

Article

Research on the Aging-Friendly Optimization Path of Elderly Music Intervention from the Perspective of Digital Art Therapy

Yi Jiang^{1,*}, Qingfeng Wu¹ and Ziyang Wei¹

¹ Sichuan Preschool Educators College, Mianyang, China

* Correspondence: Yi Jiang, Sichuan Preschool Educators College, Mianyang, China

Abstract: Against the backdrop of deepening population aging, the elderly population in China generally experiences physical and psychological challenges, including cognitive decline, emotional distress, sleep disorders, and social isolation. Traditional pharmaceutical approaches primarily target physical ailments and often fail to adequately address the psychological counseling and social deprivation issues faced by older adults, while also carrying potential side effects. As a low-cost, non-invasive, non-pharmacological rehabilitation approach, music engagement grounded in digital art therapy demonstrates strong compatibility with the physical and psychological characteristics of older adults, offering the potential to comprehensively enhance their overall well-being. Currently, domestic elderly music programs face prominent challenges such as homogeneous content, insufficient utilization of local cultural resources, limited digital adaptability, and inadequate humanistic care, with no standardized and systematic aging-friendly framework yet established. Employing literature review, case analysis, and inductive reasoning, this study integrates four representative practical cases: traditional Chinese five-element music engagement, community-based intelligent music courses, aging-friendly digital cognitive games, and music companionship services in care institutions. It systematically examines the functional mechanisms of music therapy and existing industry challenges, and constructs an aging-friendly optimization framework for elderly music programs across four dimensions: content, technology, scenario, and service. The findings indicate that the integrated application of localized music resources, lightweight digital tools, hierarchical scenario-based engagement, and humanistic companionship can effectively address industry challenges such as poor adaptability and inconsistent outcomes in elderly music rehabilitation. This study offers practical references for communities, medical facilities, and care institutions to deliver elderly music rehabilitation services, supporting the localized and standardized advancement of elderly art therapy.

Keywords: digital art therapy; music therapy; aging-friendly design; elderly health; optimization path

Received: 18 June 2026

Revised: 10 August 2026

Accepted: 21 August 2026

Published: 25 August 2026



Copyright: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

1.1. Research Background

Actively responding to population aging has become a core development strategy of China [1]. The aging population in China is characterized by a large base, rapid growth, and a high proportion of the oldest-old, making the physical and mental well-being improvement and quality of life enhancement of older adults a key priority in the rehabilitation sector. In the elderly stage, physiological functions undergo progressive degenerative changes, with gradual declines observed across the nervous, endocrine, and immune systems. These biological shifts contribute to common age-related challenges such as reduced cognitive processing speed, diminished attentional control, decreased sleep efficiency, and heightened emotional reactivity. Concurrently, demographic trends indicate a steady rise in the number of older adults living alone or without immediate family support—often referred to as 'empty-nest' elders. Prolonged periods of limited social interaction may lead to subjective feelings of isolation and persistent low mood,

which can significantly influence daily functioning and overall life satisfaction in later years. Such psychosocial dynamics underscore the importance of holistic, person-centered approaches that integrate both somatic and affective dimensions of healthy aging.

Conventional approaches to supporting elder health have historically emphasized pharmacological management and hands-on physical care, primarily targeting chronic organic conditions such as hypertension, diabetes, or osteoarthritis. While effective for symptom control in specific disease contexts, these modalities offer limited capacity to sustain cognitive vitality, foster emotional resilience, or strengthen interpersonal engagement over time. Moreover, extended reliance on medication regimens carries potential risks—including drug interactions, cumulative side effects, and reduced adherence—particularly among older individuals with polypharmacy or declining renal and hepatic function. As a result, there is growing scholarly and practical interest in complementary, non-pharmacological strategies that prioritize safety, ease of integration into daily routines, and alignment with humanistic values of dignity, autonomy, and meaningful participation. Within this evolving landscape, digital-enabled, arts-based modalities are gaining recognition for their capacity to support long-term wellness through accessible, engaging, and culturally resonant experiences [2, 3].

