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The implications of information and communication technology use for the social well-being of older adults

Jennifer Ihm[a*] and Yuli Patrick Hsieh[b]

[a]*Department of Communication Studies, Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA;* [b]*RTI International, Chicago, USA*

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Older adults, comprising a population segment more vulnerable to social isolation during the late life stages, are more likely to be excluded from the benefits of information and communication technologies (ICTs) as well as from the focus of ICT research. Addressing this research gap concerning the currently fastest growing sector of ICT users this study centers on the disparities regarding older adults' ICT access and use. Because the effects of ICTs cannot be uniform for all users, the digital inequalities older adults experience might have different influences on their social lives when compared to other populations that have been studied in the previous literature. Drawing on surveys from 1780 older adults, ages 60 years and older, residing in six suburbs in the Chicago area, this research links older adults' digital inequalities to their social well-being. We demonstrate that while socio-economic status remains the major factor affecting their quality of life, social and instrumental ICT uses can also contribute to their well-being in varied and unexpected ways. From these results, we draw implications for the study of digital disparities by examining how the impacts of ICTs vary by differential uses and different age groups.

Keywords: digital inequality; older adults; social well-being; social engagement

As information and communication technologies (ICTs) rapidly integrate into people's everyday lives, inequalities between users who can grasp the benefits of ICTs and those missing out on the benefits have crucial implications for users' socio-economic mobility as well as their social well-being. Specifically, ICTs can provide opportunities to communicate with more people and access useful information or services for disadvantaged groups, such as older adults who are likely retired or isolated from society (Cotten, Anderson, & McCullough, 2012; Hernández-Encuentra, Pousada, & Gómez-Zúñiga, 2009; Russell, Campbell, & Hughes, 2008; Xie, Watkins, Golbeck, & Huang, 2012). However, due to physical, psychological, and economic barriers (Smith, 2014), older adults are likely to experience inequalities in accessing and using ICTs. In fact, older adults' adoption rate of ICTs is growing the fastest, but it is still much lower than younger generations (Zickuhr, 2013) and their usage of ICTs is not as diverse as their younger counterparts (Madden, 2010).

Although much research has centered on socio-demographic factors (i.e. race, gender, education, and income) to explain disparities in accessing and using ICTs (Hargittai & Hsieh, 2013), older adults have not been in the major focus of such research until recently (Selwyn,

*Corresponding author. Email: ihmsy17@gmail.com

2004). Specifically, while ICT adoption among older adults has been documented (Zheng, Hill, & Gardner, 2013), the different ways older adults use and incorporate ICTs into their daily routines and the social implications of such differentiated ICT uses are under-researched. Understandably, the nature of the targeted population is inherently challenging: older adults are considered as a hard-to-reach population given that they are more likely to be socially disadvantaged and proportionally smaller than the general adult population (Freimuth & Mettger, 1990; Walsh, Rudd, Moeykens, & Moloney, 1993). As a result, such a research deficit stems from the high cost for research access and a lack of commercial interest in this population (Friemel, 2014).

Despite the lack of research on this population, previous studies suggest that older adults experience disparities in accessing and using ICTs differently from general populations (Madden, 2010; Smith, 2014). Such differences can provide unique theoretical perspectives for digital inequality scholarship compared with previous ones gained from general populations (Bunz, 2009; Friemel, 2014; Smith, 2014). As such, the current study examines the disparities in ICT access and use among older adults and the social implications of the disparities in order to address the research gap on this population and extend the theoretical dimensions of the digital inequality literature. We analyse survey data collected from a group of older adults residing in six diverse suburban communities within the greater Chicago area.

This study makes three contributions to the current digital inequality scholarship. First, we focused on the under-studied population of older adults and examined the aspects of digital inequalities in this population in comparison to other populations (i.e. young adults) that have been the focus of previous research. Second, we provided a robust analytical approach to the current literature by distinguishing the social and instrumental purposes of ICT uses and examining the ICT usage disparities within the older user group. Finally, we further examined the implications of ICT access and usage disparities with respect to the social well-being of older adults.

Literature review

From unequal ICT access to differentiated ICT use among older adults

The digital inequality was initially described as a binary divide between the haves and have-nots regarding access to computers, the Internet, or broadband connection (National Telecommunications and Information Administration [NTIA], 1995). Along with the rapid penetration of ICTs, however, researchers pointed out that inequalities in accessing ICTs might no longer be as severe as disparities in digital skills and using ICTs (DiMaggio, Hargittai, Celeste, & Shafer, 2004; Hargittai, 2010). As such, many studies (van Deursen & van Dijk, 2011; Hargittai & Walejko, 2008; Livingstone & Helsper, 2010; Zillien & Hargittai, 2009) revealed how demographic characteristics (i.e. gender, age, race, and ethnicity) and socio-economic status (i.e. income and education) differentiated people's experiences with ICTs and the skills needed to use them.

