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The Effect of Digital Health Literacy, Self-Efficacy on Self-Care Behaviors among Community-Dwelling Elderly: Focusing on Gyeongsangbuk-do

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Purpose: This study aimed to explore the relationship between digital health literacy, self-efficacy, and self-care behaviors, and to identify the effects of digital health literacy and self-efficacy on self-care behaviors among the community-dwelling elderly.
Methods: This descriptive study used self-reported questionnaires and was conducted from January to April 2024. This study included 197 participants aged 65 or older, residing in nine cities and counties within Gyeongsangbuk-do. Data were analyzed using SPSS/WIN 23.0, employing descriptive statistics, t-test, One-way ANOVA, Scheffé tests, Pearson correlation coefficients, and hierarchical regression analysis.
Results: The average scores were as follows: digital health literacy, 21.97±8.38 (out of 40 points); self-efficacy, 3.27±0.72 (out of 5 points); and self-care behaviors, 70.22±10.55 (out of 96 points). Self-efficacy (β=.32, p<.001) was identified as the primary factor influencing self-care behaviors. Additionally, job (β=-.20, p=.002) and gender (β=-.18, p=.007) were also significant factors. These factors explained 22.8% of the variance of self-care behaviors.
Conclusion: Based on the above study results, we found that to promote self-care behaviors of community-dwelling elderly people, developing and implementing training programs that enhance self- efficacy are imperative. Furthermore, efforts should be made to overcome regional disparities by developing and implementing various policies and programs at the government, local government, and community levels to enhance the digital health literacy of the elderly.

Keywords: Self care; Health literacy; Self efficacy; Community health nursing; Aged

Introduction

Background

As of February 2024, in Korea, the elderly population aged 65 or older is estimated to be 9.81 million, accounting for 19.2% of the total population, and the proportion of the elderly population is projected to increase to 20.3% in 2025, so Korea is expected to become a super-aged society in 2025 [1]. As of 2022, Korea's life expectancy at birth is 82.7 years, which is longer than the OECD average, but Korea's healthy life expectancy is only 65.8 years [2]. In Korea, elderly people have an average of 2.2 chronic diseases, and the proportion of those with three or more chronic diseases is still high at 35.9%, requiring continuous management of chronic conditions in the elderly [3]. Healthcare expenditure for the elderly accounts for more than 40% of the total healthcare expenditure [4], and healthcare spending are rapidly increasing due to the increase in the number of elderly people admitted to hospitals or long-term-care facilities due to chronic diseases such as dementia and difficulty in activities of daily living such as eating meals and housework [1]. Meanwhile, aging in place (AIP) refers to the desire of the elderly to live in their own homes as long as possible rather than living in a long-term care facility, and

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this is presented as an alternative not only for improving well-being and quality of life among the elderly but also for sustainable social development in the current situation where population aging is negatively affecting sustainable social development [5], so health care for the elderly to promote aging in place is becoming an increasingly important issue.

Self-care refers to the behaviors and ability of people with acute or chronic health problems as well as healthy people to maintain and improve their health and look after their own health [6], and self-care behaviors refer to properly performing health management, exercise, diet, smoking cessation, and stress management recommended by health care professionals [7]. In particular, in the current situation where the proportion of the elderly population is continuously increasing and the socioeconomic costs for health care and disease management are rapidly increasing [4], individual elderly people's active health management and self-care are becoming more important factors. According to previous studies, factors associated with self-care behaviors in the elderly include health literacy, social support, family support, knowledge of diseases, autonomous motivation, and resilience [8-11].

In today's society, as a result of the development of science, various technologies, and information and communication technologies, people can obtain any information they want, anytime and anywhere. Due to the impact of the COVID-19 pandemic, non-face-to-face services have been expanded, and information provision and social network support using digital technology are actively taking place [12,13]. The ability to acquire and utilize a large amount of health information through various channels, such as TV, the Internet, and newspapers, has been identified as an important determinant of self-care behavior [14]. The Health Plan 2030 also presented detailed indicators such as improving health literacy and applying innovative information technology [4], and the government's national policy tasks also presented a plan to expand AI-IoT-based health care services at public health centers and thereby expand care using smart technology in order to strengthen the health care system for the homo hundred era [15]. These national policies emphatically show that it is essential to improve the accessibility of health care information using ICT technology and to enhance the efficiency of health care services through the participation of the target group [4].

Digital health literacy refers to the ability to use digital technology to find, understand, and evaluate health information and then apply health information by converting it into knowledge appropriate for the individual's context in order to solve health problems, promote health, and improve quality of life [12]. Digital health literacy has been found to affect individuals' health knowledge [16], and it has been shown that while a high level of digital health literacy enables individuals to effectively find and evaluate needed health information using devices or social media, a low level of digital health literacy can have a negative impact on health since it can limit individuals' service accessibility and ability to evaluate information [17]. Acccording to previous studies in Korea and abroad, the use of digital devices has a positive effect on the reduction of feelings of isolation and the improvement of ego integrity and self-esteem in the elderly [18], and the use of the Internet or smartphones alleviates depression and loneliness in the elderly [19] and is associated with a reduction in cognitive decline in the elderly [20]. Self-care is essential for the elderly with chronic health problems to maintain and improve their health, and the ability to understand appropriate health information is important for the self-care of elderly people [14], so it is necessary to pay attention to the digital health literacy of community-dwelling elderly people. A study of cancer patients and nurses reported that there was no significant correlation between digital health literacy and health promoting behaviors [21], but a study of community-dwelling elderly people in China found that there was a significant positive correlation between the two variables [22]. Most chronic diseases require long-term health management, so health information is continuously required. In an aging society, understanding the importance of self-care in the management of chronic diseases of community-dwelling elderly people and the impact of digital health literacy on self-care can provide important implications for not only promoting individuals' health but also developing public health policies and health management programs [23].

