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Internet literacy and health related quality of life in urban Korean adults mediated by medication adherence and ego-resiliency

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Background As Korea's population ages, understanding factors that influence health-related quality of life (HRQoL) in middle-aged and older adults is crucial. **Methods** This study investigated how medication adherence and ego-resiliency mediate the relationship between internet literacy and HRQoL in middle-aged and older adults in South Korean. A total of 197 participants aged 40 or older, working in companies or volunteer groups, were recruited. Mediation effects were examined using Hayes' PROCESS macro (Model 4). **Results** Internet literacy was significantly related to medication adherence (r = .423), ego-resiliency (r = .417), and HRQoL (r = .378). Both medication adherence and ego-resiliency positively correlated with HRQoL (r = .408 and r = .413, respectively). Ego-resiliency and medication adherence fully mediated the relationship between internet literacy and HRQoL (ß=0.003, ß=0.005). **Conclusions** Medication adherence and ego-resiliency mediate the link between internet literacy and HRQoL. Middle and older adults need continuous internet literacy education and ego-resiliency training to enhance HRQoL. Additionally, medication adherence may be relevant even for those not currently taking prescribed medications, as it reflects broader health behaviors.

Background

With the increasing average age in Korea, there has been growing interest in health-related quality of life (HRQoL) during middle and older adulthood. Physical changes during this period contribute to a higher prevalence of chronic diseases, resulting in increased pharmaceutical consumption. Research indicates that 86.1% of older adults aged 65 and above have chronic diseases, while approximately 60% of individuals aged between 40 and 64 also suffer from chronic diseases[1].

As age increases, HRQoL decreases, and individuals with chronic diseases also experience a lower HRQoL[2,3]. In middle and older age, a decline in HRQoL can negatively impact mental health, potentially leading to conditions such as depression. Therefore, these issues should be managed and addressed.

Internet literacy is a key factor influencing HRQoL. Previous studies have shown a correlation between internet literacy and HRQoL among university students and young adults[4,5]. Moreover, older adults aged 60 and above with higher internet literacy tend to have higher levels of HRQoL[2]. Additionally, among older adults in Korea, higher internet literacy is associated with better perceived health and more frequent health-related behaviors, such as regular medical check-ups[6]. During old age, individuals undergo physical changes, resulting in an increased need for attention to health and preventive health behaviors[7]. Health-related information during this period is frequently acquired through various channels, such as the internet and television. According to the 2023 Internet Usage Survey in South Korea, internet use among adults aged 70 and above has increased fivefold since 2019[8]. Additionally, approximately 46% of those aged 60 and above reported using the internet to purchase health products. Therefore, examining the relationship between internet literacy and HRQoL among middle-aged and older adults is necessary.

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Medication adherence is another factor influencing HRQoL, and studies have shown it is also related to internet literacy[2,9]. In middle and older age, the proportion of individuals taking medications for chronic diseases increases. According to the World Health Organization, adherence broadly refers to health-related behaviors such as taking medication, following a diet, and making lifestyle changes—suggesting that medication adherence may also encompass the use of health supplements[10]. Additionally, the consumption of health supplements has become more prevalent; approximately 86% of Americans aged 50 and above take dietary supplements[11]. Furthermore, it is vital to take dietary supplements correctly. However, most previous studies on medication adherence and HRQoL have focused on individuals with chronic diseases such as hypertension and diabetes. Therefore, research including health supplements among healthy adults is necessary.

Moreover, ego-resiliency is associated with health behaviors such as maintaining a healthy diet and engaging in regular exercise[12]. This is because ego-resiliency reflects an individual's ability to overcome challenges and difficulties in pursuing health goals, contributing to sustained efforts to maintain these behaviors. A study conducted among university students during the COVID-19 pandemic found that individuals with higher internet literacy not only engaged in more preventive behaviors related to COVID-19 but also maintained higher levels of existing health behaviors[13]. Health-related behaviors are directly related to HRQoL. Therefore, the relationship between internet literacy, ego-resiliency, and HRQoL is confirmed.

