Original Paper

Factors Influencing Older Adults' Sustained Engagement in Digital Psychological Interventions in Resource-Limited Settings: Qualitative Study Guided by the Social Ecological Model

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Abstract

Background: Digital behavioral activation therapy (DBAT) is effective in reducing late-life depression (LLD). However, older adults in resource-limited settings often show low adherence and retention. This pattern is largely driven by the digital divide. Digital inclusion offers a pathway to address this gap by recognizing older adults as active participants rather than passive recipients. Despite this potential, limited research has examined low engagement from the perspective of older adults' lived experiences. This gap restricts understanding of the complex factors that shape engagement in digital psychological interventions.

Objective: This study aimed to systematically explore, through the lens of digital inclusion and guided by the social ecological model, the multilevel factors influencing older adults' sustained engagement in digital psychological interventions within resource-limited settings, specifically focusing on the lived experiences of retained users who completed the full program.

Methods: A descriptive phenomenological design was used. Semistructured interviews were conducted with older adults in Western Hunan, China. Data were transcribed using machine-assisted methods and verified manually. Data were analyzed using the Colaizzi phenomenological method combined with thematic and framework analysis guided by the social ecological model. Two researchers independently coded the data and refined themes through discussion.

Results: Nineteen older adults with LLD from resource-limited settings were included. Engagement in DBAT was shaped by factors across multiple levels. At the individual level, factors included health needs, learning motivation, physiological and cognitive limitations, and low digital literacy. At the interpersonal level, factors included intergenerational support, emotional burden, established social networks, and digital exclusion. At the society level, available devices and networks sometimes hindered engagement due to poor age-friendly design and unstable connectivity. Personal aspirations for digital participation often conflicted with social resistance. At the policy level, financial burden, standardized policy approaches, and unmet individual needs limited engagement. These factors interacted to influence engagement behavior.

Conclusions: This study identifies multilevel factors shaping older adults' sustained engagement in digital psychological interventions within resource-limited settings, reflecting the experiences of retained users. The findings advocate for integrated, context-sensitive strategies grounded in a digital inclusion framework. Crucially, nurses play a key role in promoting technology access, improving digital literacy, supporting social participation, and advocating for equitable services. These efforts can enhance accessibility and adherence, ultimately fostering more equitable and sustainable digital mental health care for vulnerable aging populations.

Trial Registration: Chinese Clinical Trial Registry ChiCTR2400091193; https://tinyurl.com/y5e6wt7p

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(JMIR Aging 2026;9:e84350) doi: 10.2196/84350

KEYWORDS

older adults; digital inclusion; social ecological model; resource-limited settings; digital divide; late-life depression; behavioral activation; mobile phone

Introduction

Background

The rapid growth of the aging population has made mental health in later life a major global public health concern [1]. The World Health Organization (WHO) projects that by 2050 the number of people aged 60 years and older will reach 2.1 billion, with a large proportion living in resource-limited settings such as low-income countries, rural areas, and remote regions [2]. Depression is one of the most common mental health conditions in this population, with an estimated prevalence of 31.8% [3]. The burden is even greater in resource-limited settings [4]. Late-life depression (LLD) is strongly associated with poor health outcomes, cognitive decline, reduced quality of life [5], and increased risk of suicide [6]. It also places a substantial burden on families, communities, and health systems. However, these settings often face severe shortages of mental health professionals, unequal distribution of health resources, and limited access to psychological care. These constraints make timely and effective management of depression difficult [7].

The rapid development of digital health technologies offers new opportunities to address these service gaps [1,8]. Digital psychological interventions, including digital behavioral activation therapy (DBAT), have shown effectiveness comparable to face-to-face treatments in reducing depressive symptoms. They also offer advantages such as lower cost, greater flexibility, and improved accessibility [9-11]. Behavioral activation (BA) was first introduced by Ferster in 1973 [12]. It is an evidence-based approach that promotes engagement in meaningful activities to increase positive reinforcement and improve mood [13,14]. This study selected BA for digital delivery because its structure is simple and suitable for self-guided use [10]. It requires limited clinical resources and has demonstrated effectiveness for LLD [11]. Compared with other digital therapies, its action-oriented design fits well with the daily routines and capacities of older adults in underserved settings. Recent advances in digital delivery have further expanded its reach beyond geographic and service barriers, making it a promising option for this population. Despite these advantages, the full potential of digital mental health interventions has not yet been realized. A key barrier is the digital divide.

The digital divide includes more than unequal access to technology. It also involves limited digital literacy, low motivation to use technology, inadequate infrastructure, financial constraints, and lack of intergenerational support [8,15,16]. Older adults in resource-limited settings are particularly affected [17]. This divide contributes to low engagement in digital psychological interventions, even though engagement is essential for both effectiveness and efficient use of resources [18]. Most existing studies have focused on feasibility and clinical outcomes. They often rely on basic indicators such as adherence and retention rates. For example, a study in Hong Kong reported retention rates of 54.8% at 1 month and 49.9% at 3 months after the intervention [19]. A randomized controlled trial in Brazil found an attrition rate of 19.4% at 5 months, which eliminated differences between treatment groups [10]. These findings suggest that although digital psychological interventions are effective in theory, their real-world impact is limited by low engagement. This leads to underuse of already scarce health resources [18,20].

