How Does Internet Access Influence Health Status? Moderated Mediation Model Based on the Digital Divide

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Abstract

Background: Nowadays, a number of people have Internet access in the U.S. Despite there being strong reasons to assume that Internet diffusion may improve individuals' health status, there remain some questions.

Objective: Information and communication technologies (ICT) play an important role in almost every aspect of citizens' lives. However, access to these technologies is not equally distributed among all groups, which can cause inequality. The current study aims to reveal the mechanism of how internet access influences individuals' health outcomes based on the digital divide theory.

Methods: The empirical data for this study were drawn from the Health Information National Trends Survey (HINTS) 5, cycle 4, 2020 (N=3,635). Mediation and moderation analyses were conducted to test the hypotheses proposed in this study.

Results: The study investigated the digital divide at all three levels (access, skill & use, and outcome). The findings reveal that Internet access is positively associated with health status through the serial mediation of eHealth engagement and health efficacy. The study also identified health self-efficacy as a mediator between the second (skill & use) and third (outcome) of the digital divide. Additionally, the study found a negative moderation effect of education on the relationship between Internet access and eHealth engagement.

Conclusions: To promote better public health conditions, it is essential to ensure more equitable access to the Internet. Internet access can improve individuals' eHealth engagement, which can then facilitate their health self-efficacy and eventually enhance their overall health condition. Furthermore, we recommend that healthcare providers pay more attention to patients' health self-efficacy during online interactions and information offerings.

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Keywords: Digital divide; Self-efficacy; eHealth; Internet access

Introduction

Nowadays, a number of people have Internet access in the U.S. Despite there being strong reasons to assume that Internet diffusion may improve individuals' health status, there remain some questions.

First, information on the internet may vary, so individuals will be exposed to both accurate and incorrect health information with wider internet access. Extensive literature found that internet diffusion could bring positive health outcomes, for instance, body weight management and healthy behaviors. However, other research revealed that internet access may be negatively correlated with mental health and other health outcomes. In addition, during the pandemic, the reliance on online systems has greatly increased [1]. With the digitalization of healthcare services boosted by the pandemic, Internet access has become fundamental for people to receive healthcare. That is, people without Internet access may be marginalized in healthcare systems and lose opportunities to use eHealth tools which are increasingly prevailing. Thus, one's internet access has become more significant for her health status than ever. Therefore, investigations into the connection between Internet access and health status are called for. The mixed findings, i.e., the different effects of internet access on health status across different

studies, might be that the internet may affect health status through various mechanisms. Nevertheless, we know very little about the mechanisms, given that related research is limited.

To address these research gaps, this study has proposed and tested a moderated mediation model by analyzing representative data. Specifically, drawing on the previous works on the digital divide [2], we propose that eHealth activity and health self-efficacy might be potential mechanisms between internet access and health status. On this basis, this study contributes to the existing literature by revealing a novel mechanism that may help explain the sophisticated influence of internet access on health status.

Digital Divide and eHealth

The digital divide refers to the unequal distribution of access to and consequential inequalities in the use and skills of ICT, leading to disparities in outcomes across various domains, including health [3–5]. To understand the concept better, a three-level distinction was defined: the access gap, use & skill gap, and outcome gap [2]. Specifically, the first level of the digital divide, the access gap, pertains to the uneven distribution of physical access to ICT, such as the possession of digital devices and access to broadband Internet [6]. The second level, the Use & skill gap, is the inequality in using ICT (e.g., frequencies, patterns) and digital skills (e.g., digital literacy, information competence) [4]. The first two levels of the digital divide ultimately lead to the third level of the digital divide, that is, the outcome gap [2]. The outcomes of the digital divide manifest in various forms of inequality in society, such as wealth, social status, and health. Despite the interconnectedness of all three levels, most studies on the digital divide focus on one of the three levels, especially the second level [2]. Therefore, this study aims to investigate the mechanism of the interaction among these three digital gaps.

