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The Alleviating Effect of Digital Literacy on Depressive Symptoms Among Rural Older Adults

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Abstract: Against the backdrop of population aging and digital transformation, rural older adults face more severe digital exclusion and mental health challenges. Based on the 2022 data from the China Family Panel Studies (CFPS), this study takes rural older adults aged 60 and above as research subjects, adopts a multidimensional digital literacy index and the CES-D depression scale, and uses ordinary least squares (OLS) regression to explore the direct association between digital literacy and depressive symptoms, controlling for covariates including gender, age group, marital status, education level, and region. The results show that digital literacy is significantly and negatively associated with depressive symptoms among rural older adults; that is, higher digital literacy corresponds to lower depression levels. From the perspective of Conservation of Resources Theory, this study interprets digital literacy as a potential emerging resource for the mental health of rural older adults and adds empirical evidence to the "resource-scarce context" in digital inequality research. The findings provide a policy basis for bridging the rural digital divide and promoting health equity, with recommendations covering tiered training, age-friendly optimization, and integrated intervention of digital inclusion and mental health.

Keywords: Digital Literacy; Depressive Symptoms; Rural Older Adults; Digital Inclusion

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1. Introduction

Against the parallel advancement of population aging and digitalization, the digital inclusion of older adults has attracted increasing academic attention. Rural older adults experience more acute digital exclusion than their urban counterparts, marked by limited internet access, poor digital proficiency, and fragile social support systems. Evidence focused specifically on rural older adults remains thin. Existing scholarship generally affirms that digital literacy benefits older adults' psychological well-being. Zhang et al. (2023) maintained that online engagement alleviates depressive symptoms by reinforcing social ties7[1]; Jin and Zhao (2019) similarly reported that internet use reduces loneliness in later life[2]. Much of this evidence, however, draws on samples that combine urban and rural respondents or include only urban residents. Where rural seniors are studied, the focus has largely been on describing digital literacy and identifying its correlates[3]. Few studies extend the inquiry to mental health outcomes.

Rural mental health care remains markedly under-resourced. Depressive symptoms among older residents often escape notice. Inadequate digital literacy exposes rural older adults to social isolation and information constraints. This raises their likelihood of depression.

Rurality is a stratified contextual variable. Rather than a neutral research setting, rural areas form a distinctive socio-ecological configuration that structurally distinguishes them from urban contexts. Limited schooling, poor digital infrastructure, and well-established local social ties all shape rural contexts. These conditions change how older people benefit from digital skills, creating results that diverge from urban samples. Such contextual differences cannot be ignored. We therefore need separate empirical tests focused specifically on rural older adults to understand how digital literacy relates to depressive symptoms.

Our empirical analysis draws on 2022 CFPS microdata and only keeps respondents aged 60 and above who reside in rural areas. Regression models examine whether variation in older adults' digital skills connects to their depressive-symptom scores within this rural sample. The analysis generates practical findings. Local policymakers may draw on these results to design digital inclusion measures and adjust mental-health services for rural senior residents.

2. Theoretical Background and Research Hypothesis

At its core, Hobfoll's (1989) conservation of resources (COR) theory holds that people strive to gain and protect valued personal resources[4]. Stress emerges when resources vanish or face expected loss, and depressive symptoms may follow. In rural settings, poor digital infrastructure and weaker social support put older adults at risk. Without solid digital skills, they can face information gaps, social isolation and lower self-esteem; all of these count as meaningful resource-loss stressors. For today's older rural population, digital literacy itself can function as a new resource. It lets seniors seek health-related information, sustain online social contact, and cope better with daily life. These benefits may offset resource-loss pressure and ease depressive feelings[5].

Accordingly, this study proposes the following hypothesis:

H1: Digital literacy is negatively associated with depressive symptoms among rural older adults.

3. Research Design

3.1 Data Source

The data used in this study are from the 2022 wave of the China Family Panel Studies (CFPS). The research subjects are rural residents aged 60 and above. After excluding samples with missing values on core variables, 592 valid samples are retained for analysis, and the data are nationally representative.

3.2 Variable Measurement

3.2.1 Dependent Variable: Depressive Symptoms

Depressive symptoms are measured using the 8-item Center for Epidemiologic Studies Depression Scale (CES-D-8), developed by Radloff (1977), which covers four core dimensions: depressive affect, positive affect, somatic symptoms, and interpersonal difficulties. After reverse coding positive items, each item is scored on a 4-point Likert scale (1–4), with a total score ranging from 8 to 32. Higher scores indicate more severe depressive symptoms[6].

The Cronbach's α coefficient of the scale in this study is 0.76, indicating good internal reliability.