While the digital divide literature traditionally emphasizes a deficit model focused on lacking access and technical skills, this study uses the digital inclusion framework to shift the analytic focus toward agency, relational dynamics, and equitable participation [21-23]. Rather than viewing nonuse simply as a technical failure to be corrected, the digital inclusion lens allows us to examine how older adults actively negotiate meaning, manage emotional burdens, and navigate structural constraints to sustain their engagement. This framework moves beyond merely cataloging material barriers, providing a critical lens to understand the complex psychosocial processes required to achieve meaningful digital citizenship in resource-limited settings. However, the lived experiences of navigating these processes remain underexplored from the perspective of older adults themselves. In resource-limited settings, there is a lack of theory-driven qualitative research that explains the psychological, experiential, and contextual factors shaping engagement in digital interventions. This gap limits the development of targeted and sustainable strategies.

To address this gap, this study used the social ecological model as a guiding framework. The social ecological model is particularly suitable for this context, as it posits that health behaviors are shaped by the interplay of individual, interpersonal, societal, and policy factors, which aligns directly with the multilevel nature of the digital divide and the concept of digital inclusion [24,25]. In the context of digital interventions, it provides a structured way to examine digital inclusion as a complex and multidimensional process. It considers individual capacity, interpersonal support, societal resources, and policy environments. In resource-limited settings, these levels are closely interconnected and jointly influence engagement in digital care.

Research Aim

This study used a descriptive phenomenological approach to explore the lived experiences of older adults participating in DBAT. The aim was to identify and understand the multilevel factors that influence sustained engagement among retained users, guided by the social ecological model and the concept of digital inclusion. By focusing on the lived experiences of older adults, this study moves beyond a descriptive inventory of structural barriers to advance the conceptual understanding of digital inclusion. Specifically, it refines the social ecological

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model by conceptualizing digital engagement as a dynamic process of navigating cross-level paradoxical tensions, such as the conflict between macropolicy pushes and microsocial resistance, and the simultaneous empowering and burdening effects of intergenerational support. Highlighting these psychosocial interactions offers a deeper, theory-informed basis for improving digital mental health interventions. The goal is to support interventions that are more inclusive, context-sensitive, and person-centered rather than to evaluate a specific implementation strategy. For nursing practice, these insights can guide improvements in intervention design, enhance accessibility, and support sustained engagement. More broadly, this study contributes both theoretical and practical evidence to inform digital health strategies in the context of population aging. It supports efforts to promote health equity and aligns with the goal of achieving accessible digital health services for all. Ultimately, it aims to improve mental health and well-being among older adults in resource-limited settings.

Methods

Overview

This study adopted a qualitative design grounded in a descriptive phenomenological approach [26]. The aim was to explore factors that influence older adults' engagement with DBAT in resource-limited settings from their own perspectives. This approach focuses on understanding lived experience while minimizing researcher assumptions. Semistructured interviews were conducted to capture participants' perceptions, emotional responses, and cognitive experiences during their engagement with digital mental health programs. This approach allowed the identification of barriers and facilitators related to technology access, interface use, and understanding of intervention content. Phenomenology was well suited to examine complex psychosocial processes, including perceived difficulty with technology, management of anxiety related to digital use, and gradual adaptation with support from family and social networks. The study followed the COREQ (Consolidated Criteria for Reporting Qualitative Research) to ensure transparency and rigor [27]. An initial interview guide was developed based on a literature review and refined through pilot interviews. All research staff completed standardized training before data collection. Inclusion and exclusion criteria were clearly defined. Before each interview, participants were informed about the study purpose and procedures, and consent for audio recording was obtained. All interviews were transcribed verbatim and coded for analysis. The analysis combined thematic analysis with framework analysis. Thematic analysis identified key patterns and meanings in participants' experiences. Framework analysis, guided by the social ecological model, organized findings across 4 levels, including individual, interpersonal, society, and policy. This approach preserved participants' lived experiences while linking them to a structured theoretical framework.

Intervention Program

The intervention was a DBAT program delivered through a digital platform and supported by research nurses trained in geriatric psychological care. The platform was designed to meet the needs of older adults in resource-limited settings, with features such as large text, voice prompts, multimedia content, and low data requirements. The program included mood and activity monitoring, identification of pleasant activities, individualized goal setting, gradual engagement in meaningful activities, and strategies to reduce avoidance and negative behaviors [13,14]. Each session lasted 45 to 60 minutes and was conducted once per week for 8 weeks. Participants accessed the program through a mobile-friendly website and completed weekly modules independently. These modules included educational videos, monitoring tools, and interactive exercises. During weekly sessions, research nurses guided participants through the content, explained instructions, demonstrated navigation, and reviewed progress. Outside these sessions, participants used the platform independently. Technical support was available through phone or text message when needed. The intervention therefore combined self-guided digital learning with structured human support. All sessions were delivered by trained research nurses with experience in geriatric psychological care.

Setting

This study was conducted at Xiangxi Autonomous Prefecture People's Hospital in Hunan Province, China, which stands as the sole Grade III Class A hospital in Western Hunan. The region is economically underdeveloped and has a high proportion of older adults, accounting for 19.88% (472,419/2,376,353) of the population. Mental health services in this area are limited and fall below the provincial average, making it a typical resource-limited setting [28].

Participants and Recruitment

Participants were recruited from the intervention group of a larger clinical trial evaluating the DBAT program. All individuals who met the eligibility criteria for this qualitative study were invited to participate. Purposive sampling was used to achieve variation in age, gender, education, and income. Participants were approached directly by research nurses involved in the intervention. All invited participants agreed to take part. Sample size was determined by data saturation. Data collection and analysis were conducted concurrently. After 16 interviews, no new themes emerged. Three additional interviews confirmed saturation, resulting in a final sample of 19 participants. All participants had completed the full 8-week intervention before the interviews. Their accounts therefore reflect the full engagement process from initial participation to completion.

