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Mapping the two levels of digital divide: Internet access and social network site adoption among older adults in the USA

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ABSTRACT

Older adults have increasingly adopted Internet and social network sites (SNSs), but little communication scholarship has explored systematic differences in access within this population. Using a nationally representative sample of Americans over the age of 50 years from the 2012 Health and Retirement Study, we examine Internet access ($N = 18{,}851$) and SNS adoption patterns ($N = 869$) among this sample and explore how these patterns vary by age. Regarding Internet access, results suggest that while the gender divide has reversed in favor of women, older adults who are economically, socioculturally, or physically disadvantaged are less likely to have reliable Internet access. In addition, the view that the various divides in Internet access are less of a concern for those who are younger is only partially supported, as some access-related divides do not vary by age or even decrease with age. For SNS adoption, we found that access to technological resources (diversity of online activities) positively predicts SNS use. Moreover, SNS users are more likely to be younger, female, widowed, and homemakers, perhaps because these individuals are more motivated to use SNSs to complement or compensate for their existing social status. These findings reveal unique challenges and motivations in relation to Internet access and SNS adoption patterns across the later life span.

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Introduction

In contrast to earlier decades, Internet use among middle-aged and older Americans is currently increasing, both in general and in the use of online tools such as social network sites (SNSs) in particular. Internet access rates have increased from less than 50% in 2000 to 88% in 2014 among US adults aged 50–64 years, and have risen from less than 20% in 2000 to 57% in 2014 among those aged 65 years or older (Smith, 2014). SNS use is also increasing rapidly among this population; the adoption rate of SNSs among US Internet users aged 50–64 years has doubled from 24% in 2009 to 65% in 2014, and has quadrupled from 13% in 2009 to 56% in 2014 among Internet users

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who are 65 years or older (Duggan, Ellison, Lampe, Lenhart, & Madden, 2015). Perhaps motivated by SNS scholarship that has demonstrated a positive relationship between SNS use and social capital among younger age groups (e.g., Ellison, Steinfield, & Lampe, 2007), as well as research that highlights the importance of social ties for older adults (e.g., Berkman, Glass, Brissette, & Seeman, 2000), researchers have proposed technological interventions, such as digital displays of family members' Facebook photos or messages, to help older adults better connect with family members via newer technologies and thus access associated social benefits (e.g., Cornejo, Tentori, & Favela, 2013). In order to better understand the ramifications of these technologies for the everyday experiences of middle-aged and older adults, this study addresses three important empirical questions. First, are there systematic differences between older adult Internet users and nonusers? Second, among older Internet users, what factors are associated with SNS adoption? Third, how do patterns of Internet and SNS adoption differ by age in older populations? Understanding who uses these tools is critical for identifying larger patterns of use and ensuring that any benefits associated with their use are equally available to all members of society.

While substantial digital divide literature in the communication field has focused on younger or general populations, only a few studies address this issue among older populations (e.g., Wagner, Hassanein, & Head, 2010), perhaps because older adults are difficult to reach and survey due to health issues (Friemel, 2014). However, this gap in the literature may be problematic in three respects. First, relatively little is known about divides in Internet access and SNS use in the older population. As Internet access is pervasive among general U.S. adults, increasing scholarship has shifted research focus from divides in Internet *access* to gaps in Internet *usage* (e.g., Hargittai, 2002). However, as older adults lag in technology use, this population is in danger of being marginalized by current scholarship that assumes that Internet access is less of a concern. Likewise, among the digital divide research examining usage, relatively little is known about determinants of older adults' SNS use, as prior work on SNS use primarily focuses on young or early middle-aged adults (e.g., Hargittai, 2007).

Second, patterns identified among younger cohorts may not apply to older populations because older adults' life circumstances are distinct from those of younger adults. For example, impaired physical and health conditions often make technology use more challenging for older adults (Charness & Boot, 2009). Later life transitions such as retirement and bereavement may spur social engagement (Cornwell, Laumann, & Schumm, 2008) and possibly technology use. These factors are rarely recognized in digital divide studies of younger adults, but are essential to include when studying digital inequalities among older populations.

Third, among digital divide studies that focus on older populations, age is often treated as an explanatory variable. Relatively little attention has been paid to how differences in technology adoption vary across later life span (Robinson et al., 2015). As age is associated with changes in physical and cognitive health, transitions in work and family trajectories, and unique experiences across cohorts (Settersten, 2003), patterns of Internet access and SNS adoption may differ by age. Thus, our goal here is to provide a comprehensive, up-to-date look at older adults' Internet access and SNS adoption patterns, and how these patterns vary by age. To this end, we use the 2012 wave of Health and Retirement Study (HRS), a population-based study of Americans over the age of 50 years, to examine

how sociocultural, economic, health, and/or technological resources embedded in older adults' lives are associated with Internet access and SNS adoption across later life span.

Divides in Internet access and SNS adoption

The term 'digital divide' was originally coined to describe the gaps between those with access to information and communications technologies (ICTs) and those without such access (e.g., DiMaggio, Hargittai, Celeste, & Shafer, 2004; van Dijk, 2005). Two explanatory frameworks within the digital divide literature address why individuals do not use certain ICTs. First, individuals may be involuntarily excluded from using ICT due to a lack of opportunities, such as socioeconomic status (Livingstone & Helsper, 2007). Second, individuals may voluntarily choose not to use ICTs because of a lack of motivation or interest (van Dijk, 2005). van Dijk (2005) argues that motivation is a key factor to explain adoption of any new technology. In this sense, one could say that the digital divide refers not only to the 'haves and have-nots,' but also to the 'wants and want-nots.' Indeed, scholars (e.g., Eynon & Helsper, 2011) have argued that the first-level digital divide (inequalities in Internet access) is more likely to result from involuntary exclusion. In contrast, the second-level digital divide (inequalities in Internet usage) is shaped not only by socioeconomic background but also by personal preferences and needs.