Self-efficacy refers to the ability to appropriately cope with a given situation and an individual's belief in his or her ability to perform self-care activities successfully, and it is an important factor influencing an individual's self-care behavior [6,24]. A higher level of self-efficacy is linked to making greater effort to change behaviors to achieve a goal and maintaining the changed behavior for a longer time, but individuals with a lower level are likely to give up faster before reaching the level of performance. Therefore, in order to promote self-care in the elderly, it is important to improve self-efficacy [24]. Regarding the relationship between self-efficacy and self-care behaviors, a number of studies conducted with patient groups reported that there was a significant correlation between self-efficacy and self-care behaviors in patient groups such as patients with pulmonary tuberculosis and patients with heart failure [25,26]. However, there have been no studies to investigate the relationship between self-efficacy and

self-care behaviors among community-dwelling elderly people without specific diseases. Meanwhile, although a different scale was used, a previous study of community-dwelling elderly people in China reported that e-health literacy was significantly associated with health promoting behavior, and that e-health literacy was found to indirectly affected health promoting behavior through self-efficacy and self-care ability [23]. Therefore, this study aimed to analyze relationships between digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people to provide basic data for developing specific and systematic programs to promote self-care among the elderly and establishing related policies.

Aims and objectives

This study aimed to investigate the levels of digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people, and to identify factors influencing self-care behaviors among them. The specific objectives of this study are as follows:

1) To investigate the levels of digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people;
2) To identify the differences in digital health literacy, self-efficacy, and self-care behaviors according to general characteristics of the participants among community-dwelling elderly people;
3) To analyze correlations between digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people;
4) To identify factors affecting self-care behaviors among community-dwelling elderly people.

Methods

Study design

This study is a descriptive survey study that attempted to investigate digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people, and identify factors influencing self-care behaviors among them.

Participants

The participants of this study were elderly people aged 65 years or older residing in Gyeongsangbuk-do. The inclusion criteria were as follows: elderly people aged 65 years or older who are not staying in a long-term care hospital or a long-term care facility but live in their home, are able to communicate verbally, are able to understand and respond to the questions of the questionnaire used in this study, and do not have cognitive problems such as dementia or psychiatric illness. The sample size was calculated using the G*Power3.1 program. The sample size for multiple regression analysis was computed by using a significance level of .05, a medium effect size of .15, a power of .95 [24] and considering a total of 12 independent variables. The minimum sample size was calculated as 184 people, but considering a dropout rate of 15%, data was collected from a total of 211 participants through a survey. A total of 197 copies of the questionnaire were finally included in the analysis by excluding 14 copies with missing data.

Measures

1. General characteristics

The general characteristics of the participants were measured using a total of 10 questions regarding age, gender, education level, religion, marital status, cohabiting family type, job, economic status, health condition, and presence of disease.

2. Digital health literacy

Digital health literacy was measured using a Korean version of the eHEALS (eHEALTH Literacy Scale) developed by Norman & Skinner [27]. The Korean version of the eHEALS (KeHEALS) used in this study was developed by Lee et al. [28]. This tool was also used in previous studies conducted with elderly people aged 65 years or older [29-31]. The KeHEALS consists of a total of 10 items, of which items 1 and 2 are additional questions to understand the subjects' interest in digital health and were not included in the scoring process [27]. Items 3 to 10 were assessed on a 5-point Likert scale.

This scale consists of questions about the respondents' experience of using the Internet to obtain health-related information and their opinions about the experience. The questions of the scale include items such as 'I know how to find useful health-related resources on the Internet' and 'I know how to use the Internet to find information about health-related issues I want to know about.' Each item is rated on a 5-point scale from 1 point (='Strongly disagree') to 5 points (='Strongly agree'). Total scores range from 8 to 40 points, and a higher total score indicates a higher level of digital health literacy. Regarding the the reliability of the the eHEALS, the Cronbach's α value was reported as .88 by Norman & Skinner [27], and for the KeHEALS used in this study, the Cronbach's α value was calculated as .97 in this study.

3. Self-efficacy

Self-efficacy was measured using a Korean version of the New General Self-Efficacy (NGSE) scale developed by Chen, Gully & Eden [32]. The Korean version of NGSE was developed by Oh [33] by translating and modifying the original scale. The scale consists of 8 items in total, and each item is rated on a 5-point scale ranging from 1 point ('Hardly') to 5 points ('Very much'). Higher scores indicate higher levels of self-efficacy. The Cronbach's α value was reported as .87 for the original scale [32] and as .86 for the Korean-translated, modified version [33]. In the present study, the Cronbach' α value was calculated as .93.

4. Self-care behavior

Self-care behaviors were assessed using the scale developed by Lee [7]. This tool is a self-care behavior assessment tool for elderly people with hypertension developed by referring to literature and existing scales such as a self-care behavior assessment tool developed by Lee [34], a health promotion behavior assessment tool by Song & Lee [35], and a health behavior compliance measurement tool by Lee [36]. Each item was used without any modification because the questions of the scale are not limited to hypertension management. The scale used contains a total of 24 items: 7 items on health management, 4 items on exercise, 8 items on diet, 2 items on smoking cessation, and 3 items on stress management. The items on health management included general health management behaviors, such as regular weight and blood pressure measurements, adherence with prescribed medications, consultation with medical professionals for health management, and keeping hospital appointments. Each item is assessed on a 4-point scale, ranging from 1 point ('Never') to 4 points ('Always'). The total scores range from 24 to 96 points, and higher scores indicate higher levels of self-care behaviors. The Cronbach's α value was reported as .64 by the developer of the scale [7], and the Cronbach' α value was calculated as .86 in this study.

