ARTICLE

Internet Use and Mental Health among Older Adults in China: Beneficial for Those Who Lack of Intergenerational Emotional Support or Suffering from Chronic Diseases?

Yuxin Wang[1,2,*] and Jia Shi[1,2]

[1]School of Economics, Hefei University of Technology, Hefei, 230601, China

[2]Center for Industrial Information and Economic Research, Hefei University of Technology, Hefei, 230601, China

*Corresponding Author: Yuxin Wang. Email: wangyuxin@hfut.edu.cn

ABSTRACT

In the 21st century, the rapid growth of the Internet has presented a significant avenue for China to respond actively to the aging population and promote the "Healthy China" strategy in an orderly manner. This study uses panel data from the China Health and Retirement Longitudinal Study (CHARLS) to empirically investigate the influence of Internet use on the mental health of older adults, particularly those who lack intergenerational emotional support and suffer from chronic diseases. This study employs a multi-period difference-in-differences (DID) method and a two-stage instrumental variable approach to address the endogenous problem. Results show that Internet use has improved the mental health of older adults in China significantly. Moreover, Older adults who lack intergenerational emotional support benefit more from Internet use. The beneficial effect is stronger for women and the elderly. Older adults with chronic diseases get greater benefits from using the Internet. Additionally, there is gender and age heterogeneity. Given this, governments should strengthen the Internet infrastructure and create a favorable online environment for older adults to maximize the positive impact of the Internet. Simultaneously, governments should make practical efforts to increase older adults' Internet usage, particularly those who lack intergenerational emotional support and those suffering from chronic diseases.

KEYWORDS

Internet use; older adults; mental health; child face-to-face contact; chronic diseases

Introduction

Many countries around the world are experiencing population aging. The current situation in China is becoming increasingly severe. By the end of 2022, there were 280 million individuals who were above 60, making up 19.8% of the overall population [1]. As the population ages, the mental health of older adults is a growing concern. It has become a global consensus to pay attention to their mental health. However, the current older Chinese mental health is not promising. According to the CHARLS 2018 data, 24.41% of them in urban areas and 35.03% of them in rural areas suffer from depression. In China, more than 20% of the elderly suffer

from depression, and health problems caused by mental health issues, such as self-harm, dementia, and suicide, are also common, putting a heavy burden on families and society while constantly influencing the public perception of an aging society [2]. Older adults' mental health not only affects the well-being of this age group but also has implications for China's future social burden of caring for older adults and its economic development potential. Improving their mental health is vital in promoting active aging and achieving the "Healthy China" strategy.

Along with aging comes high-speed information technology. People's lifestyles have changed because of the Internet's popularity, and an increasing number of people

may now enjoy convenient information delivery and a wide range of daily services via the Internet. As Bowman said, the world has changed from a "solid" society to a "liquid" society, and the Internet is triggering a revolution in contemporary society. This revolution not only alters the processes of generating, storing, distributing, and accessing information, but it also transforms how people interact [3]. The Internet has created a new social networking platform. It has gradually supplanted the previous correspondence culture. People are continually learning new skills to adapt to new social media platforms and create new social networks. As of December 2022, the China Internet Network Information Centre (CNNIC) reported that 1,067 billion people in China were using the Internet. Compared to the December 2021 survey data, the percentage of Internet users above 50 climbed from 26.8% to 30.8%, resulting in an Internet penetration rate of 75.6%. This suggests that older adults are using the Internet and adopting it faster [4]. Even though older adults use the internet less frequently than younger individuals, they benefit more from its use [5]. With the timely and efficient access to information that the Internet offers, older adults can learn more, enrich their spiritual and cultural lives, and increase overall happiness [6]. By promoting increased social interaction and providing family support, Internet use can also enhance their mental health by decreasing emotions of loneliness and social isolation [7–9]. Using the Internet for social communication, information search, and entertainment experiences has become a basic need for older adults to enjoy their lives and re-engage with society. Given this, what impacts does the Internet have on the mental health of this population, especially for those who lack intergenerational emotional support and suffer from chronic diseases? These questions deserve an in-depth discussion.

Most existing analyses of the correlation between Internet use and the mental health lack causality identification and have inadequate heterogeneity analyses [10–12]. Given this, the article uses panel data from the China Health and Retirement Longitudinal Study (CHARLS) to empirically investigate the influence of Internet use on the mental health of older Chinese, particularly those who lack intergenerational emotional support and suffer from chronic diseases. This topic has practical implications for China's strategies of "active aging," "digital construction," and "healthy China." The following are potential contributions of this study: (1) Unlike previous literature, the present research employs a two-way fixed effects model with multi-period panel data. Additionally, it attempts to ease the endogeneity problem by selecting instrumental variables and utilizing a multi-period difference-in-difference (DID) method. (2) This study finds that Internet use has improved the mental health of older adults in China significantly, particularly those who lack intergenerational emotional support and suffer from chronic diseases. Furthermore, the study examines whether this effect significantly differs between genders and age groups through heterogeneity analysis. (3) This study provides a new perspective on Internet use by older adults to enhance their mental health and thus put targeted health poverty reduction into practice. It also provides new empirical evidence to promote health-Intenet integration and the development of Internet-based mental health services.

Literature Review and Research Hypotheses

Some academics argue that older adults who use the Internet are psychologically healthier. Specifically, Internet use improves their mental health by enhancing social connectedness, alleviating loneliness, and promoting overall well-being [13–16]. Cotton et al. [17] empirically showed that Internet use by retired Americans above 50 reduced social isolation and loneliness, which reduced depressive symptoms and improved mental health. Hajek et al. [7] also noted that older persons reported feeling less lonely and socially isolated when using online social media or video chat. Shillair et al. [18] found that older adults who feel lonely or lack social support could stay connected through email, social media, or video calls. This connectivity improves their mental health. Furthermore, Karavidas et al. [6] concluded that older adults can also stay informed about their health problems through the Internet. This leads to increased self-efficacy and life satisfaction. Meanwhile, some studies in China have shown that Internet use positively and heterogeneously affects mental health, with Internet use alleviating depressive symptoms more obvious among 60-70-year-olds, females, rural residents, and low-education groups [11].

