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Association between smartphone use and frailty in older adults

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유 진 호

Abstract

Association between smartphone use and frailty in older adults

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Introduction: With worldwide aging, there are many ongoing studies to further identify the risk factors and ways to prevent age-related conditions. The most actively studied areas include frailty in the elderly.

Rapid development and increasing use of smartphones have come to play an important role in health industries. Despite the increasing importance of smartphone use for sustaining healthy life, no large study has reported the characteristics of elderly smartphone users.

Our hypothesis is that the ownership of a smartphone is inversely associated with frailty because smartphone owners can benefit from various health applications to manage their health, and the use of smartphone itself can be a good cognitive exercise that can help prevent frailty. Therefore, the aim of this study is to describe the various sociodemographic and medical characteristics of the elderly smartphone users and non-users, and to identify the association between the use of smartphones and frailty. The obtained

information may be helpful to screening frailty in small clinics.

Methods: We used the baseline data of the Korean Frailty and Aging Cohort Study which is a nationwide cohort study conducted to identify and prevent the factors contributing to aging and frailty. The data of a total of 2935 participants were analyzed for various demographic, socioeconomic, cognitive, and functional characteristics as well as frailty. Frailty was defined using Fried frailty index. The characteristics of the participants were described in terms of smartphone ownership, and multiple logistic regression analysis was performed to assess the association between the use of smartphones and frailty.

Results: Out of 2935 participants aged between 70 and 84, 1404 (47.8%) participants were using smartphones, and 1531 (52.2%) participants were using cellphones other than smartphones or did not own a cellphone. The mean age of all participants was 76.0 years old. The smartphone users were more likely to be male (53.3%), with higher educational and economic background compared to non-users. They were also more likely to be in a marital relationship and not living alone, but received less social support, and exhibited poorer daily functional abilities. However, they exhibited higher cognitive capabilities, and more importantly, less frail in all aspects of frailty criteria compared to smartphone non-users. The odds ratio of the association between smartphone ownership and frailty was 0.47, 95% confidence interval 039-055, after adjusting for various related factors.

Conclusion: Ownership of a smartphone is a result of multifactorial

circumstances and conditions as is frailty. Smartphone non-users in this study were more frail than smartphone users, and exhibited poorer cognitive abilities while maintaining better daily functional abilities and social interaction. Therefore, it is our conclusion that the ownership of a smartphone in older adults represents many background factors that are often linked to frailty in an inverse manner, and a simple question or identification of one's type of phone may be used in conjunction with other methods to screen frailty in older adults.

Keywords: frailty, aged, cell phone, smartphone, chronic disease
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Table of Contents

List of Tables

List of Figures

Chapter 1. INTRODUCTION

1.1. Aging society and frailty

Rapid increase in the older adult population is an important worldwide phenomenon. The percentage of people aged 65 years or older was reported to be 8.5% in 2015, and is projected to reach 12.0% by 2030[1]. It is a bigger problem in countries like Korea with long life expectancy (expected to reach ≥86.7 years for women, and ≥80.0 years for men by year 2030), and significantly stunted total fertility rate far below the global average (1.05 children per woman)[2, 3]. With worldwide aging, there are many ongoing studies to further identify the risk factors and ways to prevent age-related conditions. The most actively studied areas include frailty.

Frailty is a condition that increases with age, and is often recognized as a geriatric syndrome with reduced functional reserves and increased vulnerability to health risks which lead to increased risk for various adverse outcomes, including falls, hospitalization, disability, and death[4-6]. The prevalence of frailty in community-dwelling elderly adults varies widely (from 4.9% to 27.3%) by different types of tool or definition used, and the population of interest in previous studies [7].

1.2. Adoption of smartphones

1.2.1. mHealth

Another ongoing phenomenon is rapid increase in the use of smartphones. As of 2018, 59% of adults around the world reported using smartphones, with Korean adults reporting the highest rate of 94%[8]. Although this rate decreases with age, and the rate of smartphone use in older adults is far lower, this era of smartphones and wearable smart devices led to active researches on the use of these devices for various health benefits. The WHO recognizes these endeavors as mHealth or mobile health and defines it as 'medical and public health practice supported by mobile devices[9].' The WHO not only recognizes it as a new area, but to have potential to transform the face of health service delivery across the world. Rapid advances in mobile technologies and applications along with accumulated endeavors to integrate mobile health with existing health services, as well as growing coverage of mobile cellular networks make it a high possibility now more than ever.

1.2.2. Characteristics of elderly smartphone adopters

The prevalence of most chronic diseases increases with age, and much of the disease-burdened life is spent in old age. Therefore, the elderly must be considered the major treatment-target group. However, the majority of mHealth researches and efforts have been pursued on younger generation who own and can handle smartphone applications, and information regarding the elderly are scarce. Also, most researches on the elderly handled quite a small number, often less than two hundred participants. This is mostly because the rate of smartphone use decreases abruptly with increasing age. In a 2017 report by Korea Internet & Security Agency (KISA), more than 98% of adults aged between 20 and 60 were using

smartphones. This rate decreases to 79.6% in older adults between the age of 60 and 69 years, and decreases more abruptly to 29.8% in older adults aged 70 years and older[10]. In another report by the Korea Information Society Development Institute (KISDI) in 2018, 40.9%~52.7% of older adults aged 65 years and older were using smartphones[11].

However, several common characteristics of the elderly who own smartphones were identified based on the current researches. First of all, the younger elderly population is more likely to own a smartphone than older elderly population, as can be expected. Also, men are more likely to adopt a smartphone, being more open to new technologies, and higher educational and economic levels also impact owning a smartphone[12, 13]. The barriers to adopting a smartphone among the elderly included financial limitation, vision impairment, lack of interest, and lack of confidence to use new technology[14].

1.3. Frailty and smartphones

Frailty is closely associated with mental and physical health, and is often used as an index that represents the overall health in the elderly. In this digital era, not owning a smartphone can be a disadvantage to health in many ways [15, 16]. With smartphone applications, one can track daily life activities and the pattern of exercise[16–19], and can get help with weight control by monitoring daily weight and diet[20, 21]. You can also get help with lifestyle modifications other than exercise and diet through health coaching and information applications [22–24]. Poor medication compliance is also an important huddle in managing chronic diseases,

and now one can track medication compliance through daily alarm and recording[25]. Also, smartphone applications can be used to monitor mobility and prevent falls in the elderly[26], and assess and improve cognitive functions and mental health [27, 28]. However, these health applications can only be used if you own a smartphone.

Frailty is a complex condition resulting from multimodal factors including cognitive abilities. As such, it has been suggested in a number of previous studies that cognitive intervention can help prevent frailty [29]. Furthermore, learning to use a smartphone as well as the integrated application of manual and cognitive abilities to use a smartphone is being suggested as a good cognitive exercise which, in turn, can help prevent frailty [30, 31].

1.4. Objective

Despite the increasing importance of smartphone use for sustaining healthy life in the aging society with high prevalence of frailty, no large study has reported the characteristics of elderly smartphone users in Korea or the association between frailty and smartphone. Most of existing studies on the use of smartphones in the elderly not only involved a small number of participants but were also unable to assess frailty using the most widely accepted method of Fried frailty index (FFI) because assessment of frailty involves interview as well as in-person measurements of physical abilities[6].

