Exploring smartphone-related digital divide among South Korean older adults

Purpose: One of the crucial steps towards fully grasping the benefits of smartphone use for all is to explore the existence of a digital divide and its relationship to different outcomes from smartphone use. In so doing, this study explored the smartphone-related digital divide among South Korean older adults in terms of access, use and outcomes.

Design/methodology/approach: In-person interviews using questionnaires were conducted to collect the data from a total number of 372 older adults aged 60 or over in eleven community centers in the Seoul Metropolitan area in Korea, of which 223 participants owned a smartphone.

Results: This study found that most participants use smartphones to communicate with personal relationships and support system. There were, however, differences among groups across gender, age, and ICT training in terms of the extent of smartphone usage and participation in virtual communities. Across three age groups of 60+, 70+ and 80+, younger cohort and those with ICT training had higher smartphone literacy, harnessing the potential of smartphones. Those who used smartphones to stay connected to their social group and for entertainment showed lower level of loneliness.

Originality: A unique aspect of the current study is that it examines the differences in smartphone use, skills, and outcomes across three age groups: 60+, 70+ and 80+, and sheds light on similarities and differences within this cohort rather than in comparison to younger cohorts. In digital divide literature, 80+ is a rarely researched demographic.

Keywords: older adults, digital divide, smartphone, loneliness, South Korea

1. Introduction

Digital literacy stands for "the ability to harness the potential of digital tools" (IFLA, 2017), which is an essential precondition of digital inclusion in today's information society. To be digitally literate means that one can use technology to its fullest effect efficiently, effectively, and ethically to meet information needs in personal, civic, and professional lives (IFLA, 2017). However, according to Gann (2019), the three main barriers to digital inclusion are lack of access, skills, and motivation. These are found to influence older adults' use of the internet and

smartphones (Juznic *et al.*, 2006). These barriers lead towards the division between 'haves' and 'have-nots' in terms of digital access and skills, which is aptly described as the *grey digital divide* (Juznic *et al.*, 2006; Millward, 2003; Morris and Brading, 2007).

Although, research into older adults' internet use and ICT has been rapidly growing over the last two decades (for example, Álvarez-Dardet *et al.*, 2020; Friemel, 2016; Hill, *et al.*, 2015; Morris and Brading, 2007; Schehl *et al.*, 2019; Vroman *et al.*, 2015), relatively little research has been undertaken into smartphone-related digital divide among older adults (Hong *et al.*, 2018). So far, the primary focus of digital divide research has been on internet access (e.g., first-level digital divide) and internet skills and use (e.g., second-level digital divide) (Scheerder *et al.*, 2017). However, recent studies suggest that more focus needs to be placed on the third-level digital divide, where tangible outcomes of internet use are highlighted (Scheerder *et al.*, 2017).

One of the most important features of smartphones is internet connectivity, which enables 24/7 connectivity through either apps or a mini browser for countless purposes, including searching for information, connecting to a social network, or downloading music, videos, and related content (Anshari *et al.*, 2016, p.719). Past research into older adults and smartphones examined perceived difficulties and usability (Barnard *et al.*, 2013; Petrovičič *et al.*, 2018), use and dependency (Park *et al.*, 2013), or privacy concerns and attitude (Ketelaar and van Balen, 2018). Positive outcomes of smartphone use for older adults include a wider range of activities such as social networking, shopping (van Deursen and Helsper, 2015; Vroman *et al.*, 2015) and an improved quality of life thanks to the smartphone apps designed to help manage older adults' health (Doughty, 2011; Joe and Demiris, 2013; Steinhubl *et al.*,2013). However, prior studies also show that older adults tend to use their mobile devices primarily for two activities: making/receiving phone calls and texting (Fernández-Ardèvol, 2011; Renaud and Biljon, 2010), indicating that the growth in smartphone ownership among older adults does not equate with increased ability or willingness to harness the full potential of smartphones.

Our focus on South Korea (hereafter, Korea) derives from it being one of the most wired countries in the world with the highest internet penetration rate at 96% (Poushter *et al.*, 2018) and the highest-ranked country in the OECD 2019 Digital Government Index (DGI) (OECD, 2019). Smartphone ownership was recorded among 95% of Korean adults (Silver, 2019). However, internet use and smartphone adoption among Korean older adults continue to lag those of younger generations. People aged 65 or older in Korea account for 14.8 % of the

country's population (Statistics Korea, 2019), of which only 59.9% reported internet use and only 65.2% reported smartphone ownership (NIA, 2018). These statistics testify of the existence of the grey digital divide, which we wish to explore further.

