the multifaceted needs of older adults. This evolution reflects a growing understanding that successful age-friendly housing requires consideration of both physical and social environments, as well as the integration of emerging technologies and sustainable practices.

Recent literature has also emphasized the role of community engagement and participatory design in developing effective age-friendly housing solutions. Studies by Buffel and Phillipson (2019) and Choi (2022) demonstrate that successful age-friendly housing initiatives often incorporate significant input from older adults themselves, leading to more responsive and effective design solutions. Additionally, research has increasingly focused on the intersection of age-friendly housing with other critical considerations such as environmental sustainability, digital inclusion, and social equity. However, as (Ramsden Marston et al., 2020) note, there remains a significant gap between theoretical frameworks and practical implementation, particularly in the context of property reuse and social housing development.

The purpose of this systematic review is to critically examine and synthesize the key age-friendly housing models and frameworks that have emerged in the literature. The research aims to address the following:

1. What age-friendly housing models and frameworks have been developed and how they have evolved.
2. What the key components and theoretical underpinnings of these models are.
3. How these frameworks address the challenges of property reuse and social housing development for older adults.
4. The strengths and limitations of each model, and their implications for policy and practice.

By addressing these issues, this review provides a comprehensive overview of the current state of knowledge on age-friendly housing design and implementation. This analysis is particularly timely given the increasing focus on sustainable urban development and the need for innovative solutions to address the housing challenges posed by ageing populations.

Despite the growing body of research on age-friendly housing models, several critical gaps persist in the current literature. Existing studies predominantly lack a comprehensive comparative analysis that critically examines the evolution and interconnectedness of different frameworks, often focusing on individual models in isolation. The majority of research has been developed and tested primarily in Western, developed countries, leaving significant knowledge gaps regarding global applicability and adaptability, particularly in low- and middle-income contexts. The technological dimension of age-friendly housing remains under-theorized, with insufficient exploration of digital interventions, potential risks, and the digital divide among older populations. Moreover, existing frameworks often treat sustainability, technological integration, and community engagement as discrete elements rather than interconnected components, and there is a notable lack of long-term impact assessments tracking the effectiveness of these approaches in supporting older adults' quality of life and social participation. By addressing these research gaps, this systematic review aims to provide a more comprehensive, critical, and forward-looking analysis of age-friendly housing models, bridging existing knowledge silos and laying the groundwork for more innovative, inclusive, and contextually-sensitive housing strategies for an ageing global population.

The significance of this review lies in its potential to inform policy decisions, guide urban planning practices and stimulate further research in the field of age-friendly housing. Through synthesizing diverse approaches and identifying gaps in current frameworks, this research contributes to the development of more effective and comprehensive strategies for creating housing environments that support healthy ageing.

The following sections outline the methodology for conducting this systematic review, present findings on the key age-friendly housing models and

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frameworks, discuss their implications and conclude with recommendations for future research and practice.

2. Methodology

This systematic review was reported and written in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement, ensuring methodological transparency, reproducibility, and consistency (Moher et al., 2009). Although it was based on PRISMA, the review employed a comparative design of qualitative synthesis, as the variability in study types and measurement methods prevented quantitative meta-analyses from being conducted. A standards-based appraisal of PRISMA flow transparency, combined with the Mixed Methods Appraisal Tool (MMAT) and a customized AGREE II framework, was used to achieve analytical depth to assess conceptual rigor and reporting quality.

2.1. Sources of information and search strategy

Searches were performed in Scopus, Web of Science, PubMed and Google Scholar, and are complemented with backward and forward citation chasing of literature of interest. Search terms were used to search the web using both controlled vocabulary and free-text words (e.g., age-friendly housing, age-friendly community framework, ageing-in-place model, built environment, and older adults, smart age-friendly ecosystem) with Boolean operators (AND/OR). A timeframe of 2000-2024 was considered, as it could non-exclusively encompass foundational guidance and recent ecosystem-based models. Preference was given to peer-reviewed journal articles indexed in Scopus. One primary monograph (TChao, 2018) and a conceptual and definitional background were provided with the help of foundational institutional documents (e.g., World Health Organization, 2007; United Nations, 2024). All the retrieved records were exported into a reference manager, filtered for duplicates, and then checked for relevance by two independent reviewers.

2.2. Eligibility criteria

Inclusion criteria: English-language publications which:

(i) suggested, improved or even comparatively assessed age-friendly housing or community structures;
(ii) dealt with implementation in social housing and reuse of property; or/and
(iii) considered environmental or psychosocial interventions that were pertinent to age-friendly built environments.

Exclusion criteria: Clinical/biomedical publications that were not empirical, opinion/editorials that were not conceptual and purely focused design studies (e.g., research on accessibility but not systemically framed.

2.3. Study selection

The search returned 1,237 records, which underwent screening according to PRISMA guidelines (see section 3.1 for detailed results). Finally, 22 articles that complied with the eligibility criteria were incorporated in the synthesis. Two investigators independently made the screening and inclusion decisions in accordance with PRISMA standards. Any discrepancies between the investigators were resolved through consensus discussion, and screening forms were stored to maintain a complete audit trail. The study-selection process is summarized in Figure 1 (PRISMA Flow Diagram).

2.4. Data extraction

A data-extraction matrix was designed to store bibliographic data, the type of model or framework, theoretical basis, and the scope of the implementation (dwelling, building, neighborhood, or city). Other variables included empirical methods (where necessary), implementation levers (e.g., governance, procurement, or green-building strategies), and practical applications in reusing property and social housing (Sanchaniya et al., 2023). Two reviewers were used to extract data, which then formed the basis for the comparative mapping of domains across frameworks.

