

RESEARCH ARTICLE

The relationship between the digital divide and self-rated health among older adults: The mediating effect of depression

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Abstract

Digital transformation has increased the importance of digital technology in daily life, yet older adults remain vulnerable to the digital divide. Limited digital access and competency may restrict opportunities to obtain health information and utilize services, potentially affecting mental health and self-rated health. This study examined the relationship between the digital divide and self-rated health among older adults and investigated the mediating effect of depression. This cross-sectional study used data from the 2023 National Survey of Older Koreans. A total of 9,951 older adults who completed the survey themselves were included in the analysis. The digital divide was measured using three dimensions: digital access, digital use competency, and adaptation to the digital society. Depression was assessed using the Short Form of the Geriatric Depression Scale. Hierarchical regression analysis and PROCESS Macro (version 4.2) were used to test the mediating effect of depression while controlling for sociodemographic and health-related factors. Higher levels of digital access, digital use competency, and adaptation to the digital society were associated with lower depression and higher self-rated health, whereas depression was negatively associated with self-rated health. Depression significantly mediated the relationships between all three dimensions of the digital divide and self-rated health, indicating partial mediation. The findings suggest that the digital divide affects self-rated health both directly and indirectly through depression. Reducing the digital divide and promoting digital inclusion may help improve mental health and self-rated health among older adults.

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Keywords: Digital divide; Depression; Older adults; Self-rated health; Mediating effect

1. Introduction

In 2025, the Republic of Korea entered a super-aged society, with older adults aged 65 years and over accounting for more than 20% of the total population (Ministry of Data and Statistics, 2025). According to projections by the United Nations Department of Economic and Social Affairs, Population Division, the number of people aged 60 years or older worldwide is expected to reach 1.4 billion by 2030 and 2.2 billion by 2050, while the number of persons aged 80 years or older is projected to more than triple from 164 million in 2024 to 446 million in 2050 (United Nations, 2024). These demographic

changes have brought healthy aging and quality of life among older adults to the forefront of social and public health concerns. Health and quality of life in later life are influenced not only by disease management but also by independent living, maintenance of social relationships, and access to necessary resources and services. In this context, adaptation to the digital society may play an important role in enabling older adults to obtain information, utilize services, and live independently.

The onset of the COVID-19 pandemic in 2020 accelerated the transition toward contactless services and digitally mediated interactions, increasing reliance on digital devices and technologies (H. Kim *et al.*, 2023; Song, 2023). As digital transformation continues to advance, activities such as obtaining health information and maintaining social relationships are increasingly conducted through digital technologies. However, digital technologies do not provide equal opportunities for all individuals (Ibrahim, 2021; Lythreathis, 2022; Yang *et al.*, 2024). The benefits of digital technologies may vary according to individuals' preparedness and ability to use them effectively (Berkowsky *et al.*, 2018). Consequently, a digital divide emerges. The digital divide is a multifaceted concept that encompasses disparities in accessibility, affordability, digital literacy and skills, quality, and relevance of digital technologies among different population groups (Choi *et al.*, 2025; Choxi *et al.*, 2022; Litchfield *et al.*, 2021; Mubarak & Suomi, 2022). Socially disadvantaged groups, including older adults and low-income populations, are known to be disproportionately affected by the digital divide (Choi *et al.*, 2025; Choi & DiNitto, 2013; Yang *et al.*, 2024).

According to the 2023 Survey on the Digital Divide, older adults demonstrated the lowest levels of digital inclusion in terms of digital access, competency, and utilization (Jung & Chung, 2024). In addition, findings from the 2023 National Survey of Older Koreans indicated that smartphone ownership among older adults increased substantially from 56.4% in 2020 to 76.6% in 2023; however, 67.2% of respondents reported difficulties adapting to the information society (Kang, 2023). These findings suggest that although ownership of digital devices has increased, substantial disparities remain in digital competency, access to services, and adaptation to digital environments. Older adults who are unfamiliar with digital technologies often experience difficulties using digital devices, which may further exacerbate the digital divide. Failure to adapt to digital environments may limit access to necessary information and increase dependence on others in daily life.

The digital divide is also closely related to self-rated health among older adults. Self-rated health reflects

individuals' subjective evaluation of their overall health status and may capture aspects of perceived health that are not fully explained by disease status or physical functioning alone. Self-rated health is a global evaluative judgment formed through a cognitive process in which individuals integrate diverse information about their physical condition, bodily sensations, functional capacity, psychological well-being, and social circumstances within their own contextual frame of reference (Jylhä, 2009). Accordingly, these health-related factors may contribute to an individual's self-rated health but remain conceptually distinct from the overall health assessment itself. Within this conceptual framework, the digital divide may influence self-rated health by shaping individuals' access to health-related information, services, and social resources. Older adults who are unable to use digital technologies or access the internet may face limited opportunities to obtain health information, use online services, and participate in digital social activities (Seifert *et al.*, 2021). Limited access to digital information can lead to exclusion from health-related services and resources, impeding individuals' ability to manage their health and negatively affecting both perceived and actual health status (M. Kim *et al.*, 2025). Furthermore, difficulties in accessing information within digital environments may undermine self-efficacy and contribute to psychological distress, potentially increasing feelings of isolation, helplessness, and depression. Depression may therefore serve as an important psychological mechanism through which the digital divide influences self-rated health. Because individuals with higher levels of depression are more likely to evaluate their health negatively, it is important to examine the mediating role of depression in the relationship between the digital divide and self-rated health.

Recent research has also examined the relationship between social media use and self-rated health among older adults. A study of older adults in China found that social media users initially reported more favorable self-rated health than non-users; however, this association weakened after socioeconomic characteristics, social support, and health conditions were taken into account (Gu *et al.*, 2025). The association also varied according to individual characteristics and patterns of social media use. These findings suggest that the relationship between digital engagement and self-rated health may be heterogeneous and influenced by both personal characteristics and the ways in which digital technologies are used.