In middle and older ages, the prevalence of chronic diseases increases, and individuals frequently take various medications. Therefore, it is vital to examine the relationship between internet literacy, medication adherence, ego-resiliency, and HRQoL in both individuals with chronic diseases and healthy middle-aged and older adults. Accordingly, this study aims to assess the levels of internet literacy, medication adherence, ego-resiliency, and HRQoL among middle-aged and older adults. It also explores the mediating effects of medication adherence and ego-resiliency on the relationship between internet literacy and HRQoL.

This study proposes the following hypotheses: (1) Internet literacy is positively correlated with HRQoL, (2) Ego-resiliency and medication adherence are positively correlated with HRQoL, and (3) The relationship between internet literacy and HRQoL is serially mediated by ego-resiliency and medication adherence (Fig. 1).

Method
Study design and aim
This study employed a cross-sectional survey design. It aimed to evaluate the associations between internet literacy, medication adherence, ego-resiliency, and HRQoL. Furthermore, it sought to confirm the mediating effects of medication adherence and ego-resiliency on the relationship between internet literacy and HRQoL.

Setting and participants
Convenience sampling was used to recruit middle-aged and older adults working in companies or volunteer groups in cities in Seoul and Gyeongsangbuk-do, South Korea. The inclusion criteria were: (1) participants aged 40 and above, (2) participants without cognitive impairment, and (3) participants who understood the study's purpose and voluntarily agreed to participate. The required sample size for regression analysis was calculated using the G*Power 3.1.9.7[14]. A minimum of 194 participants was required to achieve a statistical power of 0.95 at a significance level of 0.05, with 14 predictors based on an effect size of 0.15. Considering an expected dropout rate, 200 participants were recruited, and the final analysis comprised 197 valid responses.

Measures
1) Internet literacy   Internet literacy was measured using the Korean version of the eHealth literacy scale, originally developed by Norman and Skinner[15]. Chang et al. translated and validated the scale[16] for use among middle-aged and older adults. The scale comprises 10 items; the first two assess the usefulness and importance of the internet in health-related decision-making, while the remaining eight assess knowledge, ability, evaluation, and use of online health information. Following Chang et al.[16], the Likert scale in this study was modified to better
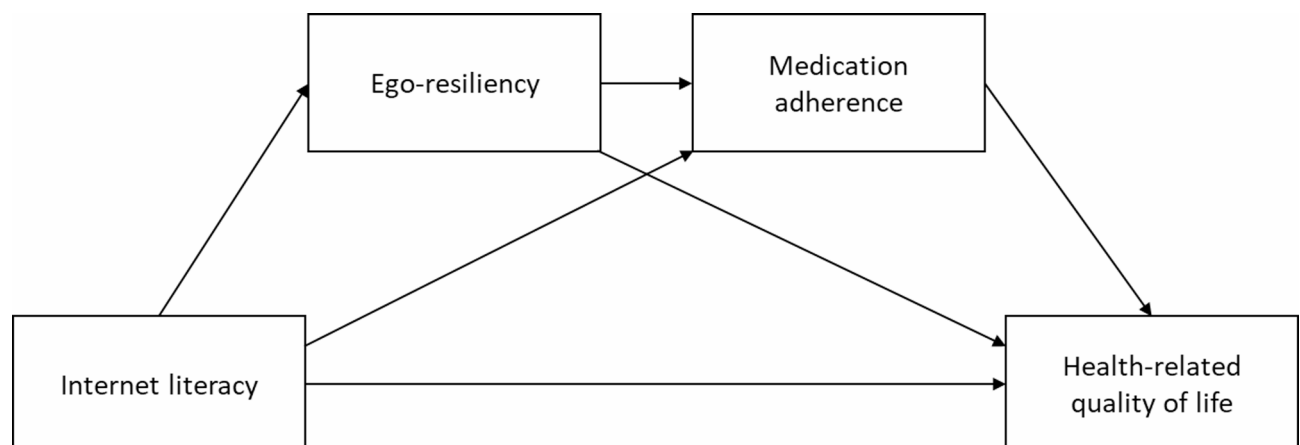

Fig. 1. Hypothesis model of the study.

align response options with the verbs used in each item. For example, in item 3 ("I know what health-related resources are available on the internet"), the response scale ranged from 1 (I do not know at all) to 5 (I know very well), instead of the original 1 (completely disagree) to 5 (completely agree). Total scores range from 10 to 50, with higher scores indicating greater internet literacy. Cronbach's α was 0.88 in the original study by Norman and Skinner and 0.89 in Chang et al.'s study[16]. In the present study, Cronbach's α was 0.957.

