

Original Paper

Smartphone Addiction, Usage Preferences, and Mental Health Among Older Adults in the Digital Age: A Moderated Mediation Model

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Abstract

This study investigates the mechanisms by which smartphone usage preferences affect depressive symptoms among the elderly. Based on a survey of 2,585 individuals, usage is classified into interactive and self-entertainment preferences. The findings reveal that an interactive preference significantly alleviates depressive symptoms by enhancing social participation. In contrast, a self-entertainment preference is positively correlated with higher levels of depression, likely because it can weaken real-world social engagement. Furthermore, the study identifies smartphone addiction as a critical moderating variable. For individuals with a strong interactive preference, addiction negatively moderates the beneficial effect of social participation on depression. The moderating role of addiction on the relationship between self-entertainment preference and social participation also varies depending on the degree of addiction. This research provides nuanced insights into the boundary conditions for promoting the healthy integration of seniors into the digital world.

Keywords

smartphone use preference, mental health, smartphone addiction, social participation

1. Introduction

1.1 Research Background

With the rapid intensification of global population aging and the swift advancement of digital technologies, older adults have emerged as an increasingly significant group in the smartphone consumption market. According to data released by the Ministry of Civil Affairs, from 2013 to 2023,

the proportion of older adults aged 60 and above in China's total population rose from 14.9% to 21.1% (Ministry of Civil Affairs, 2024a), indicating that the country has quickly stepped into a moderately aging society. Meanwhile, the Fifth Basic Data Bulletin on the Living Conditions of Urban and Rural Older Adults in China reports that as of 2021, 36.6% of older adults in China are capable of using smartphones; among those in the younger-old group, 49.6% can use smartphones—meaning nearly one in two older adults in this younger-old segment has adopted smartphone usage (Ministry of Civil Affairs, 2024b). These findings underscore the active participation of older adults in the digital era.

The increasing prevalence of smartphones among older adults has prompted scholarly attention to how smartphone use affects their mental health. Some studies suggest that smartphone use can meet everyday needs for communication, entertainment, and information access (Wu & Yang, 2023; Yan & He, 2023), thereby facilitating social participation and interpersonal interaction, which in turn reduces loneliness and depressive symptoms (Zhao et al., 2022; Hae Sagong & Yoon, 2022). Smartphone health applications are also considered valuable tools for improving older adults' mental health by providing emotional support and health guidance (Nila Navarro et al., 2024; S. Erfani & Kimiya Ramin, 2018). On the other hand, excessive smartphone reliance may weaken social bonds among older adults, disrupt intergenerational relationships, and reduce sleep quality (Wan et al., 2021; Zhang et al., 2024), and can also hasten cognitive decline (Wang et al., 2020), potentially triggering depressive symptoms. Hence, smartphone use acts as a double-edged sword for older adults' mental health: Appropriate use can foster well-being, whereas misuse may intensify depression.

Yet key questions remain unresolved: What kinds of smartphone use behaviors are most beneficial for older adults' mental health? And through what mechanisms might smartphone use help mitigate depressive tendencies among older adults? Current research has yet to provide conclusive answers. Therefore, this study aims to compare how different smartphone use preferences (interactive vs. self-entertainment) affect older adults' mental health. It also examines the mediating role of social participation and the moderating role of smartphone addiction. The goal is to elucidate the mechanisms through which smartphone usage influences older adults' mental health, thereby offering evidence-based guidance to support healthy and reasonable smartphone use among older adults and to promote their psychological well-being.

1.2 Literature Review and Research Hypotheses

1.2.1 Smartphone Use Preferences and Psychological Depression

With rapid innovations in smartphone technology, the range of available functions has grown exponentially. In addition to basic services such as phone calls and text messaging, which are provided by mobile operators, most smartphones now offer a variety of internet-based features, including instant messaging (e.g., WeChat), online video streaming, mobile gaming, music playback, and access to movies and TV shows. Empirical evidence indicates that different functions and uses of smartphones—ranging from social, entertainment, to information retrieval—exert distinct impacts on

older adults' mental health. For instance, using smartphones for online shopping and bill payments (Zhang & Rong, 2023), online voting and policy discussions (Su-Kyoung Kim et al., 2020), or maintaining contact with family and friends to expand social networks (Alessandro Caliendo et al., 2021) can lower depressive symptoms among older adults. These activities share the common characteristic of fostering social connections and enhancing social interaction, reflecting an interactive preference in older adults' smartphone use.

In contrast, smartphone use geared primarily toward personal entertainment, such as binge-watching TV series, may lead to unfavorable emotional outcomes such as depression and anxiety. Some studies show a significant relationship between binge-watching and depression (A. A. Tolba & Shaima'a Z. Zoghaib, 2022; Jia-Ji Sun & Yen-Jung Chang, 2021). Specifically, motives of escapism or coping with loneliness in binge-watching behavior can mediate the link between anxiety-depression syndromes and problematic binge-watching (Jolanta A. Starosta et al., 2021; Wheeler, 2015). Additionally, watching short videos has been found to significantly increase depression risks among younger people, especially those who are already more prone to depression (Yao et al., 2022). Although there is no direct evidence that smartphone use for personal entertainment—such as watching TV series or short videos—aggravates depression among older adults, given that older adults generally have lower internet literacy than younger cohorts, the negative mechanisms documented in younger groups could be even more salient among older adults. Based on the above, the following hypotheses are proposed:

H1: Older adults' interactive smartphone use preference has a significant negative effect on psychological depression.

H2: Older adults' self-entertainment smartphone use preference has a significant positive effect on psychological depression.