Some scholars have differing opinions. They believe that Internet usage worsens symptoms of depression and harms mental health. Internet use can reduce people's real-life communication and crowd out other activities, to some extent reducing older adults' sense of community belonging and negatively influencing their mental health [19]. Zheng et al. [20] demonstrated that respondents' Internet use significantly reduced their sadness, feelings of loneliness, and life difficulties. However, the effects varied depending on the specific functions of Internet use. For instance, people's emotions of loneliness grew when they learned online and watched short films, and their problems in life got worse when they shopped online. On the other hand, using WeChat significantly reduced sadness and life difficulties. Xie et al. [21] concluded that modern technology product design is not suitable for older adults who experience technological anxiety towards the Internet. They also found that excessive Internet use may displace the time spent with family and friends, which harms their mental health. Lohmann [22] concluded that people who regularly use the Internet have a greater desire for material things, and their expected income does not match their actual income, resulting in less contentment. Chou et al. [23] believed that adults who use Facebook for too much time are more likely to remember the happy moments shared by others. This can lead to a correspondence bias, creating a perception that life is unfair and that others are happier than oneself.

As an emerging information medium, the Internet is influential in disseminating information and partially addressing the issue of "information blocking" among older adults. They can easily and quickly access information via the Internet, which helps them integrate into society. The

Internet can also overcome spatial barriers and help older adults increase social contact, thereby alleviating their feelings of loneliness. Moreover, they may encounter more challenges in using the Internet than younger individuals. However, they will experience a greater sense of accomplishment after successfully utilizing it.

Therefore, this study proposes:

H1: Internet use improves the mental health of older adults in China significantly.

According to Maslow's Hierarchy of Needs, humans need belonging and love. If our needs for social interaction are not met, it will have a negative impact [24]. Older adults may experience various life changes, for example, the loss of family members or friends or the departure of a child. These changes can leave them with unfulfilled social interaction needs, leading to feelings of loneliness [25]. It is also crucial to note that persistent loneliness is a significant source of distress among older adults, and it increases the risk of depression [26,27]. Children depend on their parents during their childhood, but as they age, parents begin to rely on their children to varying degrees [24]. Especially in China, where traditional Confucian culture emphasizes family harmony and filial piety, the lack of contact between children and parents is considered a sign of unfiliality. Furthermore, older adults may experience an increase in symptoms of depression due to neglecting their emotional needs [28].

The most fundamental and significant interaction in intergenerational support is face-to-face interaction with children [29]. When older adults do not have frequent face-to-face interactions with children, they may become lonely, which can exacerbate depression symptoms. At this time, the Internet can be helpful, as online communication can supplement face-to-face contact and help them overcome feelings of loneliness [30]. Since the Internet provides a platform for older adults to overcome loneliness and stay connected with their friends and children, it helps bridge the communication gap. Older adults who lack child face-to-face interactions benefit more from using it [31,32]. Furthermore, through the Internet, they can overcome time and space obstacles and access large volumes of information without leaving their homes [11,33]. All of these relieve their loneliness from not seeing their children, lowering the likelihood of mental health problems. Face-to-face interactions may bring unique benefits unavailable through internet contact [30]. As a result, older adults who see their children frequently have inherently better mental health and rely less on the Internet to overcome loneliness and connect with the outside world [34]. Thus, Internet use is more useful for older adults who lack intergenerational emotional support [35].

Therefore, this study proposes:

H2: Older adults who lack intergenerational emotional support benefit more from Internet use.

Another important variable that academics are concerned with is physical health status. Fang et al. [36] discovered that the Internet's positive influence on mental health was only significant in older people with poor physical health. As individuals age, older adults are increasingly prone to developing chronic diseases. The more chronic diseases they have, the greater their activity limitations become, which can even restrict their participation in face-to-face social activities.

At this point, the Internet plays an important role in helping them overcome spatial barriers and compensating for their inability to participate in offline social activities by engaging in online activities without leaving their homes, thereby reducing mental health problems caused by limited physical activities. Furthermore, Internet use can assist sick older adults in looking up health-related information [37], which may lower their anxiety about their health status. Older adults with good physical health status have inherently better mental health and fewer physical limitations, allowing them to participate more fully in offline social activities. They are also less likely to rely on the Internet to enhance their social networks and fulfill their social needs. As a result, older adults with good physical health status benefit less from using the Internet.

Therefore, this study proposes:

H3: Older adults with chronic diseases get greater benefits from using the Internet.

Research Design

Sample selection

The data used in this study was drawn from the CHARLS database, a national household survey conducted every two years since 2011 by Peking University's National Development Research Institute [38] (http://charls.pku.edu.cn). It randomly selected older Chinese residents above 45, covering approximately 17,000 individuals in 150 counties, 450 villages, and 10,000 households. Therefore, this database can provide good data support for the study. We used the data from the CHARLS in 2013, 2015, and 2018 and matched them with the following treatment: we kept samples aged 45 years and above and excluded samples with missing key variables. As a result, we got a final set of panel data for three periods, which included 8,940 participants in the study.

Variable definitions
Mental health

Mental health status is measured in CHARLS as depressive tendencies. In the CHARLS questionnaire, depression scores were calculated using the simplified version of the CES-D Scale [39]. It is widely used in mental health research and assesses participants' levels of positivity, optimism, anxiety, and depression [40–44]. Lei et al. [41] showed good internal reliability of the CHARLS CES-D scale through an empirical study. First, the respondents were asked ten questions about their positive feelings, negative emotions, and physical symptoms during the last week [45]. Then, each question has four choices: less than one day, 1–2 days, 3–4 days, and 5–7 days. Finally, we processed the data to present the results better: based on the respondents' responses, four responses are scored 3, 2, 1, and 0 in that order, where items 5 and 8 are positive questions and are reverse scored, i.e., 0, 1, 2 and 3. The mental health status scores are summed up and range from 0 to 30, with higher scores indicating better mental health status. Thus, the positive

TABLE 1

Variable specifications and descriptive statistics of the sample characteristics

	Variable	Specifications	Mean (SD)	Min	Max
Dependent variable	Mental health	CES-D score	22.010 (6.191)	0	30
Independent variable	Internet use	Use = 1, no use = 0	0.072 (0.259)	0	1
Covariates	Age	Continuous variables	60.423 (8.518)	45	108
	Number of children	Continuous variables	1.017 (1.079)	0	10
	Gender	Male = 1, female = 0	0.498 (0.500)	0	1
	Marriage	Married = 1, others = 0	0.889 (0.314)	0	1
	Pain	Pain = 1, no pain = 0	0.413 (0.492)	0	1
	Log annual income	Add 1 to the total income and take the logarithm	6.052 (4.194)	0	13.402

coefficient indicates that the Internet has a positive impact on mental health.