2) Medication adherence   This study used the Adherence to Refills and Medication Scale developed by Kripalani et al.[17], and later adapted into Korean by Kim et al.[18]. It comprises 12 items distributed across two components: 8 items and 4 items. Each item is rated using a 4-point Likert scale ranging from "never" (0) to "always" (4). Scores for negative items 1 to 11 were converted and analyzed. Total scores range from 12 to 48, with higher scores indicating higher medication adherence. Cronbach's α was 0.81 in Kripalani et al.'s study[17], whereas it was 0.80 in Kim et al.'s study[18]. In the present study, Cronbach's α was 0.803.

3) Ego-Resiliency   Ego-resiliency was measured using the ER scale (ER89), developed by Block and Kremen[19]. This scale comprises 14 items, each rated on a 4-point scale ranging from 1 (Does not apply at all) to 4 (Applies very strongly). Total scores range from 14 to 56, with higher scores indicating greater ego-resiliency. The Korean version of the ER89[20] was used in this study. Cronbach's α was 0.82 in Jeong and Oh's study[20], and 0.892 in the present study.

4) Health-Related quality of life   HRQoL was measured using the Korean version of the EuroQol-five-dimensions three-level questionnaire (EQ-5D-3 L)[21], developed by the EuroQol group. The EQ-5D-3 L comprises five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression, with three levels: 1 (no problem), 2 (some problems), and 3 (severe problems). The EQ-5D-3 L index was calculated using the Korean value set[22], with higher scores indicating better overall health status. In this study, the Cronbach's α for the EQ-5D-3 L was 0.766.

Covariates
General characteristics included age, sex, education, occupation, smoking, alcohol, disease, hospitalization, medication, and health information search path. Internet usage-related characteristics included internet access path, daily internet usage time, health information searches using the internet during the last month, and health information search content. In this study, 11 covariates (10 general characteristics and daily internet usage time) were included in the mediation analysis with one dependent variable and two mediators.

Data collection and procedure
Data were collected from December 31, 2024, to January 15, 2025, through both online and face-to-face methods. For initial cognitive function screening, participants working at a company or in a volunteer group were selected as the population. Data from participants employed at companies were collected through an online survey. To increase access with minimal time and spatial restrictions, a study recruitment advertisement and survey link were posted on the company's internal employee website. The advertisement contained information regarding the study's purpose, methodology, participation and inclusion criteria, potential benefits and risks of participation, the right to withdraw at any time, and assurance of anonymity. After reading this information, participants were required to self-report the absence of cognitive impairment and then click an "I agree" button to provide informed consent and proceed to the full questionnaire. For volunteer groups, researchers visited the volunteer activity place in person and surveyed in the case of volunteer groups. Prior to data collection, informal cognitive screening was conducted through brief orientation-based conversation (person, place, and time). Researchers explained the study's purpose, procedure, and contents of the questionnaires to eligible participants. It was stated that participation was voluntary and that withdrawal was allowed at any time during without consequences. Medication adherence was measured based on both current and past experiences with medication or supplement use. Participants were asked to reflect on typical behaviors and past adherence, even if they were not currently taking any medications. Online and face-to-face surveys were conducted until the recruitment target of 200 people was reached, and all participants were given a gift certificate worth one cup of coffee. Of the 200 questionnaires with written consent, 197 valid responses (excluding three with missing data) were used for data analysis. All data were kept confidential.

Ethical considerations
This study was approved by the Institutional Review Board of Dongguk University (DGU IRB 20240034) and conducted in accordance with the ethical standards established in the Declaration of Helsinki. The study's purpose, procedures, and rules were explained to all participants. The voluntary nature and confidentiality of the study was emphasized and participants' personal information remained undisclosed. Informed consent was obtained from all participants.