2.5. Quality appraisal

The Mixed Methods Appraisal Tool (Hong et al., 2018) was employed to evaluate the credibility of empirical studies, facilitating cross-design comparability among qualitative, quantitative, and mixed-methods evidence. The assessment of conceptual frameworks and guidance papers was based on a modified AGREE II guideline, with the scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence subjected to evaluation (Brouwers et al., 2010b). The findings of such assessments are provided in the Results section in the Quality Appraisal Summary. Measurement transparency and reporting quality were also assessed using these appraisal tools, with a direct interpretation of the methodological

rigour serving as interpretive strength in the Discussion.

2.6. Analytical approach

The synthesis of data was conducted using a narrative thematic approach, in which a priori codes based on commonly cited frameworks were employed to facilitate comparability across heterogeneous sources. Synthesis was aimed at finding convergence, divergence, and evolution among nine major families of frameworks:

- Urban domains- WHO Age-Friendly Cities (World Health Organizations, 2007).
- Ecosystem coordination - Age-Friendly Ecosystem (Fulmer et al., 2020).
- Inclusion in the digital world - Smart Age-Friendly Ecosystem (Ramsden Marston et al., 2020; van Hoof et al., 2019).
- Built-environment performance Built environment performance: Ten Questions on the environmental quality (van Hoof et al., 2021b).
- Housing-level measure — the criteria of accessibility, adaptability, safety, and usability (Luciano et al., 2020).
- Health-system integration governance, service design, and user engagement (Karami et al., 2023).
- Social-environment interventions - environmental and psychosocial interaction domains (Sánchez-González et al., 2020).
- Outcome domains: social support, loneliness, mental wellbeing, physical capability, and life satisfaction (Sulandari et al., 2024).
- Modifiers of equity and geography — gentrification and implementation in rural areas. (Buffel & Phillipson, 2018; Montayre et al., 2022).

A comparative synthesis was conducted between the incorporation of each framework for the integration of these domains, revealing common indicators, gaps in measurement, and pragmatic levers to retrofit and apply to social housing.

2.7. Precision, extent, and restrictions

The search was limited to English-language sources, which may limit the inclusion of non-English frameworks and locally-adapted models. This heterogeneity of designs, indicators and outcome measures made quantitative meta-analysis impossible. Thus, this paper adopted a standards-oriented comparative qualitative synthesis approach, grounded in PRISMA, MMAT, and AGREE II. This method is consistent in terms of methodology and also allows for the combination of conceptual, empirical, and policy-based knowledge. The latest broad framework to be found in the dataset was published in 2021, where it is stated that more and more contributions aim at improving the measurement, adapting it to the context, and implementation pathways, but not the development of completely new umbrella frameworks, which is reflected in the Results section by way of built-environment, psychosocial, sustainability, and governance levers.

3. Results

3.1. Study selection (PRISMA summary)

The selection of studies to be included in the supplementary material was conducted in three steps: (a) identifying references through a search query; (b) evaluating identified references and (c) including only those that qualified according to the selected criteria (Frandsen & Eriksen, 2023). The process of selecting which studies became a part of the supplementary material was carried out in three steps: (a) the search query, which found all the references; (b) the screening of identified references and (c) inclusion of only those that met the criteria selected by the authors (Frandsen & Eriksen, 2023).

Database searches and citation-chasing identified 1,237 records. After removing 255 duplicates, 982 titles and abstracts were screened, leading to 156 full-text articles assessed for eligibility. Finally, 22 articles met the inclusion criteria and were included in the synthesis. The result is 22 articles that fit the inclusion criteria and were synthesized in this study (Moher et al., 2009). Figure 1 presents a PRISMA flow diagram following standard reporting guidelines.

The 22 studies included imply a variety of research designs and cover different geographic region. Table 1 shows the key characteristics of each research, the proposed framework or model, the methodology as well as main focus areas, and the contextual background. The overview allows one to perform a comparative analysis between frameworks and find common themes and gaps in the literature.

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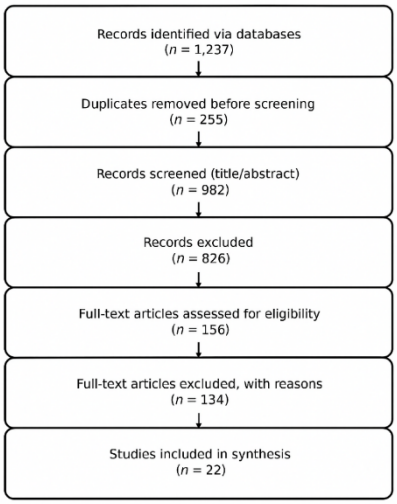

Fig. 1. PRISMA flow diagram of study selection (Create by Author). *Source*: own study.