However, recent studies (NTIA, 2013; Smith, 2014; Zickuhr, 2013) suggest that older adults might be subjected to different ICT adoption and usage circumstances, illustrating that the disparities in accessing ICTs are still a crucial issue. In the NTIA's latest report (2013), rates of ICT adoption (53%) and use (57%) among older adults (55 years and older) remain below the national average (64% and 70%, respectively). Moreover, among older adults, the percentage of ICT users drops off dramatically after the age of 75 years (from 53% to 34%), showing another significant inequality within older adults (Zickuhr, 2013).

The digital disadvantages older adults experience might be particularly problematic because they stem from older adults' cognitive, psychological (e.g. a lack of interest or perceived usefulness), and economic barriers (Freese, Rivas, & Hargittai, 2006; Lee, Chen, & Hewitt, 2011; Selwyn, 2004) rather than from an active decision not to use ICTs. Moreover, the manifestation

of older adults' digital inequality could divert from that of the general population due to older adults' retirement or health situations (Friemel, 2014; Smith, 2014). For instance, apart from exhibiting a higher rate of have-nots compared with the younger counterparts (i.e. age divide in access), older adults diverge from the general population in their choices of ICTs as they are more likely to adopt e-book reading devices, and less likely to adopt smartphones (Smith, 2014), or access social networking sites, online banking, and online news outlets (Madden, 2010).

Nonetheless, due to practical challenges for data collection and a lack of commercial interest in this population, studies rarely discuss the idiosyncratic aspects of digital disparities among older adults (Friemel, 2014; Selwyn, 2004). Therefore, the current section reviews the previous literature on digital inequalities to address the research gap on the older adult population and to compare the different attributes of the inequalities between the older and the general population.

First, age is one of the demographic factors that produced mixed results in relation to digital disparities. Whereas empirical evidence consistently suggested that age had a negative influence on access to ICTs (Friemel, 2014; Pearce & Rice, 2013; Smith, 2014), the relationship between age and differentiated ICT uses has been inconsistent, revealing no significant relationship (Helsper & Eynon, 2009; Jones, Johnson-Yale, Millermaier, & Pérez, 2009), or both negative (Bunz, 2009; Pearce & Rice, 2013; Selwyn, 2004) and positive (van Deursen & van Dijk, 2011; Livingstone & Helsper, 2010) relationships. Even though many of these studies (Gui & Argentin, 2011; Helsper & Eynon, 2009; Jones et al., 2009; Livingstone & Helsper, 2010) focused on the younger generation as a specific group of 'digital natives', studies (van Deursen & van Dijk, 2011; Pearce & Rice, 2013) paid far less attention to older adults' specific situations. Previous research suggested that age has an exponential effect on digital inequalities as a population becomes older (Friemel, 2014; Smith, 2014), so examining the influence of age on digital inequalities among older adults is a necessary step to fill the research gap.

Second, gender is another demographic predictor for digital inequalities; its influence on digital inequalities reflects a combination of gendered social structures and individual perceptions (Dholakia, 2006). Although many previous studies (Ono & Zavodny, 2003; Wasserman & Richmond-Abbott, 2005) found disparities of accessing and using ICTs between different genders, more recent studies suggest that both disparities might be the products of socio-economic inequalities from gendered structures rather than gender itself (Bunz, 2009; Friemel, 2014). Specifically, gender played different roles among different age groups. It had no effect on anxiety related to using ICTs among older adults, but it did have an effect on young female users, who had more anxiety than young male users (Bunz, 2009). Such results call for more research into gender's unique influence on digital inequalities in older populations.

Finally, compared with demographic characteristics, income has a more consistent association with ICT access and uses. As an indicator of socio-economic status, income has been found to be positively associated with a greater level of digital access (Ono & Zavodny, 2007) as well as more advanced digital skills (van Deursen & van Dijk, 2011) and variation in ICT uses (Pearce & Rice, 2013; Zillien & Hargittai, 2009). Specifically, income has a greater negative effect on older adults than younger ones regarding digital disparities (Smith, 2013), but the previous studies, again, sampled the general population without accounting for older populations' distinctive situations (van Deursen & van Dijk, 2011; Ono & Zavodny, 2007; Pearce & Rice, 2013).

The previous research regarding the association between socio-demographic components and digital inequalities suggests that the younger generation has been at the center of the research. However, studies (Bunz, 2009; Friemel, 2014; Smith, 2014) still suggest that digital disparities among older adults might reveal different patterns from the general population due to their specific situations. Considering the digital inequalities between different age groups (NTIA, 2013), focusing on the digital disparities *of* the older population as well as *within* this population

(and the socio-demographic factors inducing the disparities) will reveal how older adults actually experience ICTs in their everyday lives. Thus, we examine how older adults access and use ICTs differently, based on the aforementioned demographic and socio-economic attributes. Hence, the following hypotheses are proposed:

H1: (a) Age, (b) gender, and (c) income will be related to the level of older adults' ICT access.