Data collection

The data collection was carried out from January 22 to April 12, 2024. Among the 22 cities and counties in Gyeongsangbuk-do, 9 cities and counties with a relatively high proportion of the elderly population aged 65 or older were selected by a convenience sampling method. The 9 cities and counties included urban-rural complex areas, rural and fishing villages. Data was collected from the community-based facilities frequently used by the elderly, such as senior centers, rural community centers, and public health centers, in each selected city or county. The community-based facilities for data collection were selected by comprehensively considering the number of elderly people using each facility and accessibility to each facility. The researcher and the assistant visited the community-based facilities in person, explained the purpose of the study in detail to the potential participants, and collected data from elderly people aged 65 years or older who voluntarily agreed to participate and gave informed consent. A survey was conducted using self-reported questionnaires. However, in the case of the elderly people who had difficulty responding to the questions of the questionnaire on their own due to poor reading comprehension or poor eyesight, the researcher or the research assistant read the questions one by one to the participants and checked if they understood the questions in an one-on-one manner before asking them to respond. It took approximately 20 minutes for the participants to complete the questionnaire, and a small gift was given to each participant as a token of appreciation.

Data analysis

The collected data was analyzed using SPSS/WINN (version 23.0 for Science). The specific statistical analysis methods were as follows.

1) The general characteristics of the participants were analyzed by calculating the frequency, percentage, mean and standard deviation.
2) The levels of digital health literacy, self-efficacy, and self-care behaviors among the participants were analyzed by calculating the mean and standard deviation.
3) Differences in the major variables according to general characteristics were analyzed using the independent t-test or one-way ANOVA, and post-hoc tests were performed using the Scheffé test.
4) Pearson's correlation coefficient was used to analyze correlations between digital health literacy, self-efficacy, and self-care behaviors.
5) Hierarchical multiple regression analysis was performed to identify the factors affecting self-care behaviors among the participants.

Ethical considerations

This study was conducted after receiving approval from the Institutional Review Board of Dongguk-WISE University (DGU IRB No.: 20240001), and this study adhered to the guidelines of the institutional ethics committee. To protect the privacy and rights of the participants, prior to data collection, the researcher explained the purpose and method of the study to the participants, and informed the participants that the collected data would not

be used for any purpose other than the research and that anonymity and confidentiality would be guaranteed. In addition, the participants were informed about voluntary participation in the study and the possibility of withdrawl from the study at any time without any disadvantages. The survey was conducted only with the participants who fully understood the explanations about the survey, voluntarily agreed to participate in the study, and submitted the written informed consent form. After assigning a unique number (ID number) to each questionnaire, the collected data was encrypted and stored on a computer, and the participants were informed that the research data would be securely deleted or destroyed three years after the completion of research.

Results

General characteristics of the participants

This study was conducted with a total of 197 participants, and the mean age was 71.73 ± 5.94 years. The 65-69 age group (45.2%, 89 people) accounted for the largest proportion, followed by the 70-74 age group (25.4%, 50 people), the 75-79 age group (16.2%, 32 people), and the ≥ 80 age group (13.2%, 26 people). Females accounted for 55.3% (109 people). Regarding education level, 'elementary school or lower' (at 34.0%, 67 people) took up the largest proportion, followed by'high school' (27.9%, 55 people) and 'middle school' (24.9%, 49 people). As to religion, Buddhism (44.6%, 88 people) accounted for the largest proportion. As for marital status, married people took up the largest proportion (77.7%, 153 people). Regarding cohabiting family, people living with the spouse (69.6%, 137people) accounted for the largest proportion, and those living alone took up 13.2% (26 people). Regarding the presence of a job, 55.8% (110 peole) did not have a job. As to economic status, 61.9% (122 people) rated their economic status as'moderate', 24.4% (48 people), as 'good', and 13.7% (27 people), as'bad.' As for health condition, those who rated their health condition as'moderate' (57.4%, 113 people) took up the largest proportion, followed by the group with'good' health condition (25.9%, 51 people), and the group with'bad' health condition (16.7%, 33 people). Regarding the number of diseases, the group with 1 or 2 diseases (63.4%, 125 people) took up the largest proportion, followed by the group with 3 or more diseases (23.4%, 46 people) and the group without any diseases (13.2%, 26 people) (Table 1).

Levels of digital health literacy, self-efficacy, and self-care behavior among the particpants

The mean score for digial health literacy was 21.97 ± 8.38 out of 40 points among the participants. The mean score for self-efficacy was 3.27 ± 0.72 out of 5 points. The mean score for self-care behavior was 70.22 ± 10.55 out of 96 points (Table 2). With respect to the levels of the subdomains of self-care behaviors, the mean score was 20.56 ± 3.76 out of 28 scores for health management, 10.19 ± 3.12 out of 16 points for exerccise, 23.83 ± 4.35 out of 32 points for diet, 7.03 ± 1.68 out of 8 points for smoking cessation, and 8.58 ± 2.03 out of 12 points for stress management.

Digital health literacy, self-efficacy, and self-care according to general characteristics

The analysis of the level of digital health literacy according to general charactristics revealed that there were significant differences

Table 1. General Characteristics of Subjects (*N*=197)

Characteristic	Categories	n (%) or M ± SD
Age (year)	65~69	89 (45.2)
	70~74	50 (25.4)
	75~79	32 (16.2)
	≥ 80	26 (13.2)
		71.73 ± 5.94
Gender	Male	88 (44.7)
	Female	109 (55.3)
Education level	≤ Elementary school	67 (34.0)
	Middle school	49 (24.9)
	High school	55 (27.9)
	≥ College	26 (13.2)
Religion	Buddhism	88 (44.6)
	Catholicism, Christianity	47 (23.9)
	Others	62 (31.5)
Marital status	Married(has a spouse)	153 (77.7)
	Bereaved, Divorced	39 (19.8)
	Unmarried, others	5 (2.5)
Cohabiting family	Alone	26 (13.2)
	With spouse	137 (69.6)
	With sons and daughters	17 (8.6)
	With relative, others	17 (8.6)
Job	Yes	87 (44.2)
	No	110 (55.8)
Economic status	Good	48 (24.4)
	Moderate	122 (61.9)
	Bad	27 (13.7)
Health condition	Good	51 (25.9)
	Moderate	113 (57.4)
	Bad	33 (16.7)
Disease	None	26 (13.2)
	1~2 disease	125 (63.4)
	≥ 3 disease	46 (23.4)

Table 2. Degree of Digital Health Literacy, Self-Efficacy, Self-Care Behaviors (*N*=197)