Table 1

Summary of Included Studies

Author(s) & Year	Framework/ Model	Study Type	Methodology	Key Focus	Population/ Setting
WHO (2007)	Age-Friendly Cities (AFC)	Guideline document	Participatory consultation, global focus groups	8 domains: housing, outdoor spaces, transportation, services, participation, respect, civic engagement, communication	33 cities, 22 countries
Chao (2018)	Ageing-Well Urban Planning Model	Monograph	Literature synthesis, case studies	Nested spatial hierarchy (private to public), urban morphology, environmental performance	Urban planning contexts
Buffel and Phillipson (2018)	Age-Friendly Movement Manifesto	Position paper	Theoretical analysis	Urban agenda development, policy frameworks	Urban communities
van Hoof et al. (2019)	Housing and Technology Integration	Framework paper	Conceptual analysis	Smart home technologies, co-design with older adults	Community settings
Ramsden Marston and van Hoof (2019)	Smart Age-Friendly Ecosystem (SAfE)	Conceptual framework	Case study approach, literature review	Technology integration, digital inclusion, WHO extension	Urban environments
Buffel and Phillipson (2019)	Gentrification and Ageing	Qualitative study	Focus groups (n=58), interviews (n=30)	Community change, displacement, belonging, place attachment	Chorlton, Manchester, UK
Fulmer et al. (2020)	Age-Friendly Ecosystem (AFE)	Conceptual framework	Literature review, expert consensus	Cross-sector coordination (health, planning, social services), shared indicators	Global application
Luciano et al. (2020)	Housing Measurement Framework	Framework paper	Literature review, expert consultation	Accessibility, adaptability, safety, usability criteria	Housing assessment tools
Marston et al. (2020)	SAfE (post-pandemic adaptation)	Conceptual framework	Literature, pandemic response analysis	Digital technologies, service continuity, resilience	Post-COVID contexts
Sánchez-González et al. (2020)	Environmental & Psychosocial Interventions	Systematic review	PRISMA methodology, qualitative synthesis	Intervention effectiveness, environmental + social programs	Active ageing communities
van Hoof et al. (2021a,b)	Ten Questions on Built Environment	Framework paper	Expert consensus, literature review	Environmental quality: thermal, acoustic, lighting comfort, walkability	Built environment
Choi (2022)	Aging in Place	Quantitative	Survey (n=3,949),	Home/community features, perceived age-	AARP survey,

	Determinants	study	path analysis	friendliness, AIP intention	US communities
Montayre et al. (2022)	Rural/Remote Age-Friendly Interventions	Scoping review	Literature mapping	Geographic adaptation, service delivery, telehealth, digital divide	Rural/remote settings globally
Karami et al, (2023)	Age-Friendly Health System	Scoping review	Literature mapping, thematic analysis	Governance, service design, workforce, quality assurance, stakeholder engagement	Health systems integration
Sanchaniya et al. (2023)	Real Estate Sustainability	Empirical study	Case study, document analysis	Green building practices, portfolio governance, energy efficiency	Social housing, India
Meninato and Marinic (2024)	Social Urbanism (Medellín case)	Case study	Architectural analysis, urban design review	Community participation, inclusive design, marginalized areas transformation	Medellín, Colombia
Sulandari et al. (2024)	Psychosocial Outcome Associations	Meta-analysis	quantitative synthesis (multiple studies)	Physical capability, social support, loneliness, depression, anxiety, life satisfaction	Later life populations

Note: *The table captures seventeen of the twenty-two synthesized studies. The other five articles added supporting evidence to certain areas such as measurement tools, equity concerns, and implementation plans, but not to a particular framework.*

Source: Created by author.

As shown in Table 1, the evolution of age-friendly frameworks demonstrates a clear progression from single-domain approaches focused primarily on built-environment features (WHO AFC, 2007) toward integrated ecosystem models that incorporate technology (SAfE), health systems (AFE), psychosocial outcomes, and sustainability considerations. The geographic diversity of the studies ranges from global frameworks to context-specific implementations in urban, rural, and post-pandemic settings. In particular, recent frameworks (2019-2024) emphasize cross-sector coordination, digital inclusion, and equity considerations, reflecting growing recognition that age-friendly environments require multidimensional interventions beyond physical infrastructure alone.

3.2. Overview of included sources

The most common frameworks included the WHO Age-Friendly Cities (AFC) framework, the Age-Friendly Ecosystem (AFE), the Smart Age-Friendly Ecosystem (SAfE), Ageing-Well Urban Planning, and social-ecological approaches, which are prevalent in the literature. On the whole, these models are indicative of a distinct change in single-domain design in favor of ecosystem approaches that combine the built environment, social participation, technology, and service systems (Fulmer et al., 2020; Ramsden Marston et al., 2020; Chao, 2018; van Hoof et al., 2019; World Health Organizations, 2007). Most recent contributions focus on:

(i) integrated city planning (Chao, 2018);
(ii) performance criteria of the built-environment (walkability, thermal, lighting, and acoustic comfort) (Buffel & Phillipson, 2018; van Hoof et al., 2021a);
(iii) digital inclusion, based on smart technologies (Ramsden Marston & van Hoof, 2019; Ramsden Marston et al., 2020) and
(iv) social-ecological relationships between place design and participation.

The conceptual relationships among the major age-friendly frameworks reviewed in this study are illustrated in:

Figure 2, demonstrating the interconnected domains that span from individual housing units to city-wide systems.

Figure 3, presenting the temporal evolution of age-friendly housing models from 2007 to 2021, and highlighting the progressive shift from single-domain approaches toward integrated ecosystem frameworks that incorporate technology, sustainability, and social infrastructure.

3.3. Built environment & housing

It has been demonstrated that age-friendly design is most effective within a nested hierarchy of spaces, including private, semi-private, semi-public, and public spaces, as well as gradual changes in accessibility between dwellings, common areas, outdoor spaces, and streets. Recurring performance requirements, such as walkability, safe crossings, proximity to amenities, step-free circulation, and indoor environmental quality (including thermal, acoustic, and lighting aspects), are consistently identified across studies (van Hoof et al., 2021a).