1.2.2 The Mediating Role of Social Participation

Social participation is widely recognized as a critical factor in maintaining older adults' mental health and mitigating depressive symptoms. Studies conducted in different contexts and cultures consistently show that various forms of social participation reduce both the level and the risk of depression among older adults (He et al., 2022; Li, 2020; Zhang et al., 2021; Zhao et al., 2021; Mackenzie & Abdulrazaq, 2019; Wilkie, 2015; Rongjian Ji et al., 2023). By engaging in social activities, older adults gain emotional support and recognition from others. This external support enhances their sense of social belonging, reduces loneliness, and thus lowers the likelihood of depression.

Notably, older adults' interactive and self-entertainment smartphone use preferences may influence social participation in distinct ways. Smartphone use primarily aimed at interaction—such as social networking and information exchange—often correlates with higher levels of social participation. For example, research demonstrates that college students who use smartphones for social media are more inclined to interact with people of differing sociodemographic backgrounds and viewpoints, thereby building social capital and promoting civic engagement (Yonghwan Kim & Bumsoo Kim, 2021).

Likewise, using smartphones to exchange information or express opinions is closely associated with exposure to diverse political and social perspectives, which further spurs participation in civic affairs (Park & Zúñiga, 2019).

By contrast, smartphone use centered on self-entertainment—such as gaming or video streaming—may have a weaker impact on social participation. Although such activities can offer immediate gratification and enjoyment, they often do not foster deep-level social interaction. Studies suggest that smartphones can be intrusive, potentially undermining the quality of face-to-face interactions and their positive effects on well-being (Rotondi et al., 2017). Excessive reliance on self-entertainment applications can reduce in-person interactions and thereby dampen social participation (Groarke, 2014).

Hence, this study proposes the following:

H3: Social participation mediates the relationship between older adults' interactive smartphone use preference and psychological depression.

H3-1: Interactive smartphone use preferences promote social participation, thereby reducing depression.

H4: Social participation mediates the relationship between older adults' self-entertainment smartphone use preference and psychological depression.

H4-1: Self-entertainment smartphone use preferences decrease social participation, thereby increasing depression.

1.2.3 The Moderating Role of Smartphone Addiction

Although smartphone use has been shown to correlate with anxiety and depression among older adults, not all older adults are affected to the same degree. Hence, it is crucial to explore additional moderating factors that may alleviate—or amplify—the connection between smartphone use preferences and psychological outcomes. This study investigates whether smartphone addiction serves as one such moderator. Smartphone addiction refers to the excessive and uncontrollable use of smartphones, leading to social dysfunction, psychological distress, and behavioral problems (Liu et al., 2017). It is characterized by difficulty regulating smartphone use, withdrawal symptoms, and the tendency to use smartphones as an escape from real-life issues (Park, 2019).

Prior research indicates that smartphone addiction is positively associated with depression; increased duration of smartphone use may exacerbate this relationship (Wang et al., 2024; Ikeda & Nakamura, 2014). Such addictive behavior fosters a strong psychological dependence on smartphones, consequently reducing older adults' social interactions in real-world settings. Smartphone addiction may even create a vicious cycle in which loneliness drives more phone use, yet prolonged use exacerbates loneliness and depressive symptoms (Hou et al., 2021). While virtual socializing can offer some emotional support, overreliance on it may undermine the quality of real-life interactions (Chen et al., 2021). For older adults heavily dependent on smartphones, mental health problems can worsen due to addiction, thereby elevating their risk for depression. Moreover, long periods of smartphone usage

may negatively affect daily life, cutting down time spent with family and friends and limiting opportunities for social participation—both of which can diminish social support and worsen depressive symptoms (Zhang et al., 2019).

Accordingly, the following hypotheses are formulated:

H5: Smartphone addiction negatively moderates the direct effect of older adults' interactive smartphone use preference on psychological depression.

H5-1: Smartphone addiction negatively moderates the indirect effect of older adults' interactive smartphone use preference on psychological depression. In other words, as smartphone addiction increases, the mediating role of social participation is strengthened.

H6: Smartphone addiction positively moderates the direct effect of older adults' self-entertainment smartphone use preference on psychological depression.

H6-1: Smartphone addiction positively moderates the indirect effect of older adults' self-entertainment smartphone use preference on psychological depression. In other words, as smartphone addiction increases, the mediating role of social participation is strengthened.

In summary, the conceptual model of the study variables is presented in Figure 1. Interactive smartphone use preferences exert a negative influence on older adults' depressive symptoms, whereas self-entertainment preferences have a positive influence. Social participation mediates these relationships. Furthermore, smartphone addiction negatively moderates the impact of interactive preferences on depressive symptoms—in other words, higher levels of addiction weaken the negative effect of interactive preference on depression—and positively moderates the impact of self-entertainment preference on depressive symptoms, thereby amplifying the latter's positive effect on depression. Likewise, smartphone addiction constrains the positive effect of interactive preference on social participation (and thus the negative effect on depression), while amplifying the negative effect of self-entertainment preference on social participation (and thus the negative impact on depression).

