



Art-integrated spatial design for nursing homes: A conceptual model for healthy aging in Henan

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Abstract

China's rapid population aging necessitates a shift from basic custodial care to healthy aging environments in nursing homes. This study examines how the combined integration of spatial design, art, and sustainability can be leveraged to improve the physical, emotional, and social well-being of elderly residents in Henan Province. This research employed a mixed-methods approach, combining field observations and behavioral mapping of resident activities with policy analysis (specifically referencing the national standard GB 50340-2016), and surveys administered to residents. The data was used to develop and evaluate the conceptual model: Healthy Aging through Art-Integrated Spatial Design. The study's findings demonstrate a strong link between intentional design and improved resident outcomes. Mural placement was found to significantly increase both resident interaction and storytelling, serving as cognitive and social anchors. Furthermore, the inclusion of sustainable features (e.g., passive ventilation, green spaces, natural lighting) correlated with higher resident satisfaction and reduced depressive symptoms. However, the implementation of these holistic designs faces challenges related to funding limitations, policy gaps, and the lack of interdisciplinary collaboration. A holistic design approach—one that is participatory, culturally grounded, and environmentally sustainable—is crucial for promoting healthy aging in the Chinese nursing home context. The proposed model offers a framework for moving beyond minimum standards to create therapeutic and socially engaging built environments that directly support the well-being of the elderly.

Keywords: Healthy aging, Nursing home design, Art integration, Spatial design, Sustainable development

Introduction

The global aging population represents one of the most significant demographic shifts of the 21st century. The proportion of individuals aged 60 and above is projected to rise from 12% in 2015 to 22% by 2050, reaching 2.1 billion [1-3]. By mid-century, one in six people globally will be over 65, with notable increases in Asia, Latin America, and Africa. In 2018, for the first time, the global elderly population surpassed that of children under five, and those aged 80+ are expected to triple from 143 million to 426 million by 2050.

China illustrates the phenomenon of “growing old before getting rich,” completing its aging transition in just 25 years—compared to France's 115. This rapid transformation is especially evident in Henan Province, where the elderly (60+) constituted 18.7% of the population in 2023, exceeding the national average [4]. Henan's aging trend is marked by its scale, speed, and rural-urban inversion, with increasing elderly migration to cities driven by better healthcare access and intergenerational caregiving patterns [5-6]. However, this demographic change is not matched by adequate elderly care infrastructure, which continues

to face issues such as outdated design, uneven resource distribution, and mismatched supply and demand between private and public facilities [7-8].

In response, nursing home design must go beyond basic functionality to address the psychosocial and environmental needs of older adults. A study's “healthy aging” framework outlines three core dimensions: intrinsic capacity, functional ability, and enabling environments [9]. These principles underscore the need for integrated spatial strategies that incorporate sustainability and art-based design to promote well-being [10-12]. This study proposes a conceptual model for nursing home spatial design in Henan, uniting interdisciplinary insights from healthy aging, environmental sustainability, and art integration.

Literature Review

Healthy aging and environmental design

A study outlines a three-dimensional framework for healthy aging, emphasizing intrinsic capacity, functional ability, and enabling environments. In institutional settings, the physical environment

significantly influences these dimensions [9]. Built environments that promote autonomy, mobility, and cognitive stimulation are directly linked to improved physical and emotional well-being [13]. A study stresses how ventilation, daylight, acoustics, and ergonomic layouts support mental and physical health [14]. Another study similarly links features such as walkability and access to green spaces with enhanced subjective well-being. Although focused on children [15]. Lastly, a study shows that environmental autonomy enhances cognitive and emotional development, with similar implications for older adults in constrained settings [16].

Design elements like barrier-free circulation, non-slip flooring, and ergonomic furniture lower fall risks and boost confidence [17-18]. Thermal comfort, lighting, and noise control—elements of the GB 50340-2016 guidelines—promote sleep, circadian balance, and mood regulation [19].

Spatial design for aging populations

Spatial design must support both physical functionality and social engagement. Layouts influence navigation, access to shared areas, and routine interactions [20]. Restorative environmental features—like daylight, greenery, and intuitive circulation—improve well-being in elderly day care centers [21]. A study also emphasizes how indoor air quality, noise, and openness affect residential satisfaction in aged housing [22].

Smaller, modular units (40–60 residents) foster safety and sociability [23]. Shared dining spaces, lounges, and gardens facilitate social contact, while culturally familiar cues enhance memory and emotional grounding [24-25].

Artistic interventions in nursing home environments

Art is a therapeutic, interactive element in healthcare design, rooted in environmental psychology and healing theory [26-27]. Art exposure reduces anxiety, enhances mood, and creates a calming atmosphere [28]. Art therapy further contributes to cognitive and emotional health, especially when embedded within spatial design [29-30]. Healing environments that combine art, natural materials, and culturally resonant visuals promote holistic well-being [31].

Visual art such as murals and culturally familiar images evokes shared memory and identity while reducing stress [32-33]. Sculptures and soundscapes in activity areas provide stimuli for reflection and emotional regulation [34-35]. Participatory art programs, such as communal painting and mural projects, offer elderly residents' opportunities for creativity, agency, and social bonding [36]. These activities mitigate loneliness and foster social ties [37-38], with co-creation of artworks enhancing self-esteem and psychological well-being [39]. Regular engagement in creative activities can protect against cognitive and emotional decline in later life.