Based on this framework, this study begins by examining the divide in older adults' Internet access. It then investigates divides in SNS adoption within the older population. We focus on SNS adoption because social engagement is crucial for individuals' adjustment and survival in old age (Berkman et al., 2000). As strong evidence suggests that SNS use is associated with higher levels of perceived social capital (Ellison et al., 2007; Ellison, Steinfield, & Lampe, 2011), the use of SNSs may help older adults who have reduced social engagement due to age-related factors (e.g., retirement) to connect more effectively with their social contacts. In the following sections, we discuss how different fields of resources – sociocultural (age, gender, race/ethnicity, marital status, and employment status), economic (education, income, and wealth), health (cognitive functioning and self-rated health), and/or technological resources (diversity of online activities) – predict older adults' Internet access and SNS adoption and how these patterns differ by age.

Divides in Internet access

While Internet adoption reaches a saturation point among younger populations, disparities in Internet access remain an important issue in older populations (e.g., Friemel, 2014; Smith, 2014). Indeed, previous research that focuses on older adults shows that Internet access is stratified by sociocultural and economic differences, such that those who are older, female, racial/ethnic minorities, less educated, living alone, unemployed, and have lower income are less likely to be online (van Deursen & Helsper, 2015; Elliot, Mooney, Douthit, & Lynch, 2013; Selwyn, Gorard, Furlong, & Madden, 2003). However, it is argued that these access gaps may be generational and thus temporal. Early evidence suggests that among those who are not online, older adults are less interested in getting Internet access than younger adults (Lenhart, Rainie, Fox, Horrigan, & Spooner, 2000), perhaps because older adults do not integrate the Internet into their daily lives as deeply as their younger counterparts. As Internet access is more ubiquitous

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and pervasive among younger adults, this line of thinking assumes that the sociocultural and economic differences in Internet access may eventually close as younger generations replace older ones. Indeed, there is evidence that gender and some racial divides in Internet access may have already disappeared among the general population (Campos-Castillo, 2014; Ono & Zavodny, 2003; Schradie, 2012). Within this framework, one would expect that sociocultural and economic inequalities in Internet access would be mitigated for older adults who are younger. It is expected that access to sociocultural and economic resources increases the likelihood of Internet access, and these differences in Internet access will expand as age increases. Thus:

H1: Among older adults, (a) those who are younger, non-Hispanic White/others, more educated, male, married, employed, and have higher income and higher wealth are more likely to have Internet access, and (b) these differences in Internet access increase as age increases.

In addition to sociocultural and economic resources, health conditions play an important role in predicting older adult's Internet access. Older adults' ability to adopt ICT in general may be limited by age-related changes in physical ability, such as sensory, motor, and cognitive abilities (Charness & Boot, 2009). Regarding sensory capabilities, decreased visual acuity may make it difficult for older adults to read content displayed on a normal computer screen (Sayago, Sloan, & Blat, 2011). Changes in motor control may make it more difficult for older adults to engage in technology-related activities, such as using a mouse (Sayago et al., 2011). Declining cognitive ability also decreases the likelihood of Internet adoption (Freese, Rivas, & Hargittai, 2006). Thus, perceived health condition and cognitive functioning may be positively associated with Internet adoption. Furthermore, because access to technological support decreases with age (van Deursen & Helsper, 2015), health resources may play an increasingly important role in predicting Internet access as age increases, suggesting that the effects of health resources on Internet access may be stronger as age increases. Thus, we expect:

H2: Among older adults, (a) those who have better self-rated health and cognitive health are more likely to have Internet access, and (b) these differences in Internet access increase as age increases.

Divides in SNS adoption

Once online, it is expected that technological resources – diversity of Internet activities – may predict SNS adoption among older adults. The number of different activities that individuals do online has been theorized as one important dimension of Internet use, and is positively related to time spent online, Internet skills, and self-efficacy (Blank & Groselj, 2014; Livingstone & Helsper, 2007). The concept of diversity of online activities frames Internet use as a multistage spectrum. Basic Internet users engage in popular activities (e.g., using email), whereas more advanced Internet users engage in less common activities (e.g., blogging) in addition to popular tasks, thus engaging in a greater diversity of Internet use (Livingstone & Helsper, 2007). Since SNS use is relatively less popular than other online activities, such as email and information seeking (Blank & Groselj, 2014), older SNS users may engage in a wider variety of online activities than non-users. Thus, we propose:

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H3: Among older Internet users, those who engage in more diverse online activities are more likely to use SNSs.

Prior work also demonstrates that personal preferences or needs reflected by one's economic and sociocultural backgrounds often predict SNS adoption (Lüders & Brandtzæg, 2014; Mesch, 2012). While age is consistently associated with reduced likelihood of SNS use (e.g., Duggan et al., 2015), it is unclear how other socio-demographic factors relate to SNS adoption. Two perspectives – the complementary and compensatory hypotheses – may lead to contrary expectations about how socio-demographic differences explain SNS use. The complementary hypothesis suggests that those who are already socially advantaged are more likely to adopt SNSs to complement their existing social connections, demonstrating the Matthew effect (Merton, 1968), such that those who are socially advantaged are more likely to accumulate social capital. Because older adults who are female, non-Hispanic White, married, employed, and have higher socioeconomic status tend to have a larger network (e.g., Ajrouch, Blandon, & Antonucci, 2005; Cornwell et al., 2008; Litwin & Shiovitz-Ezra, 2011), these individuals may be more likely to adopt SNSs to assist them in maintaining their social connectedness.

On the other hand, however, the compensatory hypothesis suggests that those who are socially disadvantaged may be more motivated to adopt SNSs to compensate for their social needs. Continuity theory (e.g., Atchley, 1989) argues the loss of social ties or roles associated with life-course transitions, such as retirement and widowhood, often spurs social engagement in order to adapt to the loss. Likewise, the diversification hypothesis (Mesch, 2012) posits that, due to the principle of homophily, the socially disadvantaged are more likely to bond with others of similar backgrounds, for instance, regarding socioeconomic status, gender, race/ethnicity, and marital status. To overcome social segregation, the socially disadvantaged are more motivated to adopt social media platforms to expand their connections and acquire social benefits.