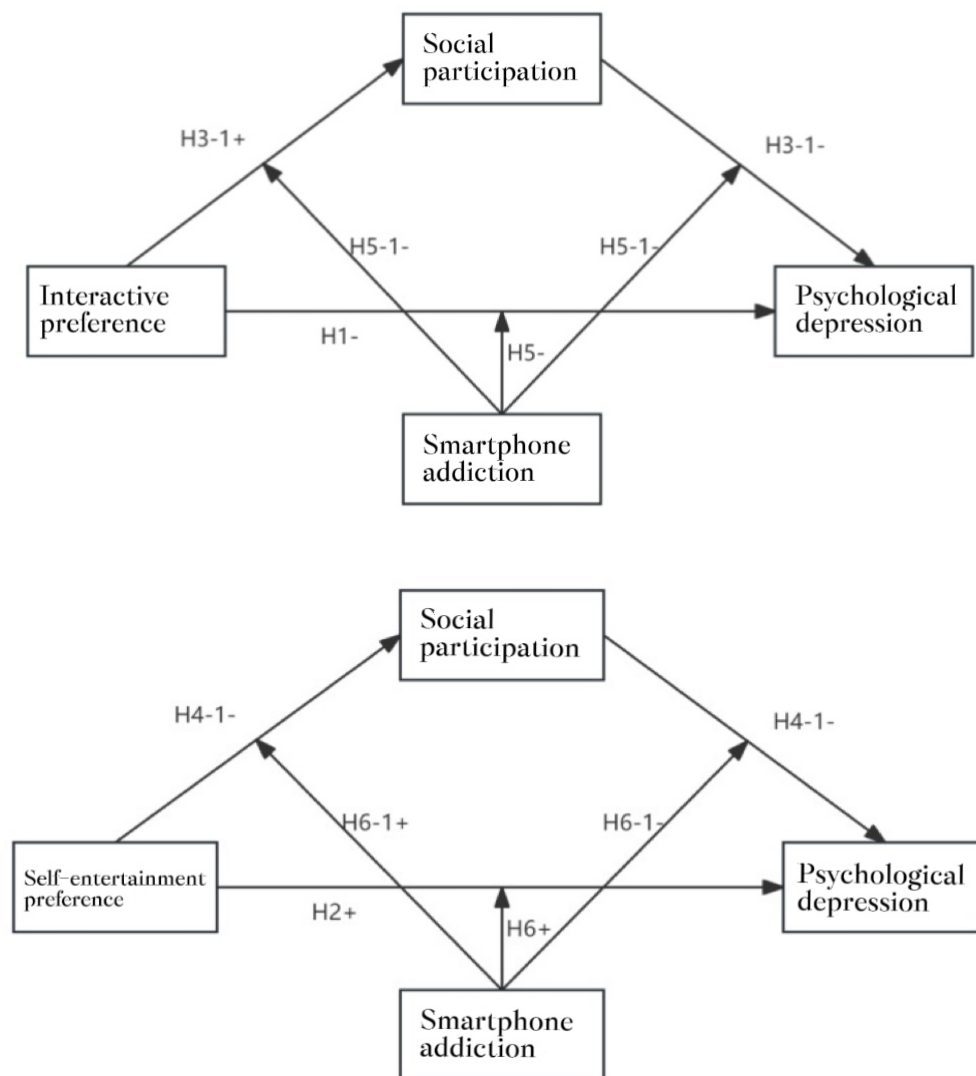


Figure 1. Variable Model

2. Method

2.1 Data Source

This study draws upon data from the Smartphone Use Behaviors and Mental Health among Older Adults survey. Conducted in October-November 2024, the survey was designed by the Social Work Research and Training Center at Guangdong University of Foreign Studies, in collaboration with local civil affairs authorities. All participants provided informed consent before participating in the study. Staff from community social work stations and home-based eldercare service centers in a major city in Southern China administered the questionnaire to a large, non-random sample through targeted distribution. Of the 2,614 questionnaires distributed, 2,585 valid responses were collected, yielding a 98.9% response rate.

2.2 Variable Description and Explanation

2.2.1 Dependent Variable: Psychological Depression

The Geriatric Depression Scale (GDS-15) developed by Huang (2013) was employed to measure depression symptoms. This 15-item scale comprises four dimensions: unpleasant mood, apathy and anxiety, hopelessness, and memory loss/social withdrawal. Respondents answered each item with “yes” or “no”. Each “yes” is scored as 1 point, and each “no” is scored as 0, with higher scores indicating more pronounced depressive symptoms. In this study, Cronbach’s α was 0.790.

2.2.2 Independent Variables: Interactive Preference and Self-Entertainment Preference

The questionnaire included two multiple-response questions on older adults’ smartphone use preferences. The first asked respondents which smartphone functions they typically use, and the second asked them to indicate, from these functions, which ones they use most frequently (up to three choices). Factor analysis of the first question’s 12 commonly used smartphone functions revealed three factors. The first factor (total variance explained = 3.627) included “watching TV series or movies”, “listening to music”, “handling work-related tasks or official matters via apps”, “playing or watching games (including card games, chess etc.)”, “stock trading/financial management” and “reading or listening to e-books or news”. These functions share a focus on individual work or entertainment. The second factor (total variance explained = 1.264) comprised functions indicative of interpersonal interaction, such as “WeChat chats (text, voice, video)”, “watching WeChat Video Channels, TikTok, or Kuaishou clips”, “taking photos or videos” and “mobile payment or money transfers”. The third factor (total variance explained = 1.122) was represented by the two basic services offered by mobile operators—“making phone calls” and “sending/receiving text messages”. All factor loadings exceeded 0.50.

To better capture older adults’ smartphone use preferences, this study focused on the first two factors. Specifically, older adults’ self-entertainment preference is measured by the number of “most frequently used” functions from the first factor, and their interactive preference is measured by the number of “most frequently used” functions from the second factor. A higher count of chosen functions indicates a stronger preference in that domain.

2.2.3 Mediating Variable: Social Participation

Social participation was assessed using a 22-item scale developed by Ren et al. (2024). The scale encompasses six dimensions—visits with relatives and friends, group recreational activities, volunteer/community services, household tasks, leisure activities, and online engagement—and uses a five-point Likert format ranging from 1 (“never”) to 5 (“always”). Respondents receive both an overall social participation score and dimension-specific scores, with higher values indicating greater participation. In this study, Cronbach’s α was 0.946.

2.2.4 Moderating Variable: Smartphone Addiction

Older adults' smartphone addiction was evaluated using the Mobile Phone Addiction Index (MPAI) developed by Leung (2008). This 17-item scale covers four dimensions: uncontrollability, withdrawal, escape, and inefficiency. Each item uses a five-point Likert scale (1 = "never", 5 = "always"), with higher scores reflecting greater smartphone dependence. In this study, Cronbach's α was 0.968.