Sustainability in elderly care architecture

Sustainable design in elderly care extends beyond environmental conservation, directly influencing health, cost-efficiency, and quality of life. China's 14th Five-Year Plan for Elderly Care prioritizes natural lighting, passive ventilation, thermal insulation, and low-emission materials to address infrastructural disparities and aging demographics [40]. Some researchers argue that aged care design must integrate efficiency, accessibility, and affordability to improve health outcomes [41]. However, researchers note persistent gaps in universal standards [42], while others highlight the growing policy shift toward embedding sustainability in care infrastructure [43].

Green materials and energy-efficient systems reduce pollutant exposure and maintain thermal stability, which is crucial for elderly residents. Natural ventilation and daylight access support circadian regulation, lower respiratory risk, and reduce depressive symptoms [44-45]. Passive solar heating, high-performance insulation, and natural airflow contribute to both environmental performance and emotional comfort, while also lowering operational costs [46]. These strategies also foster inclusive and community-oriented care environments, enhancing social sustainability [47,58]. Adaptive reuse and smart technologies—such as automated lighting and climate systems—further support sustainable, responsive care models in resource-constrained settings like Henan.

Conceptual integration: toward an art-integrated spatial model

The intersection of healthy aging, art, spatial design,

and sustainability necessitates an integrated framework. This study proposes an Art-Integrated Spatial Design model that views art as both therapeutic and participatory, spatial design as enabling autonomy and interaction, and sustainability as foundational to long-term well-being.

Tailored to Henan's socio-demographic landscape, where elderly populations shift rapidly from rural to urban contexts, the model embeds cultural familiarity, healing aesthetics, and environmental performance into care architecture. It reconceptualizes nursing homes as spaces not just for care, but for vitality, dignity, and agency.

Research gap

Despite increasing recognition of aging-supportive environments and the therapeutic and ecological benefits of integrated design, critical gaps remained especially within inland regions such as Henan Province. Existing research on nursing home architecture largely reflects Western models or urbanized coastal practices, with limited attention to the spatial and demographic realities of central China, where elderly rural-to-urban migration and infrastructural disparities necessitate context-specific design solutions. Furthermore, although the psychological benefits of art in elder care are widely acknowledged, few empirical studies have investigated its function as an environmental intervention in institutional settings, nor explored its relationship to spatial cognition, identity, or social interaction through measurable outcomes. In addition, sustainability efforts in elderly care often remain fragmented, prioritizing technical aspects such as energy efficiency or material use while neglecting holistic, user-centered frameworks that integrate environmental performance with resident well-being—an omission particularly acute in under-resourced provinces like Henan.

This study addresses these gaps by proposing an art-integrated spatial design model for healthy aging, rooted in environmental psychology, therapeutic design, and sustainable architecture. The model bridges infrastructure, emotion, and cultural identity, offering both theoretical advancement and context-sensitive design guidance for institutional elder care in Henan.

Research objectives and research questions

1. To examine the current spatial design practices and the specific needs related to healthy aging in nursing homes in Henan Province.
2. To investigate how artistic elements are integrated into nursing home design and their impact on the well-being of elderly residents.
3. To assess the role and effectiveness of sustainable design principles in enhancing the functionality and livability of nursing home environments.
4. In response to the research objectives, the research questions were determined as follows:
5. What are the current spatial design practices and healthy aging needs in nursing homes across Henan Province?
6. In what ways is art integrated into the spatial design of nursing homes, and how does it affect the well-being of elderly residents?
7. How are principles of sustainable development applied in nursing home design, and what is their impact on the living environment?

Methodology

Research design

This study employed a mixed-methods research design to investigate and develop a conceptual model for art-integrated spatial design in nursing homes in Henan Province. Structured in three phases—contextual analysis, case studies with stakeholder interviews and observations, survey, and expert validation—the approach integrates qualitative and quantitative data. This design effectively captures the complex interplay between spatial planning, psychosocial effects of artistic intervention, and sustainable architectural strategies within Henan's unique socio-demographic context.

Sample and sampling selection

This study utilized a multi-group sampling framework to gather diverse perspectives on spatial design, art integration, and well-being in elderly care facilities in Henan Province. A total of 163 participants across six stakeholder groups were

selected using purposive and non-probability sampling, consistent with the study's qualitative and mixed-methods approach. The primary group comprised 120 elderly residents, selected through stratified purposive sampling from urban and peri-urban nursing homes in Zhengzhou, Luoyang, and Xinyang, to assess perceptions of spatial comfort, emotional well-being, and artistic exposure. Additionally, 15 residents were purposively sampled for semi-structured interviews exploring lived experiences.

Institutional perspectives were captured through six administrators (two per site), selected for their roles in facility planning and policy. Six architects/designers were recruited via expert sampling to contribute professional insight into elderly care and art-integrated sustainable design. Eight care staff were selected through convenience sampling to reflect daily operational perspectives, while eight family caregivers were identified through snowball sampling during site visits to explore perceptions of environmental impact on familial well-being.

Data collection methods

This study employed four data collection methods: document analysis, case studies, semi-structured interviews, and survey questionnaires.