Internet use
In CHARLS, respondents were asked whether they had used the Internet in the last month. It was coded as 0 or 1.

Control variables
This present study has taken into consideration existing studies and controlled for various factors such as age, number of children, gender, marriage, physical pain, and log annual income to avoid any possible effects of omitted factors in the analysis [43–47]. Table 1 shows the definition and descriptive statistics of the main variables used in our research.

Model establishment
To test the research hypothesis 1 proposed in the previous section, we construct an econometric model as follows:

$$Y_{it} = \alpha_1 + \beta_1 Internet_{it} + \gamma_1 Control_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where Y_{it} refers to mental health scores for the ith adult in year t. $Internet_{it}$ is a binary dummy variable indicating whether the ith individual used the Internet in year t. $Control_{it}$ are other determinants of mental health identified in the literature. μ_i and λ_t are the individual and time fixed effects. According to hypothesis1 proposed in the previous section, $\beta_1 > 0$ is expected. In addition, ϵ_{it} is the stochastic error term.

To test the research hypothesis 2 proposed in the previous section, we construct an econometric model as follows:

$$Y_{it} = \alpha_2 + \beta_2 Internet_{it} + \rho_1 FCWC_{it} + \eta_1 Internet_{it} \\ \times FCWC_{it} + \gamma_2 Control_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (2)$$

The new variable in the model (2) is $FCWC_{it}$, showing child face-to-face contact. In CHARLS 2013, 2015, and 2018, respondents were asked how often they had seen their child in the past year. The scores were reverse coded to ensure that a higher score indicates a higher frequency. The scores range from 0 (rarely) to 8 (once a day). Moreover, if participants had more than one child, the same question was asked to each child separately. By adding up each frequency and

dividing the result by the total number of children, we determined the average frequency. $Internet_{it} \times FCWC_{it}$ represents the interaction term for Internet use and child face-to-face contact. Based on the hypothesis 2 presented previously, η_1 is expected to be <0.

To test the research hypothesis 3 proposed in the previous section, we construct an econometric model as follows:

$$Y_{it} = \alpha_3 + \beta_3 Internet_{it} + \rho_2 Chronic_{it} + \eta_2 Internet_{it} \\ \times Chronic_{it} + \gamma_3 Control_{it} + \mu_i + \lambda_t + \epsilon_{it} \quad (3)$$

The new variable in the model (3) is $Chronic_{it}$, which indicates chronic diseases. In CHARLS, the question related to chronic diseases is, "Had a doctor ever informed you that you had any of the following chronic diseases?" There are 14 chronic conditions: hypertension, dyslipidemia, diabetes, malignancies, and so on. A "yes" answer was assigned a value of 1; otherwise, it was given a value of 0. We summarized and centered the 14 responses. $Internet_{it} \times Chronic_{it}$ denotes the interaction term between chronic diseases and Internet use. According to the hypothesis 3, $\eta_2 > 0$ is expected.

Empirical Results and Discussion

Baseline regression results: a test of H1
Table 2 shows the regression results for Eq. (1). Column (1) shows the estimation results, including only control variables. A positive correlation is observed between Internet use and mental health. Column (2) uses a two-way fixed effects model, and the Internet use coefficient is still significant at the 1.1% level. Specifically, those who had used the Internet between 2013 and 2018 scored 0.5 points higher than those who had never used the Internet. Therefore, hypothesis 1 is verified.

Regarding the impact of control variables on older adults' mental health, we discover that a positive correlation exists between marriage and mental health [48]. Specifically, older adults who do not have a partner experience an increased sense of loneliness and are more prone to depression. An increase in annual income also significantly increases mental health scores, probably because an increase in annual income is more likely to meet their daily life needs without worrying about money, thus improving mental health.

TABLE 2

Baseline regression results

Variable	Mental health	
	(1)	(2)
Internet use	1.232***	0.500**
	(0.163)	(0.196)
Age	−0.026***	−0.024
	(0.007)	(0.050)
Marriage	1.826***	1.650***
	(0.160)	(0.313)
Pain	−2.984***	−1.199***
	(0.082)	(0.111)
Number of children	0.009	−0.086
	(0.052)	(0.402)
Log annual income	0.134***	0.035**
	(0.011)	(0.014)
Constant	22.383***	22.377***
	(0.462)	(3.101)
Individual FE		Yes
Time FE		Yes
Observations	17889	17883
Adjusted R^2	0.224	0.523

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively. The values in parentheses are standard errors, the same as below.

According to Rashedi et al. [49], physical pain may serve as a precursor to certain diseases, causing both physical and psychological stress, ultimately leading to harm to mental health. In contrast, the number of children did not significantly affect mental health, indicating that the number of children does not necessarily correlate positively with well-being in current Chinese society.

From Table 2, we can conclude that Internet use is significantly beneficial for mental health and reduces the likelihood of depression. Next, the results of the additional investigation in this study into whether Internet use has different effects on the mental health of different age groups are presented in Table 3. The results in column (1) show that Internet use increases mental health scores for those below 60 by 0.191, but not significantly. Column (2) shows that using the Internet by those above 60 increases mental health scores by 1.644 and is significant at the 1% level. This may be because adults below 60 are generally more physically mobile and less constrained than adults above 60, enabling them to participate in offline social activities and meet up with friends and relatives more frequently. Some of them work and can interact with their coworkers in person daily. As a result, they rely less on the Internet for online socializing. The adults above 60, in contrast, are older, their physical functions have declined, and they cannot go out regularly. They are retired and have fewer offline social activities, so they rely more on the Internet to connect with family or friends and meet their social needs. Furthermore, the Internet's entertainment function can help them pass

TABLE 3

Regression results by age groups

Variable	Mental health	
	Below 60 (1)	Above 60 (2)
Internet	0.191	1.644***
	(0.243)	(0.452)
Constant	30.217***	23.917***
	(5.123)	(4.578)
Control	Yes	Yes
Individual FE	Yes	Yes
Time FE	Yes	Yes
Observations	6669	8296
adj. R^2	0.539	0.530

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

the time and minimize loneliness. Consequently, adults above 60 gain more from Internet use in terms of mental health.