H2: (a) Age, (b) gender, (c) income, and (d) ICT access will be related to how older adults use ICTs.

Digital inequalities and social engagement among older adults

Older adults' well-being or 'successful aging', consists of three components: low probability of disease, high cognitive/physical/functional capacity, and active social engagement (Rowe & Kahn, 1997). Social engagement, defined as '(1) the maintenance of many social connections and (2) a high level of participation in social activities' (Bassuk, Glass, & Berkman, 1999, p. 165) can comprehensively enhance older adults' quality of life. Specifically, engaging in offline social activities, such as getting together with family and friends, group recreation, and participating in religious or volunteering activities, is a crucial part of older adults' social engagement in order to enact and maintain their social ties (Berkman, Glass, Brissette, & Seeman, 2000). Such offline engagement eventually leads to older adults' physical (e.g. improving immune-system functions, promoting healthy behaviors, and reducing mortality risk), psychological (e.g. offering a sense of belonging, self-esteem, or purpose of life and lowering depressive symptoms), and cognitive well-being (e.g. reducing risk of cognitive decline and dementia) (Berkman et al., 2000). Therefore, this study focuses on older adults' offline social engagement (social engagement, from now on), a fundamental component for their successful aging, and its relationship to older adults' digital life.

Based on older adults' most common uses of ICTs – communication and social support, leisure and entertainment, information seeking, and mental stimulation (Wagner, Hassanein, & Head, 2010) – this paper classifies older adults' types of uses into two categories (social and instrumental), which may influence older adults' well-being and offline social engagement. First, social uses of ICTs help maintain social connections. Social uses of ICTs indicate using ICTs for direct interaction with other people (Bassuk et al., 1999). Older adults often lose contact with their networks because of 'death of social ties, relocation to different types of living and care communities, and limitation in physical and mental health' (Cotten et al., 2012, p. 161), but the social uses of ICTs help them maintain their social ties (Cotten et al., 2012; Russell et al., 2008; Smith, 2014; Winstead et al., 2013). For example, going online more frequently predicted greater quantity and ease of contact with their networks; interviews with older adults indicated that ICTs possessed the potential to 'transcend social and spatial barriers' (Winstead et al., 2013, p. 540) as well as to overcome barriers derived from having an introverted personality, leading to increased communication with others (Russell et al., 2008). Studies on the general population also suggested that using ICTs for social purposes could build social resources (Ellison, Steinfield, & Lampe, 2007) by reviving 'dormant' relationships and maintaining contact with close connections, the social connections mostly initiated during offline interactions (Hampton, Goulet, Rainie, & Purcell, 2011; Rainie, Horrigan, Wellman, & Boase, 2006).

Next, instrumental uses of ICTs may encourage social engagement by providing ICT users with necessary information and knowledge. Instrumental uses of ICTs indicate using ICTs as convenient means or 'instruments' to obtain useful information, services, or other resources without

direct interaction with others (Campbell & Kwak, 2010). Although instrumental uses of ICTs might influence social engagement differently from the social uses by providing means or information for social engagement, previous studies have not distinguished instrumental uses of ICTs as an important concept. Some studies, however, have explained how other non-social purposes (e.g. political and informational) might predict social engagement (Campbell & Kwak, 2010; Shah, Kwak, & Holbert, 2001; Smith, Schlozman, Verba, & Brady, 2009) by providing useful knowledge, information, or opportunities. These studies, which sampled the general and younger populations, imply that non-social uses of ICTs can predict social engagement and eventually improve individuals' well-being. Although these studies leaned toward political aspects of ICT uses, the results suggest that instrumental uses of ICTs, which involve 'political' or 'informational uses', might also predict offline social engagement.

Despite previous research on different uses of ICTs (Campbell & Kwak, 2010; Ellison et al., 2007; Shah et al., 2001; Smith et al., 2009), most of the studies sampled general or younger populations. Because ICTs do not have uniform effects to all age groups (Selwyn, 2004), the results from the general or younger populations do not precisely represent the influence of ICTs on older adults' social engagement and well-being. For example, participation in offline social activities has more importance for older adults than direct civic participation in social issues in the general population (Wagner et al., 2010). Health-related uses of ICTs would account for a significant part of non-social uses for older adults (Hernández-Encuentra et al., 2009; Xie et al., 2012) compared with the younger age groups.

Therefore, research on this specific population is necessary to address how various uses of ICTs among older adults can have different impacts on their social engagement and quality of life. Considering the aforementioned positive impact of instrumental (Campbell & Kwak, 2010; Shah et al., 2001) and social ICT uses (Ellison et al., 2007; Hampton et al., 2011; Rainie et al., 2006) on social engagement, the current paper predicts a positive influence of instrumental and social ICT uses on older adults' social engagement. Hence, the following hypotheses are proposed:

H3a. Instrumental uses of ICTs are positively related to older adults' offline social engagement.