Therefore, this study aims to explore Korean older adults' smartphone use and digital divide across groups, differing in gender, age, and ICT training. According to van Dijk (2005), an individual's characteristics (e.g., age, gender, intelligence, and health) are indicators known in digital divide literature to influence technology access, use, the extent of resources, and the amount of time available for digital activities. A unique aspect of the current study is that it examines the differences in smartphone use, skills, and outcomes across three age groups: 60+, 70+ and 80+, and sheds light on similarities and differences *within* this cohort rather than *in comparison to* younger cohorts. In digital divide literature, 80+ is a rarely researched demographic.

2. Literature review

2.1. Discussing the three levels of the digital divide

Research has found three different levels of the digital divide: the first-, second-, and third-level (Scheerder *et al.*, 2017). The first level of digital divide concerns physical access to the internet, and this has previously dominated digital divide research and theory (Dijk, 2018). This initial focus has shifted beyond mere access to the skills and use, which is the second-level digital divide. More recent studies explore the third-level digital divide whereby researchers focus on the benefits and outcomes of using digital media, discussing the context and effects of digital media (non)use (Dijk, 2018).

Research on the first-level digital divide found that internet access is unequally distributed among individuals with different demographic characteristics, such as age, gender, socio-economic status, ethnicity, and geography (e.g., Helsper, 2010; Mossberger *et al.*, 2003). These factors also determine skills and use, which represent the second-level digital divide. For example, Blank and Groselj's (2014) study on three main dimensions of internet use revealed that age, educational level, and employment status cause a large proportion of the differences in the second-level digital divide. In other words, the first- and second-level digital divide have similar determinants, although the relative influence of these determinants depends on the type of skills and use measured (van Deursen and van Dijk, 2010). The growth in adoption and connectivity worldwide (e.g., internet and smartphone) has made the digital divide discourse

based on access (first-level digital divide) less relevant and the focus shifted to digital skills and differences in use (second-level digital divide) (Scheerder *et al.*, 2017). In this regard, researchers distinguished between mere skills to operate devices and literacy harnessing the potential of digital tools (Mossberger *et al.*, 2003; van Deursen and van Dijk, 2011). In recent years, there has also been a growing interest in the outcomes of internet, ICT, or digital technology use, namely, the third-level digital divide. For example, studies explored digital exclusion (Formosa, 2013), associations between internet use and loneliness (Stockwell *et al.*, 2020) and the relationship between digital divide determinants and outcomes from internet use (van Deursen *et al.*, 2017).

2.2. Loneliness and depression: exploring connections with digital technologies among older adults

According to Jopling (2015), loneliness is a complex concept, of which the causes and consequences are impossible to determine without reference to the individual and their own values, needs, wishes, and feelings. Not only does loneliness involve psychological and social aspects relating to age, gender, marital status, social contacts, interests, friendships, health, and cognition, it also is a cultural construct and a lifestyle issue (Dakers, 2018). In addition, loneliness is a fluid experience: it can come and go over a short time or persist in the longer term (Goodman *et al.*, 2015). In other words, the subjective experience of feeling lonely can be chronic for some, and for others, it is a transient or fleeting experience. As loneliness is a subjective psychological perception about the number of social contacts that one has contrasted against what one would like to have, it differs from social isolation, which is the objective absence of social contacts and social connectedness (Goodman *et al.*, 2015). Meanwhile, loneliness and depression are very closely associated with each other. Loneliness has a significant impact on psychological health and wellbeing, in that loneliness contributes to both psychological distress and depression (Goodman *et al.*, 2015). In a similar vein, depression, security, age, occupation, smoking habits, and income level were found influential in the emergence of loneliness for older adults (Aylaz *et al.*, 2012).

The relationship between the use of digital technology and its impact on loneliness and depression is of particular relevance in this study. Due to its complexity, it is challenging to examine a direct cause-effect relationship between one's use and engagement of digital technology and the level of loneliness. Findings, so far, have been inconclusive (Song *et al.*,

2014, p.447). While some argued that internet use and computer-mediated interaction might benefit users in decreasing loneliness and depression (Carpenter and Buday, 2007; Shaw and Grant, 2002), other studies found precisely the opposite (Moody, 2001; Morgan and Cotten, 2004). Regarding smartphones, no association was found between smartphone use and severity of loneliness, depression, or anxiety (Rozgonjuk *et al.*, 2018). Furthermore, there are methodological concerns such as how best to approach such an individual and personal experience with quantifiable measures that allow generalizability. For example, how older people use the internet is as important as how much time they spend on the internet (Sum *et al.*, 2008). This indicates that a qualitative, in-depth, and exploratory approach is needed as much as a quantitative and measurable one.