Given the opposing implications of the complementary and compensatory hypotheses, it is unclear how socio-demographic factors are associated with SNS adoption and how these relationships vary by age. Thus, we pose the following research questions:

RQ1: Among older Internet users, (a) how do race, education, gender, marital status, employment status, income, and wealth influence SNS adoption and (b) how do these differences in SNS adoption differ by age?

Regarding health resources little is known about the associations between older adults' health conditions and SNS adoption across the lifespan. Given the lack of literature in this area, we pose the following research questions:

RQ2: Among older Internet users, (a) how do self-rated health and cognitive conditions influence SNS adoption and (b) how do these differences in SNS adoption differ by age?

Method

Sample

In this study, we conducted secondary data analyses on data from the 2012 wave of the HRS, a nationally representative longitudinal survey of Americans over the age of 50 years. The HRS comprises six cohorts who entered the study in different calendar

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years. Once eligible respondents enter the study, they are interviewed every two years. The sample for each cohort was derived from the stratified multistage area probability design in which Blacks, Hispanics, and residents of the state of Florida were oversampled (Heeringa & Connor, 1995).

The sample sizes for our Internet and SNS adoption analyses are different. The full HRS sample was used to investigate Internet access, including 18,851 respondents. A random number generator was used to randomly assign a sub-sample of HRS respondents to the three-minute technology-use module, which included the question about SNS use. A total of 1620 respondents completed the technology-use module. Of these 1620 respondents, 869 were Internet users, which served as our sample size for analyzing SNS adoption.

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Measures

Outcome variables

Internet use. All respondents were asked: 'Do you regularly use the World Wide Web, or the Internet, for sending and receiving e-mail or for any other purpose, such as making purchases, searching for information, or making travel reservations?' (1 = yes, 0 = no).

SNS use. SNS use was included in the technology-use module, framed as: 'Do you use social networks such as Facebook or Twitter?' The response was dichotomous (1 = yes, 0 = no).

Predictor variables

Age. Age of respondents was constructed based on reported birthdate.

Gender. Female was coded as 1 while male was coded as 0.

Race/ethnicity. To assess race/ethnicity, respondents were first asked: 'Do you consider yourself Hispanic or Latino?' Then, they were asked: 'What race do you consider yourself to be?' The answer categories were White/Caucasian, Black/African-American, and other. Based on the two questions, three categories were created: non-Hispanic White/other, non-Hispanic Black, and Hispanic.

Years of education. Number of years in school was reported, which could range from 0 to 17 years.

Marital status. Respondents' current marital status was classified into four categories: never married, widowed, separated/divorced, and married.

Employment status. Respondents were asked about their current employment situation. Four categories were created: unemployed (unemployed and looking for work, temporarily laid off, and disabled), retired, homemaker (managing a household as the principal occupation), and employed (working now).

Income and wealth. Income reflected total income for the last calendar year, which was the sum of various components, such as respondent and spouse earnings, pensions and annuities, and social security retirement. Wealth was the sum of wealth components (e.g., net value of real estate, vehicles, businesses, and stocks/mutual funds/investment trusts) less debt (value of other debt). Income and wealth were classified into five categories, ranging from 0 (the lowest) to 4 (the highest).

Cognitive functioning. Cognitive functioning was assessed with 10-word immediate and delayed recall tests of memory, a serial 7s subtraction test of working memory, and counting backwards to assess attention and processing speed. Composite scores using all the items created a measure of cognitive functioning, ranging from 0 to 27, with higher scores representing better cognitive functioning.

Self-rated health. Self-rated health was measured using one question: 'Would you say your health is excellent, very good, good, fair, or poor?' The response scale ranged from 1 (poor) to 5 (excellent).

Diversity of Internet activities. To assess this, respondents were asked, 'Do you use [online services]? (1 = yes, 0 = no)' The online services were online bill payment, online banking, online wellness programs, websites for finding medical and health information, live-streaming radio, television, or movies on the Internet, email, online video or phone calls (e.g., Skype), and online chatting and instant messaging. A composite measure of diversity of Internet activities was created by summing the eight items, ranging from 0 to 8.

Table 1 reports the descriptive statistics of all variables in the study among the full sample and by Internet and SNS use.

Analytic procedures

We used logistic regression to examine Internet access and SNS adoption using SAS 9.3. All the regression models included 2012 HRS weights to account for differential probabilities of selection and take into account the clustering and stratification of the sample design using appropriate survey procedures. We created interaction of age (centered at 52 years) with other variables, including gender, race/ethnicity, years of education, marital status, employment status, income, wealth, cognitive functioning, and self-rated health, and performed regression analyses to examine whether and how the associations between various predictors and Internet and SNS use differ by age in the older population.

Results

Using a national sample of American adults who are over 50 years old, we examine patterns of Internet and SNS adoption and how these patterns differ by age. Results show that 51% of the respondents have regular Internet access. Regarding SNS adoption, 31% of all respondents and 47% of online seniors use SNSs in the older population.

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Table 1. Descriptive statistics of all the variables.

	Full sample Mean or %	Internet nonusers Mean or %	Internet users Mean or %	SNS nonusers Mean or %	SNS users Mean or %
Age (52–103)	65.72	70.18	62.74	64.51	61.23
Years of education (0–17)	13.17	11.48	14.30	14.35	14.38
Female	.54	.57	.57	.49	.63
Male	.46	.43	.43	.51	.37
Race					
non-Hispanic White/others	.81	.57	.79	.79	.79
non-Hispanic Black	.10	.24	.14	.15	.14
Hispanic	.09	.19	.07	.06	.08
Marital status					
Never married	.07	.06	.05	.04	.04
Widowed	.15	.27	.11	.12	.13
Separated/divorced	.18	.18	.17	.15	.21
Married	.61	.49	.67	.69	.62
Employment status					
Unemployed	.14	.19	.11	.09	.12
Retired	.40	.52	.38	.44	.32
Homemaker	.06	.09	.05	.03	.06
Employed	.40	.20	.46	.43	.50
Income (0–4)	2.25	1.50	2.76	2.79	2.77
Wealth (0–4)	2.18	1.70	2.51	2.61	2.39
Cognitive functioning (0–27)	15.45	12.96	17.05	16.74	17.18
Self-rated health (1–5)	3.27	2.84	3.49	3.51	3.53
Diversity of online activities (0–8)				3.47	4.76
Baseline *N*	18851	9375	9476	471	398

Notes: Sample sizes reported are unweighted. Reported means and percentages are survey-adjusted and weighted.