H3b. Social uses of ICTs are positively related to older adults' offline social engagement.

Method

Data source, instrument, and sample description

This study uses data from a 2013 Lifestyle Survey collected by a nonprofit organization serving older adults. One of this study's authors volunteered with the organization and had access to the survey's results. The survey was mailed on 14 February 2013, to a purchased sampling frame of 25,000 people, ages 60–86 years, living in six northern suburbs in the greater Chicago area. Respondents include a few people under 60 and over 85 years, because other family members might have filled out the survey or a time has passed after the age information was compiled. Respondents received a questionnaire with a paid-postage return envelope and compensation of a $10 Walgreens gift card for completion. The survey consisted of 29 questions asking about the respondents' daily routines, including social activities and exercise, opportunities for socialization and learning, ICT ownership and usage, demographic characteristics, and socio-economic status.

A total of 1780 older adults responded to the survey by 12 March 2013, a response rate of 7%. Societal and technological changes have caused decline in response rates, a significant challenge

in conducting surveys, and this study is no exception. The response rate in this study is as low as the response rate in surveys by the Pew Research Center for the People and the Press (9%), but low response rates may still be representative of the relevant sample when conducted properly (Kohut, Keeter, Doherty, Dimock, & Christian, 2012). In fact, 'additional effort and expense in the high-effort study' to increase the response rate 'appears to provide little benefit in terms of the quality of estimates' when the researchers compared high-effort studies (22% response rate) to standard surveys (9%) (Kohut et al., 2012). Specifically, the current study does not ask sensitive questions such as alcohol and drug consumption or abuse where respondents were likely to be different from non-respondents (Lahaut, Jansen, Van de Mheen, & Garretsen, 2002; Zhao, Stockwell, & MacDonald, 2009).

Another important specificity of this study is the age of the survey sample. Surveys on digital uses of general population yielded 10–13% response rate in landline and cell phone samples (Smith, 2014; Zickuhr & Madden, 2012). Considering older adults' health condition and lower mobility, the response rate of this study is comparable to surveys on general populations' digital uses. Moreover, this study used a mail survey in purpose rather than telephone, cell phone, or email surveys, because the pencil-and-pen survey form would be a more familiar mode for older adults (Friemel, 2014). Since this research is asking about older adults' uses of (and disparities in) ICTs, the pencil-and-paper survey form is a way to appropriately represent the underrepresented population who might not be reachable by or comfortable with ICTs.

Measures

Demographic and socio-economic characteristics

Demographic characteristics and socio-economic status were predictors of disparities in ICT access and use in the previous studies (Eamon, 2004; Gui & Argentin, 2011; Hargittai & Hsieh, 2013). The participants were asked about their age, gender, marital status, and household income (See Table 1 for detail). While the gender distribution was similar to the general population of Americans ages 55 years and older (female, 54%; male, 46%; Howden & Meyer, 2011), the breakdown of marital status of our sample was different from the average population of Americans in the same age range (married, 16%; unmarried, 84%; Elliott & Simmons, 2011). Because the proportion of married participants in our study was not representative of the older adult population, the current paper takes a cautious approach so as not to overgeneralize the findings.[1] Participants were instructed to indicate their annual household incomes and we constructed a binary variable by using $50,000 as the cutoff value based on the national median household income ($52,762, American FactFinder, 2013).

In addition, to control for the impact of existing levels of social participation (other than impact of ICT access and uses) on the respondents' social engagement, we included two widely adopted measures of people's existing levels of social participation (Putnam, 2001). The survey asked participants whether they belonged to any voluntary organizations or clubs, as well as to any religious organizations or places of worship. We then constructed two binary variables indicating whether participants had any memberships involving voluntary or religious organizations.

ICT access

Access to ICTs, commonly measured by device ownership, has been found to be unequally distributed and a factor differentiating ICT usage behaviors (Hargittai & Hsieh, 2013). The survey asked participants to indicate whether they owned the following technological devices: computer, cell

Table 1. Demographic and socio-economic characteristics of the participants.

	Percent (%)
Age group (*midpoint*)	
Younger than 60 (57)	4.37
60–64 (62)	17.52
65–69 (67)	19.67
70–74 (72)	17.91
75–79 (77)	14.97
80–84 (82)	15.65
85 and older (87)	9.92
Gender	
Female	56.47
Male	43.53
Marital status	
Married	50.06
Unmarried[a]	49.94
Household income	
Less than $25,000	21.89
$25,000–$50,000	33.94
$50,000–$99,000	33.94
More than $100,000	10.24

[a]Unmarried status includes single, widowed, or divorced.

phone (including smartphone), e-reader (e.g. Kindle), tablet computer (e.g. iPad), and music player (e.g. iPod). We constructed a composite measure summing the total number of devices participants possessed, ranging from 0 to 5, with an average having access to two ICT devices (SD = 1.14).