2.2.5 Control Variables

The control variables in this study include gender, age, educational attainment, income level, marital status, health status, daily smartphone use (in hours). All Variance Inflation Factors (VIF) were below 2—well under the critical threshold of 10—indicating no serious multicollinearity issues.

Table 1. Descriptive Statistics

Variable	Category	Frequency (%)	Variable	Mean	Standard Deviation
Age Group	60-69 years old	1490 (57.60)	Married	0.6244	0.4844
	70-79 years old	729 (28.20)	Male	0.3350	0.4721
	80 years old and above	366 (14.20)	Pension	0.7381	0.4398
Education Level	Elementary school or below	1056 (40.90)	Old Age Pension	0.3397	0.4737
	Junior or senior high school	1205 (46.60)	Rent Income	0.0921	0.2892
	Junior college or above	324 (12.50)	Children's Support	0.2979	0.4574
Monthly Income	Below 2000 RMB	797 (30.80)	Investment or Savings	0.0739	0.2616
	2000-5000 RMB	1224 (47.40)	Continued Work	0.0596	0.2367
	Above 5000 RMB	564 (21.80)	Government Subsidy	0.0839	0.2774
Living Area	Rural	488 (19.40)	Split Dividend	0.07	0.2552
	Urban	1615 (64.30)	Social	0	1

	Suburban	408 (16.20)	Participation Psychological depression	0	1
Self-entertainment Preference	No	2056 (79.50)	Smartphone addiction	0	1
	Moderate Preference	468 (18.10)	Mobile Usage Duration	3.9826	3.0608
	Strong Preference	61 (2.40)			
Interactive Preference	No	387 (15.00)			
	Moderate Preference	923 (35.70)			
	Strong Preference	1275 (49.30)			

3. Result

3.1 Multiple Linear Regression Estimations of Different Smartphone Use Preferences on Psychological Depression among Older Adults

This study first estimated the impact of self-entertainment preferences and interactive preferences on psychological depression. Since both interactive and self-entertainment preferences are ordinal categorical variables, they were converted into dummy variables. For both variables, older adults who did not select the category were used as the reference group. Choosing one option as the most frequently used function was categorized as weak preference dummy variable, while selecting two or more options was categorized as strong preference dummy variable. Models 1 and 2 in Table 1 are baseline regression models that only include the two dummy variables for interactive and self-entertainment preferences, respectively. The regression results from Model 1 show that, compared to no self-entertainment preference, both weak and strong self-entertainment preferences increase the level of psychological depression, but the increase due to weak self-entertainment preference is not significant, whereas the effect of strong self-entertainment preference is significant at the 1% confidence level. The regression results from Model 2 show that, compared to no interactive preference, both weak and strong interactive preferences reduce the level of psychological depression, and both are significant at the 1% confidence level.

Building upon Models 1 and 2, Models 3 and 4 include other control variables. The regression results indicate that after controlling for other variables, strong self-entertainment preference significantly increases the depression level of older adults at the 1% confidence level, compared to no

self-entertainment preference. Both weak and strong interactive preferences significantly reduce depression levels at the 5% confidence level. Thus, Hypotheses H1 and H2 are supported. Overall, the more pronounced older adults' interactive smartphone use preferences are, the lower their level of psychological depression; conversely, the stronger their self-entertainment preferences, the higher their level of psychological depression.

Male (female = 0), moderate income and high income (low income = 0), married (unmarried, widowed, divorced = 0), good health (chronic diseases or serious illnesses affecting quality of life = 0), and smartphone usage duration all have significant effects on the psychological depression levels of older adults at the 5% confidence level. Specifically, compared to women, male older adults show higher levels of depression; compared to low-income older adults, those with moderate and high incomes have lower levels of psychological depression, indicating that older adults' depression levels decrease as income increases; compared to unmarried, widowed, or divorced older adults, married older adults have lower depression levels. After controlling for other variables, the longer the smartphone usage, the more likely it is to increase depression levels. In conclusion, the interactive smartphone use preference among older adults has a positive impact on their mental health, whereas self-entertainment preference has a negative impact.

Table 2. Regression Analysis of Elderly Psychological Depression

variable	Model 1	Model 2	Model 3	Model 4
_cons	-0.016	0.296***	0.691***	0.795***
Weak self-entertainment preference (no self-entertainment preference = 0)	0.005		-0.037	
Strong self-entertainment preference (no self-entertainment preference = 0)	0.629***		0.568***	
Weak interactive preference (no interactive preference = 0)		-0.245***		-0.122*
Strong interactive preference (no interactive preference = 0)		-0.423***		-0.260***
Male (female=0)			0.088*	0.085*
70-79 years old (60-69years old=0)			-0.052	-0.067
80 years old and above (60-69years old=0)			-0.009	-0.04
Middle school (elementary education and below=0)			-0.053	-0.045
Junior college and above (elementary			-0.024	-0.001

variable	Model 1	Model 2	Model 3	Model 4
education and below = 0)				
Middle income (low income = 0)			-0.199***	-0.185***
High income (low income = 0)			-0.367***	-0.342***
Being married (unmarried/widowed/divorced = 0)			-0.195***	-0.183***
Having good health (having a chronic or serious illness that affects quality of life = 0)			-0.551***	-0.524***
Mobile phone usage duration			0.018***	0.027***
R ²	0.009	0.022	0.098	0.098
ΔR^2	0.008	0.021	0.094	0.094
F	11.848***	29.022**	23.396***	23.385***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 Mediation Effect of Social Participation

A mediation analysis was conducted using PROCESS (version 4.0) in SPSS (Model 4) with the bootstrap method (5,000 samples, 95% confidence intervals). Interactive preference and self-entertainment preference served as independent variables, depression as the dependent variable, and social participation as the mediator. Gender, health status, age, educational level, income, marital status, and daily smartphone use duration were included as control variables. This approach allowed an examination of how different smartphone use preferences affect the mental health of older adults.