Music-based approaches represent one of the most established and empirically supported non-pharmacological modalities in gerontological practice. Through structured auditory stimulation, music engages multiple neural pathways simultaneously—supporting sensorimotor coordination, memory retrieval, emotional expression, and inter-personal synchrony—thereby aligning closely with the sensory, cognitive, and affective profiles typical of older adults. With the advancement of smart elderly care ecosystems, innovations in artificial intelligence–driven personalization, real-time audio feature extraction, adaptive playback algorithms, and intuitive voice- or gesture-controlled interfaces have expanded the feasibility and scalability of music-based support tools. However, current domestic implementations remain fragmented: high-end devices often incorporate excessive functionality and complex navigation flows that hinder usability for older users with varying levels of digital literacy; conversely, community-level services frequently lack integrated digital infrastructure, relying instead on manual scheduling, paper-based documentation, and inconsistent delivery protocols. This dichotomy results in uneven service quality, limited reproducibility, and barriers to evidence-informed scaling. Grounded in principles of digital art therapy and user-centered design, this study investigates how music-based support systems can be systematically optimized for aging populations in China—accounting for regional variations in care infrastructure, prevailing patterns of technology adoption among older adults, and culturally embedded preferences for musical content, interaction style, and social context [1].

1.2. Research Significance

Theoretically, this study advances interdisciplinary integration by bridging art therapy, gerontological care, and human-centered digital design—fields that have historically operated in relative isolation. It systematically incorporates culturally rooted auditory rehabilitation modalities—including traditional Chinese five-element music theory and regionally diverse folk musical practices—into digitally mediated therapeutic frameworks, thereby enriching the conceptual architecture of music-based support for older adults. This approach directly addresses two persistent limitations in current scholarship: an overreliance on Western clinical paradigms that lack contextual resonance in Chinese sociocultural settings, and a fragmented evidentiary base that seldom accounts for regional diversity, intergenerational knowledge transmission, or embodied listening practices. By centering localization as a methodological priority rather than an afterthought, the research strengthens the epistemological foundations for culturally grounded art-based approaches to healthy aging. Practically, drawing upon empirical observations across multiple real-world contexts—including urban community centers, tertiary hospitals with geriatric departments, and residential long-term care facilities—the

study develops a comprehensive, four-dimensional aging-supportive framework [4]. This framework is calibrated to accommodate variations in physical health, cognitive capacity, sensory acuity, and social engagement patterns among older adults. It offers replicable, context-sensitive implementation pathways for service providers, supporting the standardization, scalability, and equity-oriented refinement of elder care services.

1.3. Research Methods and Innovations

This study employs three complementary research methodologies to ensure methodological rigor and practical relevance. First, a comprehensive literature review is conducted to synthesize existing scholarly work on digital art-based therapeutic approaches, music-supported strategies for older adults, and design principles for aging-in-place environments; this foundational step enables the identification of conceptual frameworks, empirical evidence gaps, and evolving best practices in gerontological support systems [5]. Second, a systematic case analysis is carried out across four carefully selected exemplars—representing clinical rehabilitation settings, community-based lifelong learning programs, commercially deployed digital health platforms, and residential long-term care institutions—to enable cross-contextual comparison of implementation models, resource requirements, user engagement patterns, and sustainability indicators. Third, an iterative inductive-deductive analytical process is applied to distill layered insights: from observed behavioral and experiential data, hierarchical rehabilitation priorities are categorized by functional domain (e.g., cognitive, emotional, sensory-motor), while systemic constraints—including technological accessibility barriers, workforce training deficits, interoperability limitations, and service integration challenges—are mapped to inform actionable, context-sensitive optimization pathways.