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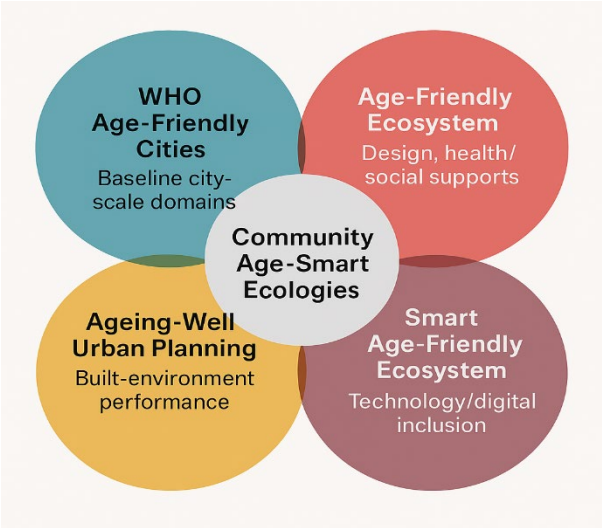

Fig. 2. Conceptual Alignment of Age-Friendly Frameworks (Created by Author). *Source*: own study.

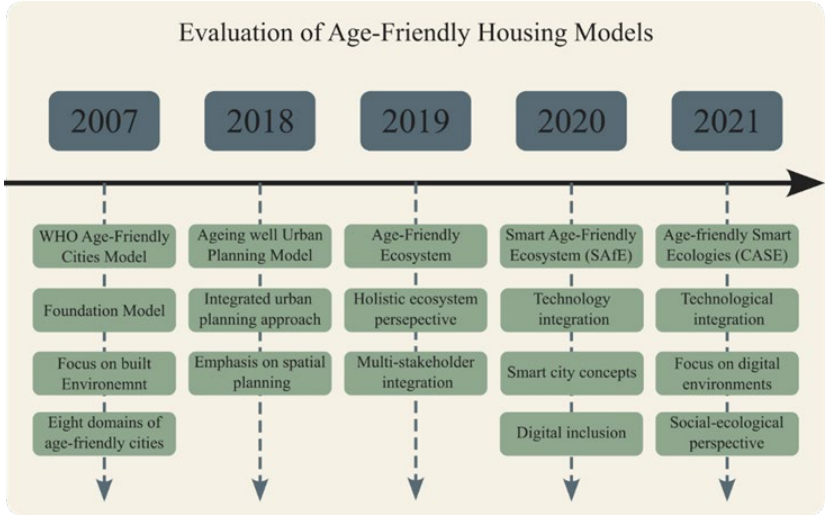

Fig. 3. Evolution of Age-Friendly Housing Models (Create by Author). *Source*: own study.

Frameworks at dwelling and shared-building levels detect quantifiable criteria, such as accessibility, adaptability, safety, and usability, which can be audited and converted into retrofit checklists (Luciano et al., 2020). Contextual factors, such as microclimate and the morphology of the urban environment, also impact comfort and mobility, indicating that street and block-level enhancements should accompany building-level ones.

It has been proven in practice that green-building practices and portfolio-wide governance in public-sector estates allow for repeating retrofit packages that enhance comfort and safety, minimize environmental impact, and reduce operational costs (Sanchaniya et al., 2023).

This nested spatial hierarchy is depicted in Figure 4, which shows that interventions in individual houses should radiate out through building commons, neighborhood spaces and infrastructures, with accessibility at each level influenced by contextual determinants such as climatic conditions, urban form, and cultural norms.

This model shows that age friendly housing (private space) requires assistance by gradually more accessible semi-private (building commons), semi-public (outdoor spaces), and public (streets, transportation) spatial domains, with all aspects of the natural environment, urban morphology, and socio-cultural influencing accessibility, and usability at all spatial levels.

At the dwelling (private) and shared-building (semi-private) levels, age-friendly housing requires measurable characteristics (accessibility, adaptability, safety, usability) and checklists to guide upgrades. The

construction/real-estate literature on implementation supports the worth of green-building practices and firm-level governance to provide comfort and safety and minimize environmental burdens- valuable tools when retrofitting existing stock.

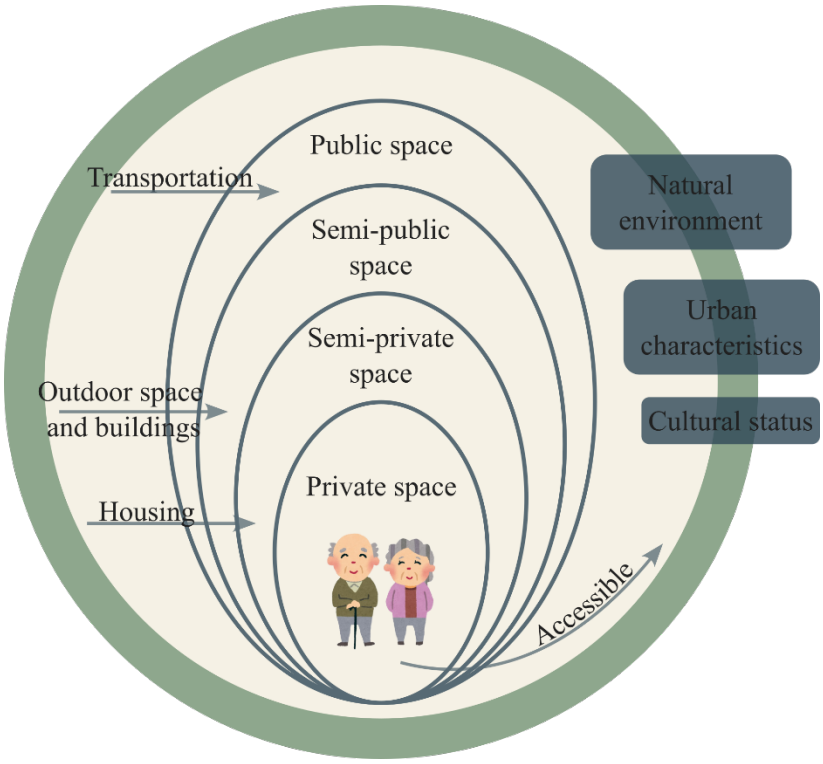

Fig. 4. The Age Well Urban Planning Model outlines the age friendly design interventions that can be found in nested spatial levels. *Source*: Chao (2018).