2.3. Conceptualizing the digital divide through the information and communication technology social networking model

Vroman *et al.* (2015) conceptualized the use of ICT among older adults and proposed a socio-ecological model (Fig. 1). It provides a useful theoretical framework for this study on three grounds. Firstly, it offers a way to interpret the attitudinal and motivational patterns of older adults' smartphone literacy, addressing the issues of use and skills (second-level digital divide) and outcomes (third-level digital divide). Secondly, it considers individual preferences and inherent values that may lead to either self-initiation of or resistance to smartphone use. Thirdly, it is a person-centered model that affords a contextualized appreciation for older adults' reasons and needs for ICT, which is suitable for the purpose of this study to explore smartphone literacy and its implications on individual psychological factors such as loneliness and depression.

Figure 1 Information and communication technology social networking motivation model
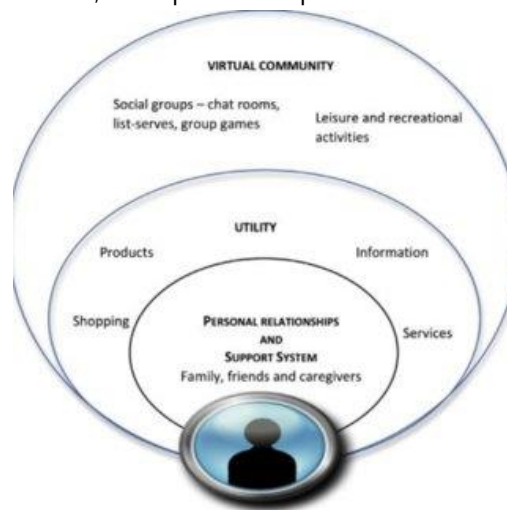
Source: Vroman *et al.* (2015, p.165)

At the core of this three-tiered, person-centered model (Fig. 1) is the older adult with his or her attitudes, needs and ICT capacity (Vroman *et al.*, 2015, p.163). The first level - personal relationships and support system - reflects one's primary interest, need, and most frequent use pattern - social networking activities with family and friends. This level is considered as the level with the greatest personal salience for older adults. Past research into older adults' smartphone use shows that older adults tend to use their mobile devices primarily for two activities: making/receiving phone calls and texting (Fernández-Ardèvol, 2011; Renaud and Biljon, 2010). However, we would like to understand to what extent these findings apply to Korean older adults and if so, with whom they communicate the most using smartphones. This leads us to the second-level digital divide research question:

RQ1. How older adults use their smartphones in terms of frequency and duration of daily use, and with whom?

The next level – utility - shows how the older adults use ICT for various functions: for example, accessing information about products and services and conducting daily tasks such as shopping. A progression from the first level to the second may occur due to the exchanges between family and friends (e.g., hyperlinks via email). Past research highlighted some positive outcomes of smartphone use for older adults: these include a wider range of activities such as social networking, shopping (van Deursen and Helsper, 2015; Vroman *et al.*, 2015) and an improved

quality of life thanks to the smartphone apps designed to help manage older adults' health (Doughty, 2011; Joe and Demiris, 2013; Steinhubl *et al.*, 2013). However, despite the growth in smartphone ownership among older adults, their ability to harness the potential of smartphones still varies. Therefore, we aim to investigate further the second-level digital divide by asking the following research question:

RQ2. How skilled are older adults in smartphone use by type and frequency of various smartphone functions used?

The final level - virtual community - represents the stage in which the older adult is making connections with their virtual community, that is, the least personally intimate social network. Examples of activities at this level are sharing common interests and further connectivity through online group activities such as interactive games and book clubs. What we are interested in is knowing the outcomes of Korean older adults' use of smartphones in relation to its impacts on levels of loneliness and depression. Hence the next research question addresses the second and third digital divide.

RQ3. How do older adults' smartphone use and skills influence levels of loneliness and depression?

The theoretical model proposed by Vroman *et al.* (2015) was developed from quantitative analyses, which may not fully encapsulate older adults' experiences, as pointed out by Hill *et al.* (2015). Furthermore, older adults are not a homogeneous group in terms of their digital technology use due to the differences in their past employment, motivation, and existing knowledge (Lee and Coughlin, 2014). However, the strengths of Vroman *et al.*'s model, as described earlier, outweigh the weaknesses and most importantly, this model provides a useful framework to explore and analyze potential outcomes of smartphone use (third-level digital divide) on individuals such as a correlation between smartphone use or skills and loneliness and depression.