Statistical analysis
SPSS Statistics 25.0 (IBM Corp, Armonk, NY, USA) and the SPSS PROCESS macro 3.4 (https://www.processmacro.org/index.html) were used to analyze the data. Skewness and kurtosis for each main variable (internet literacy, ego-resiliency, medication adherence, and HRQoL) were checked to determine whether the data were normally distributed (skewness range of all main variables − 0.896 to −0.119, kurtosis range of all main variables − 1.134 to 0.349). Descriptive statistics were used to analyze participants' characteristics and main variables. Pearson's correlation coefficients were used for bivariate correlation analyses. To evaluate the serial mediating effect of ego-resiliency and medication adherence between internet literacy and quality of life, the PROCESS macro

for SPSS (Model 6)—a bootstrapping statistical computer tool used for analyzing mediation and moderation models, developed by Andrew Hayes as an extension for both SPSS and SAS software-was used[23]. Significance was evaluated using bootstrapping in Hayes' PROCESS macro[23]. Bootstrapping is a non-parametric resampling technique that involves random and repeated subsampling of data and does not need to satisfy require the assumption of normally distributed data[23]. The bias-corrected bootstrapping method generated 95% confidence intervals (CI) from 5000 resamples. A significant indirect effect was identified when the CI did not include zero.

Results

General characteristics

Participants' general and internet usage-related characteristics are presented in Table 1. Of the 197 participants, 55.8% (110) were female, and the mean age was 51.65 years (range: 40–80). A total of 17 participants (8.6%) were aged 65 years or older. Regarding education, 121 participants (61.4%) had a high school diploma or higher. Most participants (76.1%) were employed. Ninety-one participants had a doctor-diagnosed disease (46.2%), and 30 (15.2%) had experienced hospitalization. More than half (133, 67.5%) reported taking medications or health supplements. In terms of sources for health information, 178 participants reported using hospitals, including community health centers (80, 40.6%), or the internet (98, 49.7%). The majority (137, 69.5%) accessed the internet using a smartphone or tablet PC, compared to 30.5% who used a desk or laptop. Approximately half of the participants (111, 56.3%) used the internet for one hour or more, but less than two hours. In the past month, 74.1% had searched for health information online. Topics searched online included treatments (33.0%), diseases (30.5%), and health behaviors (25.9%).

Correlations among study variables

Table 2 shows a positive correlation between internet literacy and medication adherence ($r=.423$, $p<.001$), ego-resiliency ($r=.417$, $p<.001$), and HRQoL ($r=.378$, $p<.001$). Medication adherence and ego-resiliency were positively correlated with HRQoL ($r=408$, $p<.001$ and $r=.413$, $p<.001$, respectively).

Moderating effect

Table 3 shows a significant direct effect of internet literacy on HRQoL (ß=0.003, $p=.039$), supporting Hypothesis 1. In the medication analysis, internet literacy positively predicted ego-resiliency (ß=0.403, $p<.001$) and medication adherence (ß=0.189, $p<.001$). Moreover, both ego-resiliency and medication adherence positively predicted HRQoL (ß=0.003, $p=.017$, ß=0.005, $p=.007$, respectively). The index of mediation was significant, indicating a significant indirect effect of internet literacy on HRQoL through ego-resiliency (index=0.001, BootSE=0.001, 95% BootCI [0.000, 0.002]). The indirect effect of internet literacy on HRQoL via medication adherence was significant (index=0.000, BootSE=0.000, 95% BootCI [0.000, 0.002]). Additionally, a significant serial indirect effect was observed through both ego-resiliency and mediation adherence (index=0.000, BootSE=0.000, 95% BootCI [0.000, 0.001]). The total effect of internet literacy on HRQoL, including both its direct and indirect effects via ego-resiliency and medication adherence, was statistically significant. A one-unit increase in internet literacy was associated with a 0.005-point increase in HRQoL ($\beta=0.005$, SE=0.0011, $p<.001$, LLCI 0.003 ULCI 0.007). These findings support Hypotheses 2 and 3. Figure 2 displays the mediation effect of ego-resiliency and medication adherence on the relationship between internet literacy and HRQoL.

Discussion

This study evaluated the associations between internet literacy, medication adherence, ego-resiliency, and HRQoL. It also confirmed the mediating effects of medication adherence and ego-resiliency on the relationship between internet literacy and HRQoL. To the best of our knowledge, this is the first study to investigate the mediating roles of medication adherence and ego-resiliency in this relationship among middle-aged and older adults.