The scholarly contributions of this research unfold across two interrelated dimensions. From a disciplinary standpoint, the work bridges theoretical and methodological traditions drawn from digital human-computer interaction, expressive arts-based wellness paradigms, and evidence-informed geropsychology, with particular emphasis on reconciling technological capability with empathic responsiveness in elder-centered service design. Rather than treating technology as a standalone solution, the framework foregrounds relational continuity, cultural resonance, and embodied experience as non-negotiable design imperatives. In terms of substantive contribution, the study moves beyond imported models rooted in Western clinical traditions by co-developing a culturally grounded, physiologically attuned music-supported wellness system—incorporating regional musical motifs, age-appropriate tempo and tonal structures, multisensory feedback mechanisms, and adaptive interface logic tailored to common age-related perceptual and motor changes [6]. This approach not only advances localized knowledge translation but also addresses a critical void in empirically validated, scalable digital music wellness applications specifically designed for China's rapidly aging population and its diverse sociocultural contexts.

1.4. Research Framework

This study adheres rigorously to standardized academic logic and follows a five-stage systematic framework. First, it comprehensively outlines the research background rooted in demographic aging trends, clarifies the theoretical and practical significance of music-based support for older adults, details the methodological approach—including qualitative thematic analysis, comparative case examination, and participatory design principles—and highlights conceptual and procedural innovations [7]. Second, it precisely defines foundational terms such as 'aging-friendly environment', 'music-supported well-being', and 'functional rehabilitation trajectory', while explicating underpinning theories including ecological systems theory, salutogenic health models, and embodied cognition frameworks. Third, it conducts a stratified analysis of rehabilitation needs across physical, cognitive, emotional, and social domains among older adults, and critically examines operational challenges in current music-supported practices—including accessibility barriers, standardization deficits, interdisciplinary

coordination gaps, and sustainability limitations. Fourth, it synthesizes cross-case insights from four empirically grounded implementations in community centers, senior care institutions, outpatient rehabilitation units, and digital platforms. Finally, it proposes a holistic four-dimensional aging-friendly optimization system—encompassing human-centered design, service integration, technological adaptability, and policy alignment—identifies structural bottlenecks in industrial scaling, and advances evidence-informed, long-term strategic recommendations, concluding with methodological reflections, acknowledged constraints, and directions for future transdisciplinary inquiry.

2. Core Concepts and Theoretical Foundation

2.1. Definition of Core Concepts

Digital art therapy represents an innovative, non-pharmacological approach to elderly care that synergistically integrates foundational principles of traditional art therapy with contemporary digital technology. By leveraging lightweight intelligent terminals—such as touch-enabled tablets and voice-responsive devices—and multi-sensory interactive systems—including adaptive audio feedback, haptic vibration cues, and simplified visual interfaces—it reconfigures music-based therapeutic practices into standardized, low-threshold, and widely deployable rehabilitation experiences. This paradigm shift effectively mitigates longstanding constraints associated with conventional delivery models, including geographical accessibility barriers, scheduling inflexibility, and dependence on specialized human facilitators, thereby aligning closely with national strategic goals for intelligent, inclusive, and sustainable elderly care systems. Elderly music engagement constitutes a scientifically grounded rehabilitation methodology explicitly calibrated to the physiological and psychological characteristics of older adults. Distinct from general recreational pursuits, it employs evidence-informed modalities—including structured music listening, group singing, rhythm-based physical coordination exercises, and cognitively scaffolded interactive musical games—to support holistic well-being. Its documented benefits encompass enhanced cognitive processing speed, improved emotional regulation capacity, more restorative sleep patterns, and strengthened interpersonal connection within community settings. Aging-friendly design is systematically informed by empirical understanding of age-related changes in sensory perception, motor coordination, memory retention, and information processing efficiency. Guided by the tripartite imperatives of simplification, human-centered usability, and minimal physical or cognitive load, this design philosophy holistically refines rehabilitation content sequencing, interface architecture of assistive devices, environmental integration of service delivery, and operational workflows—ensuring equitable, dignified, and barrier-free participation for diverse older adult populations [4, 8].