Document analysis

Policy documents, planning guidelines, and architectural standards—such as GB 50340-2016 and China's 14th Five-Year Plan for the Elderly Care Service System—were systematically analyzed, alongside design documents from selected nursing homes. This analysis established a baseline for evaluating spatial and regulatory frameworks in relation to national policy goals and best practices in elderly care design.

Case studies

Three nursing homes in Henan Province—urban, peri-urban, public, private, and hybrid models—were selected based on design typology, geographical location, and incorporation of artistic or sustainable features. Data collection included spatial observation using a checklist (lighting, circulation, art integration,

green features), behavioral mapping of resident interaction zones, and photo documentation. This multi-method approach enabled context-specific insight into the relationship between spatial design and resident experience.

Semi-structured interviews

Interviews were conducted with 35 stakeholders: administrators (n=6), elderly residents (n=15), architects/designers (n=6), and caregivers/family members (n=8). The themes included spatial and aesthetic needs, emotional well-being, the impact of art on memory and mood, and the cultural relevance of spatial design. The interviews aimed to uncover experiential and professional perspectives on care environments.

Survey questionnaire

A structured survey was administered to 120 elderly residents to assess emotional well-being, environmental satisfaction, and perceptions of aesthetic and sustainable design. Instruments included the Geriatric Depression Scale (GDS-15), Perceived Environmental Quality Indicators (PEQI), and custom items on art appreciation and sustainability awareness. This mixed-format instrument allowed for statistical analysis of psychological and environmental responses.

Conceptual model development

Based on qualitative interviews, case study observations, and survey data, a provisional conceptual model will be developed to integrate spatial design, art, sustainability, and cultural responsiveness in elderly care settings. Core elements include spatial zoning (e.g., communal art and nature-integrated areas), psychological functions of artistic features (e.g., memory stimulation, mood regulation), sustainable design strategies (e.g., passive ventilation, eco-materials), and culturally attuned aesthetics (e.g., traditional motifs). The model will be validated using the Delphi method through two iterative rounds with five experts in geriatric architecture, environmental psychology, and sustainable design, aiming for consensus on its theoretical and practical relevance for elderly care in central China.

Ethical considerations

This study complies with institutional and national ethical guidelines. Informed consent will be obtained from all participants, ensuring comprehension of the study’s purpose, procedures, and voluntary nature. Anonymity and confidentiality will be rigorously maintained. Given the inclusion of elderly participants, particular care will be taken to minimize physical and emotional burden, with all procedures designed to uphold their dignity, autonomy, and safety.

Trustworthiness and rigor

To ensure methodological rigor, this study employs multiple trustworthiness strategies. Data triangulation integrates policy documents, interviews, surveys, and observations to cross-validate findings. Member checking during interviews enhances interpretive accuracy, while pilot testing of the survey instrument ensures clarity and validity. The conceptual model will undergo expert validation via the Delphi method to confirm its theoretical coherence and practical applicability.

Results

Spatial design for elderly care facilities

This section addresses RQ1: What are the current spatial design practices and healthy aging needs in nursing homes across Henan Province?

Current spatial design practices in nursing homes across Henan Province show considerable disparity, particularly between urban centers and peri-urban or county-level facilities. Many older public institutions still rely on outdated, hospital-like layouts with limited attention to communal areas, aesthetic integration, or environmental stimulation. These conditions fall short of promoting the autonomy, mobility, and social engagement emphasized in the World Health Organization’s healthy aging framework [3].

According to on-site observations and document analysis, only a minority of nursing homes fully comply with the national Design Standard for Residential Buildings for the Elderly (GB 50340-2016). Key recommended elements—such as corridor widths of at least 1.5 meters, non-slip flooring, and accessible bathrooms with emergency call systems—are more commonly found in newer facilities in urban areas like Zhengzhou and Luoyang. However, these standards are inconsistently applied, particularly in resource-constrained or rural settings. In some instances, improvements are selectively implemented based on available funding, resulting in uneven care environments.

The 14th Five-Year Plan for National Economic and Social Development (2021–2025) reinforces the national commitment to modernize elderly care infrastructure. It mandates the expansion of institutional care and emphasizes the development of supportive physical environments. Despite this, field data indicate a persistent gap between policy goals and practical implementation. Interviews with residents and staff reveal common frustrations with overcrowded layouts, lack of privacy, and insufficient space for social or leisure activities.

Healthy aging needs are particularly emphasized among the active aging population (ages 60–75), who express a desire for independence, natural light, access to nature, and emotionally resonant environments. The ongoing rural-to-urban migration of elderly residents further emphasizes the importance of designing culturally responsive and socially inclusive spaces. Findings support the urgent need for a regionally tailored conceptual model that integrates art, spatial functionality, and sustainability to align with both regulatory standards and user expectations.

Building upon the spatial standards and disparities discussed above, this section explores how art integration within those environments influences emotional well-being and social engagement among elderly residents.