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Explaining Internet access

Model 1 in Table 2 presents results from the logistic regression analysis, examining how socio-demographic characteristics (H1a) and health conditions (H2a) explain regular Internet access. Results show that older adults' Internet access is stratified by various socio-demographic lines (H1a). With every additional year of age, the odds of access decrease by 8%. Economic resources, education, income, and wealth levels increase Internet access. Every additional year of education enhances the odds of access increase by 33%. With every one-level increment in income and wealth quintiles, the odds of access increase by 29% and 17%, respectively. Interestingly, findings show that women are 37% more likely than men to have reliable access in the older population. Regarding race/ethnicity, non-Hispanic Black and Hispanic are only 47% and 45% as likely as non-Hispanic White/others to have Internet access, respectively. Those who are never married and widowed are 61% and 84% as likely as their married counterparts to use the Internet, respectively. The unemployed and homemakers are 73% and 63% as likely as the employed to have access, respectively. Health resources also play an essential role in predicting Internet access in the older population (H2a). Every additional unit increment in cognitive functioning and self-rated health increases the odds of Internet access by 11% and 18%, respectively. Overall, except for gender, H1a and H2a are largely supported, such that those who are younger, non-Hispanic White/other, married, employed, more educated, have higher income, wealth, cognitive functioning, and perceived health are more likely to have regular Internet access.

We further examine how these effects differ by age. We expected that the socio-demographic characteristics (H1b) and health differences (H2b) in Internet access would be

Table 2. Logistic regression analyses: predicting older adults' Internet access.

	Model 1			Model 2	
	b	se	exp(*b*)	*b*	se
Intercept	−5.09	.24		−6.21	.43
Age	−0.08***	.00	0.92	0.00	.02
Years of education	0.28***	.01	1.33	0.33***	.02
Female	0.31***	.05	1.37	0.56***	.09
Non-Hispanic Black	−0.76***	.07	0.47	−0.73***	.13
Hispanic	−0.79***	.13	0.45	−0.90***	.18
Never married	−0.49***	.12	0.61	−0.51***	.18
Widowed	−0.17**	.06	0.84	0.02	.16
Separated/divorced	0.00	.07	1.00	0.09	.13
Unemployed	−0.31***	.09	0.73	−0.08	.14
Retired	0.07	.08	1.07	0.31	.16
Homemaker	−0.47***	.12	0.63	−22	.22
Income	0.26***	.03	1.29	.036***	.05
Wealth	0.16***	.02	1.17	0.15***	.05
Cognitive functioning	0.11***	.01	1.11	0.11***	.01
Self-rated health	0.16***	.02	1.18	0.16***	.05
Age × Education				−0.003*	.00
Age × Female				−0.02***	.00
Age × Unemployed				−0.02*	.01
Age × Retired				−0.02**	.01
Age × Homemaker				−0.02*	.01
Age × Income				−0.01**	.00
AIC	74444893			74135098	
−2 log likelihood	74444861			74135038	

Notes: $N = 17{,}720$. Those who are non-Hispanic White/others, male, married, and employed are the reference groups. All models are survey-adjusted and weighted. Interaction terms that were not significant are not depicted in the table.
*$p < .05$.
**$p < .01$.
***$p < .001$.

primarily driven by older adults who are older. The inclusion of the interaction terms significantly (likelihood-ratio test, $p < .001$) improves the overall model fit. Significant interaction results provide mixed support for H1b. Consistent with the hypothesis, Model 2 in Table 2 shows that the age and unemployed/retired/homemakers interaction terms significantly and negatively predict Internet access. These relationships are depicted in Figure 1. Compared to the employed, retirees in their early 50s have higher odds of Internet access but become increasingly less likely to use the Internet as they age. The odds of Internet access among those who are unemployed and homemakers are consistently and increasingly lower than the employed with age.

Some significant interaction results are contrary to H1b. Model 2 in Table 2 shows that the positive effects of education and income on Internet access decrease with age, suggesting that these impacts are stronger among older adults who are younger. As Figure 2 shows, those with medium (mean) and low (mean – 1SD) income levels are less likely than those with high-income levels (mean + 1SD) to have Internet access throughout the later life, but this income divide narrows as age increases. Likewise, Figure 3 illustrates that those with high education levels (mean + 1SD) are more likely to have reliable Internet access than those with medium (mean) and low education levels (mean – 1SD) across the later lifespan, but the educational divide in Internet access slightly narrows with age. Figure 4 suggests that women in their 50s and 60s are more likely than men to use the Internet, and this gap gradually diminishes with age, suggesting that the female-dominated gender divide is primarily driven by older adults

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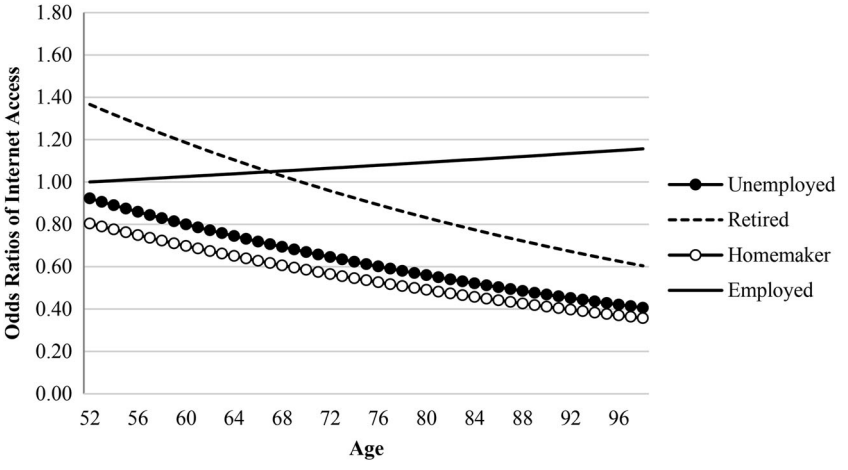

Figure 1. Predicting Internet access: two-way interaction between age and employment status.