2.2. Theoretical Foundation

This study is grounded in four interrelated theoretical frameworks that collectively inform its design and implementation. First, cognitive aging theory describes age-related changes in neural processing as a gradual, heterogeneous process rather than uniform decline; within this framework, structured auditory stimulation—particularly music with salient melodic, rhythmic, and emotional features—has been observed to enhance neural plasticity, support episodic memory retrieval, and lower perceived cognitive load during training tasks, making it especially appropriate for individuals experiencing mild cognitive impairment. Second, the physical and mental interaction model underscores the bidirectional relationship between physiological regulation and psychological states; music-based approaches can modulate autonomic nervous system activity, influence cortisol and oxytocin secretion, and promote relaxation responses, thereby integrating somatic conditioning with affective support—an approach harmonized with traditional Chinese medicine’s five-element theory of sound–organ correspondence. Third, elderly technology acceptance theory highlights that successful adoption of digital health tools depends not only on interface simplicity but also on alignment with users’ daily routines,

values, and self-efficacy expectations; optimal design requires clear functional boundaries between human agency and technological assistance, ensuring that technology serves as an enabler while preserving dignity, autonomy, and interpersonal continuity [9, 10]. Fourth, the social-emotional needs perspective emphasizes that sustained relational connection and perceived membership in meaningful groups constitute fundamental psychological resources for older adults; group-based musical engagement—such as choral singing or ensemble playing—fosters mutual attunement, shared intentionality, and nonverbal communication, thereby mitigating subjective loneliness and strengthening community integration.

3. User Needs and Existing Pain Points of Elderly Music Intervention

3.1. Hierarchical Core Needs of the Elderly

Drawing upon empirical observations across diverse elderly care settings, the rehabilitation-related requirements associated with music-based approaches can be systematically categorized into three distinct tiers, each aligned with variations in health status, cognitive functioning, and living environment. First, community-dwelling older adults who maintain good physical health and independence primarily seek culturally enriching experiences that foster social cohesion and gentle functional support; accordingly, they respond well to accessible, engaging formats such as group singing of familiar repertoire and basic rhythmic movement activities designed to promote light physical activation and emotional uplift. Second, older adults receiving inpatient care for chronic conditions often experience disrupted sleep patterns and heightened emotional sensitivity alongside reduced stamina, necessitating carefully calibrated auditory stimuli—characterized by slow tempi, predictable harmonic structures, and minimal dynamic contrast—to support physiological regulation and psychological comfort during recovery. Third, residents of long-term care facilities exhibiting early signs of cognitive change frequently encounter challenges including episodic memory fluctuations, diminished motivation for interpersonal engagement, and variable mood states; for this population, digitally enhanced, game-informed music experiences—incorporating synchronized visual, tactile, and auditory feedback—have demonstrated utility in sustaining attentional focus, reinforcing procedural learning, and nurturing affective equilibrium through structured multisensory integration.

3.2. Existing Pain Points of Elderly Music Intervention

Contemporary music-based support practices for older adults in China face several interrelated challenges that hinder their effectiveness and inclusivity. First, content standardization remains excessive, with widespread adoption of imported frameworks that do not sufficiently integrate culturally resonant domestic resources—such as traditional five-element music theory, regionally specific folk melodies, and personally meaningful nostalgic repertoire from key historical periods. This lack of contextual alignment limits emotional engagement and reduces consistency in therapeutic outcomes. Second, digital implementation exhibits pronounced disparity: while high-end intelligent devices often feature overly sophisticated interfaces and redundant functionalities, community-level elder care settings frequently lack even basic digital infrastructure or tailored software solutions. Many existing platforms neglect age-related sensory and cognitive considerations—including visual acuity decline, reduced fine motor control, and variable familiarity with touchscreen navigation—leading to frustration and disengagement. Third, the balance between technological tools and human support is frequently misaligned; an overreliance on automated systems has displaced essential interpersonal elements such as individualized companionship, empathetic listening, and adaptive emotional guidance, thereby compromising depth and sustainability of benefit [11]. Fourth, service delivery models tend toward uniformity rather than stratification, applying identical protocols across diverse populations without accounting for variations in physical health status, cognitive capacity, hearing ability, or prior experience with

digital technologies—ultimately undermining precision, accessibility, and long-term adherence.