Therefore, the aim of this study is to describe the various sociodemographic and medical characteristics of the older adult population depending on the use of smartphones, and to identify the

association between the use of smartphones and frailty. Provided the older adults who own smartphones show different baseline characteristics from those who do not, our hypothesis is that the ownership of a smartphone is inversely associated with frailty because smartphone owners can benefit from various health applications to manage their health, and the use of smartphone itself can be a good cognitive exercise that can help prevent frailty.

Furthermore, there are ongoing efforts to find a simpler approach to diagnose frailty. Diagnosing frailty requires time, manpower, and space to measure physical abilities, and it is often difficult to diagnose frailty in small clinics. Therefore, it is our ultimate goal to provide the evidence of association between smartphone ownership and frailty, and to use the obtained information to screen frailty in small clinical settings.

Chapter 2. MATERIALS AND METHODS

2.1. Study Design and Population

This study is of a cross-sectional design based on the baseline data of the Korean Frailty and Aging Cohort Study (KFACS)[32]. The KFACS is a nationwide cohort study conducted to identify and prevent the factors contributing to aging and frailty in community-dwelling older adults. A total of 3014 community-dwelling adults aged between 70 and 84 years old were recruited from 10 sites across different regions of South Korea (Seoul, Gyeonggi, Gangwon, Chungcheong, Jeolla, Gyeongsang, and Jeju) between 2016 and 2017 based on age- and gender-specific strata. Participants without serious communication problems, and living independently at home, with no plans to move out in the following two years were recruited. The study was conducted following the tenets of the Helsinki Declaration and was approved by the Institutional Review Board of Kyung Hee University Hospital (IRB number: 2015-12-103) and the Institutional Review Board of Seoul National University (IRB number: E1904/003-001). All participants gave written informed consent.

2.2. Definition of Frailty

Frailty was defined using FFI which has 5 components: unintentional weight loss, weak grip strength, self-reported exhaustion, slow gait speed, and low physical activity[6]. Participants with a score of 3 or higher in FFI were classified as

frail, those with a score of 1 or 2 were classified as pre-frail, and those without any score were classified as robust. First, 1 point was granted for unintentional weight loss of 5% of original body weight or 4.5 kg or more in last 1 year. Second, hand grip strength of the dominant hand was measured using a hand dynamometer (Takei TKK 5401, Takei Scientific Instruments, Tokyo, Japan), and 1 point was granted for grip strength <26 kg for men and <18 kg for women. The grip strength of each hand was measured twice alternately, each after a 3-minute rest, and the highest value of 4 measurements was used. Third, 1 point was granted for self-reported exhaustion when a subject said yes for 3 or more days a week to either one of the following questions I felt that everything I did was an effort" or "I could not get going" based on the Center for Epidemiological Studies-Depression (CES-D) scale. Fourth, 1 point was granted for gait speed below 1 meter per second while walking 4 meters at a normal pace. Fifth, Metabolic Equivalent Task in minutes per week (MET-min/week) was calculated to determine the physical activity, and 1 point was given for values below 494.65 kcal for men and below 283.50 kcal for women, which were equivalent to the lowest 20^{th} percentile of the gender-specific values according to a general population-based survey of older adults.

2.3. Other covariates of interest

The participants were asked to visit a study institution and go through a number of self-reported questionnaires, personal interview and medical examination. Information on the status of smoking, alcohol consumption level, academic level, marital status,

medical history etc. were provided via a questionnaire. Medical history regarding the following comorbidities were also asked of the participants: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, chronic obstructive pulmonary disease, rheumatoid arthritis, ulcers, mild liver disease, diabetes mellitus, diabetes with complications, hemiplegia, moderate or severe renal disease, any tumor, moderate or severe liver disease, leukemia, lymphoma, or acquired immune deficiency syndrome.

A smartphone is often defined as "a mobile phone with advanced computing and connectivity capability built on an operating system". The interviewers asked each participant to present the phone being used during the first visit, and identified mobile phones with a touchscreen and seemingly capable of internet connection as smartphones, and others were classified as classic cellphones.

The economic level of the participants was assessed using the net family income with the cutoff value of 2 million Korean Won (KRW) per month. Alcohol intake was categorized as drinking alcohol at least once a week and those who drink less than once a week on average. Physical activity was assessed using the metabolic equivalent for task (MET) using International Physical Activity Questionnaire (IPAQ). Cognitive functions of the participants were assessed using the Korean Mini-Mental State Examination (MMSE), and participants below minus 1.5 standard deviation (SD) for each age, sex, and educational level stratum were categorized to have cognitive impairment. The Korean version of Short-Form Geriatric Depression Scale (SGDS-K) was used to identify depression. A score of 8 or higher out of 15 was defined as depression as previously studied[33]. The number of prescription drugs each

participant took for the past 3 months or more was also checked. The Enhancing Recovery in Coronary Heart Disease Patient (ENRICHD) social support instrument was used to assess social support[34]. The level of daily functional abilities of the participants was assessed using the Korean version of Activities of Daily Living (K-ADL) and Instrumental Activities of Daily Living (K-IADL), which are short self-assessed questionnaires based on queries about various everyday activities [35, 36].

2.4. Statistical Methods

Among 3014 participants recruited during the first 2 years, 78 participants without frailty assessment data, and 1 participant without cell phone information were excluded, and the remaining 2935 participants were included for analysis.

All data are presented as mean ± SD for the continuous variables and as proportion (%) for the categorical variables. The differences between continuous variables were assessed using analysis of variance, and the differences between categorical variables were assessed using chi-squared test or Fisher's exact test. Multiple logistic regression analysis was performed to assess the association between the use of smartphones and frailty. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated with multivariate adjustment regarding age, sex, educational level, income level, number of prescription drugs taken, and depression. All statistical analyses were conducted using R version 3.4.0 (R Foundation for Statistical Computing, Vienna, Austria), and the statistical significance was set at $P < 0.05$.

Chapter 3. RESULTS

3.1. General characteristics of the participants

Out of 2935 participants, 1404 (47.8%) participants were using smartphones, 1452 (49.5%) participants were using cellphones other than smartphones, namely non-smartphones, and 79 (2.7%) participants did not own a cellphone. The participants who were using non-smartphones or did not own any cellphone were grouped together as smartphone non-users for analysis since there was only a small number of participants without any cellphone. Table 1-1 presents the baseline characteristics of the participants by ownership of smartphone. The mean age of all participants was 76.0 years old, with no significant difference between smartphone users and non-users. The proportion of women was markedly lower in smartphone users (46.7%) compared to non-users (57.7%). The level of education represented in the number of years in school was significant higher in smartphone users than in non-users, and the proportion of those with income less than 2 million Korean Won (KRW) a month was higher in non-users. Smartphone users were also more likely to be in a marital relationship and living with someone than non-users. The rate of frailty showed marked difference of 2.8% and 14.4% in smartphone users and non-users, respectively. The prevalence of various comorbidities of the participants were generally similar between the groups.

The rate of smartphone use showed significant difference between the two genders, and the baseline characteristics of

smartphone users and non-users were compared by gender in Tables 1-2 and 1-3. Both genders show no meaningful difference in terms of age, smoking, alcohol intake, number of medications, and comorbidities. Although, most of the findings of Table 1-1 were similarly found in both genders, the rate of frailty in men was 3.5% and 16.8% in smartphone users and non-users, respectively, and the rate of frailty in women was 2.1% and 12.7% in smartphone users and non-users, respectively.