Instrumental and social ICT use

ICT use has also been noted to be unequally distributed (Hargittai & Hsieh, 2013). The survey asked participants to indicate how often they engaged in a set of nine ICT-related activities. These activities consisted of two categories: instrumental and social (-interaction) purposes. Instrumental ICT use indicates using ICTs as convenient means or 'instruments' to obtain useful information, services, or other resources without direct interaction with others. It was measured by five activities in the survey: general Internet use, shopping or making purchases on the Internet, making travel plans online, completing surveys on the web, and playing computer games. In contrast, social ICT uses refer to using ICTs which naturally and purposefully involves social interaction with other people. This was assessed by four activities in the survey: using email, using social media, posting comments on social media or blogs, and using a cell phone. The survey asked participants to 'indicate how often you do each of the following activities' and named them the aforementioned activities. The participants responded on a 5-point scale, with the possibilities being once a day or more, several times a week, once a week, less than once a week, and never. We assigned numeric scores to indicate activity frequency in which *0* indicated *never* and *4* indicated *daily or more*. We then constructed two composite-score measures capturing the overall intensity of instrumental and social ICT use, respectively. On average, the respondents used ICTs for instrumental or social purposes a bit less than once a week (instrumental use: $M = 1.43$, SD = 1.01, $\alpha = 0.72$; social use: $M = 1.74$, SD = 1.07, $\alpha = 0.72$).

Social engagement

Previous studies have suggested a correlation between social engagement and ICT access and use (Campbell & Kwak, 2010; Chen, 2013; Selwyn, 2004; Shah et al., 2001; Smith et al., 2009). The survey asked participants to indicate how often they engaged in offline social activities: visiting family, seeing friends, volunteering, going to religious services, participating in activities at a place of worship, and playing cards or other games with people. The participants responded to the frequency of engagement on another 5-point scale whose range include weekly or more, biweekly, every three to four weeks, less than once a month, and never. Similarly, we assigned a numeric score to denote the frequency of individual social activity, in which 0 indicated *never* and *4* indicated *weekly or more*. We then constructed another composite measure conveying the level of social engagement. On average, the respondents participated in social events nearly once a month ($M = 1.71$, SD = 0.86, $\alpha = 0.65$).

Upon inspection, we confirmed that the aforementioned variables, including ICT access, instrumental ICT use, social ICT use, and social engagement, all exhibited an approximate normal distribution.

Analytic procedure

We fit the structural equation model (SEM) to conduct a path analysis examining the relationships between demographic and socio-economic background, ICT access and use, and social engagement as observed variables (Bollen, 1989). We acknowledged concerns that the two purposes of ICT use (social and instrumental) might not be completely exclusive to each other. Pearson's correlations documented in Table 2 suggest that the correlations between the four key variables were moderate, with the exception of the relationship between instrumental and social ICT use ($r = 0.72$, $p = .000$). Although the strong correlation between the two ICT-use variables could suggest a problem with multicollinearity when they are used as explanatory variables, the variance inflation factor (VIF) tests indicated that the VIF factors of all variables in our analyses were smaller than 2.5,[2] suggesting that our models did not exhibit multicollinearity. Hence, we concluded that our construction of both instrumental and social ICT use was appropriate for our analysis. As a result, we were able to differentiate the purposes of ICT use our sample reported.

Results

The Stata 13 software (StataCorp, 2013) was employed with maximum-likelihood estimates. The SEM showed a good fit, meeting the criteria for RMSEA (root mean square error of approximation) value less than 0.07 (Steiger, 2007), TLI (Tucker–Lewis index) greater than 0.95 (Hooper, Coughlan, & Mullen, 2008), CFI (Comparative Fit Index) greater than 0.95 (Hooper et al., 2008), and two-index combination rules (Hu & Bentler, 1999) – RMSEA value lower

Table 2. Correlations between respondents' ICT experiences and social engagement.

	(1)	(2)	(3)	(4)
(1) ICT ownership	–			
(2) Instrumental use of ICTs	0.598 (0.000)	–		
(3) Social use of ICTs	0.637 (0.000)	0.717 (0.000)	–	
(4) Social engagement	0.075 (0.007)	0.103 (0.000)	0.116 (0.000)	–

Note: *p*-values are presented in parentheses.

than 0.06 and SRMR (Standardized Root Mean Squared Residual) value lower than 0.09 or CFI value higher than 0.96 and SRMR value lower than 0.09: $x^2(14) = 27.87$, RMSEA = 0.03, CFI = 0.99, TLI = 0.98, and SRMR = 0.03. Thus, the proposed model worked well and examined the statistical significance of the causal relationships among the variables.