4. Analysis of Multi-Scenario Empirical Cases

This study selects four representative practical cases covering clinical medical treatment, community education, digital product research and development, and institutional elderly care to systematically analyze the current practical status and existing shortcomings of digital elderly music engagement. Each case reflects distinct operational logics, resource dependencies, and implementation constraints, offering complementary insights into how music-based approaches can be adapted across diverse service ecosystems serving older adults. The selection prioritizes geographical and functional diversity—spanning urban and suburban contexts, formal healthcare settings, grassroots educational platforms, technology-driven applications, and residential long-term care environments—to ensure findings possess broad relevance for policy design, service innovation, and interdisciplinary practice.

The clinical rehabilitation case is based on empirical research conducted at a provincial-level hospital specializing in integrative medicine, targeting elderly individuals experiencing persistent sleep disturbances. It employs a combined approach integrating traditional Chinese medicine physical therapies with music-based modulation aligned with constitutional patterns and symptom profiles, using curated folk-derived musical selections that correspond to foundational physiological frameworks. Irritating or overstimulating auditory materials are deliberately excluded to maintain therapeutic safety and physiological coherence. A two-week controlled experiment demonstrated that participants receiving the integrated approach exhibited statistically significant improvements in objective and subjective sleep metrics—as measured by standardized sleep diaries and validated psychometric scales—as well as measurable reductions in self-reported psychological tension. These outcomes suggest synergistic benefits across somatic regulation and affective stabilization. While this model demonstrates strong local applicability and reproducible clinical outcomes within supervised medical environments, its implementation requires specialized training in both clinical assessment and music-based pattern recognition, limiting deployment to certified healthcare facilities. Consequently, it remains unsuitable for decentralized, home-based, or community-led delivery without substantial adaptation and workforce upskilling.

The community education case centers on structured music learning programs offered through a publicly supported senior learning center located in an urban district. Leveraging multimodal intelligent tools—including automated lesson planning assistants, AI-assisted audio alignment systems, and adaptive playback interfaces—the program significantly reduces administrative and technical burdens for instructors while enhancing consistency in instructional delivery. This technological scaffolding improves accessibility for novice learners, supports pedagogical standardization, and contributes to enhanced social integration and emotional well-being among participants. Nevertheless, the current repertoire relies predominantly on widely circulated Western therapeutic compositions, with comparatively limited inclusion of regionally resonant nostalgic pieces and indigenous folk traditions that align more closely with the autobiographical memory networks of local older adults. Furthermore, excessive automation in instructional delivery risks diminishing spontaneous interpersonal exchange, shared laughter, and empathetic responsiveness—elements known to reinforce motivation and sustained engagement in lifelong learning contexts. Future iterations would benefit from hybrid models that preserve human facilitation at key relational touchpoints while retaining technological efficiencies for routine tasks.

The digital design case features a mobile application developed specifically for older adults experiencing early-stage cognitive changes, emphasizing usability through aging-informed interface principles such as high-contrast visual elements, voice-guided navigation, simplified gesture controls, and responsive feedback mechanisms. Rather than replicating conventional cognitive drills, the application embeds attentional and

memory tasks within musically structured gameplay—such as rhythmic sequencing, melodic recall, and tempo-matching challenges—thereby increasing intrinsic motivation and reducing perceived effort. Usability testing across multiple age cohorts confirmed high task completion rates, low error frequency, and positive affective responses during interaction. However, longitudinal usage data indicate diminishing returns beyond eight weeks, suggesting that therapeutic sustainability depends not only on interface design but also on deep cultural resonance and evolving musical content libraries. Expanding the repository to include geographically and generationally appropriate musical stimuli—such as regional opera excerpts, era-specific popular songs, and intergenerational lullabies—would strengthen ecological validity and support longer-term adherence.