Table 1-1. Baseline characteristics of smartphone users and non-users, number (%)

	Overall (n=2935)	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
Age (mean ± SD)	76.00 ± 3.89	76.07 ± 3.91	75.93 ± 3.87	0.334
Female	1539 (52.4)	655 (46.7)	884 (57.7)	<0.001
Years of education (mean ± SD)	8.63 ± 5.82	10.82 ± 4.51	6.62 ± 6.16	<0.001
Monthly income <2 million KRW	1888 (64.3)	720 (51.3)	1168 (76.3)	<0.001
Marital status				
Married	1972 (67.2)	1063 (75.7)	909 (59.4)	
Widowed	878 (29.9)	301 (21.4)	577 (37.7)	<0.001
Separated/Divorced	78 (2.7)	37 (2.6)	41 (2.7)	
Living arrangement				
Alone	668 (22.8)	227 (16.2)	441 (28.8)	
With spouse	1489 (50.7)	791 (56.3)	698 (45.6)	
With children	295 (10.1)	129 (9.2)	166 (10.8)	<0.001
With spouse and children	421 (14.3)	229 (16.3)	192 (12.5)	
Current smoker	167 (5.7)	78 (5.6)	89 (5.8)	0.825
Alcohol intake ≥1/week	1352 (46.1)	646 (46.0)	706 (46.1)	0.985
No. of drugs (mean ± SD)	4.08 ± 7.23	3.88 ± 5.87	4.27 ± 8.27	0.141
Fried frailty criteria				
Robust	1295 (44.1)	810 (57.7)	485 (31.7)	
Prefrail	1379 (47.0)	554 (39.5)	825 (53.9)	<0.001
Frail	261 (8.9)	40 (2.8)	221 (14.4)	
Hypertension	1702 (58.0)	804 (57.3)	898 (58.7)	0.469
Dyslipidemia	950 (32.4)	467 (33.3)	483 (31.5)	0.341
Cardiovascular disease	282 (9.6)	144 (10.3)	138 (9.0)	0.281
Cerebrovascular disease	143 (4.9)	77 (5.5)	66 (4.3)	0.165
Chronic lung disease	172 (5.9)	76 (5.4)	96 (6.3)	0.363
Osteoarthritis	742 (25.3)	336 (23.9)	406 (26.5)	0.117
Osteoporosis	476 (16.2)	213 (15.2)	263 (17.2)	0.155
Peptic ulcer disease	177 (6.0)	82 (5.8)	95 (6.2)	0.736
Diabetes mellitus	651 (22.2)	319 (22.7)	332 (21.7)	0.529
Thyroid disease	133 (4.5)	61 (4.3)	72 (4.7)	0.706
Cancer	56 (1.9)	25 (1.8)	31 (2.0)	0.728
Depression	442 (15.1)	233 (16.6)	209 (13.7)	0.03

SD, standard deviation; KRW, Korean Won

Table 1-2. Baseline characteristics of male smartphone users and non-users, number (%)

	Overall (n=1396)	Smartphone users (n=749)	Smartphone non-users (n=647)	p value
Age (mean ± SD)	76.32 ± 3.91	76.42 ± 3.98	76.19 ± 3.82	0.266
Years of education (mean ± SD)	8.88 ± 5.03	10.90 ± 4.43	6.54 ± 4.66	<0.001
Monthly income <2 million KRW	885 (63.4)	377 (50.3)	508 (78.5)	<0.001
Marital status				
Married	938 (67.2)	568 (75.8)	370 (57.2)	
Widowed	415 (29.7)	161 (21.5)	254 (39.3)	-
Separated/Divorced	40 (2.9)	19 (2.5)	21 (3.2)	
Living arrangement				
Alone	346 (24.8)	131 (17.5)	215 (33.2)	
With spouse	708 (50.7)	427 (57.0)	281 (43.4)	<0.001
With children	126 (9.0)	64 (8.5)	62 (9.6)	
With spouse and children	191 (13.7)	116 (15.5)	75 (11.6)	
Current smoker	152 (10.9)	72 (9.6)	80 (12.4)	0.119
Alcohol intake ≥1/week	597 (42.8)	317 (42.3)	280 (43.3)	0.76
No. of drugs (mean ± SD)	4.30 ± 7.85	4.01 (5.82)	4.65 (9.68)	0.131
Fried frailty criteria				
Robust	674 (48.3)	439 (58.6)	235 (36.3)	
Prefrail	587 (42.0)	284 (37.9)	303 (46.8)	<0.001
Frail	135 (9.7)	26 (3.5)	109 (16.8)	
Hypertension	758 (54.3)	412 (55.0)	346 (53.5)	0.604
Dyslipidemia	334 (23.9)	203 (27.1)	131 (20.2)	0.003
Cardiovascular disease	165 (11.8)	97 (13.0)	68 (10.5)	0.185
Cerebrovascular disease	91 (6.5)	53 (7.1)	38 (5.9)	0.424
Chronic lung disease	83 (5.9)	37 (4.9)	46 (7.1)	0.11
Osteoarthritis	191 (13.7)	105 (14.0)	86 (13.3)	0.752
Osteoporosis	49 (3.5)	26 (3.5)	23 (3.6)	1
Peptic ulcer disease	57 (4.1)	28 (3.7)	29 (4.5)	0.572
Diabetes mellitus	334 (23.9)	173 (23.1)	161 (24.9)	0.473
Thyroid disease	36 (2.6)	22 (2.9)	14 (2.2)	0.459
Cancer	26 (1.9)	14 (1.9)	12 (1.9)	1
Depression	140 (10.0)	91 (12.1)	49 (7.6)	0.006

SD, standard deviation; KRW, Korean Won

Table 1-3. Baseline characteristics of female smartphone users and non-users, number (%)

	Overall (n=1539)	Smartphone users (n=655)	Smartphone non-users (n=884)	p value
Age (mean ± SD)	75.71 ± 3.85	75.66 ± 3.80	75.74 ± 3.89	0.702
Years of education (mean ± SD)	8.41 ± 6.45	10.73 ± 4.61	6.69 ± 7.05	<0.001
Monthly income <2 million KRW	1003 (65.2)	343 (52.4)	660 (74.7)	<0.001
Marital status				
Married	1034 (67.2)	495 (75.6)	539 (61.0)	
Widowed	463 (30.1)	140 (21.4)	323 (36.5)	<0.001
Separated/Divorced	38 (2.5)	18 (2.7)	20 (2.3)	
Living arrangement				
Alone	322 (20.9)	96 (14.7)	226 (25.6)	
With spouse	781 (50.7)	364 (55.6)	417 (47.2)	<0.001
With children	169 (11.0)	65 (9.9)	104 (11.8)	
With spouse and children	230 (14.9)	113 (17.3)	117 (13.2)	
Current smoker	15 (1.0)	6 (0.9)	9 (1.0)	1
Alcohol intake ≥1/week	755 (49.1)	329 (50.2)	426 (48.2)	0.46
No. of drugs (mean ± SD)	3.88 ± 6.61	3.73 ± 5.93	4.00 ± 7.07	0.429
Fried frailty criteria				
Robust	621 (40.4)	371 (56.6)	250 (28.3)	
Prefrail	792 (51.5)	270 (41.2)	522 (59.0)	<0.001
Frail	126 (8.2)	14 (2.1)	112 (12.7)	
Hypertension	944 (61.3)	392 (59.8)	552 (62.4)	0.327
Dyslipidemia	616 (40.0)	264 (40.3)	352 (39.8)	0.889
Cardiovascular disease	117 (7.6)	47 (7.2)	70 (7.9)	0.655
Cerebrovascular disease	52 (3.4)	24 (3.7)	28 (3.2)	0.696
Chronic lung disease	89 (5.8)	39 (6.0)	50 (5.7)	0.891
Osteoarthritis	551 (35.8)	231 (35.3)	320 (36.2)	0.746
Osteoporosis	427 (27.7)	187 (28.5)	240 (27.1)	0.583
Peptic ulcer disease	120 (7.8)	54 (8.2)	66 (7.5)	0.641
Diabetes mellitus	317 (20.6)	146 (22.3)	171 (19.3)	0.177
Thyroid disease	97 (6.3)	39 (6.0)	58 (6.6)	0.705
Cancer	30 (1.9)	11 (1.7)	19 (2.1)	0.636
Depression	302 (19.6)	142 (21.7)	160 (18.1)	0.092