The medication adherence score was lower than observed in previous studies[24]. This may be due to the characteristics of this study's participants. Among them, 46.2% had been diagnosed with a disease, whereas previous studies included only participants diagnosed with chronic conditions such as hypertension or diabetes. When medications are administered for disease treatment, patients frequently obtain direct education from healthcare providers, which is likely to enhance medication adherence. Additionally, the average age of this study's participants was 51, which is relatively younger than in previous studies. The medication adherence score increased with age. Previous research indicates that in patients with heart disease after hospital discharge, the adherence score increases by one point for every 10-year increase in age[24]. However, in middle-aged or older adults, dietary intake alone may be insufficient, and supplementation with nutritional products may be necessary[25]. Regular consumption of nutritional supplements is essential. Furthermore, this study evaluated medication adherence based on participants' past experiences with medication use, regardless of whether they were currently taking any medications. In fact, only 67.5% of the participants were currently taking prescription medications or health supplements. This approach may have contributed to the lower measured adherence. Nevertheless, since past adherence behavior can influence current medication-taking habits[26], including healthy adults not presently on medication provides valuable insight and broadens the applicability of the findings.

Participants' average internet literacy score was 36.25, surpassing the 30.50 score reported among young adults with an average age of 25.5 years[27]. This contradicts previous research suggesting that internet literacy tends to decline with age. This discrepancy may result from the following factors. First, it may be due to the participants' high level of internet accessibility in this study[28]. This study's participants were individuals engaged in social activities, such as employment or volunteering, who likely utilized smartphones or PCs to seek information as part of their duties. Second, their urban residency may have facilitated easier access to

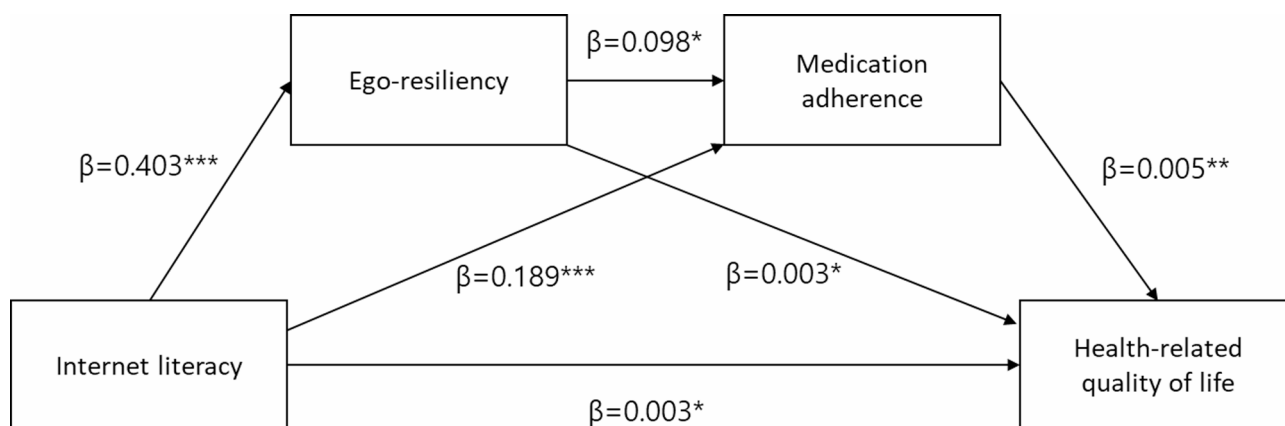| Variables	N (%) or Mean ± SD	Range
Age (years)	51.65 ± 9.29	40 ~ 80
40–49	101 (51.3)	
50–59	54 (27.4)	
≥ 60	42 (21.3)	
Sex		
Male	87 (44.2)	
Female	110 (55.8)	
Education degree		
≤ High school	76 (38.6)	
> High school	121 (61.4)	
Job		
Yes	150 (76.1)	
No	47 (23.9)	
Smoking		
Current smokers	40 (20.3)	
Non-smokers (including past smokers)	157 (79.7)	
Alcohol (during the last year)		
Yes	143 (72.6)	
No	54 (27.4)	
Diseases diagnosed by a doctor		
Yes	91 (46.2)	
No	106 (53.8)	
Hospitalization experiences		
Yes	30 (15.2)	
No	167 (84.8)	
Taking medication*		
Yes	133 (67.5)	
No	64 (32.5)	
Health information search path		
Hospital or community health center	80 (40.6)	
Internet	98 (49.7)	
Others (e.g., TV)	19 (9.6)	
Internet access path		
Smartphone or Tablet PC	137 (69.5)	
Desk or Laptop	60 (30.5)	
Daily internet usage time		
Less than 1 h	44 (22.3)	
1 h or more but less than 2 h	111 (56.3)	
2 h or more	42 (21.3)	
Health information search using the internet during the last month		
Yes	146 (74.1)	
No	51 (25.9)	
Health information search content (duplicate responses)		
Disease	60 (30.5)	
Treatment	65 (33.0)	
Medication	38 (19.3)	
Diagnosis	20 (10.2)	
Health behavior	51 (25.9)	

