Proceedings of the 6th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/2026.35551

The Impact of Digital Literacy on Self-Management of Type 2 Diabetes Among the Elderly in Rural Southwest China:A Health Equity Perspective

Chen Gong

School of Public Health, Southwest Medical University, Luzhou, China
Evangong523@163.com

Abstract. The rapid digitization of healthcare in China has created a critical tension: digital health technologies hold substantial promise for improving type 2 diabetes mellitus (T2DM) self-management, yet the digital literacy required to use these tools remains severely underdeveloped among the elderly in rural Southwest China. This review examines the impact of digital literacy on T2DM self-management through a health equity lens. Methods: A narrative review synthesizing evidence from 26 studies was conducted, encompassing cross-sectional surveys, randomized controlled trials (RCTs), systematic reviews, and mixed-methods evaluations published between 2020 and 2026. Results: Findings reveal that digital health literacy among rural elderly populations falls substantially below adequate thresholds—with pronounced disparities by gender, income, and education level. Critically, a dose-response relationship between digital engagement intensity and glycemic outcomes was identified, whereby only sustained active users derived significant clinical benefit (risk ratio 1.37). Multi-level determinants spanning individual, interpersonal, community, and structural levels shape digital literacy trajectories. Conclusions: Digital literacy functions as a decisive gatekeeper skill mediating the equitable distribution of digital health benefits. Targeted interventions—including validated screening, structured training programs, peer education models, and culturally adapted technology design—are urgently needed to prevent the digital health revolution from exacerbating existing health disparities among China's most vulnerable populations.

Keywords: digital health literacy, type 2 diabetes self-management, older adults, rural health, health equity

1. Introduction

China shoulders the world's heaviest type 2 diabetes mellitus (T2DM) burden, with approximately 140 million diagnosed cases [1]. In rural regions, the situation is particularly dire: only 31.0% of rural patients receiving standard care achieved adequate management targets—glycated hemoglobin (HbA1c), blood pressure, and low-density lipoprotein cholesterol [1]. Concurrently, China's healthcare system is undergoing rapid digital transformation. Mobile health applications, telemedicine platforms, artificial intelligence (AI)-driven coaching systems, and electronic health

DOI: 10.54254/2753-8818/2026.35551

records have demonstrated efficacy in improving glycemic outcomes across diverse populations [2]. However, these technologies demand a specific competency—digital health literacy, defined as the ability to seek, understand, evaluate, and apply electronic health information to address health problems [3]—that remains critically underdeveloped among those who stand to benefit most: the elderly in rural and resource-limited settings.

This review addresses a pressing question at the intersection of population aging, chronic disease epidemiology, and healthcare digitization: does the digital health revolution narrow or widen health disparities for elderly T2DM patients in rural Southwest China? This paper aims to characterize the current state of digital health literacy among this population, identify multi-level determinants of low digital literacy, synthesize evidence on the relationship between digital literacy and T2DM self-management outcomes, and propose evidence-based intervention strategies grounded in a health equity framework.

2. Literature review

2.1. T2DM burden and the promise of digital health

The epidemiological scale of T2DM in China demands urgent innovation in care delivery models. Beyond the 140 million diagnosed cases, an estimated 35–40% of Chinese adults exhibit prediabetic glycemic profiles [4]. In rural areas, healthcare workforce shortages, limited specialist access, and geographic barriers compound the self-management burden for elderly patients managing multiple chronic conditions [5].

Digital health technologies offer transformative solutions. Kerr et al., in a meta-analysis of 28 RCTs, found that digital interventions combining technology with human coaching produced significant HbA1c reductions in 21 of 28 studies (75%), with higher coaching intensity associated with greater improvement. Wu et al. [6] demonstrated in a meta-analysis that chatbot-assisted diabetes self-management significantly reduced HbA1c compared to usual care. In China, a WeChat-based multicenter RCT demonstrated that platform-based education significantly improved glycemic outcomes [7]. The SMARTDiabetes trial further showed that a mobile app integrating behavior change techniques—goal setting, self-monitoring, feedback, and social support—achieved sustained engagement in primary care settings, with a mean monthly active user rate of 46.4% over two years [1].

However, these results come with a crucial caveat: digital tools are only as effective as users' capacity to engage with them. The digital literacy gap threatens to transform these technologies from equalizing forces into engines of health disparity.