Internet access and eHealth engagement

EHealth refers to health services that are delivered to improve through the use of ICT [7,8]. According to the digital divide theory, the usage of eHealth, which is named eHealth engagement, is often identified as the second level of the digital divide, i.e., the use & skill gap. Meanwhile, the first level of the digital divide, that is, access to the Internet, is a key factor that enables individuals to use eHealth services for their healthcare needs [9]. Numerous studies have confirmed a positive association between Internet access and eHealth engagement. For instance, Yu et al. [10] have found that individuals with higher levels of Internet access were more likely to adopt social networking sites (SNS) for health-related purposes. Furthermore, scholars have shown that increased Internet access can lead to more online health-related activity among individuals living with AIDS [11]. Other studies [9,12] have also supported the positive effect of Internet access on the use of the Internet for health purposes. That is, the first access gap may be positively associated with the second use & skill gap within the health area.

eHealth engagement, motivational and actual health outcomes

Meanwhile, health outcomes which is the third gap, that is outcome level of the digital divide caused by eHealth engagement have caught scholars' attention [2]. On the one hand, the disparity in digital skills can lead to unequal motivational outcomes, that is self-efficacy[2]. With the rise of the patient-centered model in healthcare, self-efficacy has received much attention [13]. Self-efficacy refers to people's beliefs in their ability to attain desired goals [14].

Research has shown that eHealth engagement, particularly through health-related social media use, can have a positive impact on health self-efficacy. Previous studies, such as Niu et al. [15], reported that health-related social media use had a positive impact on health self-efficacy. Similar findings [16,17] were reported by previous works. This is because eHealth engagement could offer individuals more information and knowledge they need [15].

On the other hand, eHealth engagement as the second gap of the digital divide has also been viewed as a positive factor in improving actual health outcomes according to the theory. For instance, [18] found that Internet use can reduce mental problems among elder adults, and this effect was also observed in younger populations [19]. Additionally, the role of Internet use in improving physical health has been identified as positive in both young and elder populations [20,21].

Taking together, we, therefore, propose the interactive mechanism among these three levels of the digital divide: the first access level may be associated with both the motivational (health self-efficacy) and actual (health status) health outcomes through improving the second use & skill level. Thus, we proposed the following hypotheses:

H1: EHealth engagement mediates the association between internet access and health self-efficacy.

H2: EHealth engagement mediates the association between internet access and health status.

Through motivation to actual health outcome

The association between motivational outcome, i.e., self-efficacy, and the actual outcome, health status, has been studied empirically in several works. For instance, scholars have found that self-efficacy is positively related to mental health [22]. Similar effects on both mental and physical health were observed in studies on patients with Type-2 diabetes [23] and heart diseases [24,25]. Therefore, we postulate a potential mechanism among the three levels of the digital divide: the access level positively associated with the eHealth use level, then improving individual's health-related motivational outcomes, eventually enhancing their actual health outcomes, that is health status. Thus, we formulated the following hypothesis:

H3: The positive association between internet access and health status is sequentially mediated by eHealth engagement and health self-efficacy.

Internet access and its health outcomes

It is worth noting that access level is a fundamental requirement for obtaining both motivational and actual health outcomes through engaging in health-related online activities. On the one hand, Lack of Internet access would prevent people from getting health-related cultural capital. This would eventually limit people's ability to maintain their health [26]. Therefore, the disparity in Internet access would finally lead to one in actual health outcomes. For example, studies have shown that individuals with spinal cord injuries who have greater access to the Internet report higher levels of perceived health and experience more significant improvements in their health over time [27].

However, several studies have found differences in motivational outcomes, that is self-efficacy

derived from Internet access [28,29]. Specifically, when it comes to health-related self-efficacy, a study by Jiang & Liu found no significant association [30]. Nevertheless, given the changing times and social context, we argue that it is necessary to retest this relationship to further our understanding of the digital divide in the healthcare area.
Therefore, we proposed the following hypotheses:

H4: Internet access is positively associated with health self-efficacy.

