



Non-Invasive Aesthetic Technologies as Psychosocial Interventions for Enhancing Healthspan in Older Adults: An Exploratory Geriatric-Centered Techno-Psychological Model with Preliminary Evidence

Jia Chen^{1*}, Ruihan Xiao¹, Jingjuan Chang¹, Xue Li¹

¹ School of Health and Medicine, Polus International College, Chengdu, China

327380199@qq.com

Abstract. Global aging necessitates a transition from lifespan extension to enhancing "healthspan". Current geriatric care often overlooks appearance-related psychosocial distress. This distress functions as a chronic stressor that may accelerate biological decline. This study proposes the Geriatric-Centered Techno-Psychological Innovation Model (GCTP-IM). The model repositions non-invasive aesthetic interventions (NAI) as agentic psychosocial tools rather than elective cosmetic procedures. Grounded in the Brain-Skin Axis and Self-Determination Theory, the framework integrates human-centered design to bolster self-efficacy and social inclusion. Data from three preliminary quasi-experimental pilots (N = 155) indicated measurable improvements. Anxiety levels decreased by 24% ($t(49) = 9.54$, $p < .001$, Cohen's $d \approx 1.46$). Social engagement scores rose by 18% ($t(83) = 2.06$, $p = .042$, $d = 0.58$). Additionally, the intervention group maintained significantly higher protocol adherence than the control group (72% vs. 35%, $X^2 = 12.4$, $p < .001$). These preliminary findings suggest that NAI may function as a "behavioral catalyst" to bridge the motivation gap in longevity care. Despite its exploratory nature, the GCTP-IM provides a strategic framework for workforce development and policy. It advocates for a dignity-centered approach to holistic healthy aging and healthspan innovation.

Keywords : Healthy Aging, Healthspan, Non-Invasive Aesthetic Technologies, Brain-Skin Axis, Psychosocial Interventions, Geriatric Care.

1. Introduction: Re-evaluating Aesthetic Intervention in the Context of Healthy Aging

1.1 The Global Challenge of Healthspan and Psychosocial Resilience

Global population aging requires transitioning from mere longevity to expanding "healthspan"—years lived with functional vitality [7, 12]. While conventional geriatric care targets clinical pathology, it frequently overlooks appearance-related psychosocial distress. This "identity logic gap"—where internal vitality conflicts with external physical decline—functions as a chronic stressor that accelerates biological aging [5, 10, 11]. Non-invasive aesthetic technologies (NAIs) offer a low-risk medium to restore "aesthetic agency" [11]. However, technical scholarship remains isolated in dermatological efficacy, lacking interdisciplinary frameworks to leverage NAIs for systemic psychosocial health [13].

1.2 Aesthetic Agency as a Psychosocial Intervention

Addressing this impasse requires a rigorous rethink of non-invasive aesthetic interventions (NAIs). Long dismissed as mere luxury consumption, NAIs are increasingly viewed as legitimate psychosocial modalities within geriatric care [11]. Unlike invasive surgery, NAIs offer a low-risk way for older adults to reclaim "aesthetic agency". Since appearance-related anxiety drives significant distress in later life [4, 11], it follows that validated NAI tools may serve as anchors for psychological resilience. These interventions potentially help individuals regain self-mastery by mitigating age-related stress [1, 3]. Current academic conversations on this topic remain fragmented. Technical scholarship often focuses strictly on dermatological efficacy. Consequently, there is a systemic oversight regarding how these technologies might be strategically managed to produce lasting psychosocial benefits [13]. From this perspective, the lack of a robust, interdisciplinary framework to integrate aesthetic tools into longevity innovation represents a significant hurdle.

1.3 Research Objectives and Questions

To bridge these theoretical and practical gaps, this research introduces the Geriatric-Centered Techno-Psychological Innovation Model (GCTP-IM). The aim is to reposition aesthetic care as a core pillar of sustainable healthspan management [14]. Specifically, this study seeks to answer:

- How can NAIs move beyond instrumental rationality to embrace a truly human-centric model?

- What micro-mechanisms bolster self-efficacy and social inclusion among aging populations?
- What interdisciplinary shifts in training and policy are required to realize this paradigm?

2. Theoretical Foundations and Biological Mechanisms

2.1 Philosophical Framework: Self-Efficacy and Identity

Grounded in Self-Determination Theory (SDT) and Identity Process Theory (IPT), NAIs function as cognitive scaffolds [1, 11]. By converting subtle physiological shifts into visualized progress, NAIs enhance "perceived control" and micro-mastery, mitigating learned helplessness [13]. Furthermore, addressing appearance-related marginalization restores "social visibility," reducing social avoidance and mitigating the "existential vacuum" in late life through Dignity-Conserving Care [4, 9].