SD, standard deviation; KRW, Korean Won

3.2. Distribution of smartphone use and prevalence of frailty

The rate of smartphone use is presented for each age and sex in Figure 1. Overall, men were using smartphones more than women throughout the spectrum except for ages of 74 and 84 years. The highest rate of smartphone use was noted in 83 years old men at 64.8%, and the lowest rate was noted in 70 years old women at 30.3%. The rate of smartphone use in older adults between the ages of 70 and 84 years did not show any conspicuously decreasing tendency with increasing age.

This absence of changing tendency was still absent even when the participants were grouped at intervals of 5 years to observe any possible tendency (Table 2).

The prevalence of frailty is shown by sex and in age groups of 3 in Figure 2. The prevalence of frailty is higher in men between the ages of 70 and 75 years, and again between 79 and 81 years. The prevalence of frailty was lowest at 5.9% in ages of 70 to 72, and highest at 12.7% in women, and lowest at 7.3% in ages of 82 to 84, and highest at 12.6% in ages of 70 to 72 in men. While the prevalence of frailty showed increasing tendency with age in women, such definite tendency was not shown in men with markedly high rate of frailty in the youngest age group.

The prevalence of frailty is further presented for different age groups of five in Table 3ㄹ. Male smartphone users show similarly low rate of frailty between 3.3% and 3.8% in all age groups, while non-users show higher and varying rate between 12.8% and 21.0%. Female smartphone users also show lower rate of frailty between 0.7% and 4.3%, while non-users show higher rate between 10.7%

and 18.0%.

Figure 1. Distribution of smartphone use by age and sex

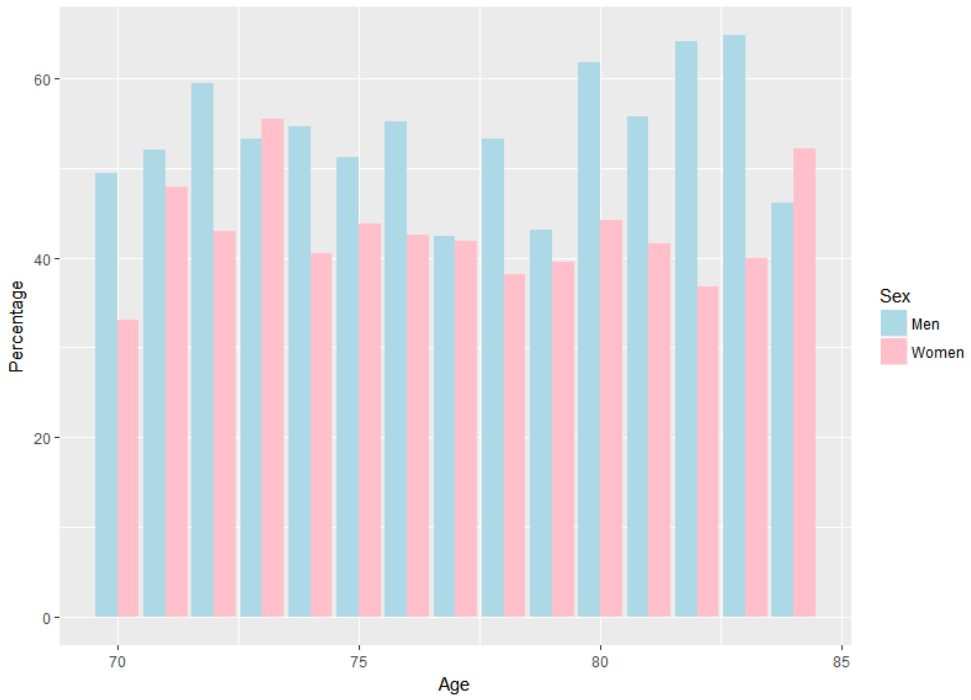

Table 2. Distribution of smartphone use by age group and sex, number

	Age		
	70-74	75-79	80-84
Male (number)			
Total	506	539	351
Smartphone user	273	266	210
% Smartphone user	54.0%	49.4%	59.8%
Female (number)			
Total	654	559	326
Smartphone user	286	232	137
% Smartphone user	43.7%	41.5%	42.0%

Figure 2. Prevalence of frailty by age and sex

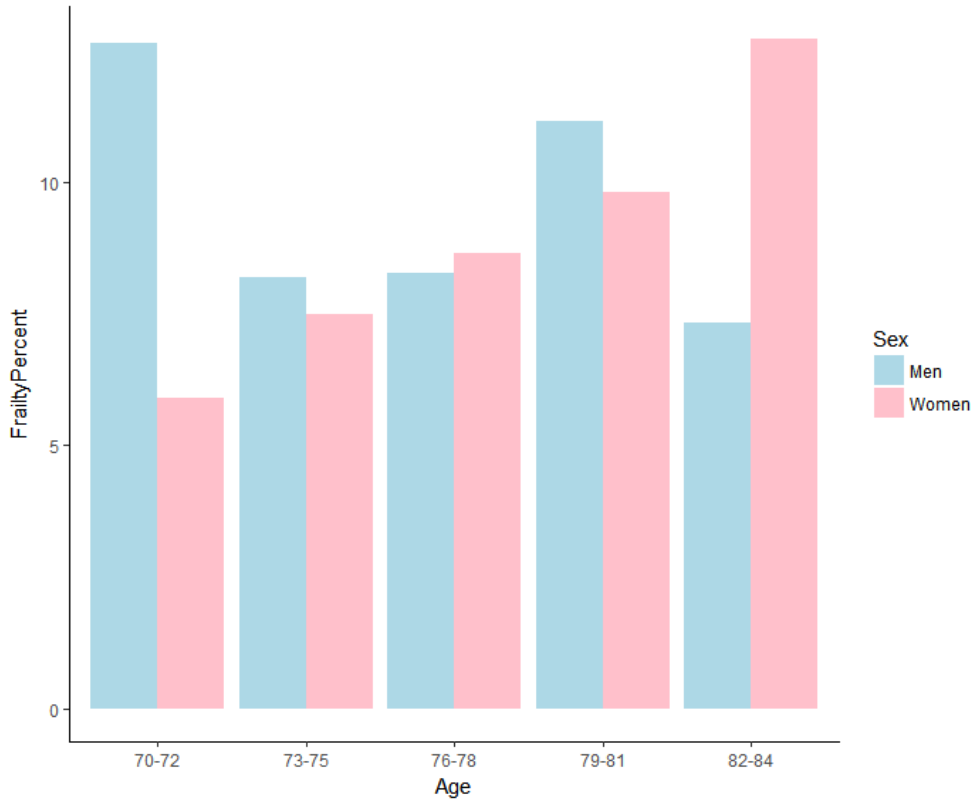

Table 3. Prevalence of frailty by type of phone, age group, and sex, number (%)

	Smartphone users			Smartphone non-users		
	70-74	75-79	80-84	70-74	75-79	80-84
Male						
Total	273	266	210	233	273	141
Frailty	9	10	7	49	35	25
% Frailty	3.3%	3.8%	3.3%	21.0%	12.8%	17.7%
Female						
Total	286	232	137	368	327	189
Frailty	2	10	2	43	35	34
% Frailty	0.7%	4.3%	1.5%	11.7%	10.7%	18.0%

3.3. Social, functional, and cognitive assessments

The level of social support each participant was receiving from people around them was assessed using the ENRICHD social support instrument (Table 4). Smartphone non-users had higher social support score of 27.46±6.07 compared to 22.84±7.66 of smartphone users (p value<0.001), and this finding was consistent throughout all 7 items of ENRICHD social support instrument.