Although previous studies have examined social media use and other forms of digital engagement in relation to health outcomes, empirical evidence regarding the multidimensional digital divide and the role of depression

in its relationship with self-rated health remains limited. Therefore, this study aimed to examine the effects of the digital divide on self-rated health among older adults and to investigate the mediating effect of depression. Specifically, the digital divide was conceptualized in terms of digital access, digital use competency, and adaptation to the digital society. The direct effects of these dimensions on depression and self-rated health, as well as their indirect effects through depression, were examined. The findings of this study are expected to provide evidence supporting the need for digital inclusion policies and mental health interventions aimed at improving self-rated health among older adults.

2. Data and methods

2.1. Data source and study participants

Data were obtained from the 2023 National Survey of Older Koreans, which is conducted every three years by the Korea Institute for Health and Social Affairs. To utilize the most recent survey data collected in 2023 (September 4 to November 12, 2023), the raw dataset and codebook were downloaded from the Statistics Korea Microdata Integrated Service (MDIS) website (<https://mdis.kostat.go.kr/index.do>), and the variables required for this study were extracted.

The National Survey of Older Koreans is a nationally representative survey conducted among adults aged 65 years and older selected through proportional stratified sampling. Data are collected through face-to-face interviews conducted during visits to sampled households in which older adults reside (Kang, 2023). Proxy responses are permitted when older adults are unable to participate due to bedridden status, psychological instability, cognitive impairment (e.g., dementia), hearing or speech difficulties, or frailty. In such cases, the household member most familiar with the respondent's circumstances provides the information (Kang, 2023).

However, because this study included items requiring respondents' personal assessments, such as digital device use and digital competency, which could not be accurately obtained through proxy responses, only self-reported data from older adults were included in the analysis. Of the 10,078 respondents who participated in the 2023 survey, 127 proxy responses were excluded. Consequently, a total of 9,951 older adults were included in the final analysis.

2.2. Variables and measures

2.2.1. Independent variables

The independent variables in this study were the three

dimensions of the digital divide: digital access, digital use competency, and adaptation to the digital society. The first independent variable was "digital access." This variable was assessed using four items: (i) availability of internet access at home, (ii) ownership of a smartphone, (iii) ownership of a computer, and (iv) ownership of a smartwatch. Responses were coded as "Yes = 1" and "No = 2." The "No" responses were recoded as 0, and a total score ranging from 0 to 4 was calculated by summing the number of items answered "Yes." Higher scores indicated greater digital access.

The second independent variable was "digital use competency." This variable assessed the ability of older adults to independently perform digital activities using a personal computer, smartphone, tablet, or kiosk without assistance. It consisted of 13 items: (i) receiving messages (e.g., text messages, KakaoTalk, Telegram), (ii) sending messages, (iii) making video calls, (iv) searching for and retrieving information, (v) taking photos and videos, (vi) listening to music, (vii) playing games, (viii) watching videos, (ix) using social networking services (e.g., online communities and platforms such as Facebook and Instagram), (x) conducting electronic transactions (e.g., online shopping, reservations, and food delivery orders), (xi) conducting financial transactions (e.g., internet banking and stock trading), (xii) searching for and installing applications, and (xiii) using kiosks for ordering and registration in places such as restaurants and hospitals. Responses were coded as "Yes = 1" and "No = 2." The "No" responses were recoded as 0, and a total score ranging from 0 to 13 was calculated by summing the number of activities respondents reported being able to perform independently. Higher scores indicated greater digital use competency. The internal consistency of the 13-item digital use competency scale was acceptable, with a Cronbach's alpha of 0.894.

The third independent variable was "adaptation to the digital society." This variable measured the degree of difficulty experienced in adapting to an information-oriented society. In the original dataset, the item was measured using a five-point response scale, with lower scores indicating easier adaptation to the digital society. The scale was reverse-coded so that higher scores indicated better adaptation to the digital society.

2.2.2. Dependent variable

Self-rated health was derived from a single survey question asking participants to evaluate their usual health as very healthy, healthy, fair, unhealthy, or very unhealthy. Responses were originally coded from 1 ("very healthy") to 5 ("very unhealthy") and were reverse-coded so that higher scores represented more favorable self-rated health.

2.2.3. Control variables

The control variables included sociodemographic characteristics and health-related factors. Sociodemographic variables consisted of sex, age, educational attainment, living arrangement (living alone or living with others), residential area (rural or urban), current economic activity, and household income level (Q1–Q5). Health-related variables included physical functional limitation status, disability status, and physician-diagnosed chronic diseases. Physical functional limitation status was assessed using Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL). Respondents who required partial or greater assistance with at least one ADL or IADL item were classified as having a physical functional limitation, whereas those who reported no limitations across all items were classified as having no physical functional limitation. These variables were included because they represent clinical and functional aspects of health that may be associated with both older adults' engagement with digital technologies and self-rated health. They were treated as conceptually distinct from, rather than as components of, the self-rated health measure and were adjusted for when estimating the associations of the digital divide and depressive symptoms with self-rated health.

2.2.4. Mediating variable

The mediating variable in this study was depression. Depression was assessed using the Short Form of the Geriatric Depression Scale (SGDS). The SGDS consists of 15 items that are easy for older adults to understand and respond to. Each item asks respondents about their

feelings and experiences during the previous week (Cho *et al.*, 1999; Lee *et al.*, 2013). Responses indicating the presence of a depressive symptom were scored as 1, and the opposite responses were scored as 0, yielding a total score ranging from 0 to 15. Higher scores indicate higher levels of depression (Y. Kim & Park, 2021; Lee *et al.*, 2013; Shin *et al.*, 2020).

2.3. Research model and statistical analysis

This study conducted a cross-sectional secondary analysis of nationally collected survey data to examine the mediating effect of depression on the relationship between the digital divide and self-rated health among older adults. A mediation model was established, as shown in Figure 1, in which the digital divide influences self-rated health through depression. In the proposed model, X represents the independent variables related to the digital divide (X_1 : digital access, X_2 : digital use competency, and X_3 : adaptation to the digital society), Y represents the dependent variable, self-rated health, and M represents the mediating variable, depression.

All analyses were conducted using IBM SPSS Statistics (version 25.0, IBM Corp., United States of America) and PROCESS Macro (version 4.2; <https://www.processmacro.org/index.html>). Descriptive statistics were used to characterize the participants and study variables. Differences in digital-divide scores were assessed using independent-samples *t* tests or one-way analysis of variance followed by Scheffé post hoc comparisons, as appropriate. Pearson correlations and multivariable regression models were then estimated. Bootstrapping with 5,000 samples in PROCESS Macro 4.2 was used to evaluate the indirect associations through depressive symptoms.