3. Methods
3.1. Procedure and measures

An in-person interview method using questionnaires was employed to address the above research questions. Older adults aged 60 or over were interviewed in eleven community centers in the Seoul Metropolitan area in Korea during March 2018. Firstly, the usage frequency of various mobile phone functions was collected based on a 5-point-scale (1 = never, 5 = very often). The mobile functions include making/receiving calls, sending/receiving texts, taking pictures, clock/alarm, calculator, calendar/diary, social network sites (such as facebook, katok, etc.), entertainment (such as watching movie/drama, listening to music, playing games), internet search, GPS (car/driving navigation), taking memo, and others. Secondly, in terms of the frequency of social contacts, participants were asked about the frequency of contacts via mobile phone communication with their children, siblings, and friends, on a 10-point-scale (0 = no contact, 9 = almost every day). Thirdly, we also examined whether or not a participant had any ICT training because researchers considered the ICT training as an important factor to determine older adults' satisfaction and connectedness with family and community (Feist and McDougall, 2013).

Fourthly, to measure loneliness, we utilized a three-item measurement tool developed in the UK (Jopling, 2015). This tool is designed to measure loneliness using a 5-point-scale (1 = strongly agree; 5 = strongly disagree) across the following three items: I am content with my friendships and relationships; I have enough people I feel comfortable asking for help at any time, and My relationships are as satisfying as I would want them to be. Fifthly, Patient Health Questionnaire-9 (PHQ-9) was used to measure the level of depression. PHQ-9 was translated into Korean in 2008 as a self-report form of measurement tool developed to diagnose depression at the primary care facility in 1999, with its validity and reliability confirmed (Han *et al.*, 2008; Park *et al.*, 2010). Eight items were measured on a 4-point-scale (0 = not at all; 3 = almost every day). Lastly, health-related information was measured using Speake *et al.*,'s (1989) Subject Health Status. It consists of three items related to current health perception, past comparative health perception, and peer comparison health perception. For each item, we asked participants to assess their health using a 5-point-scale (1 = very bad; 5 = very good).

3.2. Participants demographics

The data were collected from a total number of 372 older adults, of which 223 participants owned a smartphone. The latter was used in this study to explore the second- and third-level digital divide. The average age of the participants (N=223) was 73.87 years old. 61.9% of the

smartphone owners were female. Most of them were either married (61.4%) or being widows/widowers (30.5%), with two to four children (83.9%). However, many of them were living in one- or two-member-households (70.4%). The majority of them had religion (77.1%), with the largest group being Christians (33.2%). Most of the participants were retired (83.9%), with an average income of 1.41 million KRW (approximately 1285 US dollars). Regarding the knowledge and skills in technology, slightly more than half of the participants (56.5%) had received ICT training.

Table 1 Demographic profile of smartphone owners

Variable	Options	Frequency (N)	Percentage (%)
Age (years)	60 - 69	55	24.7
	70 - 79	127	57.0
	Over 80	41	18.4
Gender	Male	85	38.1
	Female	138	61.9
Marital status	Married	137	61.4
	Separated	7	3.1
	Divorced	9	4.0
	Widowed	68	30.5
	Never married	2	0.9
Religion	None	51	22.9
	Christian	74	33.2
	Catholic	39	17.5
	Buddhist	50	22.4
	Won Buddhist	1	0.4
	Other	8	3.6
Retired	Yes	187	83.9
	No	36	16.1
ICT education	Yes	126	56.5
	No	97	43.5

4. Results and discussion

4.1. Exploring the first- and second-level digital divide among Korean older adults

The first and second research questions of our study were formulated to gain insight into how older adults use their smartphones in terms of frequency and duration of daily use, and with whom, and how skilled they are when it comes to the type and frequency of various smartphone functions used. We asked participants to reveal how often do they use their smartphones, how frequently do they use various functions; and how frequently do they communicate with various individuals and groups using smartphones. The results reveal that the Korean older

adults on average, spend 1 hour and 46 minutes per day on their smartphones. However, their usage duration varies up to 2 hours and 3 minutes per day, indicating differences in how much time older adults spend on average using their smartphones (the longest duration reported was 12 hours and 9 minutes). Moreover, the results reveal that older Korean adults aged between 60 to 69 years on average spend 2 hours per day on their smartphones, while those aged 80+ on average spend 40 minutes less than their younger peers.