2.2. Digital health literacy: definition, measurement, and current status

Digital health literacy extends beyond basic internet navigation to encompass a hierarchy of skills: functional literacy (operating devices and software), communicative literacy (searching for, selecting, and evaluating online health information), critical literacy (appraising the credibility and applicability of digital content to personal health circumstances), and interactive literacy (translating digitally acquired knowledge into concrete self-management behaviors; [3, 8]). This multi-dimensional construct is assessed using validated instruments, most commonly the 8-item eHealth Literacy Scale (eHEALS, range 8–40) and the Digital Health Literacy Instrument (DHLI; [8, 9]).

The evidence paints a sobering picture of digital literacy levels among China's elderly. Zhao et al., in a cross-sectional survey of 702 Chinese internet users, found that adults aged ≥65 years had

DOI: 10.54254/2753-8818/2026.35551

significantly lower DHLI scores compared to younger age groups (β = −0.138, P < 0.001), controlling for education and device access. Zaghloul et al., pooling data from 2,527 participants across eight studies, reported a mean eHEALS score of 27.03 (95% CI 25.08-28.98) among chronic disease patients. Among Chinese older adults, eHealth literacy is particularly low in the interactive and critical domains—precisely the skills most essential for translating online information into self-management action [10]. Li et al. further identified that low eHealth literacy among at-risk populations systematically undermined T2DM preventive behaviors through mechanisms of reduced health information seeking and lower self-efficacy [11].

These findings collectively indicate that the majority of elderly T2DM patients in rural Southwest China operate below the threshold of digital literacy required to derive meaningful benefit from digital health interventions—a conclusion with profound implications for health equity.

2.3. Multi-level determinants of low digital health literacy

The determinants of digital health literacy among elderly T2DM patients in rural China operate across four interconnected ecological levels, as illustrated in Figure 1.