3.2.2 Independent Variable: Digital Literacy

Digital literacy refers to older adults' comprehensive ability to access, understand, and effectively use digital tools for daily practices in a digital society[7]. Referring to the mature measurement framework constructed by Chen et al. (2024) based on CFPS data, this study measures digital literacy from three core dimensions[8]:

• Digital access: whether the respondent uses the internet;

• Digital awareness: self-rated importance of the internet in five domains (work, leisure, learning & information access, social connection, daily life), scored 1–5;

• Digital application: engagement in digital behaviors (gaming, online shopping, short-video viewing, online learning, WeChat use).

After standardizing all items, the entropy weight method is applied to synthesize a comprehensive score ranging from 0 to 1. A higher score indicates a higher level of digital literacy.

3.2.3 Control Variables

Referring to existing research on older adults' mental health, this study controls for demographic and socioeconomic variables including gender, age group, marital status, education level, and region to exclude confounding effects[9]. The definitions and descriptive statistics of all variables are presented in Table 1.

Table 1 Variable Definitions and Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Depressive symptoms	592	13.826	4.339	8	30
Digital literacy	592	0.256	0.149	0.053	0.933
Gender (male = 1)	592	0.574	0.495	0	1
Age group	592	1.231	0.422	1	2
Marital status (married = 1)	592	0.894	0.309	0	1
Education level	592	1.970	0.693	1	3
Region	592	1.807	0.804	1	3

3.3 Model Specification

To test Hypothesis 1, this study constructs a baseline regression model using ordinary least squares (OLS):

$$Depression_i=\alpha+\beta Digital_i+\gamma X_i+\varepsilon_i \quad (1)$$

where $Depression_i$ is the outcome variable.

4. Empirical Results and Analysis

4.1 Baseline Regression Results

This study uses OLS regression to examine the association between digital literacy and depressive symptoms among rural older adults. The Variance Inflation Factor (VIF) test is conducted prior to regression to diagnose multicollinearity. The results show that the VIF values of all variables are below 2, far below the critical threshold of 10, indicating no severe multicollinearity and reliable estimation results.

Table 2 reports the estimation results of two models: Model 1 only includes the core independent variable digital literacy, and Model 2 adds all control variables on the basis of Model 1.

As shown in Model 1, without controlling for other factors, the regression coefficient of digital literacy is −0.696 ($p < 0.01$), indicating a significant negative association between digital literacy and depressive symptoms among rural older adults. In Model 2 with full controls, the coefficient of digital literacy is −0.604 ($p < 0.05$), with a 95% confidence interval of [−1.166, −0.042]. Although the absolute value of the coefficient decreases slightly, it remains statistically significant, indicating that the negative relationship between digital literacy and depressive symptoms is stable. In terms of effect size, each unit increase in digital literacy is associated with an average decrease of approximately 0.60 points in depression scores among rural older adults.

Table 2 Baseline Regression Results of Digital Literacy on Depressive Symptoms

Variable	Model 1 (Uncontrolled)	Model 2 (Full Controls)
Digital literacy	−0.696***(0.289)	−0.604**(0.286)
Control variables	No	Yes
Constant	0.347***(0.086)	1.052***(0.232)
Observations	592	592
R^2	0.010	0.131

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Standard errors are in parentheses. Table 3 reports robust standard errors.

4.2 Robustness Checks

We need to verify whether the baseline regression results remain stable and trustworthy. Two sets of robustness tests were carried out for this purpose.

One substitutes a proxy for the key explanatory variable. The composite digital literacy index is discarded, and a single item—respondents' perceived importance of the internet in daily life—takes its place. Column (2) of Table 3 reports the

outcome. The coefficient stays significantly negative ($\beta = -0.069$, $p < 0.05$). It closely mirrors the baseline result.

The other alters the estimation strategy. CES-D depression scores are ordinal and discrete by nature. The Ordered Probit model fits such dependent variables better, so it is used for re-estimation. Column (3) of Table 3 reveals a statistically significant negative coefficient for the core digital literacy variable ($\beta = -0.603$, $p < 0.05$).

Table 3 Robustness Check Results

Variable	(1) Baseline OLS	(2) Replaced Independent Variable	(3) Ordered Probit
Digital literacy	−0.604** (0.245)	—	−0.603**(0.268)
Importance of internet to life	—	−0.069**(0.027)	—
Control variables	Yes	Yes	Yes
Constant	1.406*** (0.250)	1.121***(0.254)	—
Observations	592	592	592
R^2 / Pseudo R^2	0.132	0.133	0.026

Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses. The Ordered Probit model does not report a separate constant term.

4.3 Heterogeneity Analysis: Regional Differences

Table 4 reports estimates from separate regressions for eastern, central, and western China, which this study uses to ask whether digital literacy alleviates depression unevenly across regions.