Table 5 shows slightly higher K-ADL score in smartphone non-users compared to users, especially the abilities of self-dressing (99.9% over 99.2%) and using the toilet by oneself (92.2% over 88.9%). The differences are more outstanding with K-IADL in Table 6, in which the mean score of the smartphone non-users (9.34±1.15) is higher than that of the users (9.01±1.42) (p value <0.001). This tendency is true over 4 domains of the questionnaire regarding the abilities for housework, cooking, laundry and managing finances by oneself.

Table 7 shows various cognitive assessments performed by the participants, and the smartphone users were graded higher scores than non-users in all six types of assessments.

Table 4. Differences in social networking and social support according to smartphone use, number (%)

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
ENRICHD social support score (mean ± SD)	22.84 ± 7.66	27.46 ± 6.07	<0.001
(1) Is there someone available to you whom you can count on to listen to you when you need to talk?			
None of the time	195 (13.9)	77 (5.0)	
A little of the time	261 (18.6)	109 (7.1)	
Some of the time	194 (13.8)	110 (7.2)	<0.001
Most of the time	143 (10.2)	254 (16.6)	
All the time	609 (43.4)	980 (64.1)	
(2) Is there someone available to give you advice about a problem?			
None of the time	219 (15.6)	77 (5.0)	
A little of the time	292 (20.8)	108 (7.1)	
Some of the time	186 (13.3)	104 (6.8)	<0.001
Most of the time	137 (9.8)	251 (16.4)	
All the time	568 (40.5)	987 (64.6)	
(3) Is there someone available to you who shows you love and affection?			
None of the time	123 (8.8)	39 (2.6)	
A little of the time	238 (17.0)	81 (5.3)	
Some of the time	223 (15.9)	99 (6.5)	<0.001
Most of the time	151 (10.8)	292 (19.1)	
All the time	667 (47.6)	1017 (66.6)	
(4) Is there someone available to help you with daily chores?			
None of the time	283 (20.2)	142 (9.3)	
A little of the time	277 (19.8)	95 (6.2)	
Some of the time	156 (11.2)	107 (7.0)	<0.001
Most of the time	103 (7.4)	218 (14.3)	
All the time	580 (41.5)	965 (63.2)	
(5) Can you count on anyone to provide you with emotional support (talking over problems or helping you make a difficult decision)?			
None of the time	225 (16.1)	70 (4.6)	
A little of the time	253 (18.1)	91 (6.0)	
Some of the time	180 (12.9)	100 (6.6)	<0.001
Most of the time	100 (7.1)	292 (19.2)	
All the time	642 (45.9)	971 (63.7)	

Table 4. (continued)

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
(6) Do you have as much contact as you would like with someone you feel close to, someone in whom you can trust and confide?			
None of the time	128 (9.1)	35 (2.3)	
A little of the time	256 (18.2)	60 (3.9)	
Some of the time	215 (15.3)	92 (6.0)	<0.001
Most of the time	41 (2.9)	332 (21.7)	
All the time	763 (54.4)	1011 (66.1)	
(7) Are you currently married or living with a partner?	1025 (73.1)	936 (61.2)	<0.001

ENRICHD, Enhancing Recovery in Coronary Heart Disease Patients randomized trial

Table 5. Differences in Korean Activities of Daily Living scores according to smartphone use, number (%)

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
K-ADL_score (mean ± SD)	6.85 ± 0.45	6.90 ± 0.33	0.001
Dressing	1393 (99.2)	1529 (99.9)	0.017
Personal hygiene	1402 (99.9)	1529 (99.9)	1
Bathing	1376 (98.0)	1503 (98.2)	0.848
Self-feeding	1397 (99.5)	1527 (99.7)	0.454
General mobility	1400 (99.7)	1531 (100.0)	0.112
Toilet-associated mobility	1403 (99.9)	1531 (100.0)	0.965
Toilet hygiene	1248 (88.9)	1412 (92.2)	0.002

K-ADL, Korean Activities of Daily Living; SD, standard deviation

Table 6. Differences in Korean Instrumental Activities of Daily Living scores according to smartphone use, number (%)

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
K-IADL_score (mean ± SD)	9.01 ± 1.42	9.34 ± 1.15	<0.001
Personal grooming	1399 (99.6)	1527 (99.7)	0.896
Doing housework	1177 (83.8)	1380 (90.1)	<0.001
Cooking	986 (70.2)	1225 (80.0)	<0.001
Doing laundry	1012 (72.1)	1247 (81.5)	<0.001
Outing	1389 (98.9)	1519 (99.2)	0.54
Driving or using public transportation	1360 (96.9)	1480 (96.9)	1
Shopping	1372 (97.7)	1508 (98.5)	0.157
Managing finances	1177 (83.8)	1374 (89.7)	<0.001
Using the phone and looking up numbers	1378 (98.1)	1515 (99.0)	0.092
Managing medications	1394 (99.3)	1523 (99.6)	0.356

K-IADL, Korean Instrumental Activities of Daily Living; SD, standard deviation

Table 7. Differences in cognitive assessment tests according to smartphone use

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
Normal MMSE range (%)	1384 (98.6)	1435 (93.7)	<0.001
Memory score (mean ± SD)	17.79 ± 3.93	15.58 ± 4.45	<0.001
Word list recall score (mean ± SD)	5.99 ± 1.92	5.01 ± 2.17	<0.001
Word list recognition score (mean ± SD)	8.85 ± 1.50	8.29 ± 2.14	<0.001
Digit span score (mean ± SD)	11.86 ± 3.52	9.37 ± 3.72	<0.001
Frontal assessment battery score (mean ± SD)	14.54 ± 2.43	12.40 ± 3.17	<0.001

MMSE, mini-mental state examination; SD, standard deviation

3.4. Association between smartphone use and frailty

The smartphone users had much lower prevalence of frailty than non-users (2.8% vs. 14.4%, p value <0.001), and this was true for all five domains of Fried frailty criteria (Table 8). Moreover, the proportion of robust participants was much higher in smartphone users (57.7%) than in non-users (31.7%). When looking at each domain, 5.7%, 10.8%, 22.3%, 5.0%, and 15.6% of smartphone users had significant weight loss, weak grip strength, self-reported exhaustion, low physical activity, and slow gait speed, respectively; and 9.3%, 25.7%, 40.3%, 11.6%, and 35.4% of smartphone non-users had significant weight loss, weak grip strength, self-reported exhaustion, low physical activity, and slow gait speed, respectively (all with p value <0.001).