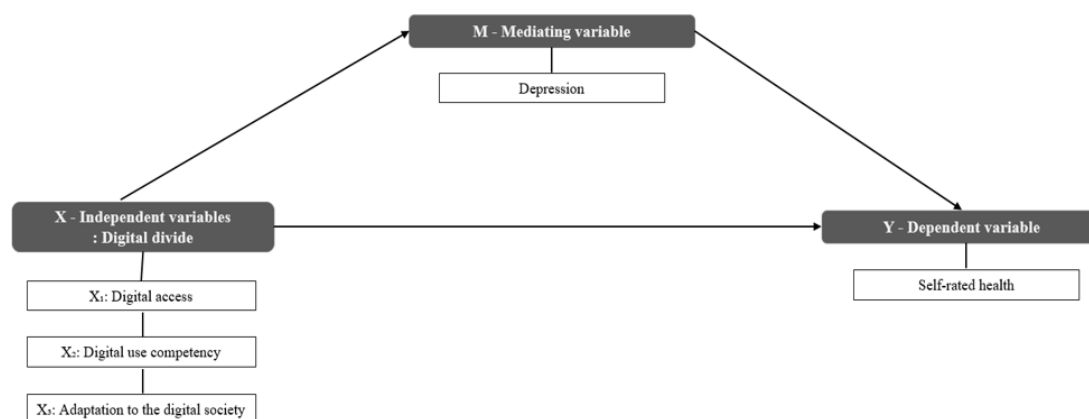


Figure 1. Research model

Note: The model was adjusted for sociodemographic characteristics—including sex, age, educational attainment, living arrangement, residential area, economic activity status, and household income level (Q1–Q5)—and health-related factors, including physical functional limitations, disability status, and physician-diagnosed chronic diseases.

3. Results

3.1. Sociodemographic characteristics and health and functional status of the participants

The sociodemographic characteristics and health and

functional status of the participants are presented in [Table 1](#).

Among the participants, 3,824 (38.4%) were men and 6,127 (61.6%) were women, with a mean age of 74 years. Regarding educational attainment, 4,355 participants

Table 1. Characteristics of the study participants

Variable	Categories	<i>n</i>	%
Sociodemographic characteristics			
Sex	Male	3,824	38.4
	Female	6,127	61.6
Age	65–69	3,243	32.6
	70–74	2,467	24.8
	75–79	1,933	19.4
	80–84	1,509	15.2
	85–89	626	6.3
	≥90	173	1.7
	Mean ± SD ^a	74.02 ± 6.75	
Education	Elementary school or below	4,355	43.8
	Middle or high school	4,974	50.0
	College or above	622	6.3
Living arrangement	Living alone	3,423	34.4
	Living with others	6,528	65.6
Residential area	Rural	2,974	29.9
	Urban	6,977	70.1
Economic activity status	No	6,009	60.4
	Yes	3,942	39.6
Household income level ^b	Q1	2,107	21.2
	Q2	2,167	21.8
	Q3	2,,026	20.4
	Q4	1,910	19.2
	Q5	1,741	17.5
Health and functional status			
Functional limitation status	No	8,303	83.4
	Yes	1,648	16.6
Disability determination status	No	9,547	95.9
	Yes	404	4.1
Physician-diagnosed chronic disease	No	1,363	13.7
	Yes	8,588	86.3
Mean±SD ^a		2.19±1.60	

Notes: ^aThis variable was analyzed as continuous and is presented as mean ± standard deviation. ^bHousehold income was divided into quintiles, from Q1 (lowest) to Q5 (highest).

(43.8%) had completed elementary school or less, 4,974 (50.0%) had completed middle or high school, and 622 (6.3%) had completed college-level education or higher. With respect to living arrangements, 3,423 participants (34.4%) lived alone, whereas 6,528 (65.6%) lived with others. Regarding area of residence, 6,977 participants (70.1%) resided in urban areas and 2,974 (29.9%) in rural areas. A total of 3,942 participants (39.6%) were currently engaged in economic activities, while 6,009 (60.4%) were not. Annual household income was distributed as follows: 2,107 participants (21.2%) in the first quintile, 2,167 (21.8%) in the second quintile, 2,026 (20.4%) in the third quintile, 1,910 (19.2%) in the fourth quintile, and 1,741 (17.5%) in the fifth quintile.

Regarding health and functional status, 8,303 participants (83.4%) reported no physical functional limitations, whereas 1,648 (16.6%) reported having physical functional limitations. A total of 404 participants (4.1%) had been officially registered as having a disability. In addition, 8,588 participants (86.3%) reported having at least one physician-diagnosed chronic disease, while 1,363 (13.7%) reported having no chronic diseases. The mean number of chronic diseases per participant was 2.19.

3.2. Differences in the digital divide by participant characteristics

The results of the analyses examining differences in the three dimensions of the digital divide according to participant characteristics are presented in [Table 2](#).

Regarding sociodemographic characteristics, men showed significantly higher scores for digital access (1.56 ± 1.05 vs. 1.27 ± 1.01), digital use competency (4.96 ± 3.57 vs. 3.93 ± 3.48), and adaptation to the digital society (2.25 ± 0.91 vs. 1.99 ± 0.89) than women. A significant age gradient was observed across all three dimensions, with the 65–69 age group showing the highest scores and the 85 years and older group showing the lowest scores. Educational attainment was strongly associated with all three dimensions; participants with college education or higher demonstrated markedly higher scores than those with elementary school education or less. Participants living with others, residing in urban areas, and currently engaged in economic activities showed significantly higher digital access, digital use competency, and adaptation to the digital society compared to their respective counterparts. A consistent income gradient was observed, with digital divide scores increasing stepwise from the lowest (Q1) to the highest (Q5) income quintile across all three dimensions. With respect to health and functional status, participants without functional limitations, without a registered disability, and without a physician-diagnosed

chronic disease showed significantly higher scores across all three dimensions of the digital divide than those with these conditions.

3.3. Descriptive statistics of the main variables

The results of the descriptive statistical analyses conducted to examine the distribution and normality of the main variables are presented in [Table 3](#).