The regression results reveal a clear east-to-west gradient of diminishing effects: the effect of digital literacy is significantly negative at the 5% level only in eastern rural areas, with a larger effect size than the full sample. When examining central rural subsamples, coefficients take negative values but do not achieve statistical significance. Such findings suggest a weak, developing relationship, though this pattern should be interpreted with caution. The western rural sample yields a coefficient near zero. It is not statistically significant. There is no evidence yet that digital literacy improves mental health there.

Regional differences line up with where digital infrastructure is concentrated. Eastern rural China is a case in point: networks are more complete, and digital applications more varied. Eastern rural residents can turn digital knowledge into real-world social connections and health-information resources. Things look different for central and western rural regions. Network access stays constrained, and local digital services remain insufficient. Even when older residents possess digital skills, local conditions often prevent mental-health-related gains. Good digital infrastructure seems to form necessary groundwork: digital literacy can ease depressive distress for rural seniors only when basic technical conditions exist. Policy responses therefore have to match local realities, particularly for less-economically-developed rural locations with infrastructure shortfalls.

Table 4 Heterogeneity Analysis: Grouped Regression by Region

Variable	(1) Eastern Region	(2) Central Region	(3) Western Region
Digital literacy	−0.869**(0.400)	−0.553(0.481)	−0.077(0.767)
Male	−0.395***(0.121)	−0.309**(0.152)	−0.193(0.204)
Age group	−0.247*(0.146)	−0.274(0.194)	−0.378*(0.213)
Married	−0.511**(0.203)	−0.885***(0.242)	−0.751***(0.277)
Education level	Controlled	Controlled	Controlled
Constant	1.127***(0.300)	1.788***(0.407)	1.900***(0.456)
Observations	259	188	145
R^2	0.097	0.132	0.098

Note. *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard errors are in parentheses.

5. Conclusions and Implications

5.1 Research Conclusions

Our sample consists of rural older adults drawn from the 2022 CFPS dataset. We test whether digital skills correlate with

depressive-symptom levels among this population. Results point to a statistically meaningful negative link: seniors with higher digital competence tend to report milder depression. Digital literacy can thus work as one protective resource supporting older-adult mental health.

Unlike many prior works relying on one-dimensional proxies, this study measures digital literacy across three dimensions: access, awareness, and hands-on application. Tests run specifically within under-resourced rural contexts. Empirical work targeting this exact group stays limited, and our analysis adds new evidence. These results carry practical meaning for closing rural digital gaps and advancing health equity for older residents.

5.2 Policy Implications

This analysis yields several practical lessons for local practice. Policymakers can draw from our findings when shaping digital-support measures and mental-health services for countryside seniors.

Merely expanding internet access cannot solve all existing problems. Rural older adults are not a uniform group, so digital-skill training needs customization. Program designers should consider participants' age, educational background, and past digital-technology experience. Training content ought to prioritize features closely connected to mental well-being: keeping online social relationships and locating reliable health information serve as key examples[10]. Informal learning formats produce good outcomes. Peer guidance and help between generations lower learning barriers for rural elders with little formal schooling. Community-based peer education can boost digital participation and skill levels. It offers one realistic path toward mitigating digital exclusion among rural older adults[11].

Infrastructure that is genuinely inclusive can help close urban-rural digital divides among ageing populations[12]. The supply side matters too. Platforms that simplify procedures, improve voice control, and enlarge fonts can lower the technical hurdles older adults encounter online[13]. Yet, empowerment transcends basic access. Rural digital inclusion requires synergistic integration with mental health intervention systems for elderly groups. It is feasible to embed digital literacy cultivation into targeted psychological service programs tailored for rural older adults. Collective digital training and online communal platforms enable seniors to accumulate practical digital competencies, expand intimate social networks and mitigate perceived loneliness, which collectively amplify the positive psychological benefits of digital technology[14].

Short-lived policies fail to preserve the long-term dividends of digital empowerment. Local authorities can monitor continuous shifts in rural older adults' digital capabilities and psychological well-being. Using such on-the-ground data, they are able to update localized digital support schemes[15]. Frequent communication between village residents can create casual peer support networks for digital skill learning. This community-based support makes up for the limits of intermittent traditional interventions. It pushes forward steady progress in digital inclusion work targeting rural older adults[16].

5.3 Limitations and Future Research

A few caveats remain. The cross-sectional design rules out causal claims; reverse causality and unobserved confounding are possible. Digital literacy is self-reported, which may bias measurement. The analysis uses a composite index and does not test whether separate dimensions operate differently. The sample covers rural older adults only, so generalizability is limited, and mechanisms are not examined. Longitudinal and mediation designs would be useful next steps.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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