Table 1. Key spatial design standards from gb 50340-2016 and their relevance to elderly care environments

Design Element	Standard Requirement	Purpose / Relevance to Elderly Care
Corridor Width	≥ 1.5 meters	Ensures wheelchair accessibility and safe two-way circulation
Door Width	≥ 0.9 meters	Accommodates mobility aids such as walkers or

		wheelchairs
Floor Surface	Non-slip, level	Reduces fall risk and improves navigation safety
Handrail Installation	0.8–0.9 meters, both sides	Provides support for balance and fall prevention
Lighting	Natural and uniform artificial	Enhances visual comfort, reduces disorientation
Sound Environment	≤ 40 dB in resting areas	Supports emotional stability and sleep quality
Bathroom Safety	Anti-slip flooring, grab bars	Reduces injury risk during self-care routines
Emergency Call System	In bedrooms, bathrooms, corridors	Enables rapid emergency response
Thermal Environment	20–26°C	Supports comfort and thermoregulation
Natural Ventilation	Required in windows/layouts	Improves air quality and reduces reliance on HVAC
Activity Space Design	Communal areas required	Supports social interaction and leisure
Cultural Features	Incorporate local aesthetics	Enhances emotional connection and memory recall

Table 1 outlines essential spatial design standards from GB 50340-2016, China’s national guideline for elderly care facilities. These guidelines support elderly residents’ safety, comfort, autonomy, and psychological well-being through thoughtful architectural and interior design.



Figure 1. Elderly care interiors aligned with GB50340-2016 standards, including safe circulation paths, communal areas, and culturally sensitive designs

As illustrated in Figure 1, the spatial design incorporates several key elements outlined in Table 1. The image highlights barrier-free circulation through wide corridors and accessible doorways, non-slip flooring, and proper lighting. Communal areas are evident, promoting social interaction and

emotional comfort. Furniture and finishes reflect local cultural aesthetics, fostering familiarity and identity for elderly residents. By combining functional and psychosocial design standards, these spaces support both the physical safety and emotional well-being of the aging population.

Table 2. Comparative compliance with gb 50340-2016 between older and newer nursing homes in Henan Province

Design Element	Standard Requirement	Older Facilities	Newer Facilities
Corridor Width	≥ 1.5 meters	No	Yes
Door Width	≥ 0.9 meters	Partial	Yes
Floor Surface	Non-slip, level	No	Yes

Handrail Installation	0.8–0.9 meters, both sides	Partial	Yes
Lighting	Natural and uniform artificial	No	Yes
Sound Environment	≤ 40 dB in resting areas	Unknown	Unknown
Bathroom Safety	Anti-slip flooring, grab bars	Partial	Yes
Emergency Call System	In bedrooms, bathrooms, corridors	No	Yes
Thermal Environment	20–26°C	Partial	Yes
Natural Ventilation	Required in windows/layouts	Partial	Yes
Activity Space Design	Communal areas required	No	Yes
Cultural Features	Incorporate local aesthetics	No	Partial

Table 2 highlights disparities in the implementation of spatial design standards in elderly care settings. It compares the observed compliance with GB 50340-2016 in older and newer nursing home facilities in Henan Province. The table shows that newer facilities generally adhere more consistently to safety and comfort standards, while older facilities often lack full compliance, especially in critical areas such as corridor width, lighting, and non-slip flooring.

Interviews conducted with staff and residents provide further insight into these disparities. As one administrator from a peri-urban facility remarked, *“We’re aware of the standards, but retrofitting costs are high, and our funding is limited to essential repairs.”* A caregiver added, *“Older buildings weren’t designed with mobility in mind—some corridors are so narrow we have to assist residents one by one during peak hours.”*

These limitations directly impact the residents' sense of autonomy and security. One 71-year-old resident shared, *“I fell once in the hallway last year because the floor was slippery and there was nothing to hold on to. Since then, I try not to leave my room unless someone walks with me.”*

These accounts reinforce the urgency of policy enforcement and the allocation of targeted resources for retrofitting, particularly in aging facilities that continue to operate without meeting basic design standards for safe and dignified elderly care.

The observed disparities in spatial standards highlight not only gaps in safety and accessibility but also opportunities to enhance psychosocial well-being through the integration of culturally resonant and aesthetically enriching art elements—an area explored in RQ2.

Art integration in nursing home spatial design and its impact on well-being

Building upon the spatial standards discussed earlier, this section explores how the integration of art within those spaces shapes resident well-being in response to RQ2: In what ways is art integrated into the spatial design of nursing homes, and how does it affect the well-being of elderly residents?

Art integration in Henan’s nursing homes is emerging but uneven. A small number of innovative institutions have begun to incorporate murals, sculptures, and traditional motifs into shared areas such as lounges, courtyards, and activity rooms ^[48]. These artistic interventions—often inspired by local cultural heritages such as Tang Sancai patterns, rural Henan landscapes, calligraphy, or Song-style furniture—enhance familiarity and emotional connection, particularly for elderly residents who have migrated from rural areas ^[49-50].

Case study observations across three nursing homes revealed that murals placed in communal zones, especially those depicting familiar cultural scenes, were associated with increased social activity. In one case, a hallway mural of a Henan village scene sparked daily storytelling sessions among residents, reinforcing memory recall and cultural identity. In contrast, facilities with minimal or poorly located artwork recorded fewer

Spontaneous interactions and higher passivity

Behavioral mapping supported these trends. Communal areas with culturally resonant murals showed higher foot traffic and dwell time. For example, a lounge mural of agricultural life became a frequent gathering point for conversation and shared

memories, whereas unadorned corridors or those with generic art saw little engagement.

These findings align with theories in environmental psychology and healing arts, which suggest that visual familiarity, aesthetic stimulation, and emotional resonance in the built environment support cognitive health and interpersonal connection. Murals reflecting local life and values appear particularly effective in reducing isolation and enhancing belonging.