Participants were eligible if they were aged 60 years or older, had lived in the region for at least two years, had mild to moderate depressive symptoms defined by a score of 5 to 11 on the Geriatric Depression Scale with 15 items (GDS-15), could communicate in basic Mandarin, and were able to use a smartphone independently. Some participants used a family member's device to access the program. Participants were excluded if they had severe physical illness that limited participation, major cognitive or psychiatric disorders, or severe visual or hearing impairments that interfered with digital use.

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Data Collection

Data were collected through one-on-one semistructured interviews that explored factors influencing engagement in DBAT across multiple levels. The interview guide was informed by prior literature, field experience, and the social ecological model. It covered individual, interpersonal, society, and policy domains [24,25]. Pilot interviews were conducted to refine the guide (see Textbox 1 for interview outline).

Textbox 1. Interview outline.

Individual level

- Could you share what motivated you to begin engaging in the digital behavioral activation therapy (DBAT) program?
- During your engagement in DBAT, what aspects of the process have been most challenging for you? How do you usually manage or adapt to these challenges?

Interpersonal level

- Are your family members, friends, or partner aware of your engagement in DBAT? In what ways, if any, have they provided support?
- When you need assistance from people around you, how do you usually seek help? How does this influence your willingness to continue engaging in DBAT?

Society level

- How common is it for older adults in your community to engage in similar online psychological health services?
- How would you describe the overall attitude in your community toward older adults using online psychological health services?

Policy level

- Are you aware of any policies or community initiatives that have supported or promoted similar online psychological health services?
- If this type of program were to continue in the future, what additional forms of support would make it easier for you to engage?

All interviews were conducted by the first author, a female graduate student trained in qualitative research and geriatric psychology. Interviews took place in a private office to ensure comfort and confidentiality. Written informed consent was obtained before each interview. Each interview lasted between 30 and 60 minutes. A research assistant recorded nonverbal observations. A local health care worker assisted with translation when regional dialects were used. After each interview, the research team recorded reflective notes. Audio recordings were transcribed within 24 hours and checked by 2 researchers for accuracy. When needed, participants were contacted to clarify unclear statements. Field notes and reflective journals were also transcribed. Data collection continued until saturation was reached [29].

Analysis

Data were analyzed using the Colaizzi phenomenological method combined with thematic and framework analysis [30,31]. The social ecological model guided the overall analytical process. To explicitly distinguish between inductive findings and theoretical interpretation, a 3-stage analytical process was used. First, initial themes reflecting participants' raw lived experiences emerged inductively through open coding. Second, these empirically derived themes were systematically organized within the predefined individual, interpersonal, society, and policy levels of the social ecological model framework. Third, rather than treating these categories as isolated silos, the research team conducted a broader theoretical interpretation to identify how these themes dynamically interacted across ecological levels. Constant comparison was used to refine this cross-level thematic structure. Data management was supported by NVivo 12, and final themes were established through team consensus.

Rigor

Trustworthiness was ensured using the criteria of credibility, transferability, dependability, and confirmability [32]. Purposeful sampling and data saturation supported the adequacy of the sample. Detailed transcripts, field notes, and reflective journals preserved contextual depth. Two researchers independently coded the data, and differences were resolved through discussion. The research process was documented in detail to allow transparency and potential replication.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the Third Xiangya Hospital, Central South University (Approval No.K24901; October 18, 2024). Written informed consent was obtained from all participants. They were informed about the study purpose, procedures, and potential risks. The study followed the principles of the Declaration of Helsinki and prioritized participants' psychological well-being. A brief mental health check was conducted before each interview. If distress occurred, interviews were paused, and supportive communication was provided. Participants who needed additional support were referred to local counseling services or community resources. At the end of the study, all participants received information on available mental health resources to support their continued well-being.

Results

Participant Characteristics

A total of 19 older adults from resource-limited settings participated in the interviews. The sample included 10 men and 9 women. Most participants were younger than 80 years.

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Educational attainment was generally low, with most participants having a primary school education or less. The majority were married, while a small number were unmarried, divorced, or widowed. Monthly income (MI) levels were low across the sample. Most participants reported having at least one physical illness, and about three-quarters were covered by basic health insurance (HI). Detailed demographic information is presented in Table 1.

Table 1. Participant characteristics.

ID	Gender	Age (years)	Education	MS[a]	MI[b]	PD[c]	HI[d]
01	Female	64	Junior high school	Married	1000-3000	Yes	Yes
02	Female	72	Junior high school	Married	＞5000	Yes	Yes
03	Female	78	Senior high school	Married	＞5000	Yes	Yes
04	Male	61	Above senior high school	Married	＞5000	Yes	Yes
05	Female	82	Primary school or below	Divorced	1000-3000	Yes	No
06	Male	65	Primary school or below	Married	＜1000	Yes	Yes
07	Male	74	Primary school or below	Married	3000-5000	Yes	Yes
08	Male	60	Primary school or below	Single	＜1000	Yes	No
09	Male	79	Above senior high school	Married	＞5000	Yes	Yes
10	Female	60	Primary school or below	Married	1000-3000	No	Yes
11	Female	73	Primary school or below	Married	＜1000	Yes	Yes
12	Male	75	Primary school or below	Married	＜1000	Yes	No
13	Male	78	Primary school or below	Widowed	1000-3000	Yes	Yes
14	Male	64	Primary school or below	Single	1000-3000	Yes	Yes
15	Male	67	Junior high school	Married	1000-3000	Yes	No
16	Male	66	Primary school or below	Married	3000-5000	No	Yes
17	Female	79	Primary school or below	Married	1000-3000	Yes	Yes
18	Female	83	Primary school or below	Married	1000-3000	Yes	Yes
19	Female	72	Junior high school	Married	1000-3000	No	No

[a]MS: marital status.