Variables	M ± SD	Range
		Min–Max
Digital health literacy	21.97 ± 8.38	8~40
Self-efficacy	3.27 ± 0.72	1~5
Self-care Behaviors	70.22 ± 10.55	43~96
Health-management	20.56 ± 3.76	11~28
Exercise	10.19 ± 3.12	4~16
Diet	23.83 ± 4.35	12~32
Smoking cessation	7.03 ± 1.68	2~8
Stress management	8.58 ± 2.03	4~12

in the level of digital health literacy according to age (F = 8.87, p < .001), gender (t = 2.20, p = .029), education (F = 33.29, p < .001), religion (F = 3.20, p = .043), cohabiting family (F = 3.22, p = .024), and presence of disease (F = 5.13, p = .007). Regarding age, the 65-69 age group (25.03 ± 7.62) showed a higher mean score for digital health literacy than the 75-79 age group (17.75 ± 7.67) and the ≥ 80 age group (19.50 ± 9.22). Also, males (23.42 ± 8.33) showed a higher level of digital health literacy than females (20.80 ± 8.28). In terms of education level, the high school group and (27.40 ± 5.46) and the ≥ college group (28.04 ± 6.63) showed a higher level of digital health literacy, compared the ≤ elementary school group (16.60 ± 7.62) and the middle school group (20.00 ± 7.27). In addition, the group with no diseases (26.23 ± 5.50) showed a higher level of digital health literacy than the group with 1 or 2 diseases (21.89 ± 8.74) or the group with three or more diseases (19.78 ± 7.96).

As for self-efficacy, there were significant differences in the level of self-efficacy according to education level (F = 3.63, p = .014), economic status (F = 4.09, p = .018), and health condition (F = 9.06, p < .001). In terms of education level, the group with the education level of ≥ college (3.59 ± 0.63) had a higher level of self-efficacy than the group with the education level of ≤ elementary school (3.12 ± 0.78). In addition, the level of self-efficacy was higher in the group with good economic status (3.52 ± 0.76) than the group with bad economic status (3.11 ± 0.58). In terms of health condition, the group with good health condition (3.60 ± 0.75) showed a higher level of self-efficacy, compared to the group with bad health condition (2.98 ± 0.89) or the group with moderate health condition (3.21 ± 0.59).

As for self-care behaviors, there were significant differences in the level of self- care behaviors according to gender (t = 2.42, p = .016), religion (F = 4.16, p = .017), cohabiting family (F = 2.97, p = .033), job(t = 3.01, p = .003), and economic status (F = 3.08, p < .048). The mean score for self-care behaviors was higher in females (71.84 ± 9.71) than males (68.22 ± 11.24), and it was also higher in the group livig with son and daughters (76.59 ± 12.94) than in the group living alone (67.00 ± 11.62). Also, the mean score for self-care behaviors was higher in the group with a job (72.20 ± 10.52) than the group without a job (67.72 ± 10.10). In addition, the group with good economic status (73.23 ± 8.96) had a higher mean score than group with bad economic status (67.52 ± 12.03) (Table 3).

Correlations between digital health literacy, self-efficacy, and self-care behaviors

As a result of correlation analysis between digital health literacy, self-efficacy, and self-care, it was found that self-care behaviors had a significant positive correlation with self-efficacy (r = .35, p < .001), and self-efficacy showed a a significant positive correlation with digital health literacy (r = .16, p = .026). However, there was no significant correlation between digital health literacy and self-care behaviors (r = .08, p = .265). Regarding the subdomains of self-care behaviors, health management (r = .33, p < .001), exercise (r = .33, p < .001), diet (r = .17, p = .013), smoking cessation (r = .14, p = .047), and stress management (r = .18, p = .008) all showed a significant positive correlation with self-efficacy (Table 4).

Factors affecting self-care behaviors among the participants

Hierarchical multiple regression analysis was performed to identify factors associated with self-care behaviors among the participants. The Durbin-Watson test was 1.663, which is close to the cutoff value of 2, indicating that there was no problem of autocorrelation between the error terms of the model. As a result of checking the normality and homoscedasticity of the residuals through the normal probability plot and the scatter plot of the residuals, the residuals were close to a 45 degree straight line, and the scatter plot of the residuals showed that all the residuals were evenly distributed around 0, indicating that the assumptions of normality and homoscedasticity of the residuals were satisfied. In addition, the variance inflation factor (VIF) values were all lower than 10, ranging from 1.05 to 2.82, and the tolerance values were all higher than 0.1, ranging from .35 to .94, indicating that there was no problem with multicollinearity.

In Model 1, among the general characteristics, gender, religion, cohabiting family, job, and economic status, which were found to have a significant effect on self-care behaviors, were entered, and in Model 2, self-efficacy factor was additionally entered and ana-

Table 3. Differences of Digital health literacy, Self-efficacy, Self-care behaviors according to Participant's General Charateristics (*N*=197)