For the independent variables representing the digital divide, the mean score for digital access was 1.38, the mean score for digital use competency was 4.32, and the mean score for adaptation to the digital society was 2.09. The mean depression score, measured as the mediating variable, was 2.99. Based on the criterion that a total score of 8 or higher on the SGDS indicates the presence of depressive symptoms (Lee *et al.*, 2013), 8,963 participants (90.1%) were classified as having no depressive symptoms, whereas 988 participants (9.9%) were classified as having depressive symptoms. The mean score for the dependent variable, self-rated health, was 3.20.

To assess the normality of the main variables, skewness and kurtosis were examined. Following previous studies, a skewness value greater than 2 and a kurtosis value greater than 7 were considered indicative of substantial deviations from normality (Choeni *et al.*, 2025; Curran *et al.*, 1996; Kline, 2023). The results showed that the absolute values of skewness and kurtosis for all variables were below the recommended thresholds of 2 and 7, respectively, indicating that the data were normally distributed.

3.4. Correlations among the main variables

The results of the correlation analyses among the main study variables are presented in [Table 4](#).

Self-rated health was positively correlated with digital access ($r = 0.312$), digital use competency ($r = 0.376$), and adaptation to the digital society ($r = 0.370$). In contrast, self-rated health was negatively correlated with depression ($r = -0.482$). Depression was negatively correlated with digital access ($r = -0.274$), digital use competency ($r = -0.296$), and adaptation to the digital society ($r = -0.261$). Among the dimensions of the digital divide, digital access was positively correlated with digital use competency ($r = 0.722$) and adaptation to the digital society ($r = 0.404$). In addition, digital use competency was positively correlated with adaptation to the digital society ($r = 0.528$).

3.5. Mediation analysis

3.5.1. Effects of the digital divide on depression

Multiple regression analysis was conducted to examine the effects of the digital divide on depression, the mediating variable. The results are presented as Model 1 in [Table 5](#).

Table 2. Differences in the digital divide by participant characteristics

Variable	Categories	Digital access	<i>t</i> or <i>F</i>	Digital use competency	<i>t</i> or <i>F</i>	Adaptation to the digital society	<i>t</i> or <i>F</i>
Sociodemographic characteristics							
Sex	Male	1.56 ± 1.05	13.423***	4.96 ± 3.57	14.207***	2.25 ± 0.91	13.919***
	Female	1.27 ± 1.01		3.93 ± 3.48		1.99 ± 0.89	
Age	65–69	1.90 ± 0.93 ^a	483.520***	6.79 ± 3.30 ^a	961.379***	2.48 ± 0.88 ^a	318.974***
	70–74	1.50 ± 0.97 ^b		4.62 ± 3.18 ^b		2.19 ± 0.90 ^b	
	75–79	1.15 ± 0.95 ^c		3.07 ± 2.71 ^c		1.89 ± 0.81 ^c	
	80–84	0.80 ± 0.89 ^d		1.90 ± 2.26 ^d		1.66 ± 0.78 ^d	
	85–89	0.56 ± 0.81 ^{de}		1.08 ± 1.77 ^e		1.55 ± 0.73 ^{de}	
	over 90	0.53 ± 0.85 ^e		0.71 ± 1.30 ^e		1.45 ± 0.70 ^e	
	Education	Elementary school or below		0.86 ± 0.85 ^a		1,418.868***	
Middle or High school		1.72 ± 0.95 ^b	5.81 ± 3.33 ^b	2.33 ± 0.87 ^b			
College or above		2.36 ± 1.02 ^c	7.59 ± 3.49 ^c	2.76 ± 0.91 ^c			
Living arrangement	Living alone	1.03 ± 0.90	−26.462***	3.42 ± 3.35	−19.117***	1.92 ± 0.88	−13.983***
	Living with others	1.56 ± 1.05		4.80 ± 3.55		2.18 ± 0.91	
Residential area	Rural	1.11 ± 0.99	−17.731***	3.35 ± 3.40	−18.498***	1.92 ± 0.90	−12.466***
	Urban	1.50 ± 1.03		4.74 ± 3.53		2.17 ± 0.90	
Economic activity status	No	1.26 ± 1.03	−14.155***	3.73 ± 3.35	−20.620***	2.01 ± 0.88	−11.273***
	Yes	1.56 ± 1.01		5.23 ± 3.65		2.22 ± 0.93	
Household income level	Q1	0.88 ± 0.88 ^a	536.348***	2.70 ± 2.96 ^a	501.394***	1.87 ± 0.84 ^a	188.558***
	Q2	1.01 ± 0.88 ^b		2.99 ± 2.86 ^a		1.84 ± 0.84 ^a	
	Q3	1.38 ± 0.95 ^c		4.35 ± 3.32 ^b		2.08 ± 0.88 ^b	
	Q4	1.76 ± 0.99 ^d		5.59 ± 3.51 ^c		2.31 ± 0.92 ^c	
	Q5	2.05 ± 1.00 ^e		6.53 ± 3.56 ^d		2.47 ± 0.92 ^d	
Health and functional status							
Functional limitation status	No	1.48 ± 1.02	21.867***	4.74 ± 3.55	33.094***	2.18 ± 0.91	24.801***
	Yes	0.90 ± 0.98		2.21 ± 2.67		1.65 ± 0.78	
Disability determination status	No	1.40 ± 1.04	7.420***	4.39 ± 3.55	10.118***	2.11 ± 0.91	8.344***
	Yes	1.04 ± 0.95		2.79 ± 3.08		1.73 ± 0.83	
Physician-diagnosed chronic disease	No	1.74 ± 1.03	13.713***	5.96 ± 3.80	17.306***	2.52 ± 0.94	18.396***
	Yes	1.33 ± 1.03		4.06 ± 3.44		2.02 ± 0.88	

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Different superscript letters within the same variable indicate statistically significant differences between groups according to Scheffé's post hoc test

Sociodemographic characteristics and health- and function-related factors were entered as control variables. The tolerance values were all greater than 0.1, and the variance inflation factor (VIF) values ranged from 1.039 to 2.772, indicating no serious multicollinearity among the variables. The Durbin–Watson statistic was 1.373, suggesting no substantial autocorrelation in the model ($F = 253.370$). After controlling for other variables, higher levels of digital access ($\beta = -0.075$), digital use competency ($\beta = -0.051$), and adaptation to the digital society ($\beta = -0.085$) were significantly associated with lower levels of depression.