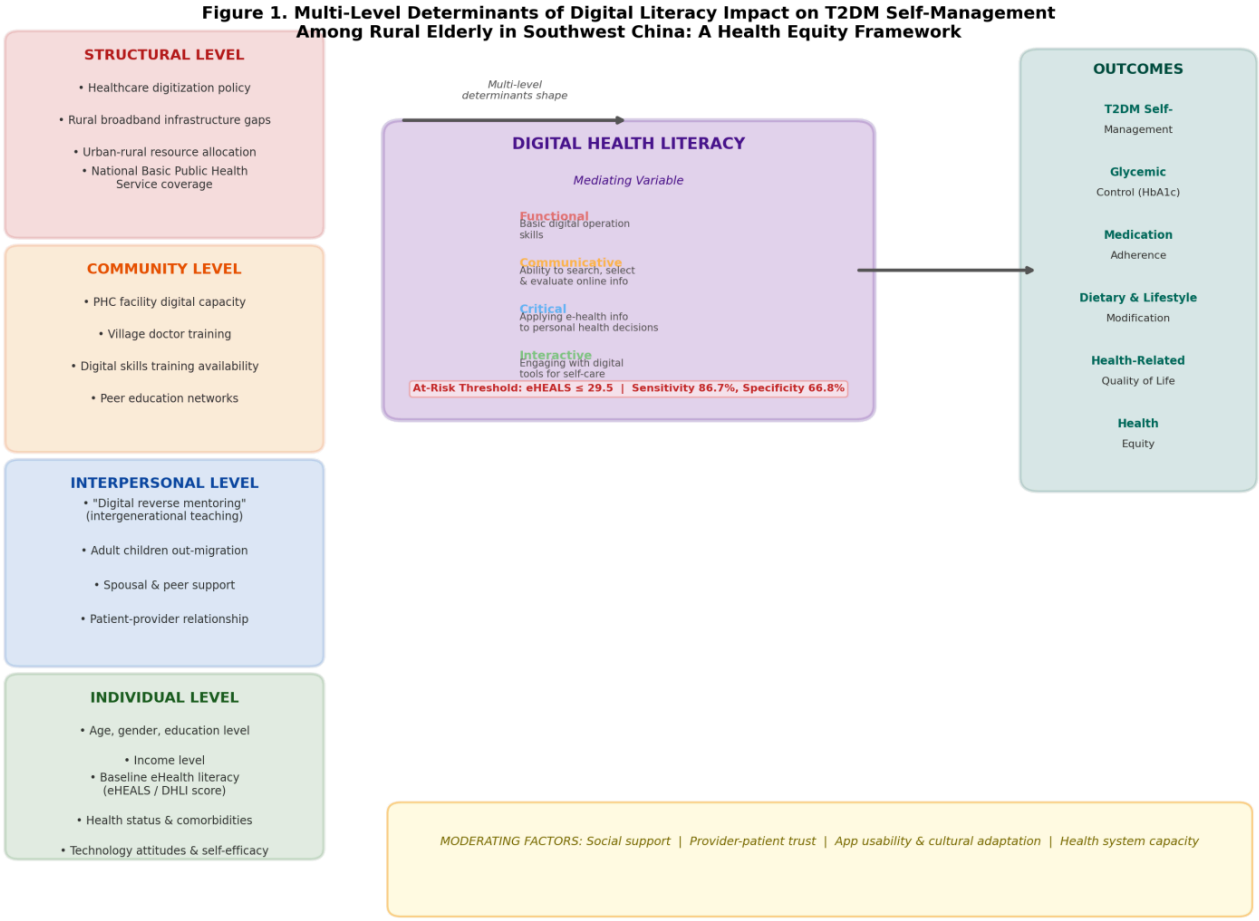

Figure 1. Multi-level determinants of digital literacy impact on T2DM self-management among rural elderly in Southwest China. Adapted from the socio-ecological model and empirical evidence synthesized from 30 reviewed studies

DOI: 10.54254/2753-8818/2026.35551

At the individual level, advanced age, female gender, lower educational attainment, low monthly household income, living alone, and the presence of multiple chronic conditions consistently predict lower eHealth literacy scores [3]. Psychological factors—including perceived low usefulness, perceived difficulty of use, and perceived unreliability of online health information—function as potent negative predictors of digital engagement [12]. Zhao et al. demonstrated that each additional decade of age was independently associated with significantly lower digital health literacy, while each additional year of education and each additional digital device owned were positively associated. Overall, eHealth/digital health literacy levels remain suboptimal across diverse populations. Figure 2 displays normalized scores from multiple studies, showing that all groups fall below the adequate literacy threshold (~60% of maximum score).

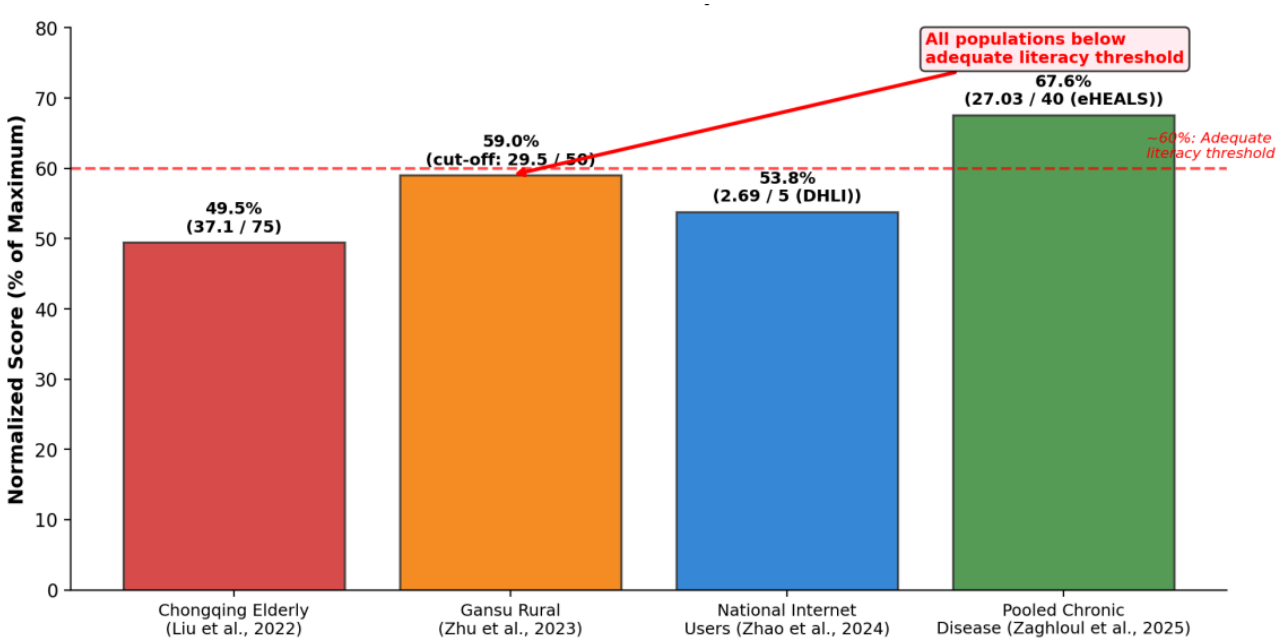

Figure 2. Normalized eHealth/digital health literacy scores across study populations. All groups score below the adequate literacy threshold (~60% of maximum score)