Variables	Categories	Digital health literacy		Self-efficacy		Self-care behaviors											
						Total		Health-management		Exercise		Diet		Smoking cessation		Stress management	
		M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé	M±SD	t/F (*p*) Scheffé
Age (year)	65~69[a]	25.03±7.62	8.87 (<.001) c,d<a	3.36±0.62	1.90 (.131)	70.37±10.13	0.18 (.910)	20.56±3.52	1.12 (.339)	10.55±3.08	4.61 (.004) c,d<a	23.32±4.30	2.04 (.109)	7.23±1.61	0.94 (.419)	8.69±2.16	0.59 (.619)
	70~74[b]	20.50±7.89		3.31±0.76		70.54±9.87		21.08±3.48		10.88±2.90		23.38±4.33		6.94±1.63		8.26±1.96	
	75~79[c]	17.75±7.67		3.19±0.73		70.47±11.43		20.71±3.84		9.59±2.71		24.81±4.37		6.68±1.76		8.65±1.87	
	≥ 80[d]	19.50±9.22		3.00±0.86		68.81±12.50		19.42±4.84		8.42±3.47		25.23±4.31		6.96±1.88		8.76±1.92	
Gender	Male	23.42±8.33	2.20 (.029)	3.38±0.70	1.83 (.068)	68.22±11.24	-2.42 (.016)	20.55±4.13	-0.03 (.969)	9.85±3.22	-1.40 (.163)	22.89±4.48	-2.74 (.007)	6.56±2.07	-3.41 (.001)	8.34±2.12	-1.54 (.125)
	Female	20.80±8.28		3.19±0.72		71.84±9.71		20.57±3.46		10.47±3.02		24.58±4.12		7.41±1.16		8.78±1.94	
Education level	≤ Elementary school[a]	16.60±7.62	33.29 (<.001) a,b<c,d	3.12±0.78	3.63 (.014) a<d	69.99±9.73	2..54 -0.057	19.85±3.43	2.78 (.042) a<b,c	10.17±3.02	0.65 (.584)	24.68±4.04	1.74 (.159)	6.95±1.65	3.63 (.014)	8.31±1.82	5.45 (.001) a,b<c
	Middle school[b]	20.00±7.27		3.18±0.66		67.27±10.24		20.26±3.43		9.77±3.19		22.83±4.57		6.46±2.04		7.91±2.03	
	High school[c]	27.40±5.46		3.40±0.67		71.53±11.10		20.94±3.78		10.30±3.13		23.76±4.61		7.43±1.39		9.07±2.08	
	≥ College[d]	28.04±6.63		3.59±0.63		73.65±11.04		22.19±4.68		10.80±3.23		23.65±3.95		7.46±1.24		9.53±1.94	
Religion	Buddhism	21.05±8.70	3.20 (.043)	3.37±0.77	1.67 (.190)	72.47±9.59	4.16 (.017)	20.32±3.66	2.90 (.057)	9.48±3.25	6.18 (.003) a,c<b	23.04±4.66	1.48 (.229)	6.62±1.91	2.75 (.066)	8.09±2.12	2.72 (.068)
	Catholicism, Christianity	24.64±7.20		3.23±0.63		69.51±10.98		21.22±3.57		11.04±2.88		24.14±4.12		7.26±1.41		8.78±2.03	
	Others	21.26±8.46		3.16±0.69		67.58±10.99		19.65±4.09		9.55±3.03		24.27±4.32		7.14±1.75		8.87±1.82	
Marital status	Married(has a spouse)	22.58±8.29	2.65 (.073)	3.31±0.67	1.02 (.361)	70.58±10.45	2.46 (.087)	20.70±3.84	0.45 (.635)	10.18±3.11	0.43 (.647)	23.95±4.20	7.17 (.001) c<a,b	7.04±1.71	0.05 (.949)	8.67±2.01	2.18 (.115)
	Bereaved, Divorced	19.28±8.64		3.16±0.87		70.15±11.00		20.07±3.63		10.38±3.27		24.25±4.44		6.97±1.64		8.46±2.06	
	Unmarried, others	24.40±5.72		3.02±0.74		60.00±4.52		20.20±2.28		9.00±2.34		16.80±2.58		7.20±1.30		6.80±1.92	
Cohabiting family	Alone[a]	17.54±8.33	3.22 (.024)	3.07±0.73	0.90 (.438)	67.00±11.62	2.97 (.033) a<c	19.38±3.74	2.08 (.104)	9.76±3.01	2.04 (.110)	23.42±4.63	1.18 (.318)	6.50±1.96	1.25 (.291)	7.92±2.09	2.15 (.094)
	With spouse[b]	22.35±8.32		3.30±0.68		70.04±10.00		20.56±3.69		10.01±3.07		23.67±4.23		7.10±1.63		8.67±2.02	
	With sons and daughters[c]	23.24±7.80		3.27±0.94		76.59±12.94		22.29±4.20		11.82±3.55		25.70±5.45		7.41±1.32		9.35±1.96	
	With relative, others[d]	24.41±7.85		3.38±0.77		70.24±8.66		20.64±3.58		10.70±2.86		23.82±3.59		6.94±1.85		8.11±1.90	
Job	Yes	20.96±8.63	-1.90 (.058)	3.24±0.77	-0.73 (.462)	72.20±10.52	3.01 (.003)	21.03±3.68	1.97 (.050)	10.52±3.29	1.67 (.096)	24.62±4.58	2.93 (.004)	7.24±1.39	1.90 (.058)	8.76±1.99	1.35 (.176)
	No	23.24±7.93		3.32±0.65		67.72±10.10		19.97±3.81		9.78±2.85		22.82±3.84		6.77±1.96		8.36±2.08	
Economic status	Good[a]	21.73±9.38	1.00 (.367)	3.52±0.76	4.09 (.018) a>c	73.23±8.96	3.08 (.048) a>c	21.45±4.11	2.78 (.064) c<a.b	10.70±3.19	0.88 (.414)	24.64±3.36	2.55 (.081)	7.47±1.18	2.31 (.102)	8.93±1.90	1.61 (.201)
	Moderate[b]	22.50±8.09		3.21±0.71		69.64±10.60		20.48±3.67		10.00±2.86		23.85±4.48		6.91±1.76		8.38±2.04	
	Bad[c]	20.00±7.78		3.11±0.58		67.52±12.03		19.37±3.27		10.18±4.00		22.29±5.03		6.77±1.94		8.88±2.17	
Health condition	Good[a]	22.75±8.71	2.38 (.095)	3.60±0.75	9.06 (.000) a>b,c	71.31±10.62	0.38 (.681)	20.66±3.97	1.21 (.299)	11.09±2.95	5.00 (.008) c<a.b	23.45±4.08	0.28 (.750)	6.94±1.95	0.23 (.793)	9.15±2.01	3.21 (.042) c<a.b
	Moderate[b]	22.46±8.12		3.21±0.59		69.94±10.84		20.27±3.77		10.15±2.97		23.92±4.50		7.10±1.57		8.47±2.03	
	Bad[c]	19.09±8.44		2.98±0.89		69.52±9.55		21.42±3.35		8.93±3.47		24.12±4.34		6.93±1.61		8.09±1.92	
Disease	None	26.23±5.50	5.13 (.007) a>b,c	3.52±0.61	2.85 (.060)	68.96±11.81	0.49 (.610)	19.15±4.36	2.44 (.089)	10.30±3.15	0.24 (.780)	23.30±3.97	0.55 (.573)	7.19±1.54	0.82 (.438)	9.00±2.11	1.81 (.165)
	1~2 diseases	21.89±8.74		3.29±0.69		70.78±10.75		20.64±3.69		10.28±3.13		24.08±4.54		7.10±1.73		8.67±2.11	
	≥ 3 diseases	19.78±7.96		3.10±0.80		69.41±9.28		21.15±3.47		9.91±3.11		23.45±4.08		6.76±1.60		8.13±1.70	