The association between observed frailty and smartphone was analyzed using multiple logistic regression as shown in Table 9. The models were adjusted stepwise to account for age, sex, years of education, income level, social support score, number of medications and MMSE score. The use of a smartphone was inversely associated with frailty when unadjusted, and this association was true after adjusting for other covariates with OR of 0.70, and 95% CI 0.58-0.84.

The association between frailty and smartphone use was further pursued by grouping the participants by smartphone use and frailty. Table 10 shows the cross-sectional differences in 4 groups: (1) smartphone users with frailty, (2) smartphone non-users with frailty, (3) smartphone users without frailty, and (4) smartphone non-users without frailty. There was not much significant difference in terms of age, smoking, alcohol consumption, number of

drugs or comorbidities between the groups. The frail participants without a smartphone had the shortest years of education (4.91±7.61), highest rate of poor income (80.1%), lowest married status (54.3%), and highest rate of living alone (34.4%) among the groups.

Cognitive, functional, and social aspects of the four groups are presented in Table 11. The frail participants without a smartphone had the lowest rate of normal MMSE range (86.4%), and lowest memory scores, word list recall scores, word list recognition scores, digit span scores, and frontal assessment battery scores of 13.47 ± 4.46, 4.11 ± 2.07, 7.70 ± 2.46, 7.72 ± 3.29, and 10.59 ± 3.21, respectively (all with p value <0.001).

Table 8. Distribution of each Fried frailty criterion according to smartphone use, number (%)

	Smartphone users (n=1404)	Smartphone non-users (n=1531)	p value
FFI weight loss	80 (5.7)	143 (9.3)	<0.001
FFI weak grip strength	152 (10.8)	394 (25.7)	<0.001
FFI exhaustion	313 (22.3)	617 (40.3)	<0.001
FFI low physical activity	70 (5.0)	178 (11.6)	<0.001
FFI slow gait speed	219 (15.6)	541 (35.4)	<0.001
FFI score			
Robust	810 (57.7)	485 (31.7)	
Prefrail	554 (39.5)	825 (53.9)	<0.001
Frail	40 (2.8)	221 (14.4)	

FFI, Fried frailty index

Table 9. Multiple logistic regression analysis to assess the association between smartphone use and frailty, odds ratio (confidence interval)

	Model 1	Model 2	Model 3	Model 4
Smartphone	0.34 (0.29–0.4)	0.35 (0.30–0.40)	0.46 (0.39–0.54)	0.70 (0.58–0.84)
Age	–	1.00 (0.98–1.02)	1.00 (0.98–1.02)	1.01 (0.99–1.03)
Female sex	–	1.25 (1.07–1.45)	1.24 (1.06–1.45)	1.42 (1.20–1.67)
Years of education	–	–	0.95 (0.93–0.97)	0.96 (0.94–0.97)
Income below 2 million KRW	–	–	1.32 (1.09–1.59)	1.28 (1.05–1.57)
ENRICHD score	–	–	–	1.13 (1.12–1.14)
Number of medications	–	–	–	1.00 (0.98–1.01)
MMSE score	–	–	–	0.46 (0.27–0.74)

Model 1: Unadjusted

Model 2: Adjusted for age and sex

Model 3: Adjusted as above plus years of education, and income

Model 4: Adjusted as above plus status of social support, number of medications, and MMSE score

KRW, Korean Won; MMSE, mini-mental state examination; ENRICHD, Enhancing Recovery in Coronary Heart Disease Patients randomized trial

Table 10. Baseline characteristics of participants by type of phone and frailty, number (%)

	Frailty		No frailty	
	Smartphone users (n=40)	Smartphone non-users (n=221)	Smartphone users (n=1364)	Smartphone non-users (n=1310)
Age (mean ± SD)	76.45 ± 3.72	76.17 ± 4.07	76.06 ± 3.92	75.89 ± 3.83
Female	14 (35.0)	112 (50.7)	641 (47.0)	772 (58.9)
Years of education (mean ± SD)	8.57 ± 5.02	4.91 ± 7.61	10.89 ± 4.48	6.91 ± 5.83
Monthly income <2 million KRW	24 (60.0)	177 (80.1)	696 (51.0)	991 (75.6)
Marital status				
Married	23 (57.5)	120 (54.3)	1040 (76.2)	789 (60.2)
Widowed	14 (35.0)	97 (43.9)	287 (21.0)	480 (36.6)
Separated/Divorced	3 (7.5)	4 (1.8)	34 (2.5)	37 (2.8)
Living arrangement				
Alone	12 (30.0)	76 (34.4)	215 (15.8)	365 (27.9)
With spouse	19 (47.5)	93 (42.1)	772 (56.6)	605 (46.2)
With children	6 (15.0)	24 (10.9)	123 (9.0)	142 (10.8)
With spouse and children	3 (7.5)	24 (10.9)	226 (16.6)	168 (12.8)
Current smoker	3 (7.5)	11 (5.0)	75 (5.5)	78 (6.0)
Alcohol intake ≥1/week	23 (57.5)	103 (46.6)	623 (45.7)	603 (46.0)
No. of drugs (mean ± SD)	3.95 ± 2.67	4.27 ± 7.26	3.88 ± 5.94	4.27 ± 8.44
Hypertension	29 (72.5)	125 (56.6)	775 (56.8)	773 (59.0)
Dyslipidemia	15 (37.5)	65 (29.4)	452 (33.1)	418 (31.9)
Cardiovascular disease	7 (17.5)	23 (10.4)	137 (10.0)	115 (8.8)
Cerebrovascular disease	1 (2.5)	6 (2.7)	76 (5.6)	60 (4.6)
Osteoarthritis	10 (25.0)	60 (27.1)	326 (23.9)	346 (26.4)
Osteoporosis	2 (5.0)	30 (13.6)	211 (15.5)	233 (17.8)
Peptic ulcer disease	2 (5.0)	12 (5.4)	80 (5.9)	83 (6.3)
Diabetes mellitus	19 (47.5)	52 (23.5)	300 (22.0)	280 (21.4)
Thyroid disease	1 (2.5)	9 (4.1)	60 (4.4)	63 (4.8)
Cancer	0 (0.0)	4 (1.8)	25 (1.8)	27 (2.1)
Depression	6 (15.0)	33 (14.9)	227 (16.6)	176 (13.4)

SD, standard deviation; KRW, Korean Won

Table 11. Cognitive, functional, and social assessments of participants by type of phone and frailty

	Frailty		No frailty	
	Smartphone users (n=40)	Smartphone non-users (n=221)	Smartphone users (n=1364)	Smartphone non-users (n=1310)
Normal MMSE range (%)	39 (97.5)	191 (86.4)	1345 (98.6)	1244 (95.0)
Memory score (mean ± SD)	15.03 ± 3.51	13.47 ± 4.46	17.87 ± 3.91	15.94 ± 4.35
Word list recall score (mean ± SD)	4.72 ± 2.04	4.11 ± 2.07	6.02 ± 1.91	5.16 ± 2.15
Word list recognition score (mean ± SD)	7.92 ± 1.79	7.70 ± 2.46	8.87 ± 1.49	8.39 ± 2.07
Digit span score (mean ± SD)	10.60 ± 2.97	7.72 ± 3.29	11.90 ± 3.53	9.65 ± 3.71
Frontal assessment battery score (mean ± SD)	13.15 ± 2.91	10.59 ± 3.21	14.58 ± 2.40	12.70 ± 3.06
KIADL score (mean ± SD)	9.00 ± 0.64	9.00 ± 1.16	9.01 ± 1.44	9.40 ± 1.14
KADL score (mean ± SD)	6.92 ± 0.27	6.87 ± 0.39	6.85 ± 0.46	6.90 ± 0.31
ENRICHD social support score (mean ± SD)	28.80 ± 6.41	28.67 ± 5.35	22.66 ± 7.62	27.26 ± 6.16

SD, standard deviation; KRW, Korean Won; ENRICHD, Enhancing Recovery in Coronary Heart Disease Patients randomized trial; K-ADL, Korean Activities of Daily Living; Korean Instrumental Activities of Daily Living

Chapter 4. DISCUSSION

4.1. Characteristics of elderly smartphone users and non-users

The smartphone users were more likely to be male, with higher educational and economic background compared to non-users, as previously reported[12, 13]. They were also more likely to be in a marital relationship and not living alone, but received less social support, and exhibited poorer daily functional abilities. However, they exhibited higher cognitive capabilities, and more importantly, less frail in all aspects of frailty criteria compared to smartphone non-users.