In addition, we observed the differences in using various smartphone functions (see Table II). Smartphones were used mostly to make or receive calls, which makes older Korean adults no different from their European peers (Fernández-Ardèvol, 2011). Other basic functions such as texts, photos, clock/alarm, calendar/diary, and social networking services (SNS) were used occasionally, while many entertaining functions that enable listening to music, playing games, and watching movies were rarely explored. This makes a stark contrast to smartphone use by other age groups in Korea. Park *et al.* (2013) found that most Koreans use numerous advanced features and functions of smartphones such as information searches, emails, music downloads, maps, schedule management, SNS and gaming. Further analysis into differences in the use of smartphone functions in relation to demographic characteristics showed some interesting results. In particular, female older adults were found to play games more frequently ($\Delta M = 0.55$, $p = 0.002$), while male more frequently used the navigation function ($\Delta M = 0.40$, $p = 0.031$).

Table 2 Details of smartphone functions used and communication activities

| | | All (N=223) | | Male (N=85) | | Female (N=138) | | 95% CI | | | |
	Variables	M	SD	M	SD	M	SD	Lower	Upper	t	p
Functions used[a]	Making/receiving calls	4.35	1.00	4.40	1.02	4.32	0.99	-0.19	0.36	.618	.537
	Sending/receiving texts	3.75	1.41	3.79	1.39	3.73	1.42	-0.33	0.44	.268	.789
	Taking pictures	3.45	1.31	3.37	1.38	3.50	1.28	-0.49	0.23	-.717	.474
	Clock/alarm	3.36	1.55	3.37	1.57	3.35	1.54	-0.40	0.45	.115	.909
	Calendar/diary	3.35	1.46	3.31	1.43	3.37	1.48	-0.47	0.34	-.325	.746
	SNS (facebook, katok, etc.)	3.15	1.64	3.15	1.65	3.15	1.64	-0.46	0.46	-.009	.993
	Calculator	2.79	1.52	2.82	1.51	2.77	1.53	-0.37	0.48	.250	.803
	Entertainment (listening to music)	2.74	1.55	2.60	1.53	2.83	1.56	-0.67	0.19	-1.081	.281
	Taking memo	2.68	1.50	2.69	1.48	2.67	1.51	-0.40	0.44	.092	.927
	Internet search	2.68	1.56	2.72	1.56	2.65	1.57	-0.37	0.50	.297	.767
	GPS (car/driving navigation)	**2.05**	**1.39**	**2.30**	**1.42**	**1.90**	**1.36**	**0.01**	**0.79**	**2.032**	**.043***
	Playing games	**1.86**	**1.37**	**1.52**	**1.09**	**2.07**	**1.49**	**-0.91**	**-0.20**	**-3.085**	**.002***
	Entertainment (movie/drama)	1.79	1.26	1.75	1.15	1.81	1.33	-0.41	0.30	-.323	.747

Communication with[b]	Children	**7.41**	**1.89**	**7.12**	**1.93**	**7.57**	**1.85**	**-0.97**	**0.07**	**-1.708**	**.089****
	Friends/neighbours/societies	7.33	1.93	7.07	1.95	7.48	1.91	-0.94	0.13	-1.490	.138
	Brothers/sisters/relatives	**6.16**	**2.16**	**5.59**	**2.06**	**6.49**	**2.15**	**-1.51**	**-0.30**	**-2.938**	**.004***
	People from the community centres	6.61	2.60	6.43	2.64	6.72	2.58	-1.06	0.48	-.751	.454
	Spouse	**7.64**	**2.10**	**7.96**	**1.77**	**7.36**	**2.32**	**-0.08**	**1.27**	**1.731**	**.086****
	Religious groups	6.12	2.60	5.83	2.47	6.25	2.66	-1.38	0.55	-.855	.394

Note: *$p \leq 0.05$, **$p \leq 0.10$. [a]Measured on a 5-point scale, 1 = never, 5 = very often. [b]Measured on a 10-point-scale (0 = no contact, 9 = almost every day).

The results from Table 2 also show the participants used their smartphones to mostly communicate with their children and friends, approximately once a week. Somewhat surprisingly, their spouses were their frequent point of contact. This might be due to the fact that just over 60% of the participants were married and living with spouses. In comparison to their female counterpart, Korean older adult males were found to more frequently communicate with their spouses ($\Delta M = 0.60$, $p = 0.086$), while less frequently communicated with their children and relatives ($p = 0.089$ and $p = 0.004$).

When observing differences among those who had or did not have ICT training and how they use their smartphones, the results revealed that those with ICT training indicated a higher level of frequency regarding the use of most functions, except making/receiving calls ($\Delta M = -0.048$, $p = 0.724$) and clock/alarm ($\Delta M = -0.227$, $p = 0.289$) compared to those without ICT training. Additionally, the group with ICT training used smartphones more often to communicate with their siblings and relatives ($\Delta M = 0.657$, $p = 0.031$).