3.2.1 Mediation Effect of Social Participation on the Relationship between Interactive Preference and Depression

The mediating effect analysis of social participation between interactive preferences and depression in older adults, as shown in Table 2, reveals that both strong and weak interactive preferences significantly negatively predict depression, and significantly positively predict social participation, compared to no interactive preference. Path analysis indicates that when both interactive preferences and social participation are included as variables, both strong and weak interactive preferences and social participation significantly negatively predict depression.

Table 3. Analysis of the Mediating Effect of Social Participation between Interactive Preferences and Depression in the Elderly

Regression Model		Fit indices			Coefficient significance	
Outcome variable	Prediction Variable	R	R ²	F	β	t
Psychological depression	Weak Interactive Preference	.3136	.0984	23.3847	-.1220	-2.0051*
	Strong Interactive Preference				-.2600	-4.2450***
Social participation	Weak Interactive Preference	.5088	.2588	74.8510	.3154	5.7178***
	Strong Interactive Preference				.3028	5.4517***
Psychological depression	Weak Interactive Preference	.3533	.1248	28.2011	-.0624	-1.0348
	Strong Interactive Preference				-.2029	-3.3414***
	Social Participation				-.1888	-8.8112***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Bootstrap analysis of path effect significance testing, as shown in Table 3, reveals the following: In the first step, the direct effect of interactive preferences on depression was tested. Using no interactive preference as the reference, strong interactive preference significantly reduces depression levels, with the effect size of the direct effect being -0.2029, accounting for 78.01% of the total effect. However, the effect of weak interactive preference is not significant, with the 95% Bootstrap confidence interval ranging from [-0.1807, 0.0559], including 0. In the second step, social participation was added as a mediator to test the indirect effect. The indirect effects of both strong and weak interactive preferences on depression were significant, with effect sizes of -0.0572 and -0.0596, respectively, accounting for 21.99% and 48.85% of the total effect. This result indicates that interactive preferences in smartphone

use among older adults directly reduce their depression risk and, furthermore, further reduce their depression levels by increasing social participation. Hypotheses H3 and H3-1 are thus validated.

Table 4. Bootstrap Analysis of the Significance Test for Path Effects

Effect	Path	Effect size	Confidence interval		Relative value of the effect size
			BootLLCI	BootULCI	
Direct effect	Weak Interactive Preference→Psychological depression	-.0624	-.1807	.0559	51.15%
	Weak Interactive Preference→Social Participation→Psychological depression	-.0596*	-.0863	-.0355	48.85%
Total effect	Weak Interactive Preference	-.1220*	-.2413	-.0027	100.00%
Direct effect	Strong Interactive Preference→Psychological depression	-.2029***	-.3219	-.0838	78.01%
	Strong Interactive Preference→Social Participation→Psychological depression	-.0572*	-.0842	-.0327	21.99%
Total effect	Strong Interactive Preference	-.2601***	-.3801	-.1399	100.00%

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

3.2.2 Mediation Effect of Social Participation on the Relationship between Self-Entertainment Preference and Depression

The mediating effect analysis of social participation between self-entertainment preferences and depression in older adults, as shown in Table 4, reveals that self-entertainment preference has a significant positive effect on depression ($\beta = 0.0395$, $t = 2.0692$, $p < 0.05$), but it does not have a significant positive effect on social participation ($\beta = 0.0248$, $t = 1.4290$, $p > 0.05$).

According to path analysis, when both self-entertainment preference and social participation are included as variables, self-entertainment preference still significantly positively affects depression ($\beta = 0.0444$, $t = 2.3595$, $p < 0.05$), while social participation significantly negatively affects depression ($\beta =$

-0.1955, $t = -9.1634$, $p < 0.001$).

Table 5. Mediating Effect of Social Participation between Self-entertainment Preference and Depression in Older Adults

Regression Model		Fit indices			Coefficient significance	
Outcome variable	Prediction Variable	R	R ²	F	β	t
Psychological depression	Weak self-entertainment preference	.3137	.0984	23.3965	-.0372	-.7577
	Strong self-entertainment preference				.5683	4.5322***
Social Participation	Weak self-entertainment preference	.4994	.2494	71.1986	.0251	.5608
	Strong self-entertainment preference				.1762	1.5402
Psychological depression	Weak self-entertainment preference	.3572	.1276	28.9165	-.0323	-.6675
	Strong self-entertainment preference				.6030	4.8856***
	Social Participation				-.1970	-9.2677***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Bootstrap analysis of path effect significance testing, as shown in Table 5, reveals the following: In the first step, the direct effect of self-entertainment preference on depression was tested. The results show that strong self-entertainment preference significantly increases depression levels, with the 95% Bootstrap confidence interval ranging from [0.3610, 0.8451], excluding 0. The effect size of the direct effect is 0.6030. In the second step, social participation was added as a mediator to test the indirect effect. The indirect effects of both strong and weak self-entertainment preferences on depression were not significant, as the 95% Bootstrap confidence intervals for both included 0. The indirect effect sizes were -0.0347 and -0.0050, respectively. Therefore, social participation does not mediate the

relationship between self-entertainment preference and depression in older adults, meaning that Hypotheses H4 and H4-1 are not supported.