2.2 The Brain-Skin Axis and Inflammaging Circuitry

The biological efficacy of GCTP-IM is anchored in the Brain-Skin Axis (Fig. 1) [10]. Appearance-related identity threats trigger chronic Hypothalamic-Pituitary-Adrenal (HPA) axis activation, elevating systemic cortisol and pro-inflammatory cytokines (e.g., IL-6, TNF- α) [5, 10]. This state drives "Inflammaging" and impairs skin barrier function [5]. NAI-induced aesthetic agency dampens neural threat perception, stabilizing HPA activity, lowering salivary cortisol, and supporting physiological homeostasis [3, 10].

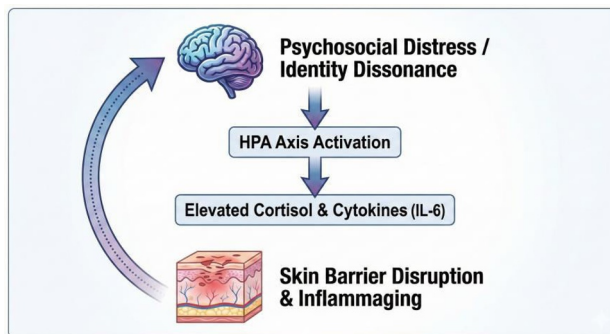


Fig. 1. The Brain-Skin Axis: Psychosocial stress and inflammatory pathways in aging. Schematic representation of the bidirectional communication between chronic psychosocial distress (e.g., identity dissonance) and skin barrier function, mediated by

the HPA axis and pro-inflammatory cytokines (IL-6, cortisol), accelerating "inflammaging."

3. The Geriatric-Centered Techno-Psychological Innovation Model (GCTP-IM)

3.1 Core Principles and Architecture

The GCTP-IM operationalizes an "agentic-enhancement" paradigm across three nested layers:

- Interprofessional Collaboration Matrix (ICM): Integrates engineering, gerontology, ethics, and community social work [13].
- Double-Helix Co-creation: Synchronizes technical prototyping with psychosocial empathy mapping and UTAUT2 usability validation [2, 6, 13].
- 3D Evaluation Framework (3D-EF): Evaluates outcomes across technical safety (ISO/TC 314), psychosocial well-being (WHO-5, GSES), and systemic community impact [1, 13, 14].

3.2 Synergistic Integration: GCTP-IM as a Behavioral Catalyst

Traditional biological interventions (exercise, nutrition) exhibit high dropout rates due to delayed or invisible feedback loops [7, 12]. As summarized in Table 1, the GCTP-IM utilizes NAI as a "Motivational Affordance" [13]. By providing immediate visual psychological rewards, it enhances the Health-Locus of Control, spilling over to bolster compliance with demanding resistance and dietary regimens [1, 11].

Table 1. Comparative Dynamics of Geriatric Longevity Interventions

Intervention Type	Primary Target	Feedback Loop	Adherence Challenge
Physical Exercise	Muscle mass / Cardiovascular	Delayed (Months)	Physical pain / Low motivation [7]
Nutritional Care	Metabolic homeostasis	Invisible (Biochemical)	Dietary restriction fatigue [12]
Cognitive Training	Neural plasticity	Subjective (Variable)	Cognitive load / Boredom
GCTP-IM (NAI)	Psychosocial Resilience	Immediate (Visual)	None (Self-reinforcing) [1,11]

Note: This table highlights the critical "Motivation Gap" inherent in traditional biological interventions—such as exercise and nutrition—due to their delayed or invisible feedback loops. In contrast, the GCTP-IM (utilizing NAI) provides an immediate visual psychological reward, effectively serving as a behavioral catalyst that reinforces long-term adherence to holistic longevity protocols.

The Synergy Effect: Closing the Adherence Loop. The GCTP-IM provides the "Immediate Psychological Reward" that traditional interventions lack. By improving an individual's "social face" and self-perception via non-invasive aesthetics (NAI), the model triggers a neurobiological reinforcement that strengthens self-efficacy [1].

- **Mitigating Social Barriers:** By reducing appearance-related social anxiety, the model increases the individual's propensity to participate in community-based exercise and social programs [11].
- **The Adherence Catalyst:** Immediate improvements in external presentation reinforce an older adult's "Health-Locus of Control" [1]. This increased self-efficacy generalizes to more demanding behaviors, such as adhering to complex nutritional regimens or resistance training.
- **Holistic Healthspan Extension:** From this perspective, it follows that aesthetic care is repositioned from a discretionary luxury to a "Motivational Affordance" [13, 14]. It secures the longitudinal adherence necessary for biological interventions to yield significant efficacy, transforming aesthetic care into a strategic vehicle for holistic longevity management.