The institutional elderly care case draws upon regularly scheduled group-based musical activities implemented within a municipally administered residential care facility. Activities include guided singing of widely recognized melodies from earlier decades, call-and-response rhythm games using handheld percussion instruments, and movement-to-music exercises designed to accommodate varying mobility levels. These practices consistently foster spontaneous conversation, mutual encouragement, and shared emotional expression, thereby mitigating feelings of isolation and contributing to improved self-reported life satisfaction scores. The model is operationally economical, requiring minimal equipment and relying primarily on staff initiative and volunteer involvement. However, the absence of documented procedural guidelines, standardized facilitation protocols, and systematic digital archiving of session plans or participant progress limits fidelity, hinders quality assurance, and impedes cross-site replication. Introducing lightweight digital documentation tools—such as templated activity logs and anonymized outcome tracking dashboards—could enhance consistency without compromising the organic, person-centered nature of the interactions.

Comprehensive comparative analysis reveals that each implementation pathway possesses inherent trade-offs between precision, scalability, cultural resonance, technological sophistication, and relational depth. Clinical models prioritize accuracy and evidence-based outcomes but operate within narrow environmental boundaries; community-based intelligent teaching enhances efficiency and reach yet often sacrifices contextual authenticity; digitally mediated applications increase engagement through novelty and interactivity but may underemphasize embodied, intersubjective dimensions of musical experience; and person-led offline activities deliver rich human connection but lack structural support for continuity and expansion. A robust, sustainable framework for supporting healthy aging through music therefore necessitates intentional integration—not merely juxtaposition—of localized musical knowledge systems, accessible and adaptable technologies, tiered implementation pathways calibrated to setting-specific capacities, and embedded human support structures that honor autonomy, dignity, and lived experience. Such integration must be guided by co-design principles involving older adults themselves as active knowledge holders and decision-makers throughout the development and evaluation process [12, 13].

5. Aging-Friendly Optimization Path

Building upon empirical observations of sectoral challenges and insights derived from applied case analyses, this study proposes a comprehensive, four-dimensional framework for aging-friendly optimization—spanning content design, technological implementation, contextual application, and service delivery. Regarding content architecture, a geographically and culturally grounded, tiered music resource repository is systematically developed to align with heterogeneous health and cognitive profiles among older adults. Specifically, five-element-based therapeutic music selections are curated for individuals managing chronic conditions, drawing on traditional integrative health principles; memory-evoking repertoire is prioritized for older adults experiencing mild cognitive decline to support autobiographical recall and affective stability; and regionally resonant folk music is integrated into wellness-oriented programming for cognitively intact seniors, thereby enhancing cultural continuity and participatory

engagement. Technologically, the approach emphasizes lightweight digital adaptation—featuring intuitive interface design, minimized operational steps, and elimination of non-essential functionalities—to reduce cognitive load and improve accessibility. A balanced human-machine collaboration model is instituted: algorithm-driven systems handle routine, standardized tasks such as session scheduling or physiological parameter monitoring, while trained personnel deliver empathetic, context-sensitive support. Within environmental contexts, differentiated strategies are deployed: brief, low-effort musical activities are tailored for domestic settings; community-based programs emphasize inclusive, group-oriented musical participation; clinical environments integrate music with physical rehabilitation protocols; and residential care facilities incorporate music-supported cognitive exercises delivered through interactive, game-informed formats. Service delivery further addresses the inherent limitations of purely digital modalities by embedding sustained interpersonal connection—volunteer-facilitated in-person companionship, individualized coaching, and intentionally preserved opportunities for peer interaction ensure that evidence-informed rehabilitation remains interwoven with relational warmth and social belonging.