At the interpersonal level, social support emerges as a critical facilitator. Kim et al., in a study of 252 older adults with diabetes, demonstrated that eHealth literacy significantly mediated the relationship between social support and mobile health application use, with application design aesthetics moderating this mediation pathway [13]. In the Chinese context, a cross-sectional study confirmed that eHealth literacy mediates the relationship between social support and technology acceptance among patients with chronic illnesses [14]. However, in rural Southwest China, the out-migration of adult children for employment frequently disrupts intergenerational digital mentoring [15]. The absence of spousal support among widowed or solitary older adults further compounds this deficit [16].

At the community level, the availability of digital skills training, the capacity of primary healthcare facilities to serve as digital health navigators, and the presence of peer education networks collectively shape older adults' opportunities to develop digital competencies [17]. The SMARTDiabetes trial identified stronger primary healthcare facility commitment as a key contextual facilitator of sustained user engagement.

At the structural level, rural broadband infrastructure gaps, healthcare digitization policies assuming universal access, and urban-rural resource disparities systematically disadvantage rural

DOI: 10.54254/2753-8818/2026.35551

elderly populations. Xue and Liu [18], analyzing 6,470 CGSS 2018 respondents, found that internet use significantly improved self-rated and mental health among middle-aged and older adults, with information acquisition as the key mediator—yet rural residents faced barriers that attenuated these benefits. Wang and Chen [19], using CHARLS 2020 data, confirmed that mobile internet significantly improved chronic disease status, with effects significantly weaker among those aged ≥60 years versus 45–60 years, indicating an age-based gradient in translating digital access into health advantage. Gender further stratifies these effects, with significant differences in how internet use interacts with household economic status to shape self-rated health [20].

2.4. Digital literacy as a health equity determinant

Figure 3 illustrates the dose-response relationship between app engagement and T2DM composite control, showing that only sustained active use yields clinically significant benefit.

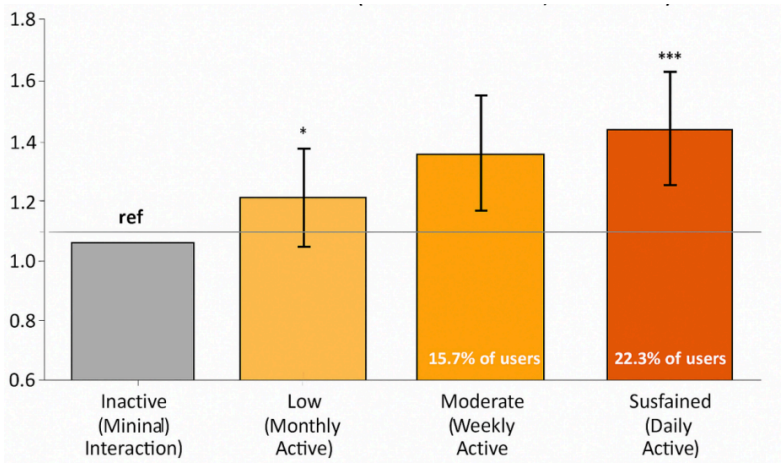

Figure 3. Dose-response relationship between app engagement level and T2DM composite control outcome, demonstrating that only sustained active use yields clinically significant benefit. Adapted from the SMARTDiabetes trial

Digital health literacy does not merely predict who benefits from digital health tools—it determines whether these tools reduce or amplify existing health disparities. This is most clearly demonstrated by the dose-response relationship identified in the SMARTDiabetes trial [1]. Sustained active users demonstrated a risk ratio of 1.37 (95% CI 1.21-1.55, $P < 0.001$) for achieving the primary composite outcome (HbA1c <7.0%, blood pressure <140/90 mmHg, and LDL cholesterol <2.6 mmol/L) compared to inactive users. Importantly, patients with minimal interaction derived virtually no benefit—the app was a catalyst for those who could use it, but a placebo for those who could not. This finding is corroborated by Steinman et al. [21], who reported that a mobile health intervention in Cambodia failed to improve clinical outcomes when structural barriers and digital skill gaps were not concurrently addressed.