Despite these benefits, most nursing homes lack a systematic framework for art integration. Artistic features are often decorative rather than therapeutic, with limited collaboration between designers, care providers, and artists. Few facilities evaluate the social or psychological impacts of aesthetic elements, resulting in underutilized opportunities for resident engagement.

Observation zone analysis revealed notable differences in resident engagement based on mural placement and environmental context. The lounge mural received the highest score (18/20), with observations indicating consistently high foot traffic and frequent resident discussions centered around cultural symbols depicted in the artwork. In contrast, the corridor mural scored significantly lower (10/20), largely due to poor lighting conditions and the absence of seating, which limited opportunities for residents to pause and engage with the visual content. The courtyard mural achieved a moderate-to-high score (15/20), with particularly strong engagement observed during afternoon hours when natural light enhanced the visibility and ambiance of the space. These findings suggest that mural effectiveness is not only dependent on content but also on placement and environmental support features such as lighting and seating.

Behavioral mapping further emphasized the influence of art placement and contextual relevance on social interaction among elderly residents. The main lounge with a culturally themed mural emerged as the most socially dynamic space, characterized by high foot traffic, storytelling sessions, and strong interpersonal bonding. In contrast, the corridor featuring generic artwork elicited low engagement, as its lack of emotional relevance failed to stimulate meaningful interaction. Similarly, the unadorned

corridor was associated with minimal resident engagement and quick transitions, highlighting the disengaging effect of visually sterile environments. Moderate interaction was observed near the activity room entrance, where a sculpture appeared to attract brief attention and initiate occasional conversations. Meanwhile, the courtyard adorned with a traditional sculpture fostered reflective behavior and informal group gatherings, particularly in the open-air setting. These findings underscore the importance of both artistic content and spatial context in shaping resident behavior and enhancing the social vitality of care environments.

Research in environmental psychology and healing architecture highlights that the placement of murals in communal or transitional areas—such as lounges, corridors, and courtyards—can significantly enhance social interaction among elderly residents. Strategically positioned murals often serve as visual anchors, drawing residents into shared spaces and prompting informal dialogue and spontaneous gathering [51, 28, 52]. In addition, murals that incorporate familiar imagery—such as local landscapes or cultural symbols—support cognitive stimulation and memory recall, encouraging residents to share personal stories and engage in emotionally meaningful exchanges [53, 54, 55]. Murals also contribute to wayfinding and spatial comfort by breaking the monotony of long corridors and creating psychological landmarks that help orient residents within the facility [23]. Importantly, when murals are co-created with residents, they not only reflect personal and collective narratives but also foster a sense of ownership, pride, and ongoing social sharing [56]. These combined effects underscore the therapeutic and relational potential of well-placed, culturally resonant art in aged care environments.

Practical design strategies for mural placement are essential to maximizing their social and psychological impact in elderly care settings. Murals should be installed at eye level in seating zones, where residents are more likely to engage with the artwork during rest or conversation. Positioning murals across from benches or windows further encourages quiet reflection, as natural light and contemplative views amplify the emotional and aesthetic experience. Murals placed near entrances to activity rooms act as visual invitations, drawing attention and prompting curiosity or interaction as residents

transition between spaces. Additionally, integrating artwork into courtyards or garden walls supports outdoor socialization, enhancing the therapeutic potential of nature-based engagement while fostering communal ties in semi-private environments. Thoughtful mural placement, when aligned with behavioral patterns and environmental cues, can meaningfully contribute to both spatial identity and resident well-being.

In sum, intentional art integration, especially when informed by local culture and resident participation, has transformative potential for nursing home design. Beyond decorative value, such integration supports memory, enhances emotional well-being, and fosters social connection. To maximize these benefits, future design efforts should involve cross-disciplinary collaboration from early planning stages and include mechanisms for evaluating the psychosocial impacts of aesthetic choices.

Sustainable development and its impact on elderly living environments

This section addresses RQ3: How are principles of sustainable development applied in nursing home design, and what is their impact on the living environment? The findings highlight both the potential and the limitations of implementing sustainable design in elderly care environments in Henan Province. This analysis draws on case studies, policy reviews, and resident surveys to evaluate outcomes across physical, psychological, and environmental dimensions. The conceptual model underpinning this section integrates three domains—Healthy Aging, Art Integration, and Spatial Design—to frame how sustainable practices contribute to holistic well-being.

Sustainable development principles are inconsistently implemented across nursing homes in Henan. While a few urban facilities have integrated green building strategies—such as passive ventilation, natural lighting, solar energy, and thermal insulation—in alignment with GB 50340-2016 and local directives, these efforts remain sporadic. Where implemented, these features support energy efficiency, indoor air quality, and thermal comfort, all of which positively affect

residents' physical health.

Case studies revealed that newer, privately funded nursing homes with sustainable features—such as natural ventilation, shaded outdoor spaces, and energy-efficient lighting—reported improved comfort and fewer environmental complaints. However, challenges persist. At two sites, solar water heaters and rainwater collection systems were installed but remained non-functional due to lack of maintenance. This illustrates a common limitation: while the 14th Five-Year Plan encourages green infrastructure, translating design intentions into operational outcomes requires staff training, dedicated maintenance budgets, and long-term planning.