6. Development Obstacles and Long-Term Countermeasures

The development of digital elderly music rehabilitation encounters four interrelated systemic challenges: a critical shortage of professionals possessing integrated expertise in both music-based therapeutic approaches and gerontological design principles; pronounced disparities in the distribution of technological infrastructure, professional support, and service accessibility across urban, suburban, and rural regions; the lack of nationally coordinated technical specifications governing service delivery, content adaptation, and outcome assessment; and substantial variation in digital competence among older adults, particularly across age cohorts and educational backgrounds. To address these challenges comprehensively, this study proposes four complementary long-term strategies [3]. First, the compound talent training system must be systematically enhanced through curriculum innovation—integrating interdisciplinary coursework in music rehabilitation science, human-centered aging technology, and inclusive interface design—alongside robust continuing education pathways for frontline practitioners. Second, resource deployment should adopt a tiered, context-sensitive model: high-fidelity intelligent rehabilitation environments may be piloted in metropolitan centers to refine best practices, while simplified, low-barrier, and hardware-light solutions should be prioritized for community health stations and senior activity centers in under-resourced areas. Third, industry-wide standardization efforts are essential to ensure consistency, safety, and comparability—specifically codifying parameters for session structure, adaptive content personalization, and evidence-informed efficacy metrics. Fourth, a dual-track service architecture must be institutionalized, guaranteeing universal access through mandatory offline modalities while offering voluntary, user-empowered digital options—thereby upholding inclusivity for frail, cognitively vulnerable, or digitally inexperienced older adults.

7. Conclusions and Prospects

From the perspective of digital art therapy, this study systematically investigates challenges and pathways for enhancing music-based support for older adults through an integrated approach combining comprehensive literature synthesis with in-depth multi-case comparative analysis. The analytical framework is grounded in four foundational theoretical pillars—namely, traditional Chinese five-element music theory, gerontological aesthetics, embodied cognition in aging, and human-centered technology design. Findings indicate that music selections rooted in culturally resonant frameworks—including compositions aligned with five-element correspondences, carefully curated nostalgic repertoire reflecting formative life periods, and regionally specific folk melodies—demonstrate significantly stronger alignment with the sensory processing

capacities, affective responsiveness, and aesthetic preferences characteristic of older adults in Chinese sociocultural contexts. This alignment contributes meaningfully to improved engagement, sustained attention, and observable psychophysiological regulation during structured musical experiences. Crucially, digital tools function most effectively not as autonomous agents but as precision-enabling platforms: they standardize delivery, ensure fidelity of stimulus parameters (e.g., tempo, spectral balance, dynamic range), and facilitate longitudinal tracking—yet they remain inherently supplementary to empathic, responsive human interaction. Sustained therapeutic benefit emerges only when technological infrastructure is deliberately interwoven with relational continuity, skilled facilitation, and contextual attunement.

The investigation further identifies persistent structural constraints across the ecosystem of music-based support for older adults, crystallizing into four interrelated dimensions: first, content homogeneity—where standardized playlists fail to reflect individual biographical narratives or regional diversity; second, technical adaptation imbalance—manifesting as interfaces or audio systems that overlook age-related perceptual shifts (e.g., high-frequency hearing loss, reduced temporal resolution); third, scenario rigidity—characterized by inflexible application models ill-suited to varied care environments (e.g., community centers, assisted living residences, home-based settings); and fourth, humanistic service gaps—particularly in continuity of relational support, caregiver training, and person-centered goal co-creation. In response, this study proposes a four-dimensional optimization system that operationalizes adaptability, efficacy stability, and scalability simultaneously. Each dimension incorporates modular design principles, interoperable data protocols, and embedded evaluation checkpoints, thereby offering transferable implementation blueprints applicable across heterogeneous elderly care infrastructures. The system supports both localized cultural adaptation and cross-contextual standardization—advancing the maturation of art therapy as an evidence-informed, context-sensitive discipline within gerontological practice.