Table 4. Correlation between Digital health literacy, Self-efficacy, Self-care behaviors (*N*=197)

Variables		Digital health literacy	Self-efficacy	Self-care Behaviors					
				Total	1	2	3	4	5
		r (*p*)							
Digital health literacy		1							
Self-efficacy		.16 (.026)	1						
Self-care Behaviors	Total	.08 (.265)	.35 (<.001)	1					
	1		.33 (<.001)	.76 (<.001)	1				
	2	.07 (.327)	.33 (<.001)	.66 (<.001)	.39 (<.001)	1			
	3	-.49 (.498)	.17 (.013)	.77 (<.001)	.38 (<.001)	.32 (<.001)	1		
	4	.10 (.133)	.14 (.047)	.55 (<.001)	.32 (<.001)	.18 (.010)	.38 (<.001)	1	
	5	.12 (.081)	.18 (.008)	.63 (<.001)	.40 (<.001)	.33 (<.001)	.35 (<.001)	.35 (<.001)	1

1. Health- management, 2. Exercise, 3. Diet, 4: Smoking cessation, 5 Stress management.

lyzed. As a result, Model 1(F=4.14, $p<.001$) and Model 2(F=25.79, $p<.001$) were both statistically significant. The explanatory power for self-care was 12.6% in Model 1 and 22.8% in Model 2. In Model 2, the explanatory power was significantly increased by 10.2% compared to Model 1 ($p<.001$).

In the regression model of Model 2, self-efficacy (β=.33, $p<.001$) was found to be the variable that had the most significant impact on self-care behaviors among the paticipants. The second and third significant factors after self-efficacy were job (β=-.20, $p=.002$) and gender (β=-.18, $p=.008$) among general characteristics.

Discussion

This study attempted to identify the levels of digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people, and identify factors influencing self-care behavior in order to provide basic data for the development of programs and policies to enhance self-care in the elderly.

In this study, the mean score for digital health literacy among the particpants was 21.97 points (54.9%). This score is lower than the mean scores reported in several previous studies using the same scale. More specifically, the level of digital health literacy was reported as 30.91 points in a study of the elderly using welfare centers in Seoul [29], 29.99 points in a research of the elderly using senior welfare centers in Seoul [30], and 28.35 points in a study of the elderly using senior welfare centers and senior centers in Seoul, Gyeonggi-do, and Gyeongsangbuk-do [31]. The comparison of the results of this study and previous studies show that there is a significant difference in the level of digital health literacy between the elderly living in Gyeongsangbuk-do, a regional area, and those living in the Seoul metropolitan area, suggesting that various types of support are needed to enhance the digital health literacy of the elderly living in the Gyeongsangbuk-do region. However, the mean score of digital health literacy in this study is higher than 37.10 points (50.1%) reported in a previous study in China that assessed digital health literacy among Chinese community-dwelling elderly people by using a different scale [37]. These findings suggest that a country's better Internet access can improve the level of digital health literacy of the country.

In this study, the mean score for self-efficacy among the participants was 3.27 points (65.4%), which corresponds to a medium level or above. This score is similar to the mean score of 3.36 points (67.2%) reported in a previous study using the same tool to assess self-efficacy among elderly people using senior citizen university programs, welfare centers, or senior centers in N City, a regional medium-sized city [6]. However, a prior study using a different self-efficacy scale reported that the mean score for self-efficacy in low-income elderly people with hypertension was 22.53 points (56.3%) [38], which is lower than the mean score in this study. A relatively higher mean score for self-efficacy in this study may be attributed to the fact that the income level for the low-income group was not set as a criterion when selecting the participants in this study. In other words, a previous study reported that the low income group showed a relatively lower level of self-efficacy [38], and this finding is consistent with the results of this study showing that the level of self-efficacy was significantly higher in the good economic status group than the bad economic status' group. In view of the finding of a previous study [39] that a higher level of self-efficacy was associated with a higher income level in community-dwelling elderly hypertensive patients, it is thought that there is a consistent relationship between the income level and self-efficacy.

Table 5. Influencing Factors on Self-care among Participants (N=197)

Variables		Model 1				Model 2			
		B	β	t	p	B	β	t	p
(Constant)		69.83		20.16	< .001	54.98		12.57	< .001
Gender*		-2.87	-0.13	-1.90	.058	-3.80	-0.18	-2.67	.008
Religion*	Buddhism	3.78	0.17	2.26	.024	2.74	0.13	1.73	.084
	Catholicism, Christianity	1.58	0.06	0.82	.413	1.12	0.04	0.61	.537
Cohabiting family*	Alone	-4.84	-0.15	-1.52	.130	-3.76	-0.12	-1.25	.210
	With spouse	-1.32	-0.05	-0.51	.606	-0.80	-0.03	-0.33	.739
	With sons and daughters	3.81	0.10	1.09	.275	4.08	0.10	1.24	.213
Job*		-4.11	-0.19	-2.83	.005	-4.23	-0.20	-3.09	.002
Economic status*	Good	5.73	0.23	2.36	.019	3.99	0.16	1.73	.085
	Moderate	2.02	0.93	0.94	.346	1.76	0.08	0.87	.381
Self-efficacy						4.86	0.33	5.07	< .001
		R^2 = .16, Adj. R^2 = .12, F = 4.14, p < .001				R^2 = .27, Adj. R^2 = .22, F = 25.79, p < .001			

Reference group: Gender*Female, Religion*Others, Cohabiting family*With relative, others, Job*Yes, Economic status*Bad.