Among the control variables, depression was significantly lower among women than men ($\beta = -0.025$), among participants of older age ($\beta = -0.058$), among those living with others rather than alone ($\beta = -0.042$), among those currently engaged in economic activities ($\beta = -0.091$), and among those with higher household income levels ($\beta = -0.049$). In contrast, depression was significantly higher among participants residing in urban areas rather than rural areas ($\beta = 0.032$), those with physical functional limitations ($\beta = 0.212$), those with a registered disability ($\beta = 0.066$), and those with a greater number of physician-diagnosed chronic diseases ($\beta = 0.241$).

3.5.2. Mediating effect of depression on the relationship between the digital divide and self-rated health

Hierarchical linear regression analyses were conducted to examine the mediating effect of depression on the relationship between the digital divide and self-rated health. The results are presented as Models 2 and 3 in Table 5. Model 2 examined the effects of the digital divide on self-rated health without including the mediating variable (depression). The tolerance values were all greater than 0.1, and the VIF values ranged from 1.039 to 2.772, indicating no serious multicollinearity among the variables. The Durbin–Watson statistic was 1.498, suggesting no substantial autocorrelation in the model ($F = 369.141$). After controlling for other variables, higher levels of digital access ($\beta = 0.048$), digital use competency ($\beta = 0.082$), and adaptation to the digital society ($\beta = 0.170$) were significantly associated with higher self-rated health. Among the control variables, self-rated health was significantly lower among women than men ($\beta = -0.022$), among those with physical functional limitations ($\beta = -0.132$), those with a registered disability ($\beta = -0.116$), and those with a greater number of physician-diagnosed chronic diseases ($\beta = -0.278$). In contrast, self-rated health was significantly higher among participants residing

Table 3. Descriptive statistics of the main variables

Variables	Mean	SD	Min.	Max.	Skewness	Kurtosis
Digital divide						
Digital access	1.38	1.04	0	4	0.287	-0.803
Digital use competency	4.32	3.55	0	13	0.567	-0.642
Adaptation to the digital society	2.09	0.91	1	5	0.529	-0.265
Depression	2.99	3.07	1	14	1.182	0.894
Self-rated health	3.20	0.86	1	5	-0.468	-0.344

Table 4. Correlation analysis

Variables	1	2	3	4	5
1. Digital access	1.000				
2. Digital use competency	0.722***	1.000			
3. Adaptation to the digital society	0.404***	0.528***	1.000		
4. Depression	-0.274***	-0.296***	-0.261***	1.000	
5. Self-rated health	0.312***	0.376***	0.370***	-0.482***	1.000

Note: *** $p < 0.001$.

Table 5. Hierarchical regression models of depressive symptoms and self-rated health

Variable	Model 1 (Digital divide → depression)		Model 2 (Digital divide → self-rated health)		Model 3 (Digital divide and depression → self-rated health)	
	<i>B</i>	β	<i>B</i>	β	<i>B</i>	β
Constant	5.645	–	2.990	–	3.476	–
Control variables						
Sex	–0.155	–0.025**	–0.039	–0.022*	–0.052	–0.029***
Age (years) ^a	–0.026	–0.058***	–0.001	–0.005	–0.003	–0.023*
Education level ^a	–0.036	–0.007	0.007	0.005	0.004	0.003
Living arrangement	–0.273	–0.042***	–0.013	–0.007	–0.036	–0.020*
Residential area	0.215	0.032***	0.061	0.032***	0.079	0.042***
Economic activity status	–0.572	–0.091***	0.115	0.065***	0.066	0.037***
Household income level ^a	–0.108	–0.049***	0.035	0.057***	0.026	0.041***
Functional limitation status	1.750	0.212***	–0.306	–0.132***	–0.156	–0.067***
Disability determination status	1.026	0.066***	–0.505	–0.116***	–0.417	–0.096***
Physician-diagnosed chronic disease ^a	0.464	0.241***	–0.150	–0.278***	–0.110	–0.204***
Independent variables (Digital divide)						
Digital access ^a	–0.223	–0.075***	0.040	0.048***	0.021	0.025*
Digital use competency ^a	–0.045	–0.051***	0.020	0.082***	0.016	0.066***
Adaptation to the digital society ^a	–0.289	–0.085***	0.161	0.170***	0.136	0.143***
Mediating variable						
Depression ^a					–0.086	–0.307***
R	0.499		0.571		0.629	
R ²	0.249		0.326		0.396	
ΔR ²	0.016		0.037		0.071	
Adjusted R ²	0.248		0.325		0.395	
F	253.370***		369.141***		465.825***	
Durbin–Watson	1.373		1.498		1.509	

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. ^aContinuous variable.

in urban areas rather than rural areas ($\beta = 0.032$), those currently engaged in economic activities ($\beta = 0.065$), and those with higher household income levels ($\beta = 0.057$).

Model 3 examined the effects of the digital divide on self-rated health after including the mediating variable (depression). The tolerance values were all greater than 0.1, and the VIF values ranged from 1.045 to 2.776, indicating no serious multicollinearity among the variables. The Durbin–Watson statistic was 1.509, suggesting no substantial autocorrelation in the model ($F = 465.825$).

After controlling for other variables, higher levels of digital access ($\beta = 0.025$), digital use competency ($\beta = 0.066$), and adaptation to the digital society ($\beta = 0.136$) remained significantly associated with higher self-rated health. In addition, higher levels of depression were significantly associated with lower self-rated health ($\beta = -0.307$).

Among the control variables, self-rated health was significantly lower among women than men ($\beta = -0.029$), among older participants ($\beta = -0.023$), among those living with others rather than alone ($\beta = -0.020$), among those with physical functional limitations ($\beta = -0.067$), among those with a registered disability ($\beta = -0.096$), and among those with a greater number of physician-diagnosed chronic diseases ($\beta = -0.204$). In contrast, self-rated health was significantly higher among participants residing in urban areas rather than rural areas ($\beta = 0.042$), those currently engaged in economic activities ($\beta = 0.037$), and those with higher household income levels ($\beta = 0.041$).