Table 6. Bootstrap Analysis of Path Effect Significance Testing

Effect	Path	Effect size	Confidence interval		Relative value of the effect size
			BootLLCI	BootULCI	
Direct effect	Weak self-entertainment preference→Psychological depression	-.0323	-.1270	.0625	86.60%
	Weak self-entertainment preference→Social Participation→Psychological depression	-.0050	-.0230	.0128	13.40%
Total effect	Weak self-entertainment preference	-.0373	-.1335	.0591	100.00%
Direct effect	Strong self-entertainment preference→Psychological depression	.6030***	.3610	.8451	106.11%
	Strong self-entertainment preference→Social Participation→Psychological depression	-.0347	-.0926	.0193	-6.11%
Total effect	Strong self-entertainment preference	.5683***	.3224	.8142	100.00%

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

3.3 Moderated Mediation Analysis

This study used Model 8 in PROCESS 4.0 to examine the mediating effect of social participation, with interactive preference and self-entertainment preference as independent variables, depression as the dependent variable, and social participation as the mediator. Gender, health status, age, educational level, income, marital status, and smartphone usage duration were included as control variables to explore the differential impact of smartphone usage behaviors for different purposes on the mental health of older adults. In this study, the independent variables were categorized as follows: X1 represents weak preference (only one most frequently used smartphone function), and X2 represents strong preference (two or more most frequently used functions), with no smartphone usage preference

as the reference group.

3.3.1 Moderated Mediation of the Effect of Interactive Preference on Depression

As shown in Table 1 and Figures 1 and 2, after controlling for relevant variables, in Equation 1, weak interactive preference significantly predicts social participation ($\beta = 0.186$, $t = 3.137$, $p < 0.01$), strong interactive preference significantly predicts social participation ($\beta = 0.182$, $t = 3.070$, $p < 0.01$), and smartphone addiction significantly predicts social participation ($\beta = 0.346$, $t = 6.869$, $p < 0.001$). However, the interaction between weak interactive preference and smartphone addiction does not have a significant effect on social participation ($\beta = -0.105$, $t = -1.872$, $p > 0.05$). Notably, the interaction between strong interactive preference and smartphone addiction has a significant effect on social participation ($\beta = -0.232$, $t = -4.141$, $p < 0.001$). As a moderating variable, smartphone addiction alters the impact of varying levels of interactive preference on social participation.

In Equation 2, weak interactive preference significantly predicts depressive emotions ($\beta = -0.186$, $t = -2.952$, $p < 0.01$), while strong interactive preference does not have a significant effect on depressive emotions ($\beta = -0.329$, $t = -5.229$, $p > 0.05$). Smartphone addiction significantly predicts depressive emotions ($\beta = 0.435$, $t = 8.051$, $p < 0.001$), and the interaction between weak interactive preference and smartphone addiction does not significantly affect depressive emotions ($\beta = -0.107$, $t = -1.796$, $p > 0.05$). However, the interaction between strong interactive preference and smartphone addiction has a significant effect on depressive emotions ($\beta = -0.159$, $t = -2.666$, $p < 0.01$). Social participation also has a significant effect on depressive emotions ($\beta = -0.263$, $t = -12.567$, $p < 0.001$).

Table 7. Moderated Mediation Effect Analysis of Interactive Preferences on Depressive Emotions

	Equation 1: Social Participation			Equation 2: Psychological depression		
	β	SE	t	β	SE	t
Weak Interactive Preference	.1856	.0592	3.1371**	-.1859	.0630	-2.9516**
Strong Interactive Preference	.1816	.0592	3.0700**	-.3292	.0630	-5.2290***
Social Participation (M)				-.2634	.0210	-12.5674***
Smartphone addiction (W)	.3464	.0504	6.8691	.4352	.0541	8.0511***
Weak Interactive Preference*Smartphone addiction	-.1053	.0563	-1.8721	-.1074	.0598	-1.7955
Strong Interactive Preference*Smartphone	-.2315	.0559	-4.1411***	-.1588	.0596	-2.6658**

addiction

Control variables	control	control	control	control	control	control
F	72.2731			41.8756		
R ²	.2968			.2069		

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

To further clarify the moderating effect of smartphone addiction between interactive preference, social participation, and depression levels, we conducted a simple slope analysis. The results in Figure 2 indicate that, in the case of low to moderate smartphone addiction, both weak and strong interactive preferences significantly increase social participation levels. However, in the case of high addiction, the positive effect of weak interactive preference on social participation decreases, and strong interactive preference even has a negative impact on social participation. This may suggest that individuals who excessively rely on smartphones may experience lower levels of social participation, especially in the context of strong interactive preferences. Figure 3 provides additional explanations.

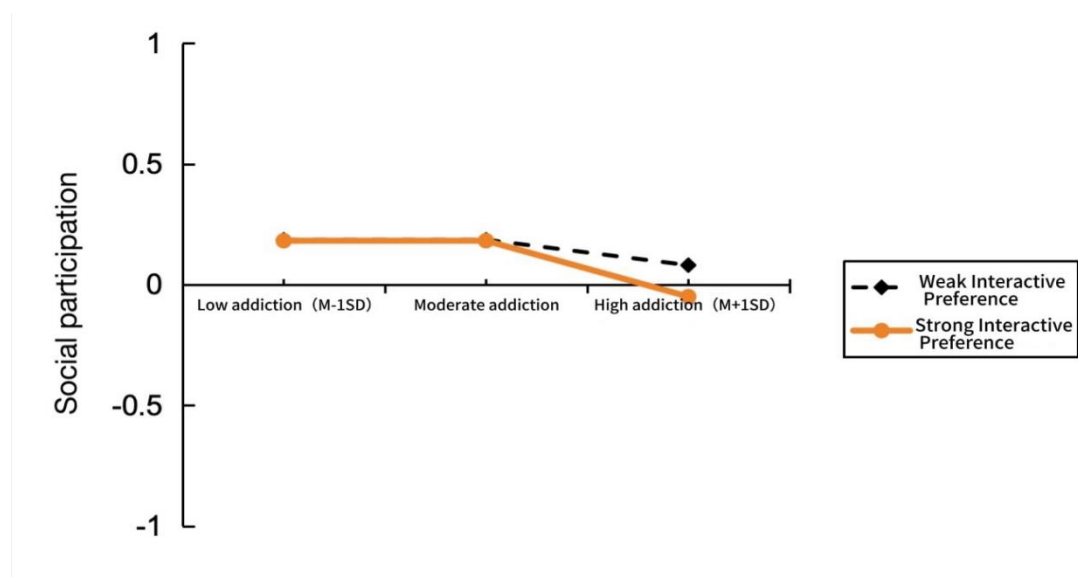


Figure 2. Moderating Effect of Smartphone Addiction on the Relationship between Interactive Preference and Social Participation