[b]MI: monthly income (CNY). A currency exchange rate of CNY 1 = US $0.15 was applicable.

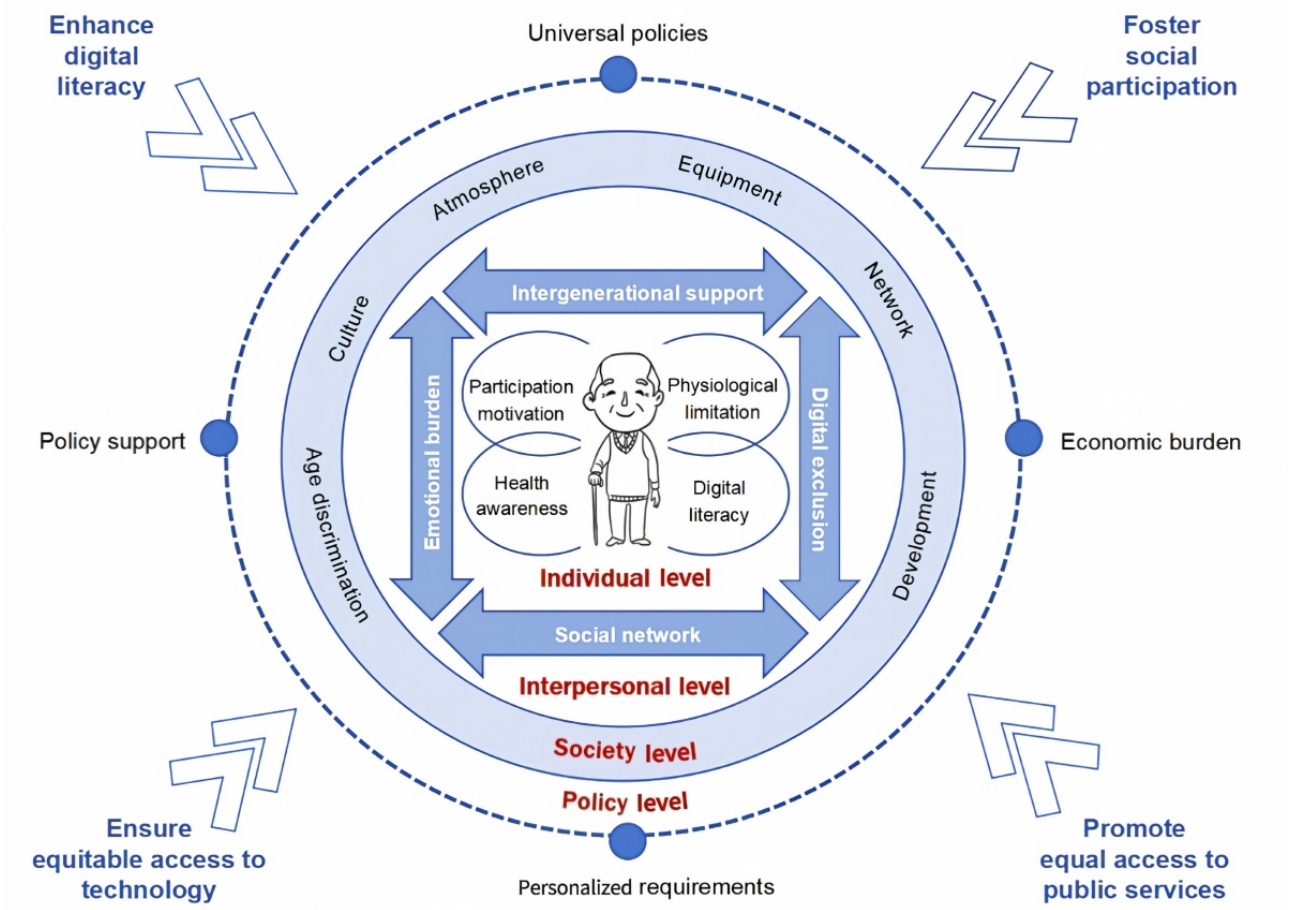
[c]PD: physical disease.

[d]HI: health insurance.

Guided by the social ecological model, the inductively derived themes shaping sustained engagement in DBAT were mapped onto the individual, interpersonal, society, and policy levels. While presented sequentially below for clarity, participants' narratives consistently revealed that these factors did not operate in isolation but dynamically interacted across levels to shape behavioral outcomes (Figure 1).

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Figure 1. Factors at 4 levels influencing older adults' engagement.



Individual-Level Factors

Health Needs Versus Physiological and Cognitive Constraints

Fourteen participants reported a strong desire to improve their mental health through DBAT. However, this motivation was often constrained by sensory decline, memory impairment, and low confidence in using digital tools. The mismatch between strong health needs and limited functional capacity emerged as a key barrier to sustained engagement. Participants showed intrinsic motivation driven by the need for social connection and avoidance of marginalization.

> *Seeing other older people actively chatting in the course video's comment section made me anxious. If only I could learn to type and leave a message, it would ease my mind a lot.* [ID 01, aged 64 years]

Three participants noted that course videos and activities reduced loneliness and increased enjoyment: "Watching course videos in my spare time makes life less monotonous and gives me something to look forward to" (ID 19, aged 72 years). Another stated, "Doing exercises with the videos every day helps me stay healthy, and I feel much more positive" (ID 03, aged 78 years). Despite this motivation, physiological constraints were prominent. Nine participants reported difficulties.