The proportion of smartphone users in older adults between the age of 70 and 84 was 47.8% which is a lot higher than 29.8% reported by KISA, but similar to 40.9%~52.7% reported by KISDI[10, 11]. The discrepancy may rise from the differences in the method of information acquisition and the range of age included to define older adults. Contrary to many previous studies that reported decreasing rate of smartphone use with increasing age, no significantly decreasing rate of smartphone use across increasing age was noted in this study[13, 37, 38]. In other words, age was not a strong indicator of smartphone use in older adults. There was no statistically significant age difference between smartphone users and non-users in this study, both groups showing the mean age of about 76 years. Furthermore, while increasing age was associated with increasing rate of frailty as reported in many previous studies,

this tendency was strong only in women[6, 39]. In fact, the highest rate of frailty was noted in 70 to 72 years group in men. Despite a large number of participants gathered from various regions of the country, we cannot overlook the possibility of selection bias during recruitment that probably impacted male participants more strongly. Also, the choice to purchase or adopt a smartphone is multifactorial. For instance, Qi Ma et al. reported that not only economic condition of the older adopters but also whether they have someone who can facilitate the use of smartphones was also an important factor in adopting smartphones in the elderly[13]. Therefore, past a certain age, the possession of a smartphone may be affected by social and family environment. This point is accentuated in a 2018 report by the KISDI which verified that only 40.9% of older adults living on their own have smartphones, while 52.7% of older adults living with younger generation have smartphones[11].

Smartphone users were much less likely to be frail than non-users while having simile rates of underlying comorbidities. They were also more likely to be male with higher educational level and income, in a marital relationship and living with someone compared to non-users. The more stable socioeconomic state of smartphone users could be expected based on previous studies[12, 13]. But the discrepancy between frailty rate and comorbidity rate was not. It is often stated that frailty is not synonymous to having more underlying comorbidities, but it is strongly associated with higher comorbidity rate[40, 41]. Therefore, it is noteworthy that while smartphone use was strongly associated with lower rate of frailty, it was not associated with any of the comorbidity rate. This may implicate that the use of smartphone is more associated with frailty

in social and economic aspects than in medical aspects.

As for social aspects, smartphone owners were expected to be more socially active, taking higher academic, economic and more engaging marital status into account. The current finding of weaker social support in smartphone owners is in agreement with previous studies on younger adults which reported that the use of smartphones tends to isolate the owners from social activities[42, 43], but contradicts previous reports that older adults with smartphones have better social functions and engagement [44, 45]. These contrasting results call for future researches concentrating on social aspects of older smartphone users with large number of participants.

Another interesting point to note was that the smartphone non-users showed better abilities of basic self-care in terms of ADL in contrast to previous findings, although the differences between the two groups were minimal to none[46]. The differences in capabilities of self-care were more strongly noted with IADL, which were generally higher in smartphone non-users than in users. The items of IADL require rather difficult cognitive functions such as basic mathematical calculation and performing cognitively and physical challenging tasks for many older adults such as doing housework, laundry, or managing one's finances. This finding is in striking opposition to another finding of this study that the smartphone users showed better cognitive functions in all types of cognitive tasks performed than non-users. Furthermore, smartphone users showed better scores in all five items of FFI, and the differences were more than double in grip strength and gait

speed, the two physical ability items directly measured during the study. As discussed in Figure 1, there is no age difference between the two groups, and we cannot assume decline of physical ability due to older age in any one group. Also, the cutoffs of physical abilities are different between men and women, so the difference did not rise from difference in sex, either. The smartphone users simply had better physical abilities compared to non-users regardless of age and sex. This means than the smartphone users were more cognitively functional, and physically capable, but were less capable of taking care of themselves or performing simple housework. It is only a conjecture at this point, but the answer may be found in basic sociological principles. It was noted that higher proportion of smartphone users were married and/or leaving with their children than non-users who had much higher rate of people leaving alone. This means that many of them did not necessarily have to perform the basic functions, and could depend on others, not because they really had to, but because they could. In contrast, when you are leaving alone, you have to be more independent and take care of all housework.

The hypothesis of this study was that smartphone users are less frail because they can better take care of their health using smartphone applications, and the use of smartphone itself may be a good cognitive exercise which prevents frailty. Although we verified that lack of smartphone ownership is associated with frailty, we could not verify the causal relationship or the hypothetical link proposed based on the given cross-sectional data. It is a grave limitation of this study that information regarding how long ago each individual adopted smartphones, and the detailed use of

smartphones, such as the frequency and duration of use, frequently used applications and so on was not gathered in the original data. Therefore, the patterns of smartphone use could not be identified, and whether smartphones are used as smartphones with various applications or simply as a classic cellphone. In other words, the current analysis cannot verity that smartphone users have less frailty because they are using health-related applications well. Therefore, future researches on this area may be a useful addition to identifying the association between frailty and smartphone use.

4.2. Digital frailty

There are a number of different criteria to diagnose frailty. The Fried frailty index is the most widely used criteria, and defines frailty rather physically[6]. With increasing evidence and accumulation of further researches, new entities of frailty have been introduced and are being pursued by many researchers. These entities, much like the World Health Organization (WHO) definition of health which encompasses physical, mental, and social aspects, include social frailty and psychological frailty. The term ‘frailty’ originally put forth is now being used to refer to physical frailty considering its components of diagnosis[47].

The International Academy on Nutrition and Aging (IANA) and the International Association of Gerontology and Geriatrics (IAGG) defined cognitive frailty as coexistence of physical frailty and cognitive impairment (defined as Clinical Dementia Rating=0.5) in absence of any type of dementia[47]. Cognitive frailty is basically a

condition in which physical frailty and cognitive decline coexist in one person. A number of researchers have reported that physical frailty predicts the onset of cognitive decline and incident dementia, and vice versa. Furthermore, the two conditions appear to reinforce each other resulting in more grave outcomes than anticipated[48–50].

Another subtype of frailty, the social frailty, is recognized as coexistence of physical frailty and absence of social resources to fulfill basic social needs. Questions about various social activities and states such as outing, meeting friends, living alone, and so on are often used to diagnose social isolation of an older person[51]. However, there is no international consensus on the diagnostic criteria of social frailty, and the researches so far have used different measures and questions to diagnose social frailty[52]. Even so, the researchers acknowledge social isolation of a person to be an important aspect of frailty that needs further attention as a separate entity that requires a different approach.