Table 3 Differences between age groups to determine the second-level digital divide

		Age groups							
		60-69 (N=55)		70-79 (N=127)		80+ (N=41)		ANOVA	
	Variables	**M**	**SD**	**M**	**SD**	**M**	**SD**	**F**	**p**
Functions used[a]	Making/receiving calls	4.58	0.71	4.30	1.01	4.17	1.22	2.313	.101
	Sending/receiving texts	**4.16**[3]	**1.03**	**3.94**[3]	**1.30**	**2.63**[1,2]	**1.61**	**19.212**	**.000**
	Taking pictures	**4.02**[2,3]	**1.03**	**3.45**[1,3]	**1.27**	**2.68**[1,2]	**1.44**	**13.465**	**.000**
	Clock/alarm	**3.91**[2,3]	**1.26**	**3.35**[1,3]	**1.54**	**2.65**[1,2]	**1.67**	**7.981**	**.000**
	Calendar/diary	**3.87**[2,3]	**1.28**	**3.34**[1,3]	**1.40**	**2.68**[1,2]	**1.61**	**8.040**	**.000**
	SNS (facebook, katok, etc.)	**3.75**[2,3]	**1.43**	**3.14**[1,3]	**1.59**	**2.36**[1,2]	**1.74**	**8.629**	**.000**
	Calculator	**3.08**[3]	**1.49**	**2.89**[3]	**1.47**	**2.08**[1,2]	**1.51**	**5.756**	**.004**
	Entertainment (listening to music)	2.96	1.54	2.72	1.50	2.51	1.71	.970	.381
	Taking memo	**3.06**[3]	**1.51**	**2.71**[3]	**1.44**	**2.08**[1,2]	**1.48**	**14.990**	**.000**
	Internet search	**3.42**[2,3]	**1.45**	**2.67**[1,3]	**1.55**	**1.72**[1,2]	**1.23**	**5.041**	**.007**
	GPS (car/driving navigation)	**2.34**[3]	**1.55**	**2.12**[3]	**1.37**	**1.49**[1,2]	**1.10**	**4.578**	**.011**

	Playing games	**2.08**[3]	**1.52**	**1.93**[3]	**1.40**	**1.33**[1,2]	**0.90**	**3.781**	**.024**
	Entertainment (movie/drama)	1.88	1.36	1.78	1.23	1.71	1.23	.219	.803
Communication with[b]	Children	7.60	2.05	7.30	1.91	7.49	1.57	.538	.585
	Friends/neighbours/societies	7.39	2.10	7.36	1.73	7.13	2.31	.251	.778
	Brothers/sisters/relatives	**6.23**[3]	**2.18**	**6.42**[3]	**2.04**	**5.22**[1,2]	**2.29**	**4.388**	**.014**
	People from the community centres	6.35	2.86	6.63	2.45	7.00	2.73	.580	.561
	Spouse	7.88	1.81	7.70	2.06	6.84	2.69	1.701	.186
	Religious groups	5.80	2.43	6.36	2.53	5.82	2.98	.717	.490

Note: $p \leq 0.05$. [a]Measured on a 5-point scale, 1 = never, 5 = often. [b]Measured on a 10-point-scale (0 = no contact, 9 = almost every day). 60-69 = Group 1; 70-79 = Group 2; 80+ = Group 3. The superscript '1' indicates a statistically significant difference (at $p<0.05$) from group 1. The superscript '2' indicates a statistically significant difference (at $p<0.05$) from group 2. The superscript '3' indicates a statistically significant difference (at $p<0.05$) from group 3.

In our sample, we had three different age groups of Korean older adults. By observing differences among them, the ANOVA results reveal some interesting findings (see Table 3). The youngest among older adults (e.g., aged 60-69) were the most frequent users of most smartphone functions, except for making or receiving calls ($p = 0.101$), watching movies ($p = 0.803$), and listening to music ($p = 0.381$). The latter puts them shoulder-to-shoulder with other groups as there were all frequently using smartphones for making or receiving calls and were least using their smartphones for watching movies or listening to music. Further, Tukey's posthoc tests have indicated that most differences were found between those aged 80+ and the other two groups, both in the functions used and in communicating with their brothers, sisters, and relatives.