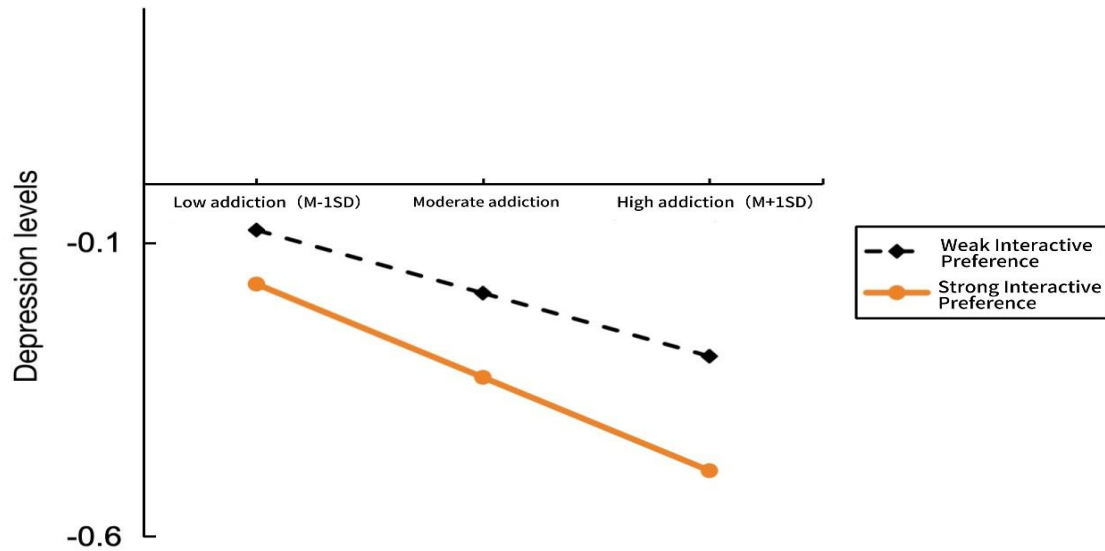


Figure 3. Moderating Effect of Smartphone Addiction on the Relationship between Interactive Preference and Depression Levels

3.3.2 Moderated Mediation of the Effect of Self-Entertainment Preference on Depression

As shown in Table 7 and Figure 4, after controlling for relevant variables, in Equation 1, both strong and weak self-entertainment preferences do not significantly predict social participation. Smartphone addiction significantly predicts social participation ($\beta = 0.1936$, $t = 9.6011$, $p < 0.001$), and the interaction between self-entertainment preferences and smartphone addiction does not have a significant positive moderating effect on social participation.

In Equation 2, strong self-entertainment preference significantly positively predicts depressive emotions ($\beta = 0.5176$, $t = 4.2607$, $p < 0.05$), and smartphone addiction significantly predicts depressive emotions ($\beta = 0.313$, $t = 15.086$, $p < 0.001$). However, the interaction between self-entertainment preference and smartphone addiction does not have a significant effect on social participation ($\beta = 0.022$, $t = 1.444$, $p > 0.05$). Social participation significantly predicts depressive emotions ($\beta = 0.260$, $t = -12.394$, $p < 0.001$), but the interaction between smartphone addiction and social participation does not have a significant effect on depressive emotions ($\beta = 0.022$, $t = 1.444$, $p > 0.05$).

Table 8. Moderated Mediation Effect Analysis of Self-entertainment Preferences on Depressive Emotions

	Equation 1: Social Participation			Equation 2: Psychological depression		
	β	SE	t	β	SE	t
Weak self-entertainment preference	.0245	.0438	.5590	-.0314	.0462	-.6802
Strong self-entertainment preference	.1050	.1151	.9122	.5176	.1215	4.2607***
Social Participation (M)				-.2677	.0208	-12.8580***
Smartphone addiction (W)	.1936	.0202	9.6011***	.2962	.0217	13.6714***
Weak self-entertainment preference*Smartphone addiction	.0314	.0431	.7287	.0300	.0455	.6586
Strong self-entertainment preference*Smartphone addiction	.1032	.0961	1.0747	.1188	.1014	1.1715
Control variables	control	control	control	control	control	control
F	68.1639			41.0224		
R ²	0.2847			.2036		

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

To better explain the substantial moderating effect of self-entertainment preference and smartphone addiction on social participation, the mean of smartphone addiction was adjusted by adding and subtracting one standard deviation ($M \pm 1SD$). The sample was divided into two groups based on their scores, representing high and low smartphone addiction, and then a simple slope test was conducted to generate the corresponding simple effect analysis chart. The results show that under high smartphone addiction ($\beta_{\text{simple}} = -0.059$, $t = -2.298$, $p < 0.05$), there is a significant negative moderating effect on the relationship between self-entertainment preference and social participation. Under low smartphone addiction ($\beta_{\text{simple}} = 0.065$, $t = 2.459$, $p < 0.05$), there is a significant positive moderating effect on the relationship between self-entertainment preference and social participation. Since the moderating effect of smartphone addiction is negative, this means that as smartphone addiction increases (from low interactive preference to high interactive preference), the positive impact of self-entertainment preference on social participation weakens.