Importantly, sustainable features also enhanced emotional and psychosocial outcomes. Garden paths, daylight-filled lounges, and accessible balconies promoted autonomy, relaxation, and mood stability among residents, confirming the holistic benefits of environmental sustainability. Nevertheless, many facilities, especially in non-urban areas, continue to rely on outdated materials and inefficient mechanical systems, leading to higher operational costs and suboptimal indoor conditions. Cost constraints and limited technical expertise are key barriers to adopting renewable energy and water recycling systems more broadly.

Where sustainability is applied effectively, residents report improved noise control, lighting comfort, and spatial orientation. These features support natural circadian rhythms and reduce physiological stress. Residents in sustainably designed homes expressed greater satisfaction with temperature regulation and air quality. However, a critical need remains for integrated decision-making tools that balance initial capital investment with operational savings and resident well-being.

To evaluate subjective outcomes, this study also conducted surveys focusing on emotional well-being (GDS-15) and environmental satisfaction using a Likert scale. These instruments provide insight into how sustainable environments affect everyday experience.

Section 1: Emotional well-being (GDS-15)

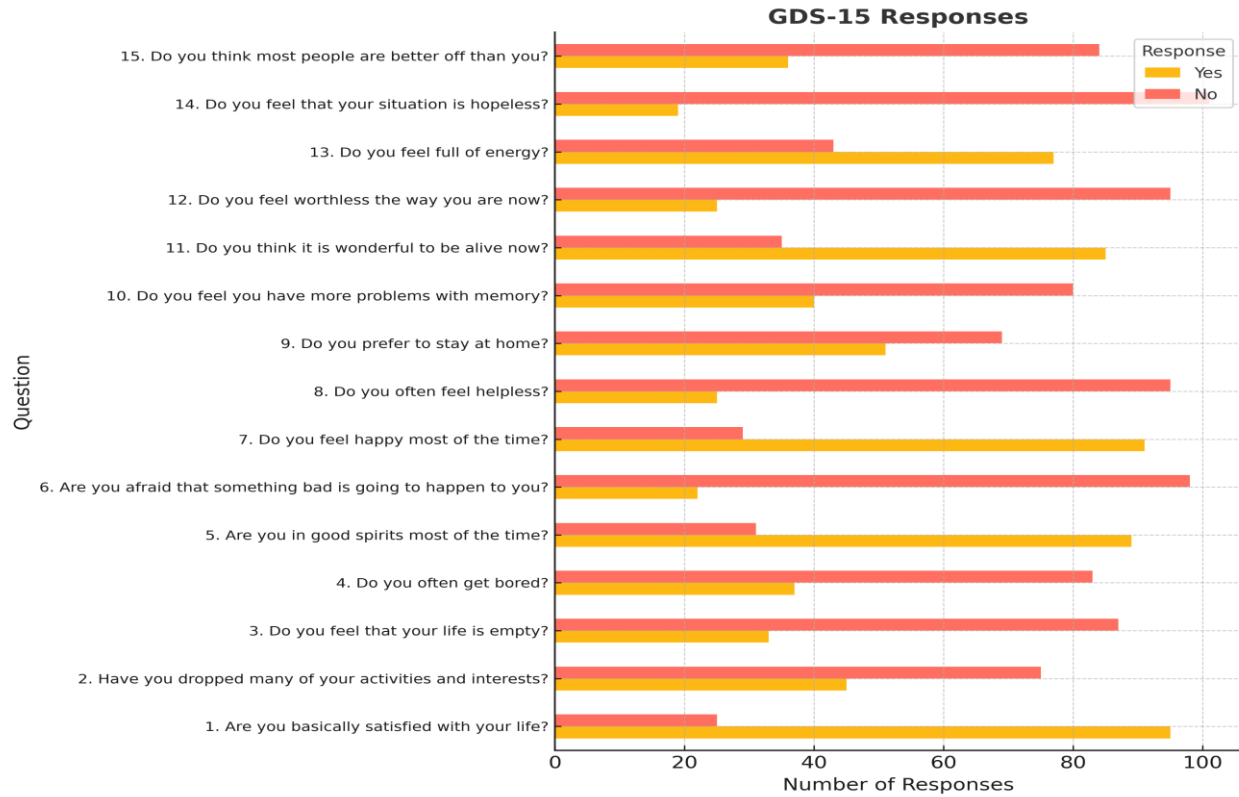


Figure 2. Emotional well-being (GDS-15)

The GDS-15 chart reveals generally positive emotional well-being among elderly residents in sustainably designed nursing homes. High “Yes” responses to positively framed items—such as life satisfaction (95), happiness (91), feeling in good spirits (89), and feeling full of energy (77)—indicate strong emotional resilience. These trends suggest that thoughtfully designed environments that include natural light, accessible green spaces, and thermally comfortable interiors can enhance mood and psychological stability.

Conversely, lower “Yes” responses to negatively framed items—such as feeling hopeless (19), worthless (25), or helpless (22)—reflect a low prevalence of severe depressive symptoms. This supports the notion that sustainable design elements, when properly implemented, contribute to psychological safety and a sense of well-being.