Overall, our findings testify of the evidence that Korean older adults used smartphones to keep up with family and friends. This reflects older adults' primary interests and needs, which corresponds to Vroman *et al.*'s (2015) primary level of communicating – social networking activities with family and friends are considered as the level with the greatest personal salience for older adults. Moreover, there were significant differences among age groups and groups with or without ICT training, indicating younger and more ICT educated to use more smartphone functions and spend more time connecting with family and friends. These differences lead us to confirm the existence of the first- and second-level of the grey digital divide among Korean older adults and that not all have the ability to harness the potential of smartphones.

4.2. Exploring the third-level digital divide among Korean older adults

The third research question was formed to bring a better understanding of how older adults' smartphone use and skills, with considerations of overall health, influence levels of loneliness and depression. We asked participants to self-indicate whether they feel lonely and depressed and to evaluate their overall health. The results showed that participants did not feel lonely or depressed and they perceived themselves to be in a moderate health condition (see Table 4). However, some differences between the sexes were observed. Males indicated to be less happy with their current relationships ($\Delta M = 0.29$, p = 0.046) and not having enough people to ask for help when needed ($\Delta M = 0.41$, p = 0.009). In addition, females felt slightly more tired ($\Delta M = 0.23$, p = 0.070), yet indicated a higher level of overall health ($\Delta M = 0.28$, p = 0.075). We also observed whether there were any differences between a group that has received ICT training and a group without ICT training. There were no statistically significant differences in how they reported on loneliness, depression, and overall health. Moreover, the same was observed for different age groups. The ANOVA test results showed no statistically significant differences among the three different age groups.

Table 4 Details of smartphone owner's perception of loneliness, depression and overall health

		All (N=223)		Male (N=85)		Female (N=138)		95% CI			
	Variables	**M**	**SD**	**M**	**SD**	**M**	**SD**	**Lower**	**Upper**	**t**	**p**
Loneliness (reversed)[a]	My relationships with others meet my expectations.	2.32	1.10	2.39	1.04	2.27	1.13	-0.18	0.42	.779	.437
	I have enough people whom I can ask for help when needed.	**2.20**	**1.12**	**2.45**	**1.10**	**2.04**	**1.10**	**0.10**	**0.70**	**2.652**	**.009***
	I am happy with the current relationships with friends and others around me.	**2.05**	**1.05**	**2.22**	**1.06**	**1.93**	**1.03**	**0.01**	**0.57**	**2.009**	**.046***
Depression[b]	Disturbed sleeping patterns	.94	1.05	0.84	1.06	1.00	1.05	-0.45	0.12	-1.133	.258
	Feeling tired	**.70**	**.91**	**0.56**	**0.86**	**0.79**	**0.93**	**-0.48**	**0.02**	**-1.823**	**.070****
	Losing appetite, losing weight or overeating	.50	.83	0.42	0.81	0.55	0.85	-0.37	0.09	-1.195	.233
	Disinterested in things, no pleasure/fun	.50	.77	0.58	0.82	0.46	0.73	-0.09	0.33	1.139	.256
	Depressed, annoyed, frustrated	.50	.79	0.49	0.75	0.50	0.81	-0.22	0.21	-.087	.930
	Hard to focus on newspaper or TV	.38	.76	0.38	0.74	0.38	0.77	-0.20	0.21	.040	.969
	Feeling that I am letting down myself or family	.31	.64	0.35	0.71	0.28	0.60	-0.11	0.25	.790	.430
	People around me can notice	.23	.55	0.25	0.56	0.21	0.55	-0.11	0.19	.523	.601

	that my movement is sluggish, or my speech is too slow, or agitated or hyper										
Overall health[c]	Better than my peers (same age group)	3.83	1.17	3.74	1.20	3.89	1.15	-0.47	0.17	-.932	.352
	Overall good health	**3.70**	**1.17**	**3.52**	**1.22**	**3.80**	**1.13**	**-0.60**	**0.03**	**-1.788**	**.075****
	Worse than in the past (reversed)	3.30	1.20	3.27	1.24	3.33	1.18	-0.38	0.27	-.334	.739

Note: *$p \leq 0.05$, **$p \leq 0.10$. [a]Measured on a 5-point scale, 1 = strongly agree, 5 = strongly disagree. [b]Measured on a 4-point-scale (0 = not at all, 3 = almost every day). [c]Measured on a 5-point scale (1 = very bad, 5 = very good).