Access and usage inequalities among older adults

H1 predicted that (a) age, (b) gender, and (c) income would be associated with ICT access inequalities. We also controlled for and examined the impact of the existing social-participation level on this association. As seen in Figure 1, H1-a and H1-c were supported with low coefficients, but H1-b was not supported; age was negatively related to ICT access, meaning older participants were less likely to have access to ICTs. Interestingly, a positive correlation surfaced between age and existing social participation, which indicates that among the participants, the older respondents were more likely to have religious or organizational memberships. The existing social-participation level, however, did not have any association with ICT access. Regarding income, it was positively related to one component of the existing social participation (religious membership) and ICT access. That is, the participants with higher incomes were more likely to have access to ICTs and be involved with religious organizations. Gender was not supported for any of the hypothesized paths.

H2 examined the digital inequalities of using ICT in different ways. H2 posited that (a) age, (b) gender, (c) income, and (d) access to ICT would play a role in the ways older adults use ICTs. As seen in Figure 1, H2-a, H2-c, and H2-d were supported. Age and income were related to instrumental and social uses both directly and indirectly via ICT access. Regarding age, a direct negative correlation existed for both instrumental and social uses of ICTs, which suggests that older

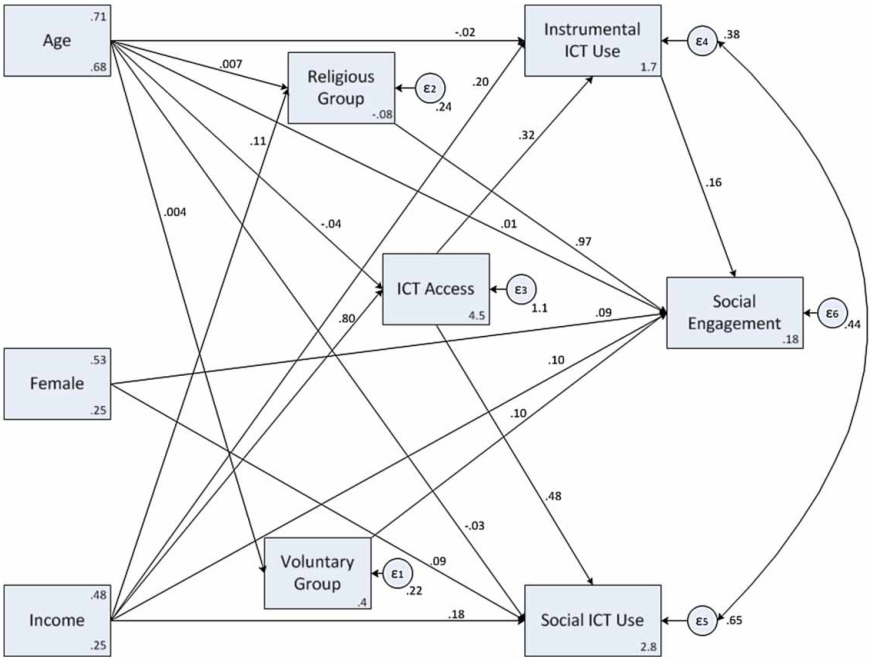

Figure 1. Structural equation modeling of older adults' socio-demographic factors, digital divides, and their impact on social life.

participants were less likely to use ICTs in either social or instrumental ways. In regard to income, a direct positive correlation existed for both uses of ICTs. ICT access was the highest predictor of instrumental and social uses of ICTs. H2-b was partially supported; gender was only directly related to social uses of ICTs. None of the existing social-participation variables was related to ICT uses.

Social engagement among older adults

H3 examined the social outcomes of digital inequalities. H3 predicted that (a) instrumental and (b) social uses of ICTs were positively related to older adults' social engagement. Only H3-a was supported. Regarding the relationship with different ICT uses, social engagement was associated with instrumental uses but not with social uses; those who used ICTs for instrumental reasons were more likely to participate in social gatherings, but those who used ICTs for social purposes did not present any relationship to their social engagement.

Perhaps not surprisingly, the variables for having religious or organizational memberships were positively related to social engagement. In regard to socio-economic and demographic variables, age, gender, and income were all positively related to social engagement, meaning that respondents who were older, female, or had higher incomes were more likely to engage in social activities.

Discussion

Access and usage inequalities among older adults

This study examines how demographic and socio-economic variables predict older adults' access to (H1) and various uses of ICTs (H2) and how their usage patterns relate to their social well-being (H3). First, in regard to hypotheses 1 and 2, age was one of the variables that predicted disparities in both accessing/owning and using ICTs. We also found a sharp drop-off of ICT access among adults older than 75 years, consistent with the previous research (Friemel, 2014; Zickuhr, 2013). The negative relationship between age and ICT access and use in the results corresponds with the findings from previous empirical research regarding the cognitive, psychological, and economic constraints involving older adults' ICT adoption and use (Freese et al., 2006; Lee et al., 2011; Selwyn, 2004; Zheng et al., 2013).

Next, gender did not relate to disparities in ICT access, but did differentiate ICT uses as women were more likely than men to use ICTs for social purposes. This suggests that older women and men might have a similar level of access disparity, however, older women tended to follow the social conventions (Dholakia, 2006; Ono & Zavodny, 2007) to communicate with others via ICTs more than their male counterparts.