However, some concerns emerged: 51 residents preferred to stay at home, and 45 had dropped many activities and interests, suggesting that while

environmental comfort is strong, social stimulation and mobility opportunities could be further enhanced through programming or spatial redesign. These insights align with the broader conclusion that sustainable design positively influences well-being but requires integration with social and therapeutic interventions for comprehensive support.

Section 2: Environmental satisfaction (Spatial Comfort)

Residents reported generally high satisfaction with environmental conditions, especially air quality, lighting, and feelings of safety. The bar chart below illustrates the mean scores of elderly residents' responses regarding various aspects of environmental satisfaction in nursing homes. Each item was rated on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The results suggest high satisfaction with lighting, air quality, safety, and overall aesthetic experience, while noise levels received comparatively lower ratings.

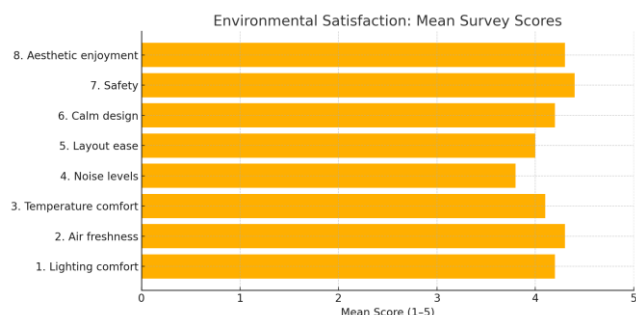


Figure 3. Emotional well-being (GDS-15)

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Highest satisfaction was reported for the statement “I feel safe in the design of the space” (Mean = 4.4), followed by “The air in the room feels fresh and clean” and “I enjoy spending time in this space because of how it looks and feels” (Mean = 4.3 each). Lighting and thermal comfort also scored well (4.2 and 4.1, respectively). However, noise levels received the lowest satisfaction score (Mean = 3.8), indicating an area for targeted improvement.

Overall, sustainable design features such as access to daylight, natural ventilation, and restorative outdoor areas play a critical role in promoting mood regulation, cognitive clarity, and general satisfaction. Nonetheless, sustainability must be accompanied by consistent maintenance and social programming to fully support the aging population's needs.

In summary, while sustainable development principles are unevenly applied across nursing homes in Henan, their thoughtful implementation contributes significantly to environmental quality, emotional well-being, and physical health. The findings underscore the need for integrated strategies that combine green infrastructure, aesthetic quality, and meaningful engagement to ensure aging environments are both supportive and

sustainable.

Conceptual model: healthy aging through art-integrated spatial design

This conceptual model synthesizes findings from RQ1 to RQ3 to demonstrate how spatial design, art integration, and sustainable development collaboratively support healthy aging in nursing home environments. It illustrates the interconnected influence of architectural standards, aesthetic engagement, and environmental strategies on elderly residents' physical, emotional, and social well-being.

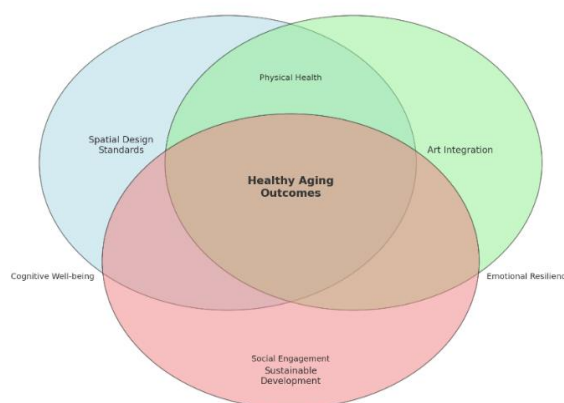


Figure 4. Conceptual model for healthy aging through art-integrated spatial design

This conceptual model integrates three core domains—Spatial Design Standards, Art Integration, and Sustainable Development—to support holistic well-being for elderly residents in nursing homes. Drawing on empirical findings from RQ1–RQ3, the model illustrates how the physical environment, when designed with intentionality, contributes to the key dimensions of healthy aging.

Spatial design standards (RQ1)

Fundamental spatial design features—such as wide corridors (≥ 1.5 meters), non-slip flooring, handrails, accessible bathrooms, and natural lighting—ensure physical safety, mobility, and comfort. These elements reduce fall risk, enhance navigability, and promote autonomy, aligning with national design codes (e.g., GB 50340-2016) and WHO healthy aging principles.

Art Integration (RQ2)

Artistic elements—such as culturally meaningful murals, sculptures, and traditional motifs—create emotionally resonant environments that stimulate memory recall, foster social interaction, and reinforce cultural identity. Artworks placed in communal and transitional spaces transform institutional settings into emotionally nurturing places, encouraging storytelling and social cohesion.

Sustainable development (rq3)

Incorporating sustainability—through passive ventilation, thermal insulation, natural daylight, energy-efficient systems, and access to gardens—improves environmental quality and psychological well-being. These features contribute to mood regulation, energy conservation, and long-term livability, while also reducing operational costs and promoting climate-resilient care infrastructure.

Integrated outcomes: Healthy aging

The synergy of these three domains leads to measurable improvements in:

- **Physical health:** Enhanced mobility, safety, and environmental comfort
- **Cognitive well-being:** Stimulated memory and reduced stress
- **Emotional resilience:** Greater life satisfaction, mood stability, and reduced depressive symptoms
- **Social engagement:** Increased interaction, inclusion, and sense of belonging

Collectively, these components form a regionally responsive and human-centered framework for designing elderly care environments that promote dignity, autonomy, and holistic aging.