> *My eyesight is failing, the small text on the screen looks like a foreign language, and I often press the wrong buttons. At this age, my physical functions have declined, and I can barely handle a smartphone.* [ID 16, aged 66 years]

Cognitive barriers further limited engagement: "I always feel like my brain is too slow for this. These new things are too complicated, and just looking at them makes me anxious" (ID 02, aged 72 years). These perceptions reduced confidence and persistence, reinforcing digital exclusion.

Learning Motivation Versus Deficits in Digital Literacy

Seven participants expressed a strong willingness to learn smartphone use, motivated by mental health needs, social connectedness, and independent information access. However, prevalent digital literacy deficits—such as difficulty recognizing interface elements, poor operational execution, and an inability to troubleshoot errors—created a persistent gap between their intentions and functional abilities.

> *I heard that watching videos can teach psychological health skills, and I can chat with others in the comments. I'm curious about it. If I could learn this, I'd finally have something interesting to do, instead of feeling every day is hard to get through.* [ID 14, aged 64 years]

Another interviewee noted, "I know it's difficult, but I'm willing to learn slowly so I can handle my depressive moods by myself and not worry my family" (ID 17, aged 79 years). Despite this, the lack of digital literacy significantly hindered progress. Many participants felt overwhelmed when first using digital devices.

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> *The course website has so many functions that confuse me. I can't tell what they all mean. Even answering calls from the nurse or exiting the website requires someone to teach me several times. I feel disconnected from this era.* [ID 03, aged 78 years]

Operational errors were common. Another participant described, "My hands are clumsy. I often press the wrong buttons. I try to send a message but accidentally exit the course, and I don't know how to go back. I just get anxious" (ID 06, aged 65 years). These experiences reflect deficits in functional understanding and error recovery, limiting effective engagement.

Interpersonal-Level Factors

Intergenerational Digital Support and Emotional Burden

Six participants identified intergenerational support as key to initial engagement. Assistance from children or grandchildren facilitated access to digital interventions. However, a similar number reported feelings of burden. Limited time or patience from younger family members often led to negative emotions and reduced engagement. Thirteen participants emphasized the emotional benefits of such support.

> *The happiest moment was when my granddaughter taught me how to use the course website. Seeing her lovely smile on the screen made me feel truly warm inside.* [ID 04, aged 61 years]

> *My grandson kept praising me when I learned how to play the videos. It made me so happy. The process brought us closer, and I felt as if he was right there with me.* [ID 10, aged 60 years]

At the same time, some participants felt pressure due to slow learning. "My child taught me several times, but I still couldn't remember. I felt terribly guilty, as if I were bothering them. When I saw their frown, I just wanted to give up" (ID 01, aged 64 years). This emotional tension highlights that intergenerational digital support is not an unconditional resource. Its effectiveness largely depends on the investment and patience of younger family members.

> *They are busy with work, yet they have to spend time teaching me. I feel bad about it. I want to learn quickly, but these functions are really too complicated.* [ID 02, aged 72 years]

This dynamic shows that intergenerational support can both enable and hinder engagement. When support is limited, older adults may withdraw due to self-doubt. Paradoxically, this form of digital caregiving could exacerbate feelings of anxiety and inadequacy, further widening the psychological gap in their digital engagement.

Entrenched Social Networks and Latent Digital Exclusion

More than half of the participants relied on face-to-face interaction and showed resistance to digital communication. This reduced motivation to engage in online interventions. Economic constraints and weak infrastructure further limited access. Six participants preferred in-person interaction.

> *I'm used to talking face-to-face. Sitting together makes me feel secure. Online chatting makes me worry no one will reply, and then I feel neglected.* [ID 05, aged 82 years]

This attachment to traditional forms of socialization was reinforced by the similar habits of peers. One participant said, "Few people around me use this, so I don't want to either. I feel we don't share common topics in that area" (ID 14, aged 64 years). This makes it difficult to integrate digital interaction into their daily lives, thus reducing the intrinsic motivation for online intervention. Material constraints also contributed to exclusion. Many older adults lacked the financial means to own smart devices, while remote geographical locations often resulted in weak network coverage and unstable connections, further impeding use even among those with devices.

> *Smartphones are too expensive for my family. My grandson bought me one a few years ago, but the signal in our village is poor, and the videos kept cutting off. I tried using it for a while, but I felt both disappointed and frustrated, realizing how far behind we are compared to city people.* [ID 17, aged 79 years]

Society-Level Factors

The Paradox of Device and Network Availability

Participants reported mixed experiences with devices and network access. When systems were simple and adapted to their needs, engagement improved. When complex or unstable, they created frustration.

> *These videos do help me maintain my mental health, but the icons on the website are so small, and the steps are too complicated. I tap around for a long time and still can't find the assignment section. Sometimes I just lose patience and confidence to keep trying.* [ID 08, aged 60 years]

Conversely, design improvements increased usability.

> *At first, I found it troublesome. Later, when they changed to larger fonts and added arrows and voice prompts, I felt it was much friendlier for older people. These improvements are really necessary. If all programs were like this, we'd be more willing to learn.* [ID 17, aged 79 years]

Yet, network instability remained a major barrier.

> *The internet in our village is unstable and keeps cutting out. Videos keep buffering, and sentences are incomplete. Sometimes I click on the next page, and it just keeps loading, loading… in the end, nothing shows up. I sigh and quit; it feels like a waste of time.* [ID 12, aged 75 years]

These findings show that technology can either enable or hinder engagement depending on design and infrastructure.