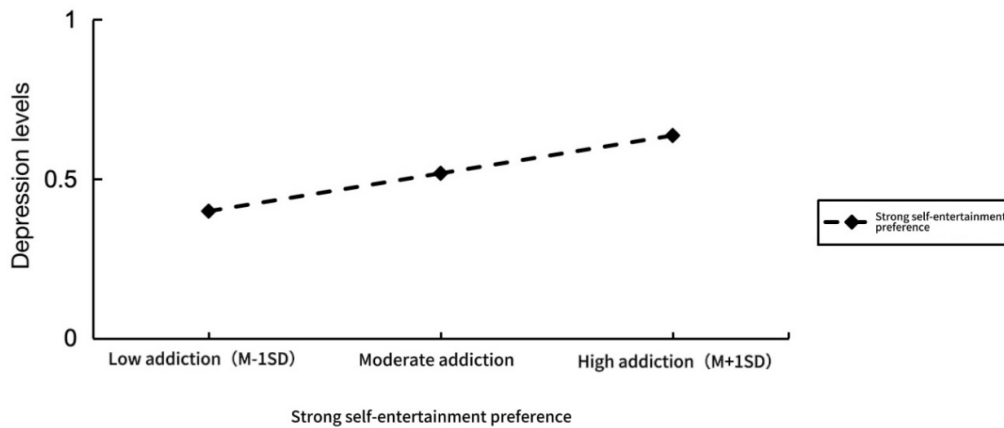


Figure 4. Simple Slope Analysis Plot

4. Discussion

The study's findings indicate that interactive smartphone use—such as WeChat chatting or social media engagement—is associated with lower levels of depression among older adults. This may be because interactive usage enhances older adults' social connections and participation, thereby reducing loneliness and depressive symptoms, thus supporting Hypothesis H1. The study also reveals that self-entertainment smartphone activities—such as watching videos or playing games—are linked to higher depression levels, possibly because excessive self-entertainment reduces face-to-face interactions and thus decreases social participation and increases the risk of depression; Hypothesis H2 is therefore confirmed. The analysis shows that social participation mediates the relationship between interactive preference and depression: older adults who engage in interactive smartphone usage are more socially involved, which in turn lowers their depression levels, confirming Hypothesis H3. Results further demonstrate that social participation mediates the relationship between self-entertainment preference and depression. Unlike interactive preference, however, self-entertainment preference increases depression by reducing social participation, thereby confirming Hypothesis H4 as well.

Although smartphone addiction does, to some extent, moderate the relationship between interactive preference and depression, this effect is not as pronounced as expected, suggesting that the influence of smartphone addiction on the interactive preference-depression link may be shaped by other factors. Hence, Hypothesis H5 is partially supported. Meanwhile, the moderating effect of smartphone addiction on the relationship between self-entertainment preference and depression is also not significant, pointing to a similarly complex influence in this domain; Hypothesis H6 is likewise partially supported.

Based on these findings, it can be inferred that older adults' smartphone use preferences significantly affect their mental health. Interactive smartphone use preferences reduce depression by enhancing social participation, whereas self-entertainment preferences may increase depression by diminishing social participation. Social participation thus plays a pivotal mediating role in this process. These conclusions are consistent with previous research, particularly regarding the connections between smartphone use, social participation, and mental health. By offering empirical analysis, this study enriches existing knowledge in the field, especially concerning the moderating role of smartphone addiction.

The results of this study contribute to a deeper understanding of how older adults can maintain or improve their mental health through smartphone usage, while also highlighting the potential risks posed by smartphone addiction. However, the non-random sampling method limits the generalizability of the findings, which are more applicable to urban older populations. Moreover, because mature scales for measuring smartphone addiction are still in development, the present study's measurement may be incomplete. Future research could further investigate how smartphone addiction affects older adults' mental health, particularly across different cultural and social contexts. Additional longitudinal studies, as well as comparative analyses of older adults of different age brackets and socioeconomic statuses, would help form a more comprehensive picture of the impact of smartphone use on older adults' mental health.

Findings from this research underscore that interactive smartphone use preferences have a protective effect on older adults' mental health, whereas self-entertainment preferences may exacerbate the risk of depression. These insights offer several valuable implications for social work with older adults:

Social workers should facilitate more opportunities for older adults to engage in community gatherings, volunteer activities, and interest groups, thereby reinforcing their social connections and participation, and by organizing in-person events, they can help older adults reduce their dependence on smartphones' self-entertainment features, lowering the risk of depression. Moreover, teaching older adults how to use smartphones for social interactions—rather than merely for entertainment—and guiding them to recognize and avoid excessive dependence can lessen the likelihood of smartphone addiction, while social workers should remain attentive to older adults' mental health, offering psychological counseling, support services, and, where necessary, professional interventions or treatment for those showing depressive symptoms. In addition, collaborations between social workers and technology companies could produce smartphone applications tailored to older adults, emphasizing social interaction and easy-to-use interfaces that foster communication and information access rather than pure entertainment, and social workers should also monitor older adults' smartphone usage, especially in cases suggestive of addictive behaviors, providing professional intervention or treatment services for those with signs of smartphone addiction. Finally, social workers can partake in policy-making to promote increased social participation opportunities and resources for older adults,

and advocacy efforts can ensure greater societal and governmental attention to older adults' smartphone use, safeguarding their rights and improving their overall well-being. By implementing these strategies, social workers can more effectively design and deliver services that enable older adults to benefit from the advantages of smartphone use while mitigating potential negative effects, thereby improving older adults' quality of life and social well-being.

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