Child face-to-face contact: a test of H2
Column (1) of Table 4 shows the regression results for Eq. (2). A positive correlation is observed between child face-to-face contact and mental health, indicating that intergenerational emotional support positively affects older adults' mental health. The interaction term between child face-to-face contact and Internet use is negative and significantly at 1%. This suggests that older adults who lack intergenerational emotional support benefit more from Internet use, which confirms hypothesis 2. As mentioned earlier, in China's particular socio-cultural context, face-to-face emotional care from children is the most important aspect of filial behavior for older adults. When they do not receive sufficient companionship from their children, they can easily experience feelings of loneliness, which harm their mental health [50]. Internet enables older adults to overcome spatial barriers, strengthen their ties with their children and friends, and expand their knowledge and experiences [51]. This can help reduce feelings of loneliness and improve their mental health [32]. Therefore, older adults who lack intergenerational emotional support benefit more from Internet use.

We also analyzed the above results for heterogeneity. First, we examined gender differences. Column (2) of Table 4 displays the regression results for males, while column (3) shows the results for females. As observed, the interaction term between child face-to-face contact and Internet use is negative and significant at 1% only in female groups. This means that Internet use has a greater effect on females who lack intergenerational emotional support. One possible reason for this is that traditional Chinese families follow the cultural norm that "women are expected to teach their children at home." Women spend most of their lives as homemakers, taking care of the whole family [52]. As a result, they may expect more support from the family than

TABLE 4

Internet use, child face-to-face contact and mental health

Variable	Mental health				
		Gender		Age	
	Full sample (1)	Male (2)	Female (3)	Below 60 (4)	Above 60 (5)
Internet use	0.399	0.574*	0.072	−0.058	1.641***
	(0.250)	(0.298)	(0.435)	(0.329)	(0.526)
Child face-to-face contact	0.160***	0.074	0.257***	0.053	0.251***
	(0.043)	(0.055)	(0.066)	(0.065)	(0.068)
Child face-to-face contact × Internet use	−0.044***	−0.012	-0.074***	−0.015	-0.062***
	(0.014)	(0.020)	(0.020)	(0.027)	(0.019)
Constant	27.064***	35.306***	22.043***	35.469***	24.105***
	(3.642)	(6.778)	(4.035)	(7.255)	(5.191)
Control	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	13624	7056	6539	4282	7102
Adj R^2	0.524	0.490	0.517	0.551	0.528

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

men do and have weaker social networks outside. Intergenerational ties between women and their children are closer. Women's views on filial piety are more conservative, and loneliness problems are more prominent and increase with age [53]. To meet their emotional requirements, women are, therefore, more prone to rely on the Internet to stay in touch with their children, whom they may not frequently, see [54]. Furthermore, women are more likely than males to choose texting, social networking, and online video calling [55]. As children grow up and start a family, women need to take on fewer household chores, often having more leisure time and more time using the Internet for entertainment [56]. In addition, shopping for supplies for the family is an important part of women's job as homemakers, and they may derive greater satisfaction and pleasure from shopping online than men [57]. These all ease the loneliness of not seeing their children. Thus, older females who lack intergenerational emotional support get greater benefits from using the internet compared to their male counterparts.

Next, we conducted an age difference analysis. Column (4) is for the adults below 60, and column (5) is for the adults above 60. It is easy to see the interaction term between child face-to-face contact and Internet use is significantly negative only in adults above 60. This implies that the benefits of Internet use for mental health are greater for adults over 60 who lack intergenerational emotional support. One possible reason may be that, as they age, they feel more isolated and have a stronger emotional need for their children than adults below 60. The Internet helps them connect with their children and friends, and they can also engage in online recreational activities for distraction, all of which can better alleviate feelings of loneliness. As a result,

adults above 60 who lack intergenerational emotional support are more likely to benefit from Internet use than adults below 60.

Chronic diseases: a test of H3
Column (1) of Table 5 shows the regression results for Eq. (3). A negative correlation exists between chronic diseases and mental health. This demonstrates that chronic disease harms mental health. The interaction term between chronic diseases and Internet use is significantly positive. This suggests that Internet use is more useful for older adults with chronic diseases. This finding confirms hypothesis 3. As mentioned above, the more chronic diseases they have, the more physically limited they are, and the more difficult it is for them to take part in offline activities. The Internet can help them connect with the outside world, participate in social activities online, and communicate with their loved ones and friends. The Internet also allows them to learn about health issues. Therefore, older adults who have chronic diseases benefit more from Internet use.

We also analyzed the above results for heterogeneity. First, we conducted an analysis of gender differences. Column (2) of Table 5 displays the regression results for males, while column (3) shows the results for females. As observed, the interaction term is positive and significant only in female groups. In other words, older females with chronic diseases benefit more from Internet use. This may be because women have a stronger need for emotion and, with chronic diseases, are limited in their physical activity and receive less emotional comfort from real life. Using the Internet not only helps them to communicate emotionally with family and friends online, but it also enables them to engage in a variety of online recreational activities. With

TABLE 5

Internet use, chronic diseases and mental health

Variable	Mental health				
		Gender		Age	
	Full sample (1)	Male (2)	Famale (3)	Below 60 (4)	Above 60 (5)
Internet use	0.366*	0.432*	0.225	0.338	1.364***
	(0.200)	(0.244)	(0.339)	(0.257)	(0.446)
Chronic diseases	-0.321***	−0.105	-0.525***	-0.203*	-0.384***
	(0.065)	(0.089)	(0.094)	(0.115)	(0.091)
Chronic diseases × Internet use	0.299**	0.188	0.433**	0.095	0.381*
	(0.118)	(0.158)	(0.177)	(0.160)	(0.228)
Constant	24.663***	27.755***	21.954***	31.762***	23.865***
	(3.272)	(6.214)	(3.688)	(6.183)	(4.880)
Control	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	16245	8347	7859	5997	7602
Adj R^2	0.520	0.487	0.518	0.536	0.527

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

chronic diseases that limit their physical activity and make offline shopping more difficult and the convenience of online shopping, women with chronic diseases can use the Internet for online shopping, which satisfies their shopping needs. In addition, the usage of the Internet by women to obtain medical information for managing chronic conditions is more common than that of males [58]. Therefore, older females with chronic diseases get greater benefits from using the Internet compared to their male counterparts.