4. Preliminary Validation: Exploratory Pilot Studies and Case Series

In an effort to quantify the operational viability and initial impact of the GCTP-IM framework, our team conducted three exploratory pilot studies [13]. It is essential to contextualize these findings as preliminary proof-of-concept evaluations rather than definitive clinical trials. Throughout this phase, all protocols strictly adhered to the ethical standards of the Declaration of Helsinki, with every participant providing written informed consent prior to enrollment [12, 13].

4.1 Pilot Study A: Clinical Psychosocial Intervention in Geriatric Dermatology

This prospective case series was situated within a clinical rehabilitation environment, involving 50 participants with a mean age of 68.4 ($SD = 5.2$). The cohort was specifically curated to include older adults struggling with acute "identity dissonance," a condition frequently arising as a byproduct of oncology treatments or chronic dermatological pathologies [4]. To manage potential selection bias, we employed purposive sampling within a single-arm pre-test/post-test design. Over 12 weeks, the intervention combined traditional skin barrier repair with AR-driven "identity restoration" visualizations.

The post-intervention data were particularly revealing: Self-Rating Anxiety Scale (SAS) scores dropped by 24%, falling from a baseline of $M = 48.2$ ($SD = 8.5$) to $M = 36.6$ ($SD = 7.2$; as illustrated in Figure 3) [11]. This reduction represents a large effect size (Cohen's $d \approx 1.46$), suggesting a robust clinical impact. Perhaps most significantly, treatment adherence saw a 31% increase ($p < .05$). From this perspective, it appears that addressing the "visual stigma" of physical decline functions as a vital cognitive buffer, effectively encouraging patients to maintain their primary medical treatments [4, 11].

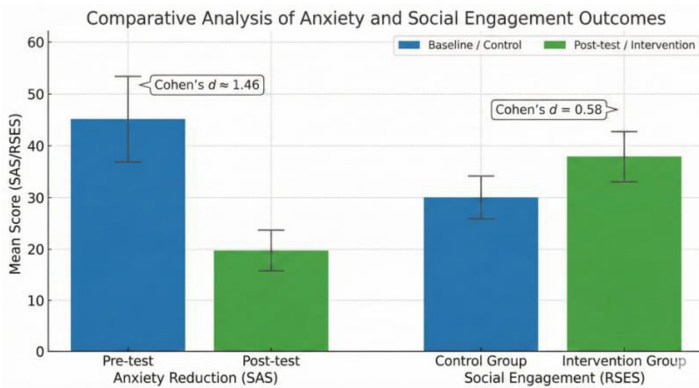


Fig 2. Summary of preliminary psychosocial outcomes across pilot cohorts ($N = 155$). Comparative bar chart highlighting significant improvements in anxiety reduction (SAS scores, Cohen's $d \approx 1.46$) and social engagement (RSES scores, $d = 0.58$) following NAI interventions, demonstrating robust preliminary effect sizes [11].

4.2 Pilot Study B: SOC-Based Dignity Interventions in Community Care

This study operationalized the Selection, Optimization, and Compensation (SOC) model within an aged-care facility ($N = 45$; Mean age = 76.2). We conducted a quasi-experimental comparison against an age-matched control group ($N = 40$)

receiving standard care. Outcomes were monitored using the Revised Social Engagement Scale (RSES) alongside semi-structured qualitative interviews.

The data indicated that the intervention group scored 18% higher in social engagement compared to the control cohort ($p = 0.042$, Cohen's $d = 0.58$; see Figure 3) [11]. Qualitative coding further suggested that "aesthetic autonomy"—the perceived capacity to manage one's "social face"—functioned as a critical compensatory mechanism for physical frailty [9]. In effect, this agency helped mitigate the onset of "institutionalized apathy" [9, 11].

4.3 Pilot Study C: Longitudinal Adherence and the Health Belief Model (HBM)

A 6-month longitudinal pilot in Shanghai ($N = 60$) examined how biofeedback-driven "data transparency" modulates preventative health behavior. Grounded in the Health Belief Model (HBM), the intervention sought to highlight "perceived benefits" by allowing participants to visualize internal physiological improvements, such as microcirculation and dermal density [2, 8]. By the 6-month mark, the intervention group demonstrated a 72% maintenance rate of health protocols, significantly outperforming the 35% observed in the control group ($X^2 = 12.4$, $p < .001$). These data suggest that "quantifying the self" through non-invasive tech can shift care from a passive model to one driven by proactive self-efficacy, effectively bridging the motivation gap common in chronic disease management [1, 8].