Discussion

This study provides new insights into how nursing home environments in Henan Province can support healthy aging through the integration of spatial design, art, and sustainability. The findings confirm and extend previous literature by demonstrating that built environments significantly influence elderly residents' physical, cognitive, emotional, and social

well-being. Three central themes emerge from the data: the uneven application of spatial design standards, the underutilized potential of culturally integrated art, and the sporadic but promising implementation of sustainable development features.

First, spatial design practices across Henan's nursing homes remain inconsistent, particularly between urban and rural or peri-urban contexts. While some newer institutions comply with GB 50340-2016 standards—such as wide corridors, accessible bathrooms, and non-slip surfaces—many older facilities do not. These spatial deficits contribute to reduced mobility, fall risks, and diminished autonomy, highlighting the critical role of environmental design in enabling functional ability. This supports the WHO framework, which emphasizes enabling environments as a pillar of healthy aging [9].

Second, the integration of art within elderly care facilities emerged as a powerful but underleveraged tool. Murals and sculptures reflecting local culture were shown to stimulate memory, foster interpersonal connection, and transform sterile institutional settings into emotionally nurturing environments. Behavioral mapping revealed that mural content and placement significantly affected engagement levels. Murals in well-lit communal spaces encouraged storytelling and social bonding, whereas poorly placed or generic artwork failed to elicit interaction. These findings align with environmental psychology theories, suggesting that familiarity and aesthetic stimulation can mitigate cognitive decline and emotional distress [53-54].

Third, sustainable development strategies showed clear health benefits but varied implementation. Facilities that successfully incorporated passive design elements—such as natural ventilation, thermal insulation, and access to gardens—reported higher levels of resident satisfaction with temperature, lighting, air quality, and general comfort. These findings mirror those of researchers [14, 45, 57], who emphasize the restorative value of green infrastructure. However, the failure to maintain renewable systems at some sites underscores the need for stronger alignment between policy directives and operational capacity.

Importantly, the study shows that the intersection of

spatial, aesthetic, and sustainable elements creates synergistic effects. Nursing homes that combined these features—safe layouts, meaningful art, and eco-friendly strategies—reported the most positive outcomes across physical health, cognitive stimulation, emotional resilience, and social interaction. The proposed conceptual model reflects this integrated approach, offering a replicable framework that aligns with both global aging policies and local cultural contexts.

Despite these contributions, several limitations must be acknowledged. The geographic focus on Henan limits generalizability; longitudinal impacts remain unexplored; and stakeholder perspectives—particularly those of designers and caregivers—are underrepresented. Future studies should adopt a multi-regional, co-creative, and long-term approach to fully assess the transformative potential of art-integrated, sustainable spatial design in aging care environments.

In conclusion, the research underscores the necessity of human-centered design in elderly care. By prioritizing not just safety and efficiency but also emotional and cultural well-being, spatial interventions can redefine aging not as a phase of decline, but as one of dignity, engagement, and continued growth.

Conclusion

This study examined the interrelationship between spatial design, art integration, and sustainable development in nursing homes across Henan Province, aiming to support healthy aging through a multidimensional environmental approach. The findings reveal significant disparities in spatial quality, aesthetic engagement, and sustainability practices between urban and non-urban facilities. While national design codes such as GB 50340-2016 provide clear spatial standards, their inconsistent implementation compromises the safety, autonomy, and comfort of elderly residents, especially in older or underfunded facilities.

Art integration emerged as a powerful, yet underutilized, strategy for enhancing emotional well-being and social engagement. Culturally resonant murals and sculptures in communal zones were shown to stimulate memory, reduce isolation, and

promote interpersonal connection—effects further amplified by thoughtful spatial placement and environmental support.

Sustainable design features, when properly implemented, contributed to improved indoor air quality, thermal comfort, emotional resilience, and life satisfaction. However, the study also highlights operational challenges such as non-functional green infrastructure and limited staff capacity for long-term maintenance.

The resulting Conceptual Model for Healthy Aging through Art-Integrated Spatial Design demonstrates how the convergence of spatial standards, cultural aesthetics, and environmental sustainability fosters holistic well-being—spanning physical health, cognitive stimulation, emotional stability, and social inclusion.

Limitations and suggestions for future research

Despite its valuable contributions, this study faced several limitations related to the integration of art in elderly care environments. First, art was often treated as a secondary design priority, with few nursing homes systematically documenting or evaluating its conceptualization, co-creation, or long-term maintenance. To address this, future research should explore co-creation methodologies where elderly residents collaborate directly with artists and staff. Such participatory approaches may enhance emotional engagement, cultural identity, and personal ownership of space. Second, stakeholder perspectives beyond residents were underexplored, particularly those of designers, family members, and caregiving staff who influence the planning and reception of artistic interventions. As such, multidisciplinary collaboration models involving architects, gerontologists, visual artists, and caregivers should be investigated to ensure holistic and contextually appropriate art integration. Finally, the study lacked longitudinal data on the impact of art installations, leaving the durability of their emotional or social benefits unclear. Longitudinal studies tracking cognitive, psychological, and social outcomes over time would provide stronger evidence of art's sustained role in promoting healthy aging within care environments.

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