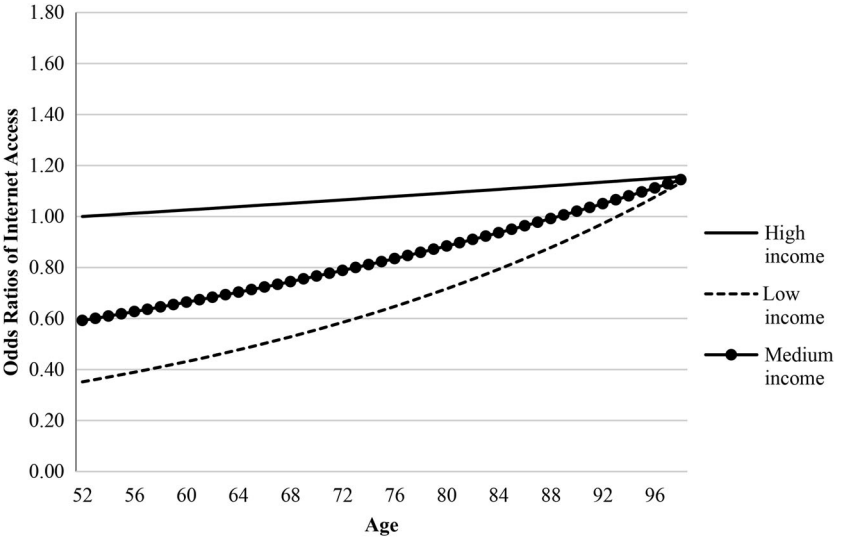

Figure 2. Predicting Internet access: two-way interaction between age and income.

who are younger. Regarding health resources (H2b), results suggest that the impacts of cognitive functioning and self-rated health on Internet access are not significantly stratified by age, rejecting H2b. Together, results show that the Internet access divide regarding employment status widens with age, but gender, income, and educational differences in Internet access narrow with age. Impacts of race/ethnicity, marital status, wealth, cognitive functioning, and self-rated health on Internet access do not vary by age. Thus, H1b is partially supported while H2b is rejected.

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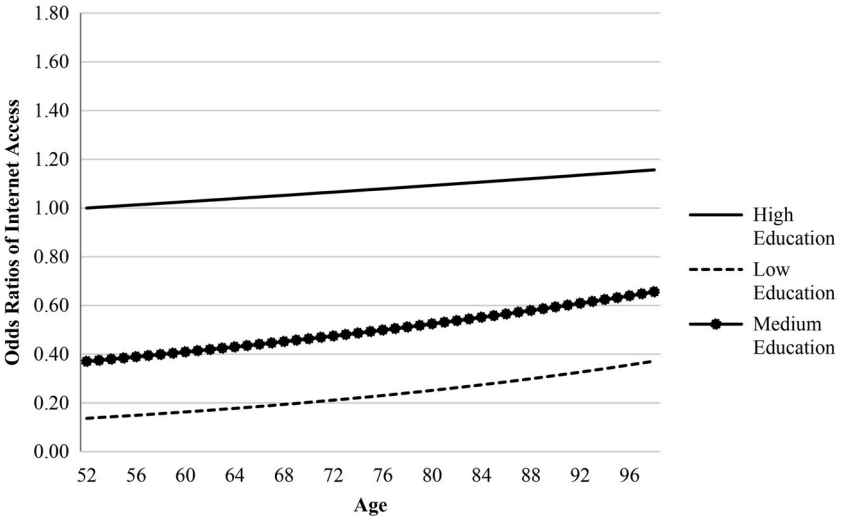

Figure 3. Predicting Internet access: two-way interaction between age and education.

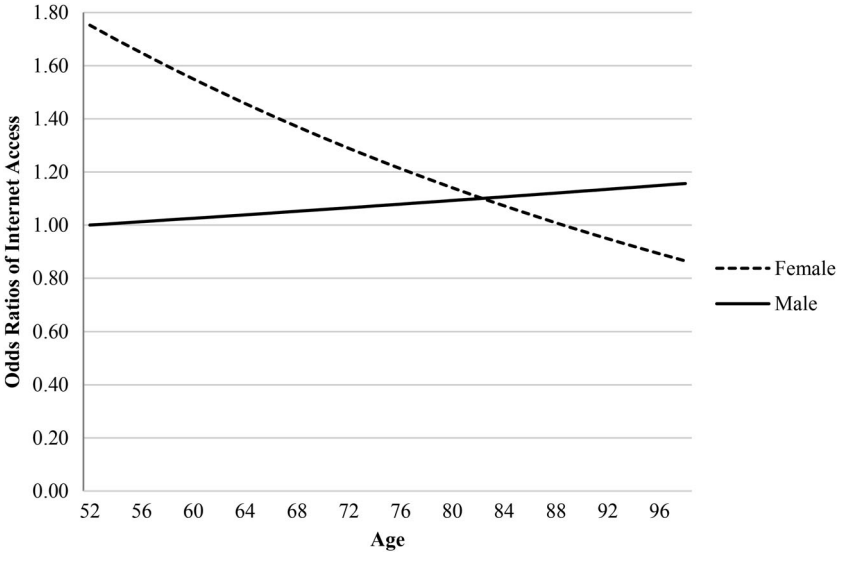

Figure 4. Predicting Internet access: two-way interaction between age and gender.