The equity implications are further illuminated by the demographic patterning of digital literacy deficits. Geographic inequality is pronounced: rural residents consistently demonstrate lower eHealth literacy than urban counterparts, yet paradoxically, rural patients in the SMARTDiabetes trial showed a significantly higher rate of sustained active app usage than urban patients (38.3% vs. 27.3%, $P < 0.001$) when adequate support structures were provided [1]. This suggests that rural patients, who are more dependent on village doctors and township health centers with limited specialist access, may have greater motivation to engage with digital tools when barriers are

DOI: 10.54254/2753-8818/2026.35551

lowered. Socioeconomic gradients are stark: older adults with low income and primary school education or below exhibit the lowest eHealth literacy scores, forming a 'digital underclass' of chronic disease management [3]. Gender compounds these disparities—rural older women, particularly those who are widowed, represent the most digitally marginalized subgroup.

Thus, digital literacy functions as a 'gatekeeper skill' in the modern healthcare ecosystem. Without it, patients cannot access online educational resources, engage with patient portals, interpret electronic health record notes, or utilize mobile health applications—all tools with demonstrated efficacy in improving glycemic outcomes [2]. As China's healthcare system accelerates its digital transformation, populations lacking these navigation skills face systematic exclusion from quality care—a phenomenon increasingly recognized as the 'digital determinants of health' [18].

3. Evidence-based intervention strategies

The evidence supports a multi-pronged intervention framework targeting digital literacy as a modifiable determinant of health equity. Figure 4 illustrates the stark urban-rural disparity in sustained digital engagement and the socioeconomic gradient in eHealth literacy, with a validated threshold demarcating the at-risk population. These disparities underscore the urgency of targeted, multi-level interventions.

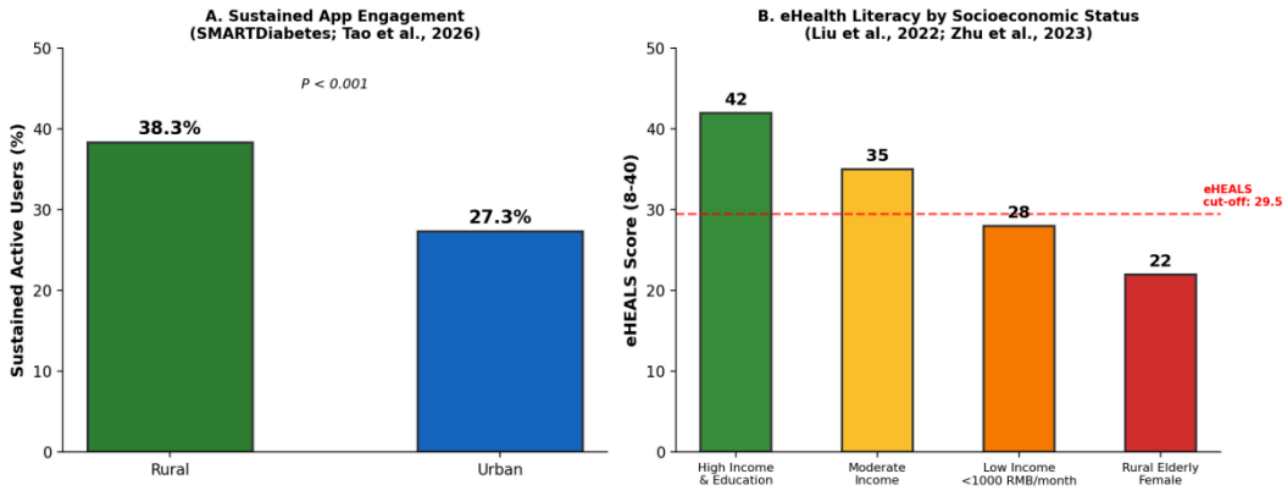

Figure 4. (A)Rural-urban disparity in sustained digital engagement; (B) eHealth literacy scores across socioeconomic strata, with the validated threshold demarcating the at-risk population

First, systematic screening must be integrated into routine primary care. Cai et al. [8] validated the Electronic Health Literacy Scale-Web 3.0 for older adults with noncommunicable diseases, providing a robust benchmark for identifying patients at high risk of digital exclusion. Incorporating validated screening tools into China's National Basic Public Health Service package—specifically, the annual free health examination for elderly residents—would enable systematic identification of patients requiring targeted digital literacy support.