Comparisons between Models 2 and 3 showed that the explanatory power of the model increased after the inclusion of depression. Although the standardized

regression coefficients (β) for the three dimensions of the digital divide (digital access, digital use competency, and adaptation to the digital society) decreased in Model 3, they remained statistically significant. Furthermore, the paths from the independent variables to the mediator, from the independent variables to the dependent variable, and from the mediator to the dependent variable were all significant. These findings indicate that depression partially mediated the relationship between the digital divide and self-rated health. In other words, the digital divide among older adults was found to influence self-rated health both directly and indirectly through depression.

3.5.3. Significance and magnitude of the mediating effect of depression

The significance and magnitude of the mediating effect of depression on the relationship between the digital divide and self-rated health among older adults were examined using PROCESS Macro (version 4.2). The results are presented in Tables 6 and 7 and Figure 2. In the PROCESS Macro analysis, 5,000 bootstrap samples were generated with a 95% confidence interval.

The indirect effect of digital access on self-rated health through depression was statistically significant, as the 95% bootstrap confidence interval did not include zero (lower limit of the bootstrap 95% confidence interval [BootLLCI] = 0.025, upper limit of the bootstrap 95% confidence interval [BootULCI] = 0.037). Similarly, the indirect effect of digital use competency on self-rated health through depression was statistically significant (BootLLCI = 0.008, BootULCI = 0.012). The indirect effect of adaptation to the digital society on self-rated health through depression was also statistically significant (BootLLCI = 0.027, BootULCI = 0.039).

Table 6. Results of the direct path analysis for the mediation model of depression in the relationship between digital divide and self-rated health

Digital divide	Direct path	B	SE	t	LLCI	ULCI	R	R ²
Digital access	X ₁ → M	-0.343	0.032	-10.651***	-0.406	-0.280	0.491	0.241
	M → Y	-0.091	0.003	-35.505***	-0.096	-0.086	0.614	0.377
	X ₁ → Y	0.068	0.008	8.272***	0.052	0.084		
Digital use competency	X ₂ → M	-0.110	0.010	-10.521***	-0.130	-0.089	0.491	0.241
	M → Y	-0.090	0.003	-35.257***	-0.095	-0.085	0.618	0.382
	X ₂ → Y	0.032	0.003	12.133***	0.027	0.037		
Adaptation to the digital society	X ₃ → M	-0.375	0.034	-11.146***	-0.441	-0.309	0.492	0.242
	M → Y	-0.088	0.003	-34.813***	-0.093	-0.083	0.627	0.393
	X ₃ → Y	0.155	0.009	18.278***	0.139	0.172		

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. X₁: Digital access, X₂: Digital use competency, X₃: Adaptation to the digital society.

Abbreviations: LLCI: Lower limit of the confidence interval; SE: Standard error; ULCI: Upper limit of the confidence interval.

Table 7. Bootstrapped indirect associations through depressive symptoms

Indirect path	B	BootSE	BootLLCI	BootULCI
Digital access → Depression → Self-rated health	0.031	0.003	0.025	0.037
Digital use competency → Depression → Self-rated health	0.010	0.001	0.008	0.012
Adaptation to the digital society → Depression → Self-rated health	0.033	0.003	0.027	0.039

Abbreviations: BootLLCI: Lower limit of the bootstrap 95% confidence interval; BootSE: Bootstrap standard error; BootULCI: Upper limit of the bootstrap 95% confidence interval.

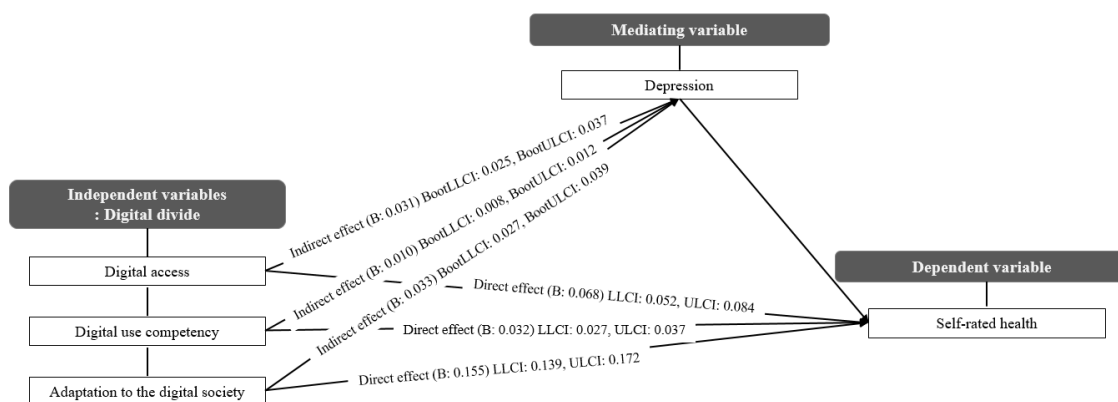


Figure 2. Direct and indirect associations between digital-inclusion indicators and self-rated health through depression

Abbreviations: BootLLCI: Lower limit of the bootstrap 95% confidence interval; BootULCI: Upper limit of the bootstrap 95% confidence interval.

Regarding the magnitude of the effects, the direct effect of digital access on self-rated health was 0.068, whereas the indirect effect through depression (digital access → depression → self-rated health) was 0.031, indicating that the direct effect was greater than the indirect effect. Likewise, the direct effect of digital use competency on self-rated health was 0.032, while the indirect effect through depression (digital use competency → depression → self-rated health) was 0.010. For adaptation to the digital society, the direct effect on self-rated health was 0.155, whereas the indirect effect through depression (adaptation to the digital society → depression → self-rated health) was 0.033. In all three dimensions of the digital divide, the direct effects were greater than the corresponding indirect effects through depression.

4. Discussion

Using data from the 2023 National Survey of Older Koreans, this study examined the associations between the digital-divide dimensions and self-rated health among older adults and investigated the mediating effect of depression in this relationship. The findings showed that digital access, digital use competency, and adaptation to the digital

society were negatively associated with depression and positively associated with self-rated health. Furthermore, depression partially mediated the relationships between all three dimensions of the digital divide and self-rated health. These findings suggest that the digital divide influences self-rated health not only directly but also indirectly through the psychological pathway of depression.