Aspirations for Progress Versus Social Resistance

Participants described a tension between the desire to adopt digital health and a resistant social environment. Public messages promoted digital health as part of modern life, which

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encouraged some participants to try new technologies. However, local gossip under the old locust tree and the recurring household refrain of "you cannot do this" often acted as an invisible web, dampening emerging intentions to engage in online psychological care.

> *The TV keeps saying how advanced digital health care is, that everyone in the new era sees doctors online. I'm really afraid of being left behind, unable to adapt, or even laughed at by others. So I wanted to try this course to keep up, but I also fear I won't learn it. I want to, but I don't dare—it's very conflicting inside.* [ID 18, aged 83 years]

Even when individuals mustered the courage to use their devices in public, peers gathered in community spaces often discouraged them:

> *They say looking at the phone strains your eyes and wastes time you could spend farming. When I mention mental health, they just shake their heads and say it's useless. They trust the village doctor more than any online program.* [ID 18, aged 83 years]

Family-level discouragement was also reported.

> *What hurts the most is my own son often discourages me. He says the course videos are too complicated, that I might break the phone. If I press the wrong button, I could leak personal information or even get scammed. I feel so wronged. I just want to learn about mental health online, but every time I bring it up, I'm shut down.* [ID 11, aged 73 years]

This social tension suspended many older adults in a state of wanting to try but not daring to, leaving online psychological interventions in a fragile limbo between aspiration and hesitation.

Policy-Level Factors

Policy Orientation Versus Economic Burden

Twelve participants were aware of national digital health policies and recognized their intent. However, most reported financial barriers related to device purchase and internet costs. Limited subsidies and complex procedures reduced policy impact. Seven participants endorsed the overall direction of national efforts, perceiving them as a sign of progress.

> *The television says the government encourages rural older adults to use smartphones for health consultations and social connections. I have thought about trying it—at my age, fewer trips to the hospital would be nice. But in the end, these policies rarely reach us.* [ID 18, aged 83 years]

Such ambivalence of hope mingled with skepticism was common. Another participant noted, "The village loudspeaker promotes digital health every day, and it makes me want to try. But we see no real action. It still feels empty" (ID 04, aged 61 years). Direct economic barriers were identified as the primary obstacle to policy implementation. Five participants cited the prohibitive cost of smart devices.

> *A smartphone easily costs over a thousand yuan, more than I spend in a year. I can't afford it, and even if I bought one, I wouldn't dare use it for fear of breaking it.* [ID 15, aged 67 years]

Internet costs were also burdensome. An interviewee stated, "Twenty yuan a month for data may not sound like much, but for someone like me who relies on a few acres of farmland to eat, it's unbearable" (ID 19, aged 72 years). Subsidies, where available, were inconsistently distributed and procedurally cumbersome. One participant lamented, "I heard the government is giving subsidies for digital health, but I haven't seen a penny" (ID 08, aged 60 years). Such administrative bottlenecks and local implementation gaps undermined the intended mitigating effects of these policies, reinforcing inequality in access to digital resources and limiting the feasibility of leveraging digital tools for psychological well-being.

Universal Policies Versus Personalized Needs

Four participants reported that current policies rely on standardized approaches that do not meet individual needs. These include uniform device distribution and centralized training. Such strategies often fail to consider variations in physical ability, digital skills, and geographic access. Two participants explicitly criticized the lack of age-friendly design considerations. One remarked about the distributed devices:

> *The policy just says they'll give us smartphones, but they don't think about our shaky hands and blurry eyes. The icons are tiny like ants, and one wrong press takes me back to the start. It makes me want to throw the phone into the ditch.* [ID 10, aged 60 years]

Thus, without adaptive design, even hardware provision fails to meaningfully enhance digital engagement. Access barriers also persisted.

> *They hold classes at the training center every week, but my legs aren't good. It takes two buses and half a day to get there. The round-trip fare costs half a month of my blood pressure medicine. So I'd rather do nothing.* [ID 04, aged 61 years]

In contrast, participants commonly expressed a strong desire for precise and personalized policy measures. The ideal policy, in their view, would not only provide age-appropriate devices but also include ongoing, context-sensitive guidance and sustained financial support.

> *If someone could come to my home, set me up with a senior-friendly phone, teach me step by step, and give me enough data every month, I'd definitely watch the course videos every day and join the online chats. I wouldn't feel lonely anymore.* [ID 17, aged 79 years]

This reflects the need for policies that are tailored, accessible, and responsive to individual circumstances.

Cross-Level Interactions

Participants' narratives consistently revealed that factors across the 4 ecological levels did not operate independently but dynamically interacted to shape sustained engagement. A barrier at 1 level frequently compounded difficulties at another. For instance, as previously noted in the participants' experiences,

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macrolevel policy initiatives providing standardized devices often clashed with individual physiological limitations (ID 10, aged 60 years). This policy-individual friction subsequently exacerbated emotional frustration and increased the burden on interpersonal assistance. Furthermore, robust individual learning motivation was frequently neutralized by intersecting societal and interpersonal barriers. This was evident when an older adult's intrinsic desire to engage with digital health was directly suppressed by family discouragement, which was in turn fueled by broader societal concerns about digital scams (ID 11, aged 73 years). These empirical observations illustrate that older adults did not experience these barriers in isolation. Rather, their sustained engagement was determined by continuously navigating intersecting vulnerabilities, where the failure to address a structural barrier could easily neutralize supportive resources at the microlevel.