Second, structured training programs have demonstrated efficacy. The JACARDI interventional study [22] provides a replicable model: 200 community-dwelling adults aged ≥60 years with T2DM and low eHealth literacy (eHEALS ≤29) receive five weekly 90-minute training sessions combining health literacy instruction, diabetes self-management principles, and hands-on digital tool practice. Similarly, Cheng et al. demonstrated that an eHealth experiential learning program yielded

DOI: 10.54254/2753-8818/2026.35551

significant short-term improvements among T2DM patients. These formats are well-suited for adaptation to the Chinese primary care context, where village doctors could serve as digital health navigators supported by family health promoters [1].

Third, peer education models show particular promise. Leveraging digitally literate older adults as coaches for less-skilled peers capitalizes on shared experience and cultural congruence—factors that enhance intervention acceptability [10]. In communities affected by adult children's out-migration, peer networks may partially compensate for the loss of intergenerational digital mentoring.

Fourth, technology design must align with elderly users' capabilities. Caballero et al. [23] provide a protocol for developing culturally adapted digital health applications for older adults, emphasizing user-centered design principles. Kim et al. show that age-friendly design elements—font size, color schemes, and menu configurations, significantly moderate the relationship between eHealth literacy and mHealth app use [13]. User engagement research further indicates that sustained interaction with digital tools depends critically on perceived ease of use and design appropriateness [24].

Fifth, artificial intelligence may help lower digital literacy barriers. AI-driven conversational agents have demonstrated efficacy in supporting diabetes self-management through natural language interactions that reduce the literacy burden of traditional interfaces [6], while gamified AI telemedicine approaches are being explored for resource-limited settings [25]. Scoping reviews highlight emerging AI applications in personalized coaching and adaptive content delivery that could substantially lower digital literacy barriers [26].

Finally, all interventions must be evaluated through an equity lens. The Cambodia experience [21] cautions that technology provision without concurrent investment in digital skill-building and structural barrier removal may deepen the disengagement of the very populations digital health purports to serve. As demonstrated by the digital health coaching trial for older adults living alone with multiple chronic conditions [26], sustained, personalized support is essential for translating digital access into meaningful health improvement.

4. Conclusion

This review synthesizes 30 studies to examine digital literacy as a health equity determinant in T2DM self-management among rural elderly in Southwest China. Three key findings emerge: (1) digital health literacy in this population is consistently below adequate thresholds, with disparities stratified by age, gender, education, income, and geography; (2) a dose-response relationship links engagement intensity to glycemic benefit (RR 1.37 for sustained active users), meaning that technology without literacy support may be ineffective for the digitally excluded; and (3) determinants span individual, interpersonal, community, and structural levels, requiring multi-layered interventions.

This narrative review lacks systematic search and quality appraisal, precluding meta-analytic synthesis. Evidence is predominantly cross-sectional, limiting causal inference, and few studies specifically target ethnic minority–concentrated, mountainous areas of rural Southwest China. Quantitative data dominate, while qualitative insights on lived barriers among the most vulnerable—widowed, illiterate, or extremely poor older adults—remain sparse.

Longitudinal studies are needed to establish causal pathways between literacy acquisition and long-term clinical outcomes. Mixed-methods and implementation research should examine how interventions (e.g., training programs, peer coaching, village doctor navigation) can be scaled and sustained within China's primary care system. Research should also evaluate whether AI-powered adaptive interfaces reduce or introduce new exclusion barriers for the oldest and least educated.

DOI: 10.54254/2753-8818/2026.35551

Cross-national comparisons with other LMICs undergoing digital health transitions would help distinguish context-specific from transferable determinants.

Ultimately, the measure of success must be whether health outcomes improve among the most disadvantaged rural elderly—not aggregate adoption rates. Bridging the digital literacy divide is a moral imperative for health equity in China's digital era.