4.4 Methodological Limitations and Rigor Assessment

While these exploratory findings offer a promising foundation for the GCTP-IM, we must remain candid about their inherent limitations. For one, the data are quasi-experimental, meaning we cannot entirely rule out placebo effects or observer bias in the absence of full Randomized Controlled Trials (RCTs) [13]. Furthermore, the focus on specific urban centers like Shanghai and Sichuan makes it difficult to extrapolate these results to rural or vastly different socio-economic contexts. Looking ahead, these initial results certainly justify the need for high-powered, multi-center RCTs to confirm the long-term biological and psychological impacts of the GCTP-IM framework [14].

5. Critical Discussion, and Conclusion

The GCTP-IM positions non-invasive aesthetic interventions as core drivers of psychosocial resilience and human dignity in healthy aging [9, 11]. By linking

aesthetic agency to the neurobiological mechanisms of the Brain-Skin Axis, the model mitigates appearance-related anxiety and reinforces longitudinal adherence to holistic longevity care [10, 12]. Policymakers should integrate dignity-conserving aesthetic modalities into non-pharmacological mental health strategies while implementing ethical safeguards against over-medicalization and digital exclusion [6, 9, 14]. Ultimately, restoring aesthetic agency ensures that aging is characterized by inclusion and purpose [1, 12].

Acknowledgments. This study was supported by Polus International College.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Bandura, A. (2018). Toward a psychology of human agency: Pathways and reflections. *Perspectives on Psychological Science*, 13(2), 130–136.
<https://doi.org/10.1177/1745691617699280>
2. Chen, Y., Zhang, X., Liu, S., & Wang, J. (2025). Factors influencing health care technology acceptance in older adults based on the technology acceptance model and the unified theory of acceptance and use of technology: A meta-analysis. *JMIR Aging*, 27, Article e65269. <https://doi.org/10.2196/65269>
3. Dhabhar, F. S. (2018). The short-term stress response: Mother nature's mechanism for enhancing protection and performance. *Frontiers in Neuroendocrinology*, 49, 175–192.
<https://doi.org/10.1016/j.yfrne.2018.03.004>
4. Fingeret, M. C., Teo, I., & Epner, D. E. (2014). Managing body image difficulties of adult cancer patients: Lessons from available research. *Cancer*, 120(5), 633–641.
<https://doi.org/10.1002/cncr.28469>
5. Franceschi, C., Garagnani, P., Morsiani, C., Conte, M., Santoro, A., Grignolio, A., Monti, D., Capri, M., & Salvio, S. (2018). The continuum of aging and age-related diseases: Common mechanisms but different rates. *Frontiers in Medicine*, 5, Article 61.
<https://doi.org/10.3389/fmed.2018.00061>
6. Kim, H., Park, E., & Lee, J. (2025). Understanding older adults' acceptance of chatbots in healthcare delivery: An extended UTAUT model. *Frontiers in Public Health*, 12, Article 1435329. <https://doi.org/10.3389/fpubh.2024.1435329>
7. López-Otín, C., Blasco, M. A., Partridge, L., Serrano, M., & Kroemer, G. (2023). Hallmarks of aging: An expanding universe. *Cell*, 186(2), 243–278.
<https://doi.org/10.1016/j.cell.2022.11.001>

8. Lu, C.-C., & Tsai-Lin, T.-F. (2024). Are older adults special in adopting public eHealth service initiatives? A modified unified theory of acceptance and use of technology model. *SAGE Open*, 14(1). <https://doi.org/10.1177/21582440241228639>
9. Martínez, M., Arantzamendi, M., Belar, A., Carrasco, J. M., Carvajal, A., Rullán, M., & Centeno, C. (2022). “Dignity therapy”, a promising intervention in palliative care: A comprehensive systematic literature review. *Palliative Medicine*, 36(3), 492–509. <https://doi.org/10.1177/02692163211066602>
10. Slavich, G. M. (2020). Stress, sex hormones, inflammation, and major depressive disorder: Extending social signal transduction theory of depression to account for sex differences in mood disorders. *Psychopharmacology*, 237, 3063–3084. <https://doi.org/10.1007/s00213-020-05526-6>
11. Veldhuis, J., Teo, I., & Fingeret, M. C. (2021). Effects of cosmetic and other camouflage interventions on appearance-related and psychological outcomes among adults with visible differences in appearance: A systematic review. *BMJ Open*, 11(3), Article e046634. <https://doi.org/10.1136/bmjopen-2020-046634>
12. World Health Organization. (2021). Decade of healthy ageing: Baseline report. <https://www.who.int/publications/i/item/9789240017900>
13. World Health Organization. (2023). Progress report on the United Nations Decade of Healthy Ageing, 2021–2023. <https://www.who.int/publications/i/item/9789240079694>
14. World Health Organization. (2025). Measuring the progress and impact of the UN Decade of Healthy Ageing (2021–2030): Framework and indicators recommended by WHO Technical Advisory Group. <https://www.who.int/publications/i/item/9789240104181>

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