Explaining SNS adoption

Next, we examine how diversity of online activities (H3), socio-demographic characteristics (RQ1a) and health conditions (RQ2a) explain online seniors' SNS adoption. As Model 1 in Table 3 presents, with every additional online activity, the odds of SNS adoption increase by 49%, supporting H3. Regarding socio-demographic variables, age negatively predicts SNS adoption, such that with every additional year of age, the odds of using SNSs decrease by 4%. Women are 67% more likely than men to use SNSs. Marital and employment status also play a role in SNS adoption. The odds of SNS use for widows and homemakers

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Table 3. Logistic regression analyses: Predicting older adults' SNS adoption.

	Model 1			Model 2	
	b	se	exp(*b*)	*b*	se
Intercept	−1.30	.72		−3.26	1.43
Age	−0.04**	.01	0.96	0.20*	0.09
Years of education	0.01	.05	1.01	0.05	0.10
Female	0.51*	.22	1.67	0.17	0.36
Non-Hispanic Black	−0.24	.24	0.79	0.98	0.74
Hispanic	0.41	.46	1.51	0.85	0.83
Never married	−0.01	.41	0.99	1.09	0.85
Widowed	0.72*	.35	2.05	1.80*	0.76
Separated/divorced	0.05	.27	1.06	−0.01	0.53
Unemployed	−0.16	.38	0.86	−0.10	0.76
Retired	0.24	.33	1.27	−0.19	0.59
Homemaker	1.31*	.55	3.71	3.37**	0.99
Income	−0.02	.09	0.98	−0.09	0.16
Wealth	−0.12	.09	0.89	−0.18	0.17
Cognitive functioning	0.00	.03	1.00	0.01	0.04
Self-rated health	−0.06	.12	0.94	−0.01	0.20
Diversity of online activities	0.40***	.06	1.49	0.50***	0.11
Age × non-Hispanic Black				−0.17*	0.07
Age × Hispanic				−0.19*	0.08
Age × Never married				−0.16*	0.08
Age × Homemaker				−0.19*	0.09
AIC	5764567			765583	
−2 log likelihood	5764533			765549	

Notes: $N = 856$. Those who are non-Hispanic White/Others, male, married, and employed are the reference groups. All models are survey-adjusted and weighted. Interaction terms that were not significant are not depicted in the table.
*$p < .05$.
**$p < .01$.
***$p < .001$.

are 2.05 and 3.71 times the odds of SNS use for the married and employed, respectively. Access to economic (i.e., education, income, and wealth) and health resources (i.e., cognitive functioning and self-rated health) is not associated with SNS use.

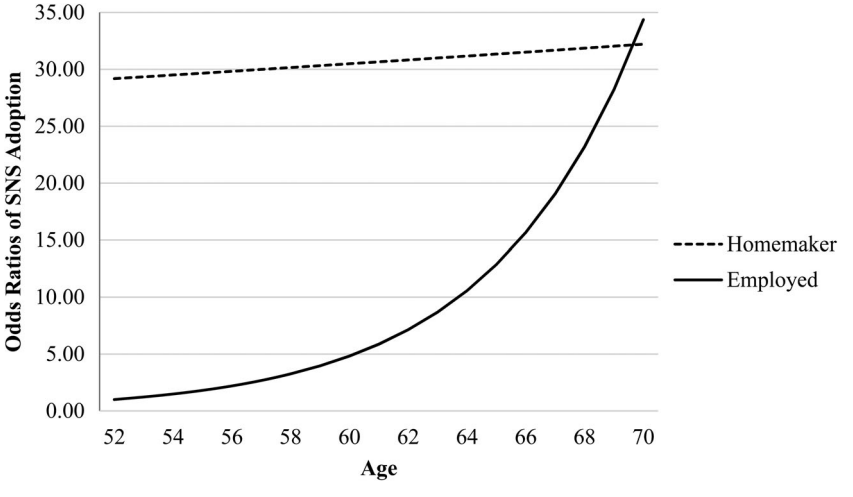

Figure 5. Predicting SNS adoption: two-way interaction between age and employment status (homemaker and employed)

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We further examine the role of age in the relationships between diversity of online activities, socio-demographics (RQ1b), and health conditions (RQ2b) and SNS adoption. Model 2 in Table 3 shows that the association between diversity of online activities and SNS use does not significantly vary by age, but age significantly shapes the relationships between SNS use and employment status, race/ethnicity, and marital status. Figure 5 shows that, compared to the employed, homemakers are more likely to use SNSs at 50s and early 60s, but beyond late 60s, homemakers are less likely to adopt SNSs. Interaction results regarding race/ethnicity and marital status demonstrate similar patterns. As Figures 6 and 7 show, the odds of SNS use among racial/ethnic minorities and the never married are slightly higher than non-Hispanic Whites and the married at early

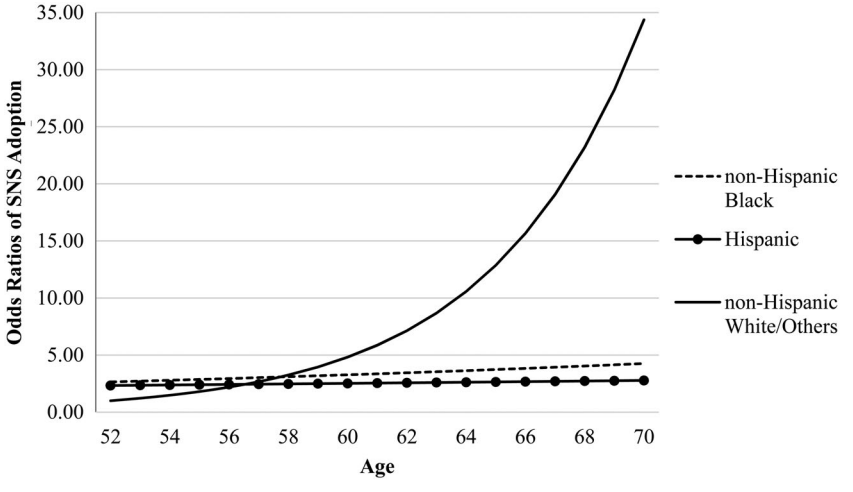

Figure 6. Predicting SNS adoption: two-way interaction between age and race/ethnicity.