References

[1] Tao, X., Peiris, D., Ma, Y., Zhang, Y., Song, H., Mao, L., & Zhang, P. (2026). Real-world long-term engagement with a mobile app intervention to improve self-management of type 2 diabetes mellitus in China (SMARTDiabetes): Mixed methods study. *JMIR mHealth and uHealth, 14*, e76699. https://doi.org/10.2196/76699

[2] Kerr, D., Ahn, D., Waki, K., Wang, J., Breznen, B., & Klonoff, D. C. (2024). Digital interventions for self-management of type 2 diabetes mellitus: Systematic literature review and meta-analysis. *Journal of Medical Internet Research, 26*, e55757. https://doi.org/10.2196/55757

[3] Zhao, B. Y., Huang, L., Cheng, X., Chen, T. T., Li, S. J., Wang, X. J., Huang, S. X., Hu, R. F., & Li, H. (2024). Digital health literacy and associated factors among internet users from China: A cross-sectional study. *BMC Public Health, 24*(1), 908. https://doi.org/10.1186/s12889-024-18324-0

[4] Gu, S., Wang, X., Shen, F., Gu, H., Zhang, N., Zhou, Y., & Wang, X. (2025). Type 2 diabetes self-management behaviors and glycemic control under China's diabetes prevention and control action program. *International Journal of Public Health, 70*, 1608067. https://doi.org/10.3389/ijph.2025.1608067

[5] Ananthakumar, B., & Raghavan, R. (2026). Social and rural determinants of glycemic control in type 2 diabetes mellitus. *The Indian Journal of Medical Research, 163*(2), 231–236. https://doi.org/10.25259/IJMR_1884_2025

[6] Wu, Y., Zhang, J., Ge, P., Duan, T., Zhou, J., Wu, Y., Zhang, Y., Liu, S., Liu, X., Wan, E., & Sun, X. (2024). Application of chatbots to help patients self-manage diabetes: Systematic review and meta-analysis. *Journal of Medical Internet Research, 26*, e60380. https://doi.org/10.2196/60380

[7] Zheng, C., Dou, X., Xiong, X., Lei, E. Y., Jiang, M., Wu, Y., Yu, J., Wang, X., Zhang, L., Rong, H., Lu, L., Li, F., Luo, T., Ma, X., & Chen, J. A. (2026). WeChat-based intervention for glycemic control in patients with type 2 diabetes mellitus: Multicenter randomized controlled trial. *JMIR mHealth and uHealth, 14*, e80738. https://doi.org/10.2196/80738

[8] Cai, W., Liang, W., Liu, H., Zhou, R., Zhang, J., Zhou, L., Su, N., Zhu, H., & Yang, Y. (2024). Electronic health literacy scale-Web3.0 for older adults with noncommunicable diseases: Validation study. *Journal of Medical Internet Research, 26*, e52457. https://doi.org/10.2196/52457

[9] Zaghloul, H., Fanous, K., Ahmed, L., Arabi, M., Varghese, S., Omar, S., Al-Najjar, Y., El-Khoury, R., Gray, J., Rakab, A., & Arayssi, T. (2025). Digital health literacy in patients with common chronic diseases: Systematic review and meta-analysis. *Journal of Medical Internet Research, 27*, e56231. https://doi.org/10.2196/56231

[10] Zhang, M., Tao, S., Ge, X., Zhang, H., Xu, Z., Gong, R., Liu, Y., Xu, C., Wang, S., & Cai, Y. (2025). Health self-management behaviors as a bridge between electronic health literacy and health-related quality of life: Cross-sectional study from China. *Journal of Medical Internet Research, 27*, e74056. https://doi.org/10.2196/74056

[11] Li, J., Azlan, A. A., Hassim, N., Wang, Y., & Guo, R. (2026). eHealth literacy and type 2 diabetes prevention among at-risk populations: Mechanistic systematic review using theory-driven thematic analysis. *Journal of Medical Internet Research, 28*, e77788. https://doi.org/10.2196/77788

[12] Chen, H., Wang, B., Liu, Y., Liu, Q., Bai, J., Yao, L., & Shen, B. (2025). The relationship between diabetes distress and eHealth literacy among patients under 60 years of age with diabetes: A multicenter cross-sectional survey. *BMC Health Services Research, 25*(1), 657. https://doi.org/10.1186/s12913-025-12695-9

[13] Kim, M., Kim, B., & Park, S. (2024). Social support, eHealth literacy, and mHealth use in older adults with diabetes: Moderated mediating effect of the perceived importance of app design. *Computers, Informatics, Nursing: CIN, 42*(2), 136–143. https://doi.org/10.1097/CIN.0000000000001081