The findings should be interpreted in light of the conceptual distinction between self-rated health and specific health-related conditions. Self-rated health represents a global evaluative judgment of health, whereas chronic diseases, disability, functional limitations, and depressive symptoms represent distinct clinical, functional, and psychological domains that may inform this judgment. This suggests that digital resources and depressive symptoms may be associated with how older adults integrate and evaluate diverse information about their overall health, even after differences in clinical and functional health status have been taken into account.

First, higher levels of digital access, digital use competency, and adaptation to the digital society were associated with better self-rated health. This finding is consistent with the study by M. Kim *et al.* (2025), which

reported that older adults with higher levels of digital literacy demonstrated better subjective health status and greater life satisfaction. The present findings are also in line with previous research suggesting that the digital divide may function as a social determinant of health associated with self-rated health among older adults (Yang *et al.*, 2024). This finding is also broadly consistent with evidence that social media use may be associated with more favorable self-rated health among older adults. However, Gu *et al.* (2025) found that this association was attenuated after socioeconomic, social support, and health-related factors were considered, suggesting that the relationship between digital engagement and self-rated health may differ across population subgroups and patterns of technology use. Older adults who are able to utilize digital devices and services may have greater opportunities to access health information, use online services, and maintain social relationships, which may contribute to more positive evaluations of their own health status (Aggarwal *et al.*, 2020; Zhao *et al.*, 2022). Therefore, efforts to improve self-rated health among older adults should consider not only traditional factors such as disease burden, functional limitations, and income, but also individuals' ability to access and utilize information and services in digital environments. Furthermore, subgroup analyses further revealed that older age, lower education, lower income, rural residence, and the presence of chronic disease or disability were consistently associated with a wider digital divide across all three dimensions, underscoring the need for targeted digital inclusion interventions for these high-risk groups.

Second, all three dimensions of the digital divide were significantly and negatively associated with depression. In other words, higher levels of digital access, digital use competency, and adaptation to the digital society were associated with lower levels of depression. This finding is consistent with the study by Wang *et al.* (2025), which reported that digital exclusion was associated with an increased risk of depressive symptoms among older adults. Because older adults are more likely to experience reductions in social relationships due to retirement, bereavement, and declines in physical functioning, digital technologies may serve as important tools for maintaining communication with family and friends, exchanging information, and participating in social activities. Conversely, older adults who repeatedly experience difficulties in digital environments may face restricted access to information, greater dependence on others in daily life, and increased psychological distress, all of which may contribute to higher levels of depression.

Third, depression was found to have a significant

negative effect on self-rated health. This finding is consistent with previous research indicating that individuals with higher levels of depressive symptoms are more likely to evaluate their health status negatively (Mulsant *et al.*, 1997). The World Health Organization (2025) has identified depression and anxiety as major mental health concerns among older adults and has highlighted social isolation and loneliness as key risk factors for mental health problems in later life. Therefore, interventions aimed at improving self-rated health should not be limited to managing physical illnesses or improving functional status but should also address mental health factors such as depression.

Fourth, a key finding of this study was that depression partially mediated the relationship between the digital divide and self-rated health. Digital accessibility, digital competence, and digital social adaptation had direct effects on self-rated health, while also exerting indirect effects through reducing levels of depression. These findings suggest that the digital divide is not merely an issue of information access and use but may also influence older adults' subjective evaluations of their health through their emotional well-being. Notably, even after depression was included in the model, the direct effects of all three dimensions of the digital divide on self-rated health remained statistically significant. This indicates that depression is not the sole explanatory pathway linking the digital divide to self-rated health and that other mechanisms may also be involved. Although these additional pathways were not directly tested in the present study, several mechanisms may theoretically explain the remaining direct effects of the digital divide on self-rated health beyond depression. For example, access to health information, social participation, self-efficacy, and experiences with healthcare service utilization may serve as additional pathways through which the digital divide influences self-rated health, though these were not directly examined in the present study. Future studies should examine these mechanisms in greater detail.

Fifth, digital social adaptation demonstrated stronger direct and indirect effects than digital accessibility and digital competence. This finding suggests that beyond simply possessing digital devices or having the skills to use them, the ability to adapt to a rapidly evolving digital society is closely associated with older adults' self-rated health. Indeed, the digital divide is increasingly recognized as a multidimensional concept encompassing not only access to information and communication technologies but also differences in digital skills and outcomes of digital use. Consequently, it is regarded as an issue that cannot be resolved solely through the provision of digital devices or internet access (Mubarak & Suomi, 2022). Therefore, efforts

to reduce the digital divide among older adults should go beyond improving access to smartphones and the internet. Such efforts should include practical support that enables older adults to independently utilize digital services in their daily lives, as well as educational programs designed to reduce anxiety and perceived burdens associated with digital technologies.

From a practical standpoint, the present findings suggest that improving digital access, digital use competency, and adaptation to the digital society can translate into tangible benefits in older adults' everyday lives. Older adults who have reliable internet access and use smartphones or computers confidently are more likely to search for health information, schedule medical appointments online, access telehealth services, and communicate regularly with family and friends, all of which can support better self-management and higher self-rated health. The findings of this study also have important policy implications. Policies promoting digital inclusion among older adults should move beyond a narrow focus on digital literacy training or device provision and adopt a more integrated approach that encompasses health management, access to health and welfare services, social participation, and mental health support. Older adults who experience difficulties using digital technologies may be at greater risk of depression and poorer self-rated health. Therefore, community welfare centers, public health centers, and customized care services for older adults could consider providing digital skills training alongside depression screening and counseling services. In addition, digital education programs should be offered in a continuous and practical manner rather than as one-time interventions. Such programs should focus on activities that are directly relevant to older adults' daily lives, such as using kiosks, making hospital appointments, and searching for health information. Because digital competence influences multiple aspects of later life, including independent living, health management, and leisure activities, sustained support for strengthening digital capabilities among older adults is essential.