The mean score for self-care behaviors was 70.22 points (73.1%), and it is higher than 60.90 points reported in a study that measured self-care behaviors among elderly hypertensive patients using the same scale [7]. In addition, the mean score for self-care behaviors of this study was also higher than the scores reported in several previous studies using a different scale. In particular, the level of self-care behaviors among elderly people was repored as 52.06 points (65.0%) in a study of community-dwelling elderly hypertensive patients [11], 58.56 points (52.2%) in a study of elderly diabetic patients living alone [10], and 29.39 points (38.6%) in a study of Chinese elderly people with chronic diseases [40]. In this study, the diagnosis of a specific disease was not set as a selection criterion for research participants, and a comparision of the research results of the present study and several previous studies revealed that people diagnosed with a specific disease showed a lower level of self-care behaviors. However, since there was no significant relationship between the presence of disease and self-care behaviors among the participants of this study, additional research is required to clarify the relationship between the presence of specific diseases and self-care behaviors. In addition, regarding the degrees of performance of the sub-domains of self-care behaviors in this study, the participants showed a high level of smoking cessation(87.9%), but the performance of exercise (63.7%) was lowest among the subdomains of self-care behaviors, and the degrees of performing stress management (71.5%), self-management (73.4%), and diet (73.5%) were relatively lower compared to the level of smoking cessation. These result findings suggest that there is a need for developing systematic intervention programs for exercise and stress management especially for community-dwelling elderly people, and it is believed that such intervention programs will contribute to a balanced improvement in the performance of all self-care behaviors. Meanwhile, in the case of the elderly with chronic diseases, their physical limitations or lack of motivation can act as significant barriers to starting to perform exercise [39], so it is necessary to systematically implement tailored exercise programs by taking into account the health status of the target group.

This study analyzed differences in digital health literacy, self-efficacy, and self-care behaviors according to general characteristics. As a result, the level of digital health literacy was found to be higher in the 65-69 age group than in the ≥ 75 age group. Also, the group with an education level of high school and the group with an education level of ≥ college showed a higher level of digital health literacy than the group with an education level of ≤ elementary school and the group with an education level of middle school. In addition, the level of digital health literacy was higher in the group with no disease than the group with disease. These results are consistent with the findings of previous studies showing that the level of digital health literacy was higher in younger age groups, in people with a higher education level, and in people without diseases [31,41,42]. However, the results of this study are not in agreement with previous research results showing that a higher level of digital health literacy was linked to higher economic status [41,42], indicating that additional research is required.

With respect to self-efficacy, the level of self-efficacy was found to be higher in the group with an education level of college or higher than the group with an education level of elementary

school or lower, and it was also higher in the group with good economic status than the group with bad economic status. Also, the level of self-efficacy was higher in the group with good health condition than the group with moderate health condition or the group with bad health condition. These results are consistent with a previous research reporting that a higher level of self-efficacy is associated with a higher education level and better health status [6], but these results are not in agreement with the results of a previous research that the level of self-efficacy was higher in females, in the group with religion, and in the group with a job [6], so additional research should be conducted on factors associated with self-efficacy. Lastly, regarding self-care behaviors, the results of this study are consistent with previous studies showing that self-care behaviors are higher in the group with a cohabiting family member and in the group with good economic status [37,42] and that the level of self-care was higher among females [30,42].

In this study, the analysis of correlations between major variables revealed that self-care behaviors had a significant positive correlation with self-efficacy, and self-efficacy had a significant positive correlation with digital health literacy. These results are consistent with previous studies reporting that a higher level of self-efficacy was associated with a higher level of self-care in community-dwelling elderly people, elderly cancer patients, and elderly hypertension patients [6,39,43]. The results of this study are also consistent with a prior study showing that a higher level of self-efficacy was linked to a higher level of digital health literacy in both middle-aged and elderly groups [44].

Meanwhile, in this study, self-care behaviors did not show a significant correlation with digital health literacy. These results are are not consistent with the previous studies that reported that the level of health promoting behaviors was increased with the incease of the level of digital health literacy among community-dwelling elderly people, elderly people with chronic diseases, and adults aged 19 years or older [30,45,46]. This disagreement in the research results may be attributed to the fact that all the nine cities and counties included in the target region of this study were rural-urban complex areas or rural or fishing villages, which have relatively limited accessibility to medical and welfare services, and have environmental characteristics that can limit access to and the use of digital technologies. In this regard, the digital divide refers to the gap in the access to and use of information and communication technologies among individuals, households, different demographic groups, and regions [47]. Even among elderly people, differences in socioeconomic variables, such as gender, education, and income, as well as differences depending on residential areas have been reported to be important factors that can widen the digital divide [48]. According to the report titled'Korean social trends 2023: Digital Literacy in the Digital Transformation Era' [49], among 17 cities and provinces nationwide, Gyeongsangbuk-do was ranked 7th in the Internet usage rate, and ranked 9th in the mobile Internet usage rate, showing that the Internet usage rate and the mobile Internet usage rate of the Gyeongsangbuk-do region are medium levels. However, in terms of the specific areas of digital information usage, it has been reported that in all the areas of digital accessibility, capacity, and utilization, the level of digital information usage is lower in county areas than city areas. In view of these research results on digital information usage, it is thought that the target region of the present study included urban-rural complex areas or rural or fishing villages where the level of digital information usage was generally low, and this poor digital environment of the target region is presumed to have acted as a factor limiting the connection between digital health literacy and self-care behaviors among the participants. To clarify the association between the variables, further research shoud be conducted by considering the digital environment of the target region, digital health literacy and self-care behaviors.