This research acknowledges several methodological boundaries. As a predominantly qualitative inquiry anchored in detailed case documentation and thematic triangulation, it does not incorporate large-scale randomized controlled trials or extended longitudinal monitoring, limiting generalizability across broader demographic strata and geographic regions. Additionally, while user segmentation accounts for broad age bands and care settings, finer-grained differentiation—such as cognitive subtypes, linguistic backgrounds, or migration histories—remains underdeveloped. Future work should prioritize prospective, multi-site controlled studies incorporating objective biomarkers (e.g., heart rate variability, salivary cortisol), validated behavioral metrics, and participatory outcome mapping. Complementing this, integration of multimodal sensing—including AI-driven vocal prosody analysis, facial micro-expression interpretation, and low-burden wearable physiological monitoring—could enable real-time responsiveness in music selection and pacing. Such capabilities would support the evolution of adaptive, feedback-informed systems capable of dynamically calibrating musical stimuli to shifting affective and physiological states. Ultimately, these advances aim to strengthen the scientific rigor, personal relevance, and systemic integration of digitally supported music-based approaches—contributing concretely to national frameworks promoting healthy aging through culturally grounded, human-centered innovation.

References

1. Y. Jin, W. Cai, L. Chen, Y. Zhang, G. Doherty, and T. Jiang, "Exploring the design of generative AI in supporting music-based reminiscence for older adults," in *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, May 2024, pp. 1–17.
2. K. C. Richards, *The Effect of a Muscle Relaxation, Imagery, and Relaxing Music Intervention and a Back Massage on the Sleep and Psychophysiological Arousal of Elderly Males Hospitalized in the Critical Care Environment*. Austin, TX: The University of Texas at Austin, 1993.

3. J. Y. Li, D. C. Ma, X. Liu, H. Yan, W. J. Wang, Y. X. Xie, et al., "Digital art therapy for emotional well-being in adults with cancer: A scoping review of digital health interventions," *Digital Health*, vol. 12, p. 20552076261435080, 2026.
4. E. Partesotti, A. Peñalba, and J. Manzolli, "Digital instruments and their uses in music therapy," *Nordic Journal of Music Therapy*, vol. 27, no. 5, pp. 399–418, 2018.
5. K. H. Jonassen, "Music Technology Tools—a Therapist-in-a-box? Human–computer Interaction and the Co-creation of Mental Health," in *Voices: A World Forum for Music Therapy*, vol. 21, no. 2, Jul. 2021.
6. M. D. Rucsanda, N. Karácsony, and I. A. Rucsanda, "Theoretical Perspectives of the Application of Digital Technologies in Music Therapy," in *International Conference on Interactive Collaborative Learning*, Sep. 2024, pp. 665–674.
7. M. Viega, K. McFerran, P. Derrington, and S. Saarikallio, "Globalizing adolescence: Digital music cultures and music therapy," in *Handbook of Music, Adolescents, and Wellbeing*, 2019, pp. 217–224.
8. V. Saladino, "Art-based therapy in the digital age: a new form of participation," in *Cinematic Psychotherapy*, London, UK: Routledge, 2023, pp. 69–89.
9. S. Chu, S. Huang, and H. Ten, "Exploring the digital art exhibition experience with immersive music therapy creation as a performance form," in *IET Conference Proceedings CP893*, vol. 2024, no. 22, Oct. 2024, pp. 122–123.
10. O. H. Darewych, N. R. Carlton, and K. W. Farrugie, "Digital technology use in art therapy with adults with developmental disabilities," *Journal on Developmental Disabilities*, vol. 21, no. 2, p. 95, 2015.
11. Y. Li, Y. Liu, R. Yuan, and H. Zhang, "Meditation and music therapy in the era of digitalization: Challenges and future considerations," *J Posthumanism*, vol. 5, no. 5, pp. 4127–4138, 2025.
12. Y. L. Feng, Z. Wang, Y. Yao, H. Li, Y. Diao, Y. Peng, and H. Mi, "Co-designing the collaborative digital musical instruments for group music therapy," in *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, May 2024, pp. 1–18.
13. A. Zubala, N. Kennell, and S. Hackett, "Art therapy in the digital world: an integrative review of current practice and future directions," *Frontiers in Psychology*, vol. 12, p. 595536, 2021.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of Publisher and/or the editor(s). Publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.