Consistent with research revealing a relationship between traditional socio-economic status and digital inequality (DiMaggio & Bonikowski, 2008), household income was the strongest positive predictor of older adults' ICT access. It was also a strong indicator, second to ICT access, of using ICTs for both instrumental and social purposes.

In the meantime, engaging in religious or volunteer activities did not exhibit any relationship with older adults' ICT access and uses. Given that home access was the main usage mode for older adults (Zickuhr, 2013), our results reemphasize that older adults' engagement with organizations might not help them connect to ICTs. This result contradicts the prior work, which found a positive influence of social capital on closing digital gaps (Chen, 2013). However, the contradiction actually points out the idiosyncrasy of older adults' digital inequalities, indicating that older adults' digital inequalities might not have the same positive association with social capital as

general adult population (Chen, 2013; Hampton, Sessions, & Her, 2011). This suggests the importance of conducting more research on this under-studied population with a different theoretical approach. Such research will open up a new theoretical realm in understanding the implications of digital inequalities for social capital. The results also imply that diminishing older adults' digital disparities would require a new practical approach in comparison to one for other age groups.

Our results for hypotheses 1 and 2 suggest that inequalities in accessing and using ICTs exist among older adults. Specifically, even though the access disparity might become less of a concern over time among the general population, our findings suggest that such inequality could still be a major issue for older adults. Their ICT access primarily depends on their income, and both the income and the access disparities are major predictors in their differentiated uses of ICTs. That income is the strongest socio-demographic factor for both digital inequalities among older adults is problematic because older adults with lower incomes lack alternatives to compensate for their digital inequalities when compared to their younger counterparts (i.e. going online with other mobile devices if they did not own computers; Smith, 2013). Moreover, because older adults are more likely to access ICTs at home (Zickuhr, 2013), income deteriorates not only the inequalities in accessing, but also using ICTs.

Social engagement among older adults

Perhaps the most notable finding from our study concerns the implications of ICTs in terms of inequality and the social well-being of older adults (H3). We found that the traditional fault line of social inequality – age, gender, household income, and existing religious/organizational memberships – drove older adults' social engagement.

However, besides socio-demographic variables, ICTs seem to exhibit additional effects on older adults' social well-being, because we found that ICT access and use were related to older adults' social engagement. Instrumental uses of ICTs predicted more involvement in social activities for older adults, whereas social uses of ICTs did not. Moreover, the younger and more affluent the older adults were, the more access they had to ICT devices and the more they used them for instrumental instead of social purposes. In other words, older adults may benefit from diverse and instrumental online activities, which eventually support more engagement in their social activities.

On the other hand, we discovered that older adults who used ICTs to communicate with others did not necessarily participate in offline social activities or communicated much offline. For older adults, social use of ICTs and offline social engagement were two distinct experiences even though they both involve communication with others; social use of ICTs neither decreases (substitutes) nor increases (encourages) offline social engagement. The results of H3 suggest that the role of ICTs in encouraging offline social activities depends on *how* older adults use ICTs, not how *much* they use ICTs. These results contradict the previous findings regarding the positive role of both social and other non-social (informational, political) uses of ICTs in social engagement (Campbell & Kwak, 2010; Ellison et al., 2007; Hampton et al., 2011; Rainie et al., 2006; Shah et al., 2001; Smith et al., 2009). Because the previous studies were primarily based on general population, the contradiction calls for more attention and a nuanced approach to the older adults in order to understand this hard-to-reach population better and improve their social well-being. The results also extend the ICT and social engagement literature by providing a new theoretical insight in the implications of digital inequality for the seemingly related concepts – online and offline social activities.

Reinforced digital and social inequalities among older adults

We discovered that socio-economic status plays a crucial role in the digital inequality among older adults, but their existing organizational memberships appear to have little influence on ICT access and use. That is, the existing social participation of older adults might not be helpful in overcoming the economic barriers of ICT access. The positive relationships of income, ICT access, instrumental ICT uses, and social engagement among older adults also suggest that enjoying a better quality of life and diverse aspects of online and offline activities might be available only to those who already possess media and economic resources. When using ICTs instrumentally, older adults are not substituting any offline social engagement; rather, they are broadening the spectrum of their online and offline lives.

The results regarding social engagement also indicate that disparities are reinforced by social and economic resources. Apart from the positive effect of instrumental ICT uses on social engagement, both household income and existing social-participation levels had a direct positive influence on enhancing older adults' social engagement. In other words, older adults with sufficient economic or social capital did not need ICTs for social engagement, whereas older adults without such capital could not even take advantage of ICTs for social engagement. The results regarding both digital and social inequalities unfortunately reemphasize how rich older adults (with social, economic, and digital resources) get richer, not only in quantity but also in quality of enjoying diverse aspects of social life.