Columns (4) and (5) of Table 5 display the regression results for adults below 60 and above 60, respectively. We can see that the interaction is significantly positive only in adults above 60. This implies that adults above 60 with more chronic diseases tend to experience an improvement in their mental health when they use the Internet. This may be because adults above 60 are less fit, more restricted by chronic diseases, and almost trapped at home, with only the Internet for social interaction or recreational activities, compared to adults below 60. Therefore, adults above 60 who have chronic diseases are more likely to benefit from Internet use than adults below 60.

Endogenous problems

Instrumental variables approach

Endogeneity is further considered, using 2SLS for estimation [48]. We choose Internet penetration among older adults at the district level as an instrumental variable. This is because Internet penetration at the district level meets the criteria for selecting instrumental variables. First, relevance, district Internet penetration, and older adults' Internet use are highly correlated. As district Internet penetration increases, the likelihood of individuals using the Internet also

increases; second, exogenous, district-level Internet penetration is often used as a general indicator of a region, but it typically does not directly impact mental health. Specifically, we categorize the sample from the CHARLS questionnaire by community code. Then, we calculate the Internet usage rate in their communities as the Internet penetration rate at the district level. Table 6 reports the results of the IV-2SLS regression, showing a P-value of 0.000 for the Kleibergen-Paap rk LM statistic. According to this finding, there is a high correlation between the instrumental variables and the endogenous independent variables (Internet use). The Kleibergen-Paap Wald rk F statistic is 229.27, significantly greater than the value of

TABLE 6

Instrumental variable regression

Variable	(1) First stage	(2) 2SLS
Internet use		2.571***
		(0.949)
Internet penetration rate of older adults in the community in the current period	0.813*** (0.054)	
Control	Yes	Yes
Individual FE	Yes	Yes
Time FE	Yes	Yes
Observations	17883	17883
Kleibergen-Paap rk LM	180.79***	
Kleibergen-Paap Wald rk F	229.27	

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

16.38 for the 10% maximal IV size proposed by Stock et al. [59]. So, we do not need to be concerned about weak instrumental variables. Columns (1) of Table 6 reports the first-stage regressions, and columns (2) reports the second-stage regressions. Even after controlling for all control variables and two-way fixed effects, there is still a significant positive effect of Internet use on mental health [35]. This suggests that the conclusion of this paper remains valid even after considering the possibility of endogeneity.

Multi-period difference-in-difference (DID)
We further discuss endogeneity using a multi-period DID model. Firstly, we assume the first Internet use to be a shock to older adults. Secondly, the sample of older adults who used the Internet intermittently was excluded. Then, we constructed the model and conducted a parallel trend test. From Fig. 1, we can observe no significant difference in mental health before older adults use the Internet. However, there is a noticeable increase in mental health after they start using the Internet. Table 7 presents the findings of the multi-period DID analysis, controlling for time and individual fixed effects. Internet use still significantly improves the mental health of older adults, further supporting hypothesis 1.

Robustness tests
To ensure the reliability of our estimations, four types of robustness tests are conducted. (1) Removing outliers. To mitigate bias caused by measurement error or outliers, we exclude the 1% of individuals at both ends of the mental health scores [43]. (2) Sample age restriction. Considering that adults above 60 use the Internet less, the sample was restricted to adults above 60. (3) Add the squared term of age. We enhance the analysis of the impact of age on mental health in older adults by including the squared term of age in the model. The findings continue to be solid and reliable. (4) Alternative indicators for Internet use. Frequency of Internet use measures the use of the Internet from another perspective.

The results, as shown in Table 8, show that none of the above four methods impact the conclusions of this paper, and we therefore conclude that older adults who use the Internet are indeed psychologically healthier.
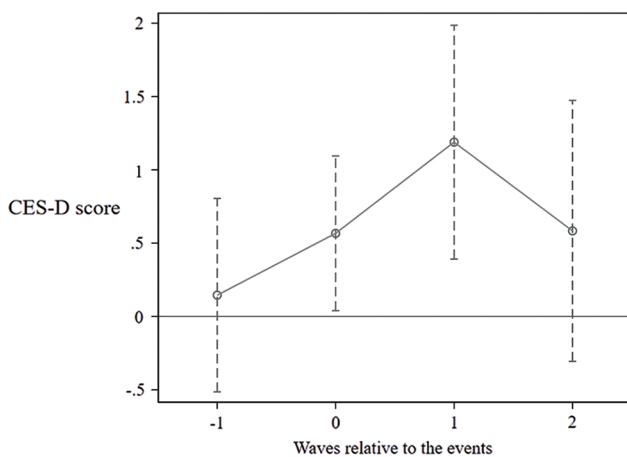

FIGURE 1. Parallel trend test.

TABLE 7

Multi-phase difference-in-difference (DID) regression results

Variable	Mental health
Internet use between 2013 and 2018	0.595**
	(0.233)
Age	−0.025
	(0.050)
Number of children	−0.072
	(0.404)
Marriage	1.580***
	(0.318)
Pain	−1.220***
	(0.113)
Log annual income	0.039***
	(0.015)
Constant	22.431***
	(3.144)
Individual FE	Yes
Time FE	Yes
Observations	17283
Adj R^2	0.521

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

Further discussion
We further explore the impact of Internet use functions and APP use on the mental health of older adults. There is no data on Internet use functions and APP use in the 2013 and 2015 CHARLS databases. Therefore, we utilized the 2018 CHARLS data for our analyses. Table 9 shows that all the functions, except the financial management function, have a

TABLE 8

Robustness tests

Variable	Mental health			
	(1)	(2)	(3)	(4)
Internet use	0.490**	1.644***	0.556***	
	(0.195)	(0.452)	(0.196)	
Frequency of Internet use				0.228**
				(0.102)
Constant	22.571***	23.917***	31.860***	22.417***
	(3.049)	(4.578)	(4.701)	(3.102)
Control	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	17883	8296	17883	17883
Adj R^2	0.523	0.530	0.523	0.523