3.4. Psychosocial consequences of age-friendly environments

The evidence base is linked to a consistent psychosocial profile, which indicates that greater physical potential and social support are associated with lower levels of loneliness, depression, and anxiety, as well as increased life satisfaction (Sulandari et al., 2024). These trends are associated with various study designs, indicating that psychosocial and biomedical determinants have a complex interaction that affects well-being (as shown in Figure 5). Essentially, the findings are based on extraneous meta-analytic data (Sulandari et al., 2024), as opposed to additional pooling in this review. Using this evidence as an extension of built-environment research highlights the importance of social infrastructure in age-friendly planning. The WHO AFC model specifically incorporates social participation and communication as central areas (World Health Organizations, 2007). Intervention syntheses reveal that the use of programs with environmental upgrades and components of participation and community support demonstrates more improvements in mobility, perceived safety, and connectedness when compared to physical works alone (Sánchez-González et al., 2020). On the other hand, in gentrifying neighborhoods, qualitative studies highlight the dangers of elderly members losing their sense of belonging and security due to increasing prices and removal (Buffel & Phillipson, 2019). All literature suggests the implementation of an ecosystem approach, in which physical planning, public health, and social care programs work together, complemented by digital inclusion programs that minimize isolation (Fulmer et al., 2020; Ramsden Marston et al., 2020; van Hoof et al., 2019).

Meta-analytic evidence synthesized by Sulandari et al. (2024) quantifies the relationships between psychosocial determinants and health outcomes in later life. Figure 5 presents one component of this analysis, demonstrating how social support, physical capability, and related factors influence stroke risk among older populations. This evidence reinforces the importance of integrating psychosocial considerations into age-friendly housing frameworks.

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The forest plot presents hazard ratios (HR) with 95% confidence intervals (CI) from multiple studies examining stroke risk. Each row represents an individual study included in the meta-analysis, with the diamond indicating the pooled effect size. HR values >1.0 indicate increased stroke risk, while values <1.0 suggest protective effects. The overall meta-analytic estimate (HR = 0.85, 95% CI: 0.76-0.94) demonstrates that favorable psychosocial factors are associated with reduced stroke risk in older adults, with low heterogeneity (I^2=61%, p=0.00). The weight column indicates each study's contribution to the pooled estimate based on sample size and precision.

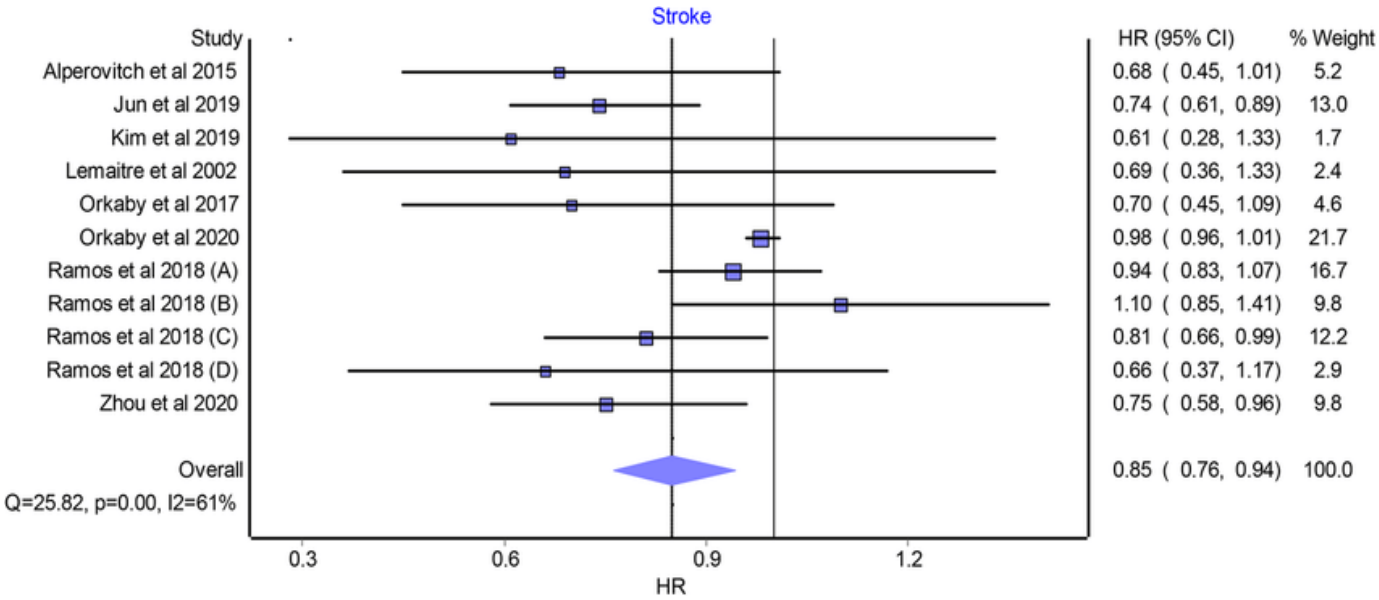

Fig. 5. Meta-analytic associations between stroke incidence and psychosocial factors in later life. *Source*: Sulandari et al. (2024).