Conclusion

We examined digital inequalities among older adults and their relation to the older adults' social engagement. We discovered that socio-economic status plays a significant role in digital inequality among older adults, but their existing social participation does not affect their ICT access and use. We also found that older adults' instrumental uses of ICTs, instead of social uses, were related to their social well-being. While this finding seems to suggest that older adults are catching up with the benefits from ICT adoption, it demonstrates a classic Matthew effect with respect to ICT's implications for these late adopters. Our findings regarding older adults' differential ICT uses illustrate the need for a more nuanced approach to digital inequality research. Even though using ICTs has important implications for older adults' well-being, our findings suggest that the links among the different types of ICT use and life outcomes may vary, depending on demographic or socio-economic attributes.

Admittedly, future work needs to be conducted to address in detail the nuances and limitations of our study. Given the concerns of sensitivity in the original questionnaire regarding the respondents' household incomes, constructing a binary income measure might provide a crude estimate regarding the relationship of socio-economic status to digital inequality. Other measures for socio-economic status (i.e. (parental) education), or digital skills (Hargittai & Hsieh, 2013) could be included in future studies. Additionally, future studies can attempt to obtain more representative samples than the Chicago area or to conduct qualitative or longitudinal studies for a more generalizable and comprehensive analysis on older adults' digital and social life.

This study makes three contributions to the current research on the relationship between digital inequality and social participation. First, this study focuses on older adults' ownership and usage of ICTs, which has not been at the center of digital inequality scholarship. The results from this study suggest that this population might reveal different aspects of digital inequalities and social life when compared to the general population. As an under-studied age group that has a growing rate of adoption, older adults might require additional attention as well as different approach to the psychological and physical attributes that enable their ICT

use, given that older adults' cognitive and physical abilities progressively deteriorate due to aging (Freese et al., 2006; Lee et al., 2011; Selwyn, 2004).

Second, this study approaches the disparities in using ICTs more analytically by distinguishing the social and instrumental purposes of ICT use. The extent to which ICTs are incorporated into users' everyday lives depends on how those users employ ICTs (Campbell & Kwak, 2010; Ellison et al., 2007; Shah et al., 2001). This study's distinction between instrumental and social uses of ICTs builds a concrete picture of how ICTs impact older adults' social well-being. Such distinction also extends the digital inequality scholarship, from older adults' ICT adoption (Zheng et al., 2013) to the social implications of their differentiated uses for their successful aging.

Finally, perhaps the most significant contribution of our study involves our examination and identification of the links between different types of ICT use and older adults' quality of life. Although many studies have focused on the usability or effectiveness of ICTs as motivations for older adults (e.g. Hernández-Encuentra et al., 2009), the ways in which ICT use might enhance older adults' overall social lives remained an underdeveloped research area. This study reveals how different uses of ICTs have different impacts on older adults' social engagement and interprets its meaning to their overall well-being and successful aging. Specifically, the positive relationship of instrumental ICT uses and no significant relationship of social uses to social engagement contradict the previous findings (Hampton et al., 2011; Rainie et al., 2006; Smith et al., 2009) and provide new insight into the unique status and influence of older adults' ICT uses on their social well-being in comparison to the general population's relationship between ICTs and their offline social lives. This directs to a new theoretical understanding and development of digital inequality and social engagement research. The results also provide a practical implication for enhancing older adults' digital and social quality of life, which should be approached differently from the general population.

Along with the deep integration of ICTs into people's lives, digital inequalities have become a significant concept in explaining individual and social disparities with respect to enjoying the advantages of ICTs. This study's results suggest that the essence of ICT access and use lies in the well-being of the users and their abilities to deploy ICTs rather than in mere access to the ICTs themselves. Realizing how various users' attributes condition the diverse usage of ICTs redirects attention to a more comprehensive meaning of ICTs in relation to every aspect of a person's life and to society.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. The marital status did not have a significant effect on the major variables, so we did not include it in the models reported here.
2. The general rule of thumb is that a VIF factor larger than 10 indicates a multicollinearity problem. A low threshold (VIF = 5) is often used for more robust detection (O'brien, 2007).

Notes on contributors

Jennifer Ihm is a Ph.D. candidate in the Department of Communication Studies at Northwestern University and is participating in the Network for Nonprofit and Social Impact. Jennifer is interested in how organizations use information and communication technologies (ICTs) to engage the community and extend their online engagement to offline environment. [email: ihmsy17@gmail.com]

Yuli Patrick Hsieh is a survey methodologist and digital sociologist in the Program on Digital Technology and Society at RTI International's Survey Research division. His research focuses on the implications of ICTs for social relationships and digital inequalities in people's life outcomes. He also examines how to integrate ICTs into survey methodology to facilitate mixed-method research design. Patrick received his doctoral degree from the Media, Technology, and Society Program in Northwestern University's School of Communication. [email: yph@rti.org]

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