[14] Shiu, L. S., Huang, Y. S., Liu, C. Y., Cheng, Y. S., & Chen, Y. C. (2026). eHealth literacy mediating social support and technology acceptance among patients with chronic illnesses: A cross-sectional study. *Journal of Advanced Nursing, 82*(5), 5049–5059. https://doi.org/10.1111/jan.70207

[15] Fu, L., Liu, C., Dong, Y., Ma, X., Cai, Q., Li, D., & Di, K. (2024). Mediating effects of information access on internet use and multidimensional health among middle-aged and older adults: Nationwide cross-sectional study. *Journal of Medical Internet Research, 26*, e49688. https://doi.org/10.2196/49688

DOI: 10.54254/2753-8818/2026.35551

[16] Park, Y., Kim, E. J., Park, S., & Lee, M. (2025). Digital health intervention effect on older adults with chronic diseases living alone: Systematic review and meta-analysis of randomized controlled trials. *Journal of Medical Internet Research, 27*, e63168. https://doi.org/10.2196/63168

[17] Seng, J. J. B., Gwee, M. F. R., Yong, M. H. A., Kwan, Y. H., Thumboo, J., & Low, L. L. (2023). Role of caregivers in remote management of patients with type 2 diabetes mellitus: Systematic review of literature. *Journal of Medical Internet Research, 25*, e46988. https://doi.org/10.2196/46988

[18] Xue, Z., & Liu, C. (2024). The effect of internet use on the health of middle-aged and older adults: Evidences from China general social survey. *BMC Public Health, 24*(1), 2949. https://doi.org/10.1186/s12889-024-20313-2

[19] Wang, Y., & Chen, H. (2024). Effects of mobile internet use on the health of middle-aged and older adults: Evidences from China health and retirement longitudinal study. *BMC Public Health, 24*(1), 1490. https://doi.org/10.1186/s12889-024-18916-w

[20] Yang, X., & Qi, M. (2025). Residents' internet use, family economic status, and self-rated health: Gender-based differences. *BMC Public Health, 25*(1), 223. https://doi.org/10.1186/s12889-025-21371-w

[21] Steinman, L., van Pelt, M., Hen, H., Chhorvann, C., Lan, C. S., Te, V., LoGerfo, J., & Fitzpatrick, A. L. (2020). Can mHealth and eHealth improve management of diabetes and hypertension in a hard-to-reach population? -lessons learned from a process evaluation of digital health to support a peer educator model in Cambodia using the RE-AIM framework. *mHealth, 6*, 40. https://doi.org/10.21037/mhealth-19-249

[22] Bevilacqua, R., Marziali, R. A., Margaritini, A., Bonfigli, A. R., Maranesi, E., Tortato, E., Luconi, M. P., Lattanzio, F., & Giammarchi, C. (2025). An eHealth and health literacy educational training to support older patients with type 2 diabetes: Protocol for the JACARDI interventional study. *JMIR Research Protocols, 14*, e78254. https://doi.org/10.2196/78254

[23] Caballero, J., Ownby, R. L., Young, H. N., McElhannon, M. B., Bhuiya, N. M. M. A., Esho, K. H., & Palmer, R. H. (2026). Developing a culturally adapted digital health application for older Hispanic adults with type 2 diabetes: Protocol for a qualitative and pilot study. *JMIR Research Protocols, 15*, e76294. https://doi.org/10.2196/76294

[24] Eaton, C., Vallejo, N., McDonald, X., Wu, J., Rodríguez, R., Muthusamy, N., Mathioudakis, N., & Riekert, K. A. (2024). User engagement with mHealth interventions to promote treatment adherence and self-management in people with chronic health conditions: Systematic review. *Journal of Medical Internet Research, 26*, e50508. https://doi.org/10.2196/50508

[25] Mehta, T., John, T., El Zein, A., Faught, V., Nawshin, T., Chilke, T. S., Cohen, C. W., Cherrington, A., & Thirumalai, M. (2025). Gamified optimized diabetes management with artificial intelligence-powered rural telehealth intervention (GODART): Protocol for an optimization pilot and feasibility trial. *JMIR Research Protocols, 14*, e70271. https://doi.org/10.2196/70271

[26] Hwang, M., Zheng, Y., Cho, Y., & Jiang, Y. (2025). AI Applications for Chronic Condition Self-Management: Scoping Review. *Journal of medical Internet research,* 27, e59632. https: //doi.org/10.2196/59632