3.5. Rural and remote settings

The results of the scoping reviews of age-friendly initiatives in rural and remote settings reveal that the barriers are systematic, including the lack of services, long-distance travel, scarce transportation, discontinuous referral routes, and inequalities in broadband availability (Montayre et al., 2022). Effective programs transform urban structures by utilizing outreach methods, hub-and-spoke/mobile delivery, local co-design, and the utilization of community resources, such as libraries, halls, and volunteer networks.

Technology provides accessibility, including telehealth, remote monitoring, and smart-home adaptations, provided that connectivity and digital literacy training are in place, aligning with the Smart Age-Friendly Ecosystem (SAfE) focus on inclusion (Ramsden Marston et al., 2020). The built-environment enhancements emphasize safe access to vital places, lighting, and walking rather than relying on mass transit, which is consistent with performance-based comfort and safety standards (van Hoof et al., 2021a). All in all, the evidence supports the idea of local adaptation of the core age-friendly domains of the WHO to local capacities, while retaining the same conceptual pillars (World Health Organizations, 2007).

3.6. Service/system integration

The Age-Friendly Ecosystem (AFE) utilizes the conceptualization of practice as a cross-sector alignment of municipal planning, public health, clinical care, and social supports, based on shared indicators (Fulmer et al., 2020). Applying this idea to practice, (Karami et al., 2023) identified the determination of governance, leadership, workforce skills, models of service delivery, quality assurance, and stakeholder involvement as essential levers.

These observations support the idea of care-capable infrastructure, placing housing and neighborhood improvements into the context of a wider range of prevention and rehabilitation pathways. Co-commissioning environmental improvements with health and public health partners, and comparing them with paired outcomes such as environmental performance, accessibility (Luciano et al., 2020; van Hoof et al., 2021b), and psychosocial wellbeing, should therefore be evaluated (Sulandari et al., 2024). The evidence syntheses suggest that built-environment modifications have the most significant effect when combined with participation and social-

support programs (Sánchez-González et al., 2020). Such coherence is reminiscent of the AFC domain of the WHO, which connects community and health services with the necessity of embedding housing and public-realm interventions into an integrated community health undertaking, as opposed to siloed projects (Fulmer et al., 2020; Karami et al., 2023; World Health Organizations, 2007).

3.7. Digital inclusion and technology

In the Smart Age-Friendly Ecosystem (SAfE), digital technologies constitute a layer of cross-cutting that promotes the physical environment and provision of services. Another important element is the integration of telehealth, sensorized housing, accessible interfaces, and digital communication platforms, which are co-designed with older adults to be usable and inclusive of them (Ramsden Marston et al., 2020; van Hoof et al., 2019). The AFE complements this by integrating digital tools into integrated health-and-community systems, which enable prevention, rehabilitation, and continuity of care at home (Fulmer et al., 2020).

Technologies, including fall-detection sensors, medication reminders, and video check-ins, can only be utilized as a retrofit pathway when they are accompanied by training, technical support, and procedures for privacy and consent. The barriers to accessibility are strongest in rural regions, where connectivity provision and outreach are critical (Montayre et al., 2022). This agenda aligns with the AFC domain of Communication and Information, which requires the presence of accessible and inclusive information channels in the environment (World Health Organizations, 2007). Technology programs should therefore be evaluated in terms of social connection results and physical design advantages, which aligns with meta-analytic evidence on the relationship between social support, loneliness, and wellbeing (Sulandari et al., 2024).

The integration of digital technologies across physical and service domains is conceptualized in Figure 6, which illustrates the Smart Age-Friendly Ecosystem (SAfE) model and its cross-cutting technological layers that support aging in place

Fig. 6. Smart Age-Friendly Ecosystem (SAfE). *Source*: Marston and van Hoof (2019) and van Hoof et al. (2021a).

3.8. Sustainability and retrofit pathways

Sustainability acts as a facilitating factor in all age-friendly areas. The energy-efficient and environmentally responsible upgrades simultaneously enhance comfort, safety, and usability, which helps individuals age in place (van Hoof et al., 2021b; World Health Organizations, 2007). Retrofit packages, which include insulation, airtightness, ventilation, efficient lighting and acoustic control, are integrated to deliver multiple performance improvements.

Accessibility adaptations should be accompanied by sustainability measures, such as step-free entry, bathroom modifications, and widened circulation. Accessibility, adaptability, safety, and usability criteria

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should be measured to audit the house-level benefits (Luciano et al., 2020). Standardized specifications and procurement in the context of public and social housing portfolios enable systematic repetition at the scale of an estate and the installation of green-building techniques (Sanchaniya et al., 2023).

This must be verified against quantitative performance targets, such as the ranges of thermal comfort, acoustic limits, and illuminance thresholds, and short-term post-occupancy tests, with the results of built environments related to broader wellbeing pathways in the age-friendly ecosystem (Fulmer et al., 2020; Luciano et al., 2020; van Hoof et al., 2021a).

Figure 7 presents the Concept of Age-friendly Smart Ecologies (CASE), demonstrating how smart technologies, ecological sustainability, and community engagement converge to create comprehensive age-friendly environments.