Discussion

Principal Findings

To our knowledge, this study is among the first to apply the social ecological model to systematically examine factors influencing older adults' engagement in DBAT within resource-limited settings. While the identified determinants—such as limited digital literacy and infrastructural barriers—align with well-established digital divide literature, this study advances existing conceptual frameworks by revealing the cross-level paradoxical tensions that characterize digital inclusion. Rather than viewing digital exclusion as a static lack of resources, our findings conceptually refine digital engagement in resource-limited settings as a highly relational and emotionally fraught process. For instance, intergenerational support acts as a double-edged sword, providing essential technical access while simultaneously generating emotional burden and guilt that can deter sustained use. Similarly, older adults are often caught in a limbo between macrolevel aspirations for digital progress and rigid microlevel social resistance. These findings are consistent with previous large-scale research showing that single-level interventions are insufficient to sustain engagement [33]. They support the core principles of digital inclusion, which emphasize equitable access, improved digital literacy, increased social participation, and fair access to services. Effective strategies require coordinated action across levels. Interventions should combine individual capacity building, family and peer support, community-based delivery, and responsive policy design. Such integrated efforts can improve intervention outcomes, support efficient use of resources, and promote equitable and sustainable digital health development in line with global health priorities [34].

Translating Barriers Into Digital Inclusion Strategies

The analytic value of applying a digital inclusion framework, rather than a conventional digital divide lens, lies in shifting the focus from deficit correction to relational empowerment. A standard barrier analysis might conclude that simply providing devices and basic training resolves digital exclusion. In contrast, evaluating our findings through the digital inclusion framework reveals that overcoming material deficits is insufficient without addressing the psychosocial and relational dimensions of engagement. For instance, while providing a smartphone addresses a structural deficit at the policy level, a digital inclusion perspective highlights that true participation requires mitigating the emotional guilt associated with intergenerational training and countering entrenched community stigma. Consequently, translating these findings into inclusion strategies demands interventions that move beyond mere hardware provision to cultivate digital autonomy, emotional safety, and meaningful social embeddedness across all ecological levels.

In resource-limited settings, older adults often show low adherence to digital interventions due to physical decline, cognitive limitations, and limited health literacy [8,20]. Interventions should therefore extend beyond technical adaptation. Health education can increase awareness of mental health and the value of digital care. Structured digital literacy training with large text, voice guidance, and gradual progression can reduce operational difficulty [35]. Leite et al [36] reported that such improvements foster technological inclusion and subjective well-being among older adults. Education on privacy and data security is also important to build trust. In addition, helping older adults develop realistic expectations and critical awareness can reduce frustration and dropout. In nursing practice, BA strategies should be combined with continuous support, follow-up, and remote guidance. This approach allows for effective and accessible care. Evidence from a Chinese cohort demonstrated that bridging the digital divide not only improved intervention outcomes directly but also indirectly enhanced cognitive function and general health [37]. Training nurses in both psychological care and digital skills can support the implementation of these strategies.

At the interpersonal level, intergenerational digital support plays a dual role by both facilitating and constraining engagement. Family members often provide essential technical guidance and encouragement, which can improve participation in digital interventions. However, excessive reliance may lead to emotional burden, reduced autonomy, and avoidance of help-seeking among older adults [17,20]. This reflects the structural influence of family resources and education highlighted in prior studies [38,39]. Recent evidence indicates that internet altruistic behaviors, such as offering help and sharing information online, can enhance affective well-being [40]. These findings suggest that extending support beyond the family to broader digital networks may reduce emotional strain and improve engagement. Nurses should provide caregiver education that promotes supportive yet autonomy-preserving interactions. Encouragement and confidence building are essential, while assistance should remain limited to maintain self-efficacy [41]. As Qiu et al [42] noted, intergenerational digital gaps temporarily narrowed during the pandemic but lacked long-term sustainability measures. Thus, nurse-led peer support and digital navigator programs can expand nonfamilial support, foster mutual assistance, and strengthen digital social networks [35]. These strategies may reduce dependence on family members and promote more sustainable engagement.

Despite gradual improvements in digital infrastructure, older adults in resource-limited settings continue to face significant barriers. Limited access to devices, unstable internet connections, and inadequate maintenance reduce the usability

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of digital psychological interventions [43]. In their review of older adults' digital engagement, Kebede et al [44] highlighted key intervention strategies, including training, equipment support, and social participation. In nursing practice, community-based models offer a practical solution. Digital health access points can be established in local centers where nurses and trained volunteers provide guidance and support. Regular feedback and program adjustment can further improve effectiveness. At a broader level, digital connectivity should also be recognized as an essential resource. Investment in infrastructure and data security is necessary to ensure safe and equitable access [15,20]. Aly et al [45] emphasized the importance of privacy education tailored to regional and age-specific needs, alongside customized digital literacy training. Age-friendly applications, simplified interfaces, and combined online and offline support can improve sustained engagement [17,41]. Collaboration between government, community organizations, and local stakeholders is essential. Peer learning and incentive mechanisms can further encourage participation and create a positive cycle of engagement.

Current policies often focus on broad coverage but do not fully address individual needs. Financial barriers, limited subsidies, and fragmented services remain key challenges. Future policies should adopt a more targeted approach. Resources should be directed toward underserved populations to reduce inequality. Suggested strategies include flexible subsidy systems, device support programs, and stronger legal protection for data security [46,47]. Wu et al [48] also emphasize the necessity of policy transformation. Integrating digital skills training into public health and eldercare services can improve long-term engagement. Simplified procedures and user-friendly tools can also support individuals with low literacy [15,49]. Nurses can play a central role in implementing these policies. They can support coordination, provide follow-up care, and contribute to ongoing evaluation. Their involvement is essential for translating policy into practice and ensuring effective outcomes [41].