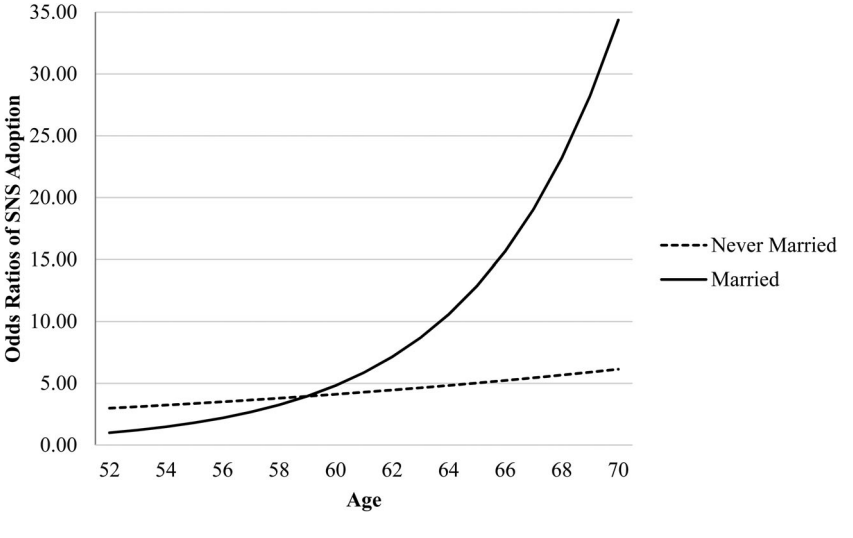

Figure 7. Predicting SNS adoption: two-way interaction between age and marital status (married and never married).

50s, but beyond the mid-50s, the more socially advantaged are increasingly more likely to use SNSs. Overall, findings show that homemakers, racial/ethnic minorities, and the never married are more likely to use SNSs than their more advantaged counterparts during the early mid-life period, while the odds of SNS use among their advantaged counterparts increasingly rise with age.

Discussion

Using a national sample of older American adults over age 50, this study contributes to the current digital divide literature in three important ways. First, our study focuses on older adults – a population that is increasing in size and has a growing rate of Internet access and SNS adoption, but remains relatively understudied. Second, we consider unique life circumstances in later life, such as health conditions and later life transitions (e.g., retirement and bereavement), to understand Internet and SNS adoption patterns in the older population, while these factors are rarely recognized in digital divide studies of younger or general populations. Third, instead of simply treating age as an explanatory variable, we adopt a life course perspective by examining how Internet access and SNS adoption patterns vary by age. Our findings provide an updated look at patterns of Internet access and underscore unique differences between SNS users and non-users across the later lifespan.

Divides in Internet access

Regarding access divide, there are two trends in the findings. First, results show that older adults' Internet adoption is stratified by access to various sociocultural, economic, health resources, such that those who are older, racial/ethnic minorities, retired/homemakers, less educated, poor, have worse cognitive or health conditions are less likely to have reliable Internet access. A key concern raised by these patterns is highlighted by the fact that digital exclusion limits opportunities to access corresponding sociocultural, economic, and health resources online; thus digital exclusion may further exacerbate existing social inequalities.

Based on the assumption that the access divide will close as younger generations replace older ones, one may expect that the sociocultural, economic, and health divides are narrower among middle-aged adults but become wider as age increases. However, our findings provide mixed support for this hypothesis. Consistent with the hypothesis, we found that the access disparities between those who are unemployed/retired/homemakers and those who are employed increases with age. Prior work shows that pre-retirement computer use is a strong predictor of older adults' Internet adoption (Friemel, 2014), which suggests that working environments facilitate older adults' Internet adoption. Thus, one explanation for this finding is that, because Internet access is more widely available among those who are younger, middle-aged adults may be able to access the Internet through various ways other than work (e.g., school and home). In contrast, work settings may be the primary means through which those who are older learn how to use a computer and gain Internet access, which, in turn, results in a wider access gap regarding employment status with age. If the differential effects indeed result from the different learning experiences by age, the gap may be attributable to generational differences and

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may gradually close as today's younger adults who have multiple means to access the Internet become older.

However, some findings are contrary to the expectation that the access gap increases with age. For example, results show that the positive effects of education and income on Internet access decrease as age increases. From the life course perspective, one of the key differences between middle and late adulthood is that the former is associated with less leisure time due to multiple responsibilities related to family and work (Blieszner & Roberto, 2004; Robinson et al., 2015). Thus, it is possible that midlife adults with lower education and income levels may not have reliable Internet access at home and at work, and importantly, due to time constraints, midlife adults may be less likely than their older counterparts to use public Internet access, such as libraries. If Internet access is associated with time use and work status during the life course, there is a possibility that these disparities may persist, as current young adults with disadvantaged socioeconomic backgrounds enter later life stages in the future.

Second, interestingly, in contrast to earlier research that shows that older men were more likely to be Internet users (Selwyn et al., 2003), results show that in the older population, women are more likely than men to use the Internet and this result is primarily driven by the younger participants in our sample. Documentation of a female-dominated gender divide may not be completely surprising, since there is evidence that the male-dominated gender divide in Internet access may have disappeared or even been reversed since the 2000s (Ono & Zavodny, 2003; Wasserman & Richmond-Abbott, 2005). Gendered employment patterns may help to explain this finding. As prior work suggests that among people who do not use the Internet at home, women are more likely than men to use the Internet outside the home (Ono & Zavodny, 2003), it is possible that women are more likely to work in an environment with computer and Internet access than men. Another possibility is that women may be more motivated to use the Internet to maintain their social ties than men (Ihm & Hsieh, 2015; Jackson, Ervin, Gardner, & Schmitt, 2001), resulting in the access divide.