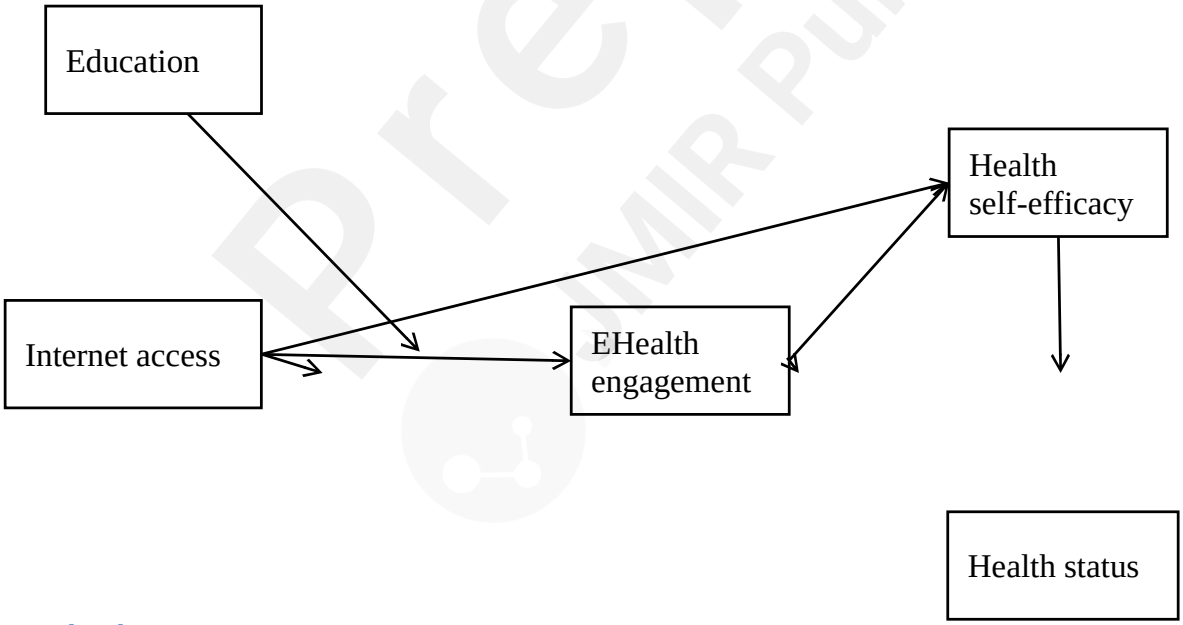
H5: Internet access is positively associated with health status.

Education as the moderator

Socioeconomic status is widely recognized as one of the most important factors in digital divide theory. Particularly, insufficient education has been considered the major barrier to accessing digital technologies [31,32]. For instance, scholars have found that education, in particular, has a positive effect on Internet health information seeking [30]. Similarly, other studies have confirmed that education was an important predictor of eHealth engagement[9,33,34]. Thus, we posit that the impact of Internet access on eHealth behavior may differ among different education groups. To explore this possibility, we have formulated the following hypothesis, and the whole model is shown in **Figure 1**:

H6: Education positively moderates the association between internet access and eHealth engagement.

Figure 1. Proposed model



Methods

Sampling

The data of this study was drawn from the Health Information National Trends Survey collected in 2020 (HINTS 5, Cycle 4). HINTS is a nationally representative survey administered by the National Cancer Institute to assess American adults' access to health information, as well as their health-related knowledge, attitudes, and behaviors. More details about HINTS are

available at https://hints.cancer.gov/. The final sample size is 3635.

Measures

Internet Access was measured by three items [30] about participants' device possession of (1) a tablet computer, (2) a smartphone, and (3) a basic cell phone only. Responses were summed up with having a tablet computer or smartphone coded as 2, having a basic cell phone only as 1, and having none of the above as 0 to assess the internet access of participants. Higher scores indicated higher internet access.

EHealth engagement was measured by four items [35] on participants' experience of using electronic means in the past 12 months to (1) look for health or medical information for themselves; (2) communicate with a doctor or a doctor's office; (3) lookup medical test results; and (4) make appointments with a health care provider. Dichotomous responses (*1 = yes, 0 = no*) were added up to represent participants' level of eHealth engagement. A higher score meant a higher level of eHealth engagement.

Health Self-efficacy was measured by a single item [30] about how confident the participant is to take good care of her health on a 5-point Likert scale (*from 1 = non-confident at all to 5 = completely confident*).

Education was also measured by a single item on the highest schooling level of the participant completed (*from 1 = less than 8 years to 7 = postgraduates*).

Health Status was measured by asking participants about whether a doctor or other health professional ever told them that they had: (1) diabetes or high blood sugar; (2) high blood pressure or hypertension; (3) a heart status; (4) chronic lung disease, asthma, emphysema or chronic bronchitis; and (5) depression or anxiety disorder[1]. Dichotomous responses (*1 = no, 0 = yes*) were summed up to construct the variable. A higher score represented a participant's better health status.