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

TABLE 9

Internet use fuctions, APP use and mental health

Variable	Mental health							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Online chatting	1.808***							
	(0.281)							
Reading news		2.185***						
		(0.258)						
Watching videos			1.745***					
			(0.279)					
Playing online games				2.120***				
				(0.446)				
Financial management					1.180			
					(0.844)			
WeChat pay						1.985***		
						(0.308)		
WeChat moments							2.063***	
							(0.275)	
WeChat								2.089***
								(0.243)
Constant	21.425***	21.096***	21.465***	21.901***	22.215***	21.222***	21.233***	20.795***
	(0.662)	(0.662)	(0.662)	(0.654)	(0.652)	(0.669)	(0.666)	(0.670)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7020	7020	7020	7020	7020	7020	6972	7020
adj. R^2	0.125	0.129	0.125	0.123	0.120	0.125	0.128	0.129

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

positive and significant effect on older adults' mental health at the 1% level. The mental health of older adults is specifically improved by online chatting, reading news, watching videos, and playing online games, which raise their scores by 1.808, 2.185, 1.745, and 2.120 levels, respectively. The positive effect of financial management function on mental health is not significant. The possible explanation is that while using the Internet for investment may lead to increased income for older adults, there is a certain level of risk involved. This risk can result in financial loss, and they may have a lower tolerance for such losses. Thus, the positive impact of financial management on mental health is not significant. Using WeChat, WeChat payment, and sharing WeChat moments all have significant positive effects on mental health. The results suggest that WeChat provides a more convenient and faster way for older adults to socialize. They are integrating into the digital life of using WeChat and experiencing greater mental health benefits [60].

Conclusions

Promoting the mental health of older adults is a fundamental aspect of implementing the "Healthy China" Strategy and a crucial foundation for proactively addressing population aging. This paper uses data from the CHARLS to empirically assess if Internet use affects older adults' mental health. Firstly, Older adults who use the Internet are mentally healthier. Secondly, older adults who lack intergenerational emotional support benefit more from Internet use. This effect is particularly evident among females and adults above 60 groups. This might be because women are more reliant on their children, and using the Internet helps them alleviate the loneliness that arises from being unable to see their children. Compared to adults below 60, adults above 60 experience more loneliness as they age and have a greater emotional need for their children. The Internet helps them stay in touch with their children. Thirdly, older adults with chronic diseases benefit more from using the Internet. This effect is particularly evident in females and adults above 60 groups. This might be due to women's greater emotional needs. When their chronic illnesses prevent them from doing social offline, ladies can socialize online thanks to the Internet. In addition, adults above 60 have declining bodily functions, are more limited in their physical activities due to chronic diseases and can only utilize the Internet for social or recreation. Fourthly, Internet activities such as chatting, watching videos, and using WeChat can all contribute to mental health.

These experiments confirm that Internet use positively affects older adults' mental health. The paper makes the following three recommendations.

First, increasing older adults' internet usage. Governments are supposed to actively utilize the Internet as an adjunctive treatment for older adults' depression. In comparison, the Internet is simpler and faster than any other healthcare device, and its availability could be a "solution" to an "urgent problem." Firstly, governments should strengthen Internet infrastructure to reduce regional disparities. Secondly, there is a need to revamp existing Internet devices, and some Internet designs may need to be more suitable for older adults. For example, page layouts and smaller fonts can be overwhelming for them. Thirdly, communities and children should endeavor to ease older adults' fears about the Internet and encourage them to use the various Internet functions and apps. Specifically, communities and children should provide training services to address their difficulties when using the Internet. This will assist them to learn how to use the Internet and prevent them from becoming "digital refugees." Finally, older adults should overcome their fear and resistance towards the Internet and learn how to use it actively, becoming "silver-haired surfers".

Second, strengthening the attention to the older adults' mental health who lack emotional support from their children. While face-to-face contact with children is still an essential factor in mental health, the frequency of intergenerational emotional interactions has significantly declined. This is due to children moving away from home as urbanization becomes more common. In response, governments and communities should encourage online communication between older adults and their children. Although it cannot replace face-to-face contact, it can fill the mental gap of not being able to see children for a long time and prevent mental health problems arising from not seeing them for a long time. The Internet also enables various entertainment activities, such as watching videos, online shopping, and accessing health information.

Third, strengthening the attention to the older adults' mental health who have chronic diseases. Depression is more common among those who are not well. As people age, it is inevitable for them to be more prone to chronic diseases. Governments and communities should actively promote Internet use to enhance older adults' mental health. Simultaneously, Internet use can help them expand social connections, increase knowledge, and improve mental health in numerous ways. The Internet is a product of its time, and it is not limited to younger generations. Older adults can also be affected by the changes brought about by the Internet. Internet use can help them combat loneliness, enhance life satisfaction, improve mental health, and foster social harmony.

There are some potential limitations to our study. First, the control variables selected for this study may not fully account for confounding factors related to Internet use and older adults' mental health. Secondly, the representativeness of the CHARLS sample implies that applying our findings to other contexts needs caution. Despite these limitations, our analysis utilized a two-way fixed effects model, an instrumental variables approach, and a multi-period DID method to address the endogeneity problem. The empirical analysis yields results that are closer to causal identification.

Therefore, the findings of this paper are still relevant to China and other developing countries.

Author Contributions: Both authors have contributed to the paper.

Availability of Data and Materials: The data will be provided upon request to the corresponding author.

Ethics Approval: None.

Conflicts of Interest: Both authors declare that there is no conflict of interest in this paper.

References

1. National Bureau of Statistics of China. Bulletin on National Economic and Social Development of the People's Republic of China 2022. http://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html. [Accessed 2023].

2. Li D, Zhang DJ, Shao JJ, Qi XD, Tian L. Ameta-analysis of the prevalence of depressive symptoms in Chinese older adults. Arch Gerontol Geriatr. 2014;58(1):1–9. doi:10.1016/j.archger.2013.07.016.

3. Bauman Z. Modernidad líquida. Buenos Aires: Fondo de Cultura Económica; 2006.

4. China Internet Network Information Centre (CNNIC). The 51st statistical report on the development of China's Internet, Beijing. https://cnnic.cn/n4/2023/0302/c199-10755.html. [Accessed on 2023].

5. Quinn D, Chen L, Mulvenna MD, Bond R. Exploring the relationship between online social network site us-age and the impact on quality of life for older and younger users: an interaction analysis. J Med Internet Res. 2016;18(9):e245. doi:10.2196/jmir.5377.