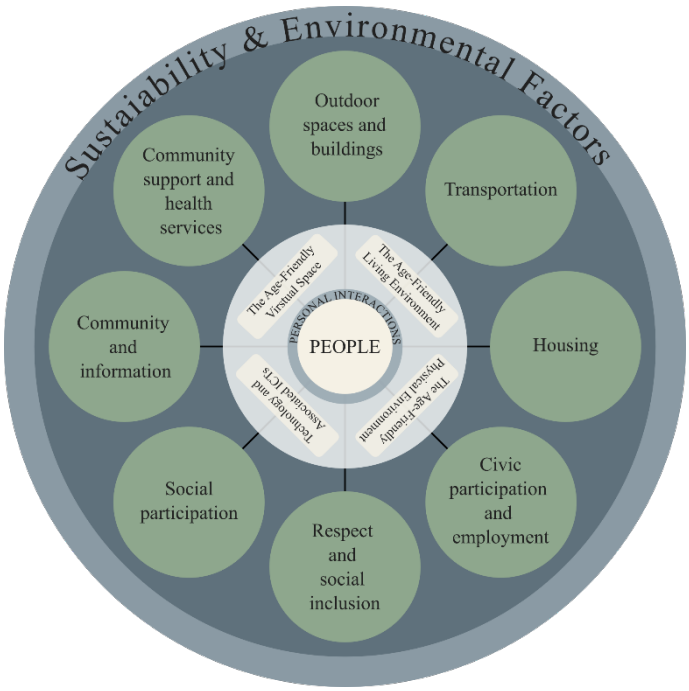

Fig. 7. Concept of Age-friendly Smart Ecologies. *Source*: Marston and Van Hoof (2019).

3.9. Quality appraisal summary

Quality evaluation based on the (Hong et al., 2018) and modified AGREE II model demonstrated a mixed quality of reporting across the sources (Brouwers et al., 2010a; Hong et al., 2018). The involvement of stakeholders, applicability, and editorial independence, which are the areas most likely to guarantee credibility, were most frequently excluded in framework and guidance papers. The empirical research was often incomplete in terms of the sampling frame, description of recruitment, and explanation of measurement instruments. Future studies ought to make the measurement of outcomes standard, that is, combining built-environment indicators (e.g., accessibility, adaptability, safety, usability, and thermal/acoustic/lighting comfort) with psychosocial and health outcomes that have already been reported to covary in later life (Luciano et al., 2020; Sulandari et al., 2024; van Hoof et al., 2021a). Participation and connectedness outcomes should also be included in reporting to account for the overall effect of age-friendly programs (Sánchez-González et al., 2020). Moreover, a more regular contextual description, i.e., urban/remote versus rural delivery, should be adopted to promote the transferability of results (Montayre et al., 2022). This is necessary because it is essential to focus on transparent PRISMA-based reporting as a means of building cumulative evidence (Moher et al., 2009).

Quality evaluation showed that there was variability: five studies had high methodological rigor, twelve studies had moderate rigor, and five studies had low rigor. The usual weaknesses included inadequate reporting of stakeholder participation in framework papers and vague proceedings of sampling and measurement in empirical research. These weaknesses limit the external applicability of the cost estimates and effect sizes presented in the discussion.

4. Discussion

This review reflects a paradigmatic shift from single-domain, checklist models to an ecosystem framework that brings together place, services, and technology. The center of gravity across the five dominating frameworks in our corpus would be on polycentric systems approaches to the issue of ageing in place, such as WHO Age-Friendly Cities (AFC), the Age-Friendly Ecosystem (AFE), the Smart Age-Friendly Ecosystem (SAfE), Ageing-Well Urban Planning, and Community-Age-Smart Ecologies (CASE). It is also important to note that the most recent overall framework, which was retrieved here, was released as late as 2021, suggesting that the frontier now lies in implementing and adjusting existing umbrellas to various situations, rather than creating brand new ones.

The trend indicates that the built environment is the primary focus, and the evidence further reveals that the most effective way for physical improvements to occur is through the integration of services and social infrastructure. Recurrent cues, such as walkability, circulatory accessibility, proximity to daily facilities, and thermally/audibly/optically comfortable housing interiors at both housing and neighborhood scales, are now effectively translated into housing-level checklists (accessibility, adaptability, safety, and usability) that aid audits and retrofits. These environmental levers are to be considered the minimum requirements in any age-friendly program, particularly where property reuse is at the centre of the delivery pipeline.

Green-building practices and portfolio-level governance are other implementation literature opportunities that have been found to scale age-friendly retrofits in public and social housing. Defining sustainability as a cross-cutting modifier, as opposed to a competing priority, allows owners to realize comfort, safety, and energy performance concurrently. For asset managers, this involves bundling procurement arrangements for accessibility works, insulation, ventilation, lighting, and acoustics in repeatable packages, suitable for older stock. This enhances quality assurance and life-cycle control of costs at the estate level.

The psychosocial evidence base is directly related to design and delivery. There is evidence of external meta-analytic studies (e.g., Sulandari et al., 2024) that connect social support, loneliness, depression/anxiety, physical capability, and life satisfaction. It is emphasized that age-friendliness is not based solely on better buildings. Practically, this is implemented through translating material upgrades, enabling participation and engagement in intergenerational activities, and preserving communal spaces. It also involves addressing place change: the forces associated with gentrification may disrupt a sense of belonging and perceived security among traditional older residents; thus, anti-displacement policies and tenure security are part of an age-friendly agenda and not supplements.

Modern frameworks also suggest that age-friendly provision must be integrated into the frameworks of public health and healthcare, as opposed to coexisting with them. Aligning urban settings with prevention, primary care, rehabilitation, and community services facilitates understanding of governance, workforce skills, safety procedures, and continuity across home, community, and clinic boundaries. The practical implication to municipalities and housing providers is to co-commission services with health partners, share outline sets and design dwellings and neighborhoods as care-capable infrastructure to enable independence and recovery at home.

Technology serves as a facilitator, enabling planned inclusion. In line with AFE and SAfE, framework smart-home capabilities, telehealth, remote monitoring, and digital communication are resources to enhance autonomy and connectedness, as long as retrofits also provide connectivity, compatibility with devices, and support to users, while additionally addressing privacy, consent, and maintenance by establishing digital inclusion as a matter of property standard and service contract, and not as an added-value option, better uptake rates among the most vulnerable groups will be achieved, including rural and remote area residents.