Table 1. General characteristics of the study participants. *Taking medication includes both medical treatment and health supplements.

online information. This study encompassed participants residing in cities such as Seoul and Gyeongsangbuk-do. Previous research on internet literacy scores among university students residing in urban versus rural areas revealed significantly higher scores for students in urban settings, despite the uniform curriculum implemented across universities[29]. This is likely due to individuals in urban areas having greater exposure to digitally enriched environments, including diverse educational opportunities for accessing online information. Additionally,

	M ± SD	Range	1	2	3	4
1. Internet literacy	36.25 ± 7.50	10–50	1			
2. Medication adherence	39.43 ± 4.71	25–48	0.423**	1		
3. Ego-resiliency	37.94 ± 7.43	15–56	0.417**	0.339**	1	
4. Health-related quality of life	0.93 ± 0.12	0.12–0.99	0.378**	0.408**	0.413**	1

Table 2. Correlation among study Variables.

Outcome		β	SE	p	LLCI	ULCI
Ego-resiliency	Constant	15.557	6.620	< 0.020	2.500	28.618
	Internet literacy	0.403	0.074	< 0.001	0.257	0.548
	$R^2 = 0.293$, F = 6.357, $p < .001$					
Medication adherence	Constant	26.328	4.308	< 0.001	17.829	34.827
	Internet literacy	0.189	0.047	< 0.001	0.089	0.290
	Ego-resiliency	0.098	0.047	0.039	0.005	0.192
	$R^2 = 0.283$, F = 5.516, $p < .001$					
Health-related quality of life	Constant	0.746	0.107	< 0.001	0.534	0.956
	Internet literacy	0.003	0.001	0.039	0.001	0.005
	Ego-resiliency	0.003	0.001	0.017	0.005	0.005
	Medication adherence	0.005	0.002	0.007	0.001	0.008
	$R^2 = 0.409$, F = 8.988, $p < .001$					

Table 3. Mediation testing results. LLCI = low limit confidence interval, ULCI: upper limit confidence interval; Values were controlled for covariates (all general and internet usage-related characteristics excluding health information search content). Note. The solid arrow line represents a significant pathway; *$p < .05$, **$p < .01$, ***$p < .001$.

Fig. 2. Mediating effect of ego-resiliency and medication adherence on the relationship between internet literacy and HRQoL.

since 2023, the Korean government has actively implemented community-based digital education programs. As these programs have been primarily conducted through senior welfare centers, they likely contributed to improvements in digital literacy among middle-aged and older adults.

Internet literacy was positively correlated with medication adherence, ego-resiliency, and HRQoL. Individuals with higher internet literacy may be more likely to seek health information online and recognize the significance of regular medication intake. In South Korea, the Ministry of Food and Drug Safety and major university hospitals disseminate health information online and emphasize the significance of medication adherence. Therefore, it is possible that individuals with greater internet literacy exhibit enhanced medication adherence. Additionally, those with higher internet literacy are more inclined to engage in health-related behaviors[13], which may relate to better medication adherence, ego-resiliency, and HRQoL; however, given the cross-sectional design of this study, there are inherent limitations in establishing causal relationships. Accordingly, longitudinal or experimental studies are needed to further investigate these associations.