6. Karavidas M, Lim NK, Katsikas SL. The effects of computers on older adult users. Comput Hum Behav. 2005;21(5):697–711. doi:10.1016/j.chb.2004.03.012.

7. Hajek A, Konig HH. Social isolation and loneliness of older adults in times of the COVID-19 Pandemic: canuse of online social media sites and video chats assist in miti-gating social isolation and loneliness? Gerontology. 2021;67(1):121–4. doi:10.1159/000512793.

8. Yu K, Wu S, Chi I. Internet use and loneliness o-f older adults over time: the mediating effect of social contact. J Gerontol B Psychol Sci Soc Sci. 2021;76(3):541–50. doi:10.1093/geronb/gbaa004.

9. Hajek A, Konig HH. Frequency of contact with friends and relatives via internet and psychosocial factors in middle-aged and older adults during the COVID-19 pandemic. Findings from the German Ageing Survey. Int J Geriatr Psychiatr. 2022;37(1). doi:10.1002/gps.5623.

10. Liao S, Zhou Y, Liu Y, Wang R. Variety, frequency, and type of internet use and its association with risk of depression in middle- and older-aged Chinese: a cross-sectional study. J Affect Disord. 2020;273(2):280–90. doi:10.1016/j.jad.2020.04.022.

11. Yang HL, Zhang S, Zhang SQ, Xie L, Wu YY, Yao YD, et al. Internet use and depressive symptoms among older adults in China. Front Psychiatry. 2021;12:739085. doi:10.3389/fpsyt.2021.739085.

12. Li L, Jin G, Guo Y, Zhang Y, Jing R. Internet access, support, usage divides, and depressive symptoms among older adults in China: a nationally representative cross-sectional study. J Affect Disord. 2023;323:514–23. doi:10.1016/j.jad.2022.12.001.

13. Cotten SR, Anderson WA, McCullough BM. Impact of internet use on loneliness and contact with others among older adults: cross-sectional analysis. J Med Internet Res. 2013;15(2):e39. doi:10.2196/jmir.2306.

14. Gaia A, Sala E, Cerati G. Social networking sites use and life satisfaction. A quantitative study on older people living in Europe. Eur Soc. 2020;23(1):98–118. doi:10.1080/14616696.2020.1762910.

15. Khalaila R, Vitman-Schorr A. Internet use, social networks, loneliness, and quality of life among adults aged 50 and older: mediating and moderating effects. Qual Life Res. 2018;27(2):479–89. doi:10.1007/s11136-017-1749-4.

16. Bessiere K, Pressman S, Kiesler S, Kraut R. Effects of internet use on health and depression: a longitudinal study. J Med Internet Res. 2010;12(1):e6. doi:10.2196/jmir.1149.

17. Cotten SR, Ford G, Ford S, Hale TM. Internet use and depression among retired older adults in the United States: a longitudinal analysis. J Gerontol B Psychol Sci Soc Sci. 2014;69(5):763–71. doi:10.1093/geronb/gbu018.

18. Shillair RJ, Rikard R, Cotten SR, Tsai HY. Not so lonely surfers: loneliness, social support, Internet use and life satisfaction in older adults. iConference 2015 Proceedings, 2015; USA. https://hdl.handle.net/2142/73666. [Accessed 2023].

19. Hage E, Hasan, Henry Linger H, Wortmann H, van Offenbeek M, Boonstra A. The dual impact of online communication on older adults' social connectivity. Information Technology & People. 2016;29(1):31–50. doi:10.1108/ITP-09-2014-0216.

20. Zheng H, Ma W, Li J, Botero J. Relationship between Internet use and negative affect. Appl Res Qual Life. 2023; 1–21. doi:10.1007/s11482-023-10158-z.

21. Xie L, Yang HL, Lin XY, Ti SM, Wu YY, Zhang S, et al. Does the internet use improve the mental health of Chinese older adults? Front Public Health. 2021;9:673368. doi:10.3389/fpubh.2021.673368.

22. Lohmann S. Information technologies and subjective well-being: does the Internet raise material aspirations? Oxford Econ Pap. 2015;67(3):740–59. doi:10.1093/oep/gpv032.

23. Chou HTG, Edge N. They are happier and having better lives than I am: the impact of using Facebook on perceptions of others' lives. Cyberpsychol, Behav Soc Netw. 2012;15(2):117–21. doi:10.1089/cyber.2011.0324.

24. Coyle CE, Dugan E. Social isolation, loneliness and health among older adults. J Aging Health. 2012;24(8):1346–63. doi:10.1177/0898264312460275.

25. Wood V, Robertson JF. Friendship and kinship interaction: differential effect on the morale of the elderly. J Marriage Fam. 1978: 367–75. doi:10.2307/350767.

26. Luanaigh CO, Lawlor BA. Loneliness and the health of older people. Int J Geriatr Psychiatr. 2008;23(12):1213–21. doi:10.1002/gps.2054.

27. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: crosssectional and longitudinal analyses. Psychol Aging. 2006;21(1):140–51. doi:10.1037/0882-7974.21.1.140.

28. Cheng ST, Chan ACM. Filial piety and psycho-logical well-being in well older Chinese. J Gerontol Ser B. 2006;61(5):P262–P269. doi:10.1093/geronb/61.5.P262.

29. Ward R, Deane G, Spitze G. Life-course changes and parent-adult child contact. Res Aging. 2014;36(5):568–602. doi:10.1177/0164027513510325.

30. Fingerman KL, Ng YT, Zhang S, Britt K, Colera G, Bi-rditt KS, et al. Living alone during COVID-19: social contact and emotional well-being among older adults. J Gerontol B Psychol Sci Soc Sci. 2021;76(3):e116–21. doi:10.1093/geronb/gbaa200.

31. Jing R, Jin G, Guo Y, Zhang Y, Li L. The association between constant and new Internet use and depressive symptoms among older adults in China: the role of structural social capital. Comput Hum Behav. 2023;138:107480. doi:10.1016/j.chb.2022.107480.

32. Liu W, Li W, Mou J. Does Internet usage make middle-aged and older adults feel healthier? Mediating role of social engagement. Ind Manage Data Syst. 2023. doi:10.1108/IMDS-04-2023-0236.

33. Cotten SR, Ford G, Ford S, Hale TM. Internet use and depression among older adults. Comput Hum Behav. 2012;28(2):496–9. doi:10.1016/j.chb.2011.10.021.