To observe whether smartphone usage skills were connected to loneliness and depression, we performed two linear regression analyses (using the Enter method) to predict loneliness and depression based on smartphone functions used. A significant regression equation was found for loneliness [$F(20,52) = 1.637$, $p = 0.079$, $R^2 = 0.386$]: it was shown that loneliness had been negatively influenced by making or receiving calls ($\beta = -0.267$, $p = 0.048$) and watching movies ($\beta = -0.344$, $p = 0.058$) but it was positively influenced by the use of memo function ($\beta = 0.283$, $p = 0.097$). On the other hand, no statistically significant equations were found for depression and the evaluation of overall health. Overall, our findings testify of the evidence that Korean older adults perceive themselves as in moderately good health and not being depressed or lonely. The latter could also be attributed to their skills and use of smartphones. That is, a different set of smartphone functions were associated with lowering the feeling of loneliness. Similar to the studies of van Deursen and Helsper (2015), and Vroman *et al.* (2015), these findings support the notion that smartphones can benefit older adults. More importantly, smartphone use was shown to benefits users in decreasing loneliness, corroborating the results from the computer-mediated-setting studies of Carpenter and Buday (2007), and Shaw and Grant (2002).

5. Conclusion

For the last few decades, we have witnessed many benefits from the internet in terms of enhancing global connectivity and communication. This has been even more amplified by the use of smartphones, which enable 24/7 connectivity in various situations, places, and settings. However, one of the crucial steps towards fully grasping the benefits of smartphone use *for all* is to explore the existence of a digital divide and its relationship to different outcomes from smartphone use. In so doing, this study explored Korean older adults' smartphone use, skills,

and outcomes. The importance of this study lies in the fact that it sets the basis for understanding the three levels of the digital divide, with a specific focus on unfolding differences across three age groups: 60+, 70+ and 80+, rather than comparing these groups to younger generations.

In our study, a questionnaire-based in-person interview method was used with the aim to understand 'if', 'how', and 'why' older adults aged 60 or over in the Seoul Metropolitan area use smartphones. The results of our research bring to light all three levels of the grey digital divide, exposing differences among older adult groups in fully harnessing the potential of the smartphone. More specifically, our results show that smartphones are owned by the majority of older adults but the group not owning a smartphone is still prominent. Among those owning the smartphone, the devices are predominately used to make and receive calls from their children, friends, and spouses. Hence, we found evidence that older adults in all three age groups used smartphones in Vroman *et al.*'s (2015) primary level of communicating with personal relationships and support system. This was the most frequently used pattern of connecting with friends and family, reflecting older adults' primary interests and needs. This finding also makes Korean older adults no different from their European peers, which may help in generalizing the use of smartphones cross-culturally.

Moreover, we found evidence of the other two levels of smartphone use according to Vorman *et al.*'s (2015) model. Younger older adults were much more prone to using all other smartphone functions compared to their older peers, making them champions of smartphone literacy. Functions such as games and navigation were rarely used but when they were used, the user profiles were different: more female participants played games on smartphones whereas more males used the navigation function. In terms of connecting with virtual communities, SNS activity was rarely shown. This indicates older adults' shyness or reluctance or lack of literacy to engage with the least personally intimate social network such as online interest groups. Although it was not at the level of a virtual community, those who had the ICT training were more confident in communicating with a broader range of people via smartphones. For example, those who had the ICT training used smartphones more frequently to communicate with their siblings, relatives, and people from their community centers. This confirms previous research findings that ICT training facilitates users to acquire and improve digital skills and competence.

Lastly, this study also contributes to a better understanding of the benefits of using smartphones

among older adults. Our results found evidence that using smartphones to stay connected to their social group and for entertainment such as watching movies aids in decreasing the feeling of loneliness. Nowadays, this finding is even more relevant due to Covid-19 pandemic which resulted in a majority of the world's population being confined to self-isolation, strict social distancing rules and avoidance of in-person contact with members outside the household. Also, older adults were shown to be the group most jeopardized by the pandemic. Hence, using smartphones to stay connected with their social groups and to be entertained is even more critical in reducing loneliness that may come as a result of the pandemic. However, our study was conducted two years before the virus outbreak, making this finding a good starting point to test these pandemic-related assumptions.

Our study is not without limitations. Those who used various smartphone functions were a minority that it is hard to generalize the exact impact of smartphone use and literacy on an individual's psychological factors. Due to the sample size and the participant demographics, our findings have limited applicability. Same age groups owning a smartphone but living in rural areas may result in different findings. In addition, a more detailed investigation about the type of ICT training, length, and intensity of the training will provide more practical lessons for making suitable training programs for older adults. Future research can also examine, both at the micro (individual) and macro (societal) level, different experiences of digital technology engagement (e.g., tablets and wearable technology) among older adults and how society can better prepare literacy training programs for more beneficial outcomes.

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