Smartphone users having better cognitive functions according to various cognitive tests, the authors have come to recognize the similarities between the smartphone non–users with frailty and cognitive frailty. These smartphone non–users with frailty can be expected to have high prevalence of cognitive frailty and share many similar characteristics, and yet with some differences. This condition of frailty in smartphone non–users may be referred to as “digital frailty” and studied further longitudinally in the future. It has been established that physical frailty predicts the onset of cognitive decline, and vice versa, and that they could reinforce each other to

result in more detrimental outcomes[48-50]. It is the opinion of the authors that digital frailty may have similar effects and analyzed the cross-sectional characteristics of four groups divided by ownership of smartphones and presence of frailty at baseline as reported in Tables 10 and 11.

In this study, the prevalence of frailty in smartphone users was 2.8% which is a lot lower than 14.4% reported in non-users. After adjusting for various related factors, frailty was still inversely associated with smartphone use in older adults according to the multiple logistic regression analysis. Ownership of a smartphone is a result of multifactorial conditions as is the diagnosis of frailty. Therefore, a simple question of whether or not an older adult owns a smartphone may be used in conjunction with other simple questionnaires to screen frailty in small clinical settings in which there is not enough time or manpower to diagnose frailty based on the widely accepted tool of FFI.

4.3. Strengths and limitations

It was noted earlier that the smartphone users were more cognitively functional, and physically capable, but were less capable of taking care of themselves or performing simple housework. This contradictory finding may be due to a shortcoming of this study, basing the data on community-dwelling older adults only. Older adults who were admitted or residing in medical or non-medical institutions including acute to subacute care hospitals, as well as long-term care facilities or hospitals were excluded in this study.

With improving medical care and increasing rate of deaths from chronic diseases, increasing number of people are dying in medical institutions rather than in their own homes. This is also true in Korea, and it has been studied that more than 75% of deaths occur in medical facilities often after quite a length of stay in medical facilities[53]. Therefore, the trajectory of life is not whole in the community. Truly frail older adults are often unable to take care of themselves and are admitted to long-term care facilities. Therefore, the results of this cross-sectional are shortcoming in that aspect.

Furthermore, the participants of this study had to be capable of vising the study institutions and enduring several hours of various questionnaires, physical tests, and medical tests to partake in the study. This implies that those who were too frail to visit the institutions were selectively excluded from the beginning of the study despite the intention of the study design. Also, all older adults who encountered a chance to participate in the study always had a choice, and we can expect that those socially withdrawn or physically challenged were less likely to voluntarily participate in the study, leading to additional selection bias, given that the ideal study design would include as diverse group of participants as possible.

Despite these limitations, this study included over 3,000 participants from 10 different sites in regions all over South Korea. As such, the large number and geographic diversity of the participants are important strengths of this study, and the study data could be argued to represent the older adults living in the community.

This study included personal interviews during which the types of phone used by the participants were directly checked out by the interviewers, and not simply asked of the participants. Therefore, the accuracy of distinguishing the type of phone was also a strength.

Chapter 5. CONCLUSION

Ownership of a smartphone is a result of multifactorial circumstances and conditions as is frailty. Smartphone non-users in this study were more frail than smartphone users, and exhibited poorer cognitive abilities while maintaining better daily functional abilities and social interaction. Therefore, it is our conclusion that the ownership of a smartphone in older adults represents many background factors that are often linked to frailty in an inverse manner, and a simple question or identification of one's type of phone may be used in conjunction with other methods to screen frailty in older adults.

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Abstract in Korean

국문 초록

노인에서 스마트폰 사용과 노쇠의 연관성 및 관련요인

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배경 및 목적 : 전 세계적으로 고령화가 진행됨에 따라 만성질환을 예방할 수 있는 위험요소와 방법을 파악하고자 하는 많은 연구가 진행되고 있다. 노쇠는 가장 활발하게 연구되고 있는 분야 중 하나이다. 노쇠 연구와 동시에 지난 수년간 스마트폰은 빠른 발전과 성장을 보여 이제 건강 사업에 중요한 역할을 하게 되었다. 건강한 삶의 영위에 스마트폰 사용의 중요성이 증가하고 있음에도 불구하고 노인 스마트폰 사용자들의 특성에 관한 대규모 연구는 미미하다.
본 연구의 가설은 스마트폰 소유자들은 건강을 관리하기 위해 다양한 스마트폰 애플리케이션을 사용할 수 있으며 스마트폰의 사용 자체가 좋은 인지기능 발달운동이 되기 때문에 스마트폰 소유자들에게 노쇠가 덜 존재할 것이라는 것이다. 따라서, 본 연구를 통해 노인 스마트폰 사용자 및 비사용자의 다양한 사회인구학적 및 의학적 특성을 기술하고, 스마트폰 사용과 노쇠의 연관성을 확인하고자 한다. 이를 통해 얻은 정보는 소규모 의료시설에서 노쇠를 선별하는데 큰 도움이 될 것이다.

방법 : 본 연구는 한국노인노쇠코호트사업(KFACS)의 자료를 1차 자료를 사용하여 진행되었다. KFACS는 노화 및 노쇠와 관련한

인자들을 찾아내고 이를 예방하고자 진행되고 있는 한국의 국가기반 코호트 연구이다. 만 70세에서 84세의 총 2935명 참가자의 데이터를 사용하여 다양한 인구학적, 사회경제적, 인지적 및 기능적 특성과 관련된 분석을 진행하였으며 노쇠와의 관련성 또한 분석하였다. 노쇠는 Fried 노쇠지수를 사용하여 정의하였다. 참가자들의 특성을 스마트폰 소유 유무에 따라 기술하였으며 로지스틱 다중회귀분석을 수행하여 스마트폰 사용과 노쇠의 연관성을 평가하였다.

결과 : 총 2935명의 참가자 중 1404명(47.8%)이 스마트폰을 사용하였으며 1531명(52.2%)는 스마트폰이 아닌 핸드폰을 사용하거나 핸드폰을 가지고 있지 않았다. 참가자들의 평균 연령은 76.0세였다. 스마트폰 사용자들은 남성이 더 많았으며 (53.3%), 비사용자들에 비해 교육 및 경제적 수준이 높았다. 사용자들은 또한 결혼상태인 비율이 높고 독거의 비율이 낮았으나 사회적 상호관계가 적었고 더 낮은 일상적 능력을 보여주었다. 이에 반해 인지기능은 더 뛰어났으며, 특히 노쇠기준의 5가지 항목 모두에서 비사용자들보다 뛰어난 상태를 보였다. 스마트폰 사용과 노쇠의 연관성의 교차비는 다양한 관련 요소를 보정한 후 0.47이었으며 95% 신뢰구간은 0.39~0.55였다.

결론 : 스마트폰의 소유는 노쇠와 마찬가지로 여러가지 요소가 상호작용한 결과물이다. 본 연구에서는 스마트폰 비사용자들이 스마트폰 사용자들보다 더 뛰어난 일상적 능력과 사회적 상호관계를 보여주었으나 인지기능이 더 부족하였으며 더 높은 노쇠의 비율을 나타내었다. 따라서, 고령자의 스마트폰 소유는 종종 노쇠와 역상관관계를 나타내는 여러가지 인자를 대변한다고 볼 수 있으며, 어떤 타입의 핸드폰을 사용하고 있는지에 대한 간단히 질문이 다른 노쇠 관련 선별검사와 함께 작은 의료기관에서 노쇠를 선별하기 위한 좋은 방법이 될 수 있겠다.

주요어 : 노쇠, 노인, 핸드폰, 스마트폰, 만성질환

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