Design frameworks have to be translated into the practice of retrofit, which requires the development of quantifiable standards. Minimum performance targets are determined through convergent evidence: the indoor temperatures should be at 18 to 21°C, the background noise should not exceed 35 dB, task lighting must be in the range of 300 to 500 lx, and the circulation should be free of steps with doorways of no less than 850mm (Luciano et al., 2020; van Hoof et al., 2021b). The standards of accessibility include level thresholds, bathroom grabrails, elements of control at 900-1200mm, and emergency communication. At the neighborhood level, vital services must be within 400m of walking distance, and crossings should have a light and rest seat at 100m intervals (Chao, 2018). Digital infrastructure should be able to provide a

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broadband connection, user-friendly interfaces, with a font size of 14 pt or higher, and a technical support policy (van Hoof et al., 2019). These standards allow repeatable audits and repeatable quality assurance of estates when applied to the portfolio level procurement specifications (Sanchaniya et al., 2023). Portfolio governance and procurement structures are still the main implementation levers since they ensure consistency in the specifications and lifecycle cost containment (Jaymin-Sanchaniya at al., 2024), but not variability at the project level.

There is a focus on equity and geography. Most frameworks are urban-based, but synthesis suggests what is possible to transfer to rural/remote areas: outreach-based services, hub-and-spoke or mobile services, tele-enabled services, and tailoring of design standards to low-density and limited transport through local resources, including community halls, libraries, primary-care outposts, and volunteer rnetworks. On the other hand, there must be some built-in protection for long-term residence and social circles around the old, which, despite environmental investments, do not unwittingly cut corners.

Measurement and reporting remain imbalanced, which is hindering cumulative learning. Outcome families need to be standardized to match built-environment measures (e.g., accessibility/adaptability/safety/usability; thermal, acoustic, and lighting performance; walkability) with psychosocial and health outcomes (e.g., social connection, mental health, mobility, life satisfaction). The implementation of transparent review standards (PRISMA) and analysis tools (MMAT with empirical designs; modified AGREE II with frameworks/guidance) will enhance reproducibility and facilitate further meta-syntheses that could generate the necessary scale of multi-domain effect assessment.

The strong points of this review are the ability to convert narrative literature into comparative understanding and the capacity to maintain a clear direction in implementation. Its drawbacks include limitations to English-language research, the predominance of well-off settings, and the lack of post-2021 frameworks, which impact overall generalizability to low-resource settings. Flexibility in the involvement of stakeholders, editorial independence, sampling frames, and measurement instruments among studies make the interpretation of effect sizes and cost claims even more limited.

In a relatively stable framework, testing, measuring, and scaling now take priority. Five practice steps are suggested: publish implementation recipes (governance, procurement, workforce, sequencing, costs) for property-reuse and social-housing portfolios; measure multi-component programs (combine place + services + social, reporting differentials) through income, tenant, and digital access; trial rural/remote implementations to customize standards and delivery models; include digital-inclusion supports into all technology rollouts; and shift to a single outcome set which combines environmental, psychosocial, and health outcomes. Furthering this agenda will shift the discipline from an agreeable conceptual framework to a sustainable practice that secures social networks, promotes autonomy, and provides scalable well-being.

5. Conclusions

This review reveals that the initial WHO model of Age-Friendly Cities (AFC) has evolved into more holistic, ecosystem-focused models, namely Age-Friendly Ecosystem (AFE), Smart Age-Friendly Ecosystem (SAfE), Ageing-Well Urban Planning, and Community-Age-Smart Ecologies (CASE). These models integrate the built environment, health and public health systems, social infrastructure, digital technologies, and sustainability principles. It has been established that age-friendly housing requires environmental attributes such as accessibility, walkability, comfort, and proximity to amenities to be met, which can be ensured through the use of retrofit-ready checklists and portfolio-level governance structures that provide quality and consistency across projects.

Psychosocial wellness becomes something that cannot be separated from physical design. The literature demonstrates that the combination of programs involving environmental enhancements, opportunities for participation, and safeguards against displacement has longer-term effects than the implementation of physical enhancements alone. The housing interventions that protect residents long-term, maintain local networks, and develop social connections have a direct impact on mental health and life satisfaction. Technology also has a significant facilitating effect, which expands autonomy under conditions of application in conjunction with connectivity, maintenance, and privacy protection. Digital inclusion should be considered as part of the standards and service contracts for properties, rather than being an add-on, to enhance equity in the access to and usability of services among older adults.

Sustainability is a modifier system, rather than a parallel priority. It must be institutionalized in the standards, purchase procedures, and performance criteria so that advancements can be made in a balanced approach that prioritizes comfort, safety, energy efficiency, and environmental responsibility. By balancing green-building approaches with accessibility and retrofit programs, age-friendly transformation will be cost-effective and resilient in the future.

The short-term focus of the field should be translation and application. Researchers and practitioners need to embrace integrated outcome sets to capture the environmental and psychosocial dimensions. They should design and test multi-component interventions that integrate place, services, and social support. Additionally, they should report implementation parameters, including sequencing, workforce, costs, and governance, for property reuse and social housing portfolios. This involves transforming rural and remote area structures through outreach models, tele-enabled services, and locally sourced infrastructure.

The critical challenge now is translating the conceptual model into measurable, scalable practice, which will help build inclusive, resilient environments that promote healthy and connected aging. Age-friendly housing can move beyond rhetoric and provide practical solutions to enhance the well-being, autonomy, and quality of life of older adults in various settings by ensuring that sustainability, digital equity, and social participation are embedded in the same structural and policy frameworks.

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