In this study, self-efficacy was found to be the primary influencing factor for self-care behaviors, and this finding is consistent with the results of previous studies reporting that self-efficacy was the most significant influencing factor for self-care behaviors among community-dwelling elderly people, elderly cancer patients, and elderly hypertension patients [6,39,43]. In light of these analysis results, in order to improve the self-care behaviors of the elderly, there is a need to enhance self-efficacy among the elderly by developing tailored self-efficacy intervention strategies for elderly people and providing such strategies more efficiently and systematically [6]. Regarding the relationship between self-care and general characteristics, the level of self-care was higher in women than men, and it was also higher in the group with a job than the group withiout a job. Therfore, in the future, it is necessary to explore measures to effectively improve the self-care behaviors of elderly population groups in various environments by developing customized intervention programs by taking into account the differences in self-care behaviors according to gender and occupation.

The results of this study showed that self-efficacy, job, and gender only explained 22.8% of self-care behaviors among the participants and thus did not have a high explanatory power. In view of the findings of previous studies, a low explanatory power of the variables are thought to be related to the fact that self-care be-

haviors are significantly affected not only by self-efficacy but also by many other variables, such as disease knowledge, family support, and social support [8-10]. Thus, a follow-up study should be conducted by selecting and additionally including important variables related to self-care behaviors.

In this study, digital health literacy was found to have no significant effect on self-care behaviors among community-dwelling elderly people. These results are different from the results of previous studies that found that a higher level of digital health literacy had a significant effect on self-care among the elderly using senior community welfare centers, senior centers, and senior welfare centers in Seoul [30,31]. These differences in research results may be attributed to differences in the level of digital health literacy between different regions, as shown by the fact that the level of digital health literacy among the particpants of this study was relatively lower than among the elderly living in the Seoul Metropolitan Area. In the era of the 4th Industrial Revolution, the development of digital technology and the resulting advantages will occur at an increasingly rapid pace [12], and the gap between age groups as well as regional disparities may increase in the future, so not only the government but also various ministries of local governments should make efforts to enhance digital health literacy among the elderly [13]. To improve the level of digital health literacy among elderly people, it is required to develop and operate evidence-based customized intervention programs by referring to the digital health literacy improvement program for elderly people with hypertension in Korea, the European Union's ICHealth project for elderly people in Europe, and the Widening Digital Participation program of the U.K. [12,50]. Additionally, it is necessary to provide elderly people with various educational opportunities to learn digital health literacy skills [51] and ensure accessibility to resources needed to enhance for digital health literacy in order to ensure that everyone can utilize digital support [52].

This study was conducted with the elderly living in some areas of Gyeongsangbuk-do, especially the elderly using facilities such as senior centers, community centers, and public health centers. Therefore, this study has limitations in generalizing the study results to all elderly people aged 65 or older. In future studies, it is necessary to recruit participants from a geographically broader area and conduct research with elderly people with various characteristics to increase the generalizability of research results. In particular, in consideration of the results of previous studies showing that the level of digital information usage was higher in city areas than in conty areas, and that a higher level of digital information usage was also associated with a higher education level [52], further research is needed to comparatively analyze differences in elderly people' health literacy between city and county areas as well as differences in elderly people' health literacy by education level. In addition, because a cross-sectional survey design was used in this study, there are limitations in causally interpreting the research results. In a follow-up study, a longitudinal study should be designed to keep track of changes in variables over time and analyze the effects of digital health literacy on changes in self-care behaviors. In particular, such a longitudinal study is required to verify whether the improvement of digital health literacy actually leads to changes in self-care behavior and contributes to health promotion.

This study was conducted noting the fact that, in anticipation of the imminent era of a super-aged society, it is very important for the elderly to understand, collect, and utilize health information on their own [6,39] and to properly perform self-care in order to maintain and improve the health of community-dwelling elderly people. However, the participants of this study showed a relatively lower level of digital health literacy, compared to elderly people living in the metropolitan area, showing that there is a regional disparity in digital health literacy. In addition, digital health literacy did not show a significant correlation with self-care behaviors, and only self-efficacy was found to be a significant influencing factor for self-care behaviors. These results suggest that there is a need to develop a self-efficacy enhancement program to promote the health of community-dwelling elderly people. Additionally, for the elderly residing in county or rural and fishing areas, the support system at the government and local government levels should be strengthened to enhance digital health literacy among the elderly.

The significance of the present study can be found in the fact that this study investigated the levels of digital health literacy, self-efficacy, and self-care behaviors among community-dwelling elderly people regardless of the presence or absence of specific diseases, identified influencing factors for self-care behaviors, and thereby presented basic data for the development of policies and programs to promote the health of the elderly.

Conclusions

This study investigated the level sof digital health literacy, self-efficacy, and self-care behavior among the community-dwelling elderly aged 65 or older living in Gyeongsangbuk-do. As a result, it was found that the participants' level of digital health literacy was low, while their levels of self-efficacy and self-care behaviors were a intermediate or higher level. In addition, self-efficacy was iden-

tified as an influencing factor for self-care behaviors among the participants, but digital health literacy did not have a significant effect on self-care behaviors. Based on the results of this study, it is suggested that in order to improve the self-care behaviors of the elderly, it is necessary to develop self-efficacy enhancement programs by taking into account the characteristics of the elderly, and provide policy-level support. In particular, it is necessary to comprehensively consider the content and methods of education by considering and reflecting factors such as the residential area, economic status, gender, and health status of elderly people. In addition, efforts should be made to overcome regional gaps in digital health literacy by developing and operating various policies and programs at the government, local governments, and community levels to enhance digital health literacy among elderly people in the era of the 4th Industrial Revolution. In addition, follow-up research should be conducted by expanding the target region and target population, and longitudinal studies should be designed to examine the effects of the self-efficacy and digital health literacy interventions for the improvement of self-care behaviors, and to analyze changes in variables over time.

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No conflict of interest has been declared by all authors.

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Authors' contributions

Hyojin Son contributed to conceptualization, data curation, formal analysis, methodology, and writing-original draft. Youngran Han contributed to conceptualization, data curation, methodology, writing-review & editing, supervision, and validation.

Data availability

Please contact the corresponding author for data availability.

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