The mediating effect analysis in this study confirmed that ego-resiliency fully mediates the relationship between internet literacy and HRQoL. In other words, internet literacy among middle-aged and older adults positively affected ego-resiliency, which, in turn, positively impacted HRQoL. These findings are supported by previous research indicating that higher internet literacy results higher ego-resiliency, and that higher ego-resiliency is associated with a more objective evaluation of one's health and better quality of life[30]. In middle-aged and older adults, health-related changes may result in a decrease in HRQoL compared to younger individuals. Ego-resiliency, a personal trait that facilitates overcoming challenges and adapting to current circumstances, can help individuals adapt to physical changes associated with aging, thereby enhancing HRQoL. Ego-resiliency tends to increase with age, as it develops through accumulated life experiences[31]. A previous study on individuals with chronic tinnitus also found that older patients exhibited higher ego-resiliency, and these individuals reported lower levels of tinnitus-related distress[32]. To improve HRQoL in adults beyond middle age, it is essential to incorporate education that enhances ego-resiliency alongside education that enables individuals obtain health information via the internet.

Furthermore, we confirmed that medication adherence mediates the relationship between internet literacy and enhancements in HRQoL. This indicates that both internet literacy and medication adherence should be enhanced to improve quality of life. Previous studies have reported that higher medication adherence is associated with better quality of life among individuals with chronic diseases. However, most of these studies focused on patients with chronic diseases such as hypertension, and research targeting healthy adults are rare, thus complicating direct comparisons. Nevertheless, it is reasonable to assume that when individuals recognize the significance of regular medication intake for managing their health, health-promoting behaviors will increase, likely leading to improved quality of life. Conversely, previous studies have reported no significant relationship between internet literacy and medication adherence[33]. This contradicts previous research findings, which reported no relationship between internet literacy and medication adherence. The difference may be ascribed to the average age of the study participants, which was 50, a life stage at which individuals more actively search for information online. Upon investigating how participants sourced health information, 49% indicated utilizing internet searches, representing the predominant response. Therefore, to enhance HRQoL in middle-aged and older adults, it is imperative to incorporate both internet literacy education and interventions aimed at enhancing medication adherence.

Limitations

One limitation of this study is that it employed convenience sampling to recruit participants from urban areas in Seoul and Gyeongsangnam-do, specifically individuals who were socially active through companies or volunteer groups. Consequently, the generalizability of the findings is limited. Future studies should aim to include a nationally representative sample, including participants from rural areas. Second, only 17 participants in this study were over 65 years old. Due to issues with the normal distribution in the elderly group, a distinction between middle-aged and older adults was not made. However, differences in internet usage patterns and quality of life may exist between these age groups, which may mask potentially divergent effects. Therefore, future research is recommended to examine the influence of age group on internet literacy, ego-resiliency, medication adherence, and quality of life. Third, cognitive function was not formally assessed, and participants were assumed to have adequate capacity based on their level of social engagement. Lastly, the inclusion of participants not taking medications complicated the accurate assessment of actual medication adherence. Moreover, medication adherence was broadly defined to include both prescription medications and supplements, which may limit comparability with clinical adherence studies. In addition, the retrospective self-reporting of past behaviors may introduce recall bias. However, this study's strength lies in its confirmation that improving HRQoL in healthy middle-aged and older adults necessitates the enhancement of internet literacy, medication adherence, and ego-resiliency.

Conclusions

This study investigated internet literacy, ego-resiliency, medication adherence, and HRQoL in middle-aged and older adults. It also examined the mediating effects of medication adherence and ego-resiliency on the relationship between internet literacy and HRQoL. The results confirmed that both ego-resiliency and medication adherence fully mediate this relationship. To enhance the HRQoL in middle-aged and older adults, an integrated approach is recommended. This includes education to augment internet literacy for critically interpreting online health information, as well as specific methods to improve medication adherence and ego-resiliency. Specifically, digital literacy programs should offer training in the use of health-related applications, medication management, and building psychological resilience through online tools.

Data availability

The datasets generated and/or analysed during this study are not publicly available due to privacy or confidentiality concerns but are available from the corresponding author on reasonable request.

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Author contributions

Conceptualization, J.Y.W.; methodology, J.Y.W. and L.B.J.; investigation, K.J.H., J.Y.W. and L.B.J.; data curation, software, and formal analysis; J.Y.W., writing – original draft preparation; K.J.H., J.Y.W. and L.B.J.; writing – review and editing, K.J.H. and J.Y.W. All authors have read and agreed to the published version of the manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethic approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University of D (DGU IRB 20240034). Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Additional information

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