Overall, however, notwithstanding the fact that the gender divide is reversed in favor of women, results show that the first-level digital divide is salient in the older population, such that those who are sociocultural, economically, and physically disadvantaged are more likely to be digitally excluded. Without access to the corresponding resources online, these individuals may be further excluded offline, exacerbating existing social inequalities. Moreover, as the interaction results show that many of the access divides do not vary by age or even decrease with age, the argument that access disparities are less of an issue among older adults who are younger is not (yet) well supported. Future research should continue to probe the mechanisms underlying the various disparities in Internet access, such as time use and access to Internet at work, and employ longitudinal data to explore whether Internet access patterns change throughout the life course.

Divides in SNS adoption

Among online seniors, there are no significant differences between SNS users and non-users regarding their access to economic (e.g., income, wealth, and education) and health resources (e.g., cognitive and self-rated health); instead, their differences result

from possession of technological and sociocultural resources. Results show that diversity of Internet activities is significantly associated with SNS use and this association does not vary by age, suggesting that access to technological resources is important for older adults' SNS use throughout the later lifespan. As diversity of Internet activities is positively associated with the amount of Internet use, online skills, and self-efficacy (Livingstone & Helsper, 2007), it could be that SNS non-users do not have the time, skills, or self-efficacy to engage in more diverse online activities. This finding is consistent with prior research that suggests that confidence in one's technology use is a barrier to older adults' SNS use (Lüders & Brandtzæg, 2014).

Regarding sociocultural resources, results provide mixed support for the complementary and compensatory hypotheses. On the one hand, we found that older adults who are younger and female are more likely to use SNSs than their older and male counterparts. Socio-emotional selectivity theory posits that people become increasingly oriented toward strong and emotionally rewarding relationships with age (Charles & Carstensen, 2010), and this tendency is more pronounced among older men than women because men are more likely than women to experience major challenges in later life, such as retirement and health declines (Cornwell, 2011). Because relational goals vary by age and gender, those who are younger and female in the older population may be more motivated to use SNSs to maintain a larger and more diverse social network than their counterparts, supporting the complementary hypothesis.

The complementary hypothesis might also explain the significant interaction results which show that the married and non-Hispanic Whites are increasingly likely to use SNSs than the never married and racial/ethnic minorities among those who are older than mid-50s. As prior work suggests that the primary motivation for older adults' adoption of SNSs is to connect with family (e.g., Bell et al., 2013), it may be that married individuals are more motivated to use SNSs to connect with children or even grandchildren than the never married as age increases. Similarly, as longitudinal research shows that non-Hispanic Whites are more likely to sustain a stable network than racial/ethnic minorities over time, perhaps due to more material resources and better health (Cornwell, 2015), non-Hispanic Whites may be more likely than minorities to adopt SNSs as they age.

On the other hand, findings show that older adults who are widows and homemakers are more likely to be SNS users than their married and employed counterparts, consistent with the compensatory perspective. Prior work shows that widowhood often increases social participation (Utz, Carr, Nesse, & Wortman, 2002), perhaps because loss of one's life partner sparks efforts to cultivate social relationships to adapt to the loss (Atchley, 1989). Likewise, homemakers who work solely within the home have fewer opportunities to cultivate non-kin relationships (Ajrouch et al., 2005) and may thus be more motivated to use SNSs to diversify their network structure to access bridging social capital, compared to their employed counterparts (Mesch, 2012). Together, these results regarding SNS adoption suggest that once online, differences in socioeconomic backgrounds and health conditions between older SNS users and non-users are not significant. Instead, the technological resources and sociocultural backgrounds that often motivate older adults' SNS use to complement or compensate for their existing social status play a more essential role in SNS use.

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Limitations and future directions

Several potential limitations of this study should be noted, as they also suggest opportunities for future research. First, given that only cross-sectional data were used, the results of this study only indicate associations between measures, rather than causal relationships. As results show that patterns of Internet and SNS adoption vary by age, longitudinal panel data would provide better insights into how Internet access and SNS use patterns change when individuals enter middle or late adulthood, and when they experience major life changes, such as widowhood. Another limitation of this study stems from our measures and the quantitative nature of the study. The HRS Internet and SNS-use items in the study are relatively simple, dichotomous measures. More refined measurements of Internet access (e.g., Internet access at home, work, and through public facilitates) could help to highlight the mechanisms behind the disparities in Internet adoption in the older population. Further, qualitative research such as interviews with seniors could better describe the motivations for SNS adoption by various sociocultural groups.

Concluding remarks

Using a representative sample of Americans over the age of 50 years, this study contributes to our understanding of the relationships between economic, sociocultural, health, and/or technological resources, and Internet and SNS use across later lifespan in three important respects. First, our study suggests that Internet access remains a crucial issue in the older population. Findings show that nearly half of respondents do not have regular Internet access. While the access divide in gender is reversed in favor of women, those who are socioculturally, economically, and physically disadvantaged are less likely to have reliable Internet access, raising the concern that the possible involuntary exclusion may further exacerbate existing social inequalities. Second, while it is argued that various divides in Internet access are generational and should be smaller among those who are younger, this view is only partially supported. Significant interaction effects suggest that some divides (employment status) may be attributable to generational differences and may close over time, but other (education and income) divides may be associated with life stages and may persist as current young adults enter later life, unless specific interventions address these issues. Third, once online, results show that economic backgrounds and health conditions are not significant predictors of older adults' SNS use. Instead, older adults' SNS use is associated with their access to technological resources and sociocultural backgrounds that may motivate SNS use in order to complement or compensate for their existing social status. Future efforts are needed to understand how the socially disadvantaged use SNSs and outcomes associated with their use. Overall, with a focus on older adults, an understudied population that has growing rates of Internet access and SNS adoption, this study highlights unique challenges and motivations regarding Internet and SNS use across the later lifespan.

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