This study has several limitations. First, the primary variables were based on self-reported responses, which may be subject to measurement error arising from respondents' subjective perceptions or recall bias. Second, the digital access variable was operationalized as a simple summation of four binary items (internet access at home, smartphone, computer, and smartwatch ownership), with equal weight assigned to each item. This approach may not fully capture the qualitative differences in how each device contributes to digital inclusion. For example, ownership of a smartwatch may not represent the same degree of meaningful digital engagement as regular internet use. In addition, usage

intensity was not considered in this measure. Future studies should consider weighted or frequency-based measures of digital access to more accurately capture the multidimensional nature of digital inclusion. Third, although the three dimensions of the digital divide were treated as conceptually distinct constructs, some degree of conceptual overlap among them may exist. While these dimensions have been theoretically differentiated in prior literature, digital access refers to the availability of devices and infrastructure, digital use competency reflects the ability to perform specific digital tasks, and adaptation to the digital society captures subjective adjustment to a digitalized environment (Choi *et al.*, 2025; Mubarak & Suomi, 2022). However, their empirical boundaries may not be entirely separable. Future studies should consider employing confirmatory factor analysis or latent variable approaches to more rigorously examine the distinctiveness of these constructs. Fourth, the cross-sectional design of this study precludes the establishment of causal or temporal relationships among the variables. Accordingly, the significant bootstrapped indirect effects should be interpreted as statistical indirect associations consistent with the proposed theoretical model, rather than as evidence that the digital divide temporally or causally increases depressive symptoms and subsequently lowers self-rated health. Although the proposed model posits that the digital divide influences self-rated health through depression, the direction of these relationships may not be straightforward and could operate in the reverse direction. Specifically, older adults with higher levels of depression may experience reduced motivation and decreased energy, which may impede their engagement with digital technologies and reduce their willingness to acquire new digital skills. In addition, older adults with poor subjective health may perceive digital learning as burdensome or less relevant to them, thereby reducing their motivation to acquire or improve digital competencies. In this respect, the possibility of reverse causality cannot be ruled out. In other words, depression and lower self-rated health may not only be consequences of the digital divide, but may also act as factors that deepen it. This bidirectional relationship has also been reported in longitudinal studies. Li and Liu (2025) employed a cross-lagged mediation model using three waves of data and demonstrated that while internet use predicted reduced depressive symptoms over time, higher depressive symptoms also significantly predicted less subsequent internet use among middle-aged and older adults. Similarly, Kouvonen *et al.* (2021) reported that both poor self-rated health and depressive symptoms were associated with a lower likelihood of digital information technology use, and concluded that the relationship is likely bidirectional. These findings suggest

a potential vicious cycle in which the digital divide and mental health problems mutually reinforce each other. Future longitudinal studies, preferably employing cross-lagged panel models or fixed-effects designs, are needed to disentangle the directionality of the associations observed in this study. Fifth, self-rated health is a subjective measure that may not fully correspond to objective clinical health status. Older adults with objectively poor health may nonetheless report relatively good self-rated health due to adaptation effects, social comparison, or anticipated future decline. Future studies should consider supplementing self-rated health with objective health indicators to provide a more complete picture of health status.

Despite these limitations, this study contributes to the literature by utilizing nationally representative data from older adults in Korea to examine the relationship between the digital divide and self-rated health and to identify statistically significant indirect associations through depressive symptoms. In particular, rather than treating the digital divide as a single construct, this study distinguished among digital accessibility, digital competence, and digital social adaptation, thereby providing a more nuanced understanding of the digital factors associated with self-rated health among older adults. The findings suggest that policies aimed at promoting healthy aging should not treat digital inclusion and mental health support as separate issues but rather as interconnected policy priorities. Future research should employ longitudinal data to establish temporal relationships among variables and develop more comprehensive models incorporating additional mediating and moderating factors, such as social participation, loneliness, self-efficacy, and health literacy, to further elucidate the relationship between the digital divide and health.

5. Conclusions

This study used data from the 2023 National Survey of Older Koreans to examine the effects of the digital divide on self-rated health among older adults and to investigate the mediating role of depression in this relationship. The findings revealed that higher levels of digital accessibility, digital competence, and digital social adaptation were associated with lower levels of depression and higher levels of self-rated health. Furthermore, depression showed a significant partial mediating effect in the relationship between the digital divide and self-rated health. In other words, the digital divide among older adults not only had a direct effect on self-rated health but also influenced it indirectly through the psychological pathway of depression.

These findings suggest that efforts to improve self-rated health among older adults should address both the digital

divide and mental health support. In particular, digital inclusion policies should move beyond the simple provision of digital devices or one-time training programs and focus on enabling older adults to effectively utilize digital resources in their daily lives, including access to health information, hospital appointment systems, healthcare and welfare services, and tools for maintaining social relationships. Moreover, difficulties in adapting to digital environments may contribute to depression; therefore, integrated interventions that combine community-based digital literacy and competency programs with depression prevention and management services are needed.

In conclusion, the digital divide among older adults is not merely a matter of technology use but an important social determinant associated with both self-rated health and mental health. Therefore, policy efforts aimed at enhancing digital accessibility, digital competence, and digital social adaptation are essential for supporting healthy aging in a super-aged society. Such efforts may contribute to improving health equity and quality of life among older adults.

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Conflict of interest

The author declares no competing interests.

Author contributions

This is a single-authored article.

Ethics approval and consent to participate

The data used in this study were derived from the 2023 National Survey of Older Koreans, a nationally approved survey dataset. As this study was based on secondary analysis of anonymized data that are available to researchers upon application and approval by the data provider, obtaining ethical approval was not applicable.

Consent for publication

Not applicable.

Availability of data

The dataset used for analysis of this study is available on the Microdata Integrated Service (MDIS) website (<https://mdis.kostat.go.kr/eng/index.do>) of the National Statistical Office in the Republic of Korea. Statistics Korea

not only collects microdata of self-produced statistics, but also collects microdata of other statistical agencies such as research institutes in one place, so that people can conveniently use various statistical data through MDIS. The dataset used for this study was derived from the 2023 National Survey of Older Koreans, a nationally representative survey conducted by the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs (KIHASA). To utilize the most recent survey data collected in 2023 (September 4 to November 12, 2023), the raw dataset and codebook were downloaded from the MDIS website (<https://mdis.kostat.go.kr/index.do>), and the variables required for this study were extracted.

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