Interaction Between Multilevel Factors

A key conceptual contribution of this study is demonstrating that engagement in digital interventions is fundamentally shaped by dynamic and often contradictory interactions across social ecological model levels. This challenges the static notion that resolving a barrier at 1 level automatically facilitates inclusion. Instead, we observed compensatory and canceling cross-level effects. For example, robust interpersonal support can temporarily compensate for low individual digital literacy, but entrenched society-level resistance such as community stigma can entirely cancel out both individual motivation and policy-level infrastructural improvements. Based on these theoretical insights, effective strategies must move beyond addressing isolated factors to resolving these cross-level frictions [50]. Therefore, we propose a multistakeholder, multilevel intervention framework. At the individual level, improving knowledge, skills, and confidence is essential. At the interpersonal level, balanced support from family and peers can promote sustained use. At the society level, accessible services and supportive environments can reduce barriers. At the policy level, fair resource allocation and integrated services can ensure long-term impact.

These levels are closely connected. Policy support can improve infrastructure and reduce financial barriers, but without local adaptation, resources may remain underused. Interpersonal support can compensate for low skills but may also create dependence if not balanced. Positive social environments that combine technical support and peer interaction can reduce pressure on families and promote independent engagement [51,52]. Feedback across levels can further improve system design. Increased engagement at the individual level can also strengthen support from families and communities, creating a reinforcing cycle.

To ensure long-term impact, evaluation should be conducted in stages. Early phases should focus on engagement, followed by retention and sustained use, and finally long-term outcomes such as mental health and well-being. Continuous feedback and adaptation are essential to maintain effectiveness.

Limitations

This study has several limitations. The sample was drawn from a single region in China, which may limit generalizability. Cultural, social, and policy contexts differ across settings and may influence engagement. Multi-site and cross-cultural comparisons are therefore needed in future work. As a qualitative study, this research did not quantify the relative importance of each factor. Mixed-methods approaches could provide further insight. The study focused only on older adults and did not include perspectives from policymakers, health care providers, or family members. A more comprehensive view would benefit from including multiple stakeholders in future investigations. Participants were recruited from a clinical trial and had completed the intervention. This may limit transferability to individuals who do not engage or who drop out early. Their experiences may emphasize successful engagement rather than barriers to initial participation. Including individuals who discontinue interventions is an important direction for future inquiry. In addition, individuals with severe cognitive, sensory, or psychiatric conditions were excluded. As a result, the findings may underestimate the extent of digital exclusion. Exploring the perspectives of these underrepresented groups remains a necessary next step.

Conclusions

Guided by the social ecological model, this study systematically identified multilevel factors that influence older adults' sustained engagement in DBAT in resource-limited settings, specifically capturing the adaptive experiences of users who completed the intervention. Beyond merely categorizing known barriers, including cognitive limitations and infrastructural deficits, this study advances the conceptualization of digital inclusion by revealing the cross-level paradoxical tensions that older adults must navigate. The findings refine the social ecological model by illustrating how emotional burdens of interpersonal support and societal resistance deeply complicate digital engagement. Ultimately, the digital inclusion framework adds critical analytic value by demonstrating that sustained engagement is not merely a technical fix of the digital divide but a profound socioemotional transition. Achieving true inclusion requires moving beyond hardware distribution to cultivate digital autonomy and supportive relational environments. Nurses are

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well positioned to support this process. They can coordinate care, provide guidance, and contribute to the development of integrated strategies across levels. Such efforts can improve engagement and treatment outcomes while promoting equitable and sustainable digital mental health services. This study provides practical and theoretical insights to support the development of digital health strategies for aging populations, particularly in resource-limited settings.

Data Availability

The data that supported the findings of this study are available on request from the first author. The data are not publicly available due to privacy restrictions.

Funding

This work was supported by the Wisdom Accumulation and Talent Cultivation Project of the Third Xiangya Hospital of Central South University (No.BJ202205) and the Yale-China Association Chia Community Health Services Program (No.2024YC01). The funder had no involvement in the study design, data collection, analysis, interpretation, or the writing of this paper.

Generative AI Use

No generative AI tools were used at any stage in the preparation of this manuscript.

Authors' Contributions

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Investigation: WY, DL
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Conflicts of Interest

None declared.

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Abbreviations

BA: behavioral activation
COREQ: Consolidated Criteria for Reporting Qualitative Research
DBAT: digital behavioral activation therapy
GDS-15: Geriatric Depression Scale with 15 items
HI: health insurance
LLD: late-life depression
MI: monthly income
WHO: World Health Organization

Edited by J Wang; submitted 18.Sep.2025; peer-reviewed by E Granholm, F Yang, D Yu; comments to author 24.Mar.2026; revised version received 16.Sep.2026; accepted 09.Oct.2026; published 19.Nov.2026

Please cite as:
Wang J, Luo Y, Jia S, Yang W, Liu D, Li J, Gan G, Zhou Y, Wang S, Xie J
Factors Influencing Older Adults' Sustained Engagement in Digital Psychological Interventions in Resource-Limited Settings: Qualitative Study Guided by the Social Ecological Model
JMIR Aging 2026;9:e84350
URL: https://aging.jmir.org/2026/1/e84350
doi: 10.2196/84350
PMID:

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