34. Drentea P, Goldner M, Cotten S, Hale T. The association among gender, computer use and online health searching, and mental health. Inf Commun Soc. 2008;11(4):509–25. doi:10.1080/13691180801999019.

35. Yan X, Wu W, Chen X, Xu G, Yu S, Li S. Intergenerational caregiving on mental health of middle-aged and older adults in China: empirical insights. Front Public Health. 2023;11:1224062. doi:10.3389/fpubh.2023.1224062.

36. Fang Y, Chau AKC, Wong A, Fung HH, Woo J. Information and communicative technology use enhances psychological well-being of older adults: the roles of age, social connectedness, and frailty status. Aging Ment Health. 2018;22(11):1516–24. doi:10.1080/13607863.2017.1358354.

37. Cresci MK, Jarosz PA, Templin TN. Are health answers online for older adults? Educ Gerontol. 2012;38(1):10–9. doi:10.1080/03601277.2010.515890.

38. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort profile: the China health and retirement longitudinal study (CHARLS). Int J Epidemiol. 2014;43(1):61–8. doi:10.1093/ije/dys203.

39. Qin X, Wang S, Hsieh CR. The prevalence of depression and depressive symptoms among adults in China: estimation based on a National Household Survey. China Econ Rev. 2018;51:271–82. doi:10.1016/j.chieco.2016.04.001.

40. Zimmerman FJ, Katon W. Socioeconomic status, depression disparities, and financial strain: what lies behind the income-depression relationship? Health Econ. 2005;14(12):1197–1215. doi:10.1002/hec.1011.

41. Lei X, Sun X, Strauss J, Zhang P, Zhao Y. Depressive symptoms and SES among the middle-aged and elderly I-N China: evidence from the China Health and Retirement Longitudinal Study national baseline. Soc Sci Med. 2014;120:224–32. doi:10.1016/j.socscimed.2014.09.028.

42. Radloff LS. The CES-D scale: a self report depression scale for research in the general population. Appl Psych Meas. 1977;1(3):385–401. doi:10.1177/014662167700100306.

43. Wang Y, Wang L, Wu H, Zhu Y, Shi X. Targeted poverty reduction under new structure. China Agr Econ Rev. 2019;11(3):555–66. doi:10.1108/CAER-12-2018-0243.

44. Wang Y, Ma H, Zheng L. Do child characteristics matter to mitigate the widowhood effect on the elderly's mental health? Evidence from China. Int J Ment Health Promot. 2023;25(5):673–86. doi:10.32604/ijmhp.2023.026394.

45. Wang R, Chen Z, Zhou Y, Shen L, Zhang Z, Wu X. Melancholy or mahjong? Diversity, frequency, type, and rural-urban divide of social participation and depression in middle- and old-aged Chinese: a fixed-effects analysis. Soc Sci Med. 2019;238:112518. doi:10.1016/j.socscimed.2019.112518.

46. Zhang Y, Harper S. The impact of son or daughter care on Chinese older adults' mental health. Soc Sci Med. 2022;306:115104. doi:10.1016/j.socscimed.2022.115104.

47. Arulsamy K, Delaney L. The impact of automatic enrolment on the mental health gap in pension participation: evidence from the UK. J Health Econ. 2022;86:102673. doi:10.1016/j.jhealeco.2022.102673.

48. Chen F, Zhang X, Chen Z. Air pollution and mental health: evidence from China Health and Nutrition Survey. J Asian Econ. 2023;86:101611. doi:10.1016/j.asieco.2023.101611.

49. Rashedi V, Asadi-Lari M, Foroughan M, Delbari A, Fadayevatan R. Mental health and pain in older adults: findings from urban HEART-2. Community Ment Health J. 2017;53(6):719–24. doi:10.1007/s10597-017-0082-2.

50. Xie Y, Ma M, Wu W, Zhang Y, Zhang Y, Tan X. Dose-response relationship between intergenerational contact frequency and depressive symptoms amongst elderly Chinese parents: a cross-sectional study. BMC Geriatr. 2020;20(1):349. doi:10.1186/s12877-020-01751-0.

51. Winstead V, Anderson WA, Yost EA, Cotten SR, Warr A, Berkowsky RW. You can teach an old dog new trick: a qualitative analysis of how residents of senior living communities may use the web to overcome spatial and social barriers. J Appl Gerontol. 2013;32(5):540–60. doi:10.1177/0733464811431824.

52. Chan A, Malhotra C, Malhotra R, Ostbye T. Living arrangements, social networks and depressive symptoms among older men and women in Singapore. Int J Geriatr Psychiatr. 2011;26(6):630–9. doi:10.1002/gps.2574.

53. Golden J, Conroy RM, Bruce I, Denihan A, Greene E, Kirby M, et al. Loneliness, social support networks, mood and wellbeing in community-welling elderly. Int J Geriatr Psychiatr. 2009;24(7):694–700. doi:10.1002/gps.2181.

54. Li J, Zhou X. Internet use and Chinese older adults' subjective well-being (SWB): the role of parent-child contact and relationship. Comput Hum Behav. 2021;119:106725. doi:10.1016/j.chb.2021.106725.

55. Kimbrough AM, Guadagno RE, Muscanell NL, Dill J. Gender differences in mediated communication: women connect more than do men. Comput Hum Behav. 2013;29(3):896–900. doi:10.1016/j.chb.2012.12.005.

56. Kuoppamäki SM, Taipale S, Wilska TA. The use of mobile technology for online shopping and entertainment among older adults in Finland. Telemat Inform. 2017;34(4):110–117. doi:10.1016/j.tele.2017.01.005.

57. Alreck P, Settle RB. Gender effects on Internet, catalogue and store shopping. J Database Marketing Custom Strategy Manage. 2002;9:150–62. doi:10.1057/palgrave.jdm.3240071.

58. Campbell R. Older women and the Internet. J Women Aging. 2004;16(1–2):161–74. doi:10.1300/J074v16n01_11.

59. Stock JH, Yogo M. Testing for weak instruments in linear IV regression. USA: National Bureau of Economic Research Cambridge; 2002. doi:10.1017/cbo9780511614491.006.

60. Wei N, Sun D, Huang W. Effects of WeChat use on the subjective health of older adults. Front Psychol. 2022;13:919889. doi:10.3389/fpsyg.2022.919889.