Socio-demographic variables include *gender* (1 = male, 0 = female) and *age* (18-24 years = 1, 25-59 years = 2, 60-104 years = 3).

Results

Data were analyzed with the PROCESS macro [36] of SPSS 26. Model 6 was used to test the serial mediation model, while model 83 was applied to test the moderation model.

Sample characteristics are shown in **Table 1**. Most participants were female (58.5%). As shown in **Table 2**, most of the variables of interest were correlated.

Table 1. Descriptive statistics of variables (N=3,635)

	Original scale				0-1 Percentage scale			
Variables	Min	Max	Mean/%	SD	Min	Max	Mean/%	SD
1. Gender (1 = male)								
Female			58.5				58.5	
Male			41.5				41.5	
2. Age[a]	1	3	2.45	0.56	0	1	.73	.28
3. Internet access	0	4	2.82	1.29	0	1	.71	.32
4. EHealth activity	0	4	2.11	1.46	0	1	.53	.37
5. Health self-efficacy	1	5	3.86	1.46	0	1	.71	.21
6. Health status	0	5	3.85	0.83	0	1	.77	.22
7. Education	1	3	2.18	0.82	0	1	.59	.41

[a]Age (18-24 years = 1, 25-59 years = 2, 60-104 years = 3)

	1	2	3	4	5	6
1. Age						
2. Gender	-.02					
3. Education	-.15***	.27***				
4. Internet access	-.28***	.06***	.24***			
5. EHealth engagement	-.23***	.08***	.28***	.37***		
6. Health self-efficacy	-.05**	.03*	.11***	.11***	.07***	
7. Health condition	-.30***	-.05**	.08***	.11***	.03	.22***

Table 2. Zero-order correlation (N=3,635)
*$p < .05$, **$p < .01$, ***$p < .001$.

Results showed that the indirect association between Internet access and health status through eHealth engagement and health self-efficacy was statistically significant.

As shown in **Tables 3 & 4**, **H1** predicted a positive and indirect association between Internet access and health self-efficacy through eHealth engagement. Findings suggested that Internet access was positively associated with health self-efficacy through eHealth engagement (b = 0.01, b_p = .01, *95%CI*: [.01, .01]). Thus, **H1** was supported.

H2 proposed a positive effect of eHealth engagement on health status through eHealth status. EHealth engagement was found to mediate the association between internet access and health status (*b* = -0.01, b_p = -.01, *95%CI*: [-.02, -.004]), which supported **H2**.

H3 proposed the sequential mediation roles of eHealth engagement and health self-efficacy in this study. Indirect associations of Internet access and health status through eHealth engagement and health self-efficacy (*b* = 0.002, b_p = .001, *95%CI*: [.0001, .01]) were supported by the findings. Thus, **H3** was supported.

The direct path from Internet access to health self-efficacy was predicted by **H4**. Findings supported the increase of Internet access positively influenced health self-efficacy (*b* = 0.06, b_p = .03, *p* < .001), thus supporting **H4**.

H5 was about the direct association between internet access and health status. Findings suggested that internet access was positively associated with health status (*b* = .05, b_p = .03 *p* < .001). Thus, **H5** was supported.

H6 proposed a positive moderation effect of education on the association between Internet access and health engagement. To address research question 1, moderation analysis was conducted. The positive moderation effect of education i.e., the positive association between the interaction between Internet access and education (internet access × education) and eHealth engagement, was marginally significant (see **Table 5**). High (*M + 1SD*), medium (*M*), and low (*M - 1SD*) groups of education were conducted to investigate the moderation effect. As shown in **Figure 4**, the slope increased from the high to medium education group and medium to low education group, which supported the positive moderation effect of education on the association between Internet access and eHealth engagement.

Table 3. Hierarchical regression models

	b (b_p)	SE	95% CI	p
EHealth engagement				
Internet access	0.35(.47)***	.02	[.31, .38]	< .001
Education	0.10(.23)***	.01	[.08, .11]	< .001
Internet access*education	0.01(.20)*	.01	[.003, .02]	.014
Health self-efficacy				
Internet access	0.06(.03)***	.01	[.04, .09]	< .001
EHealth engagement	0.02(.02)*	.01	[.002, .04]	.034
Health status				
Internet access	0.04(.02)**	.01	[.02, .07]	.002
EHealth engagement	-0.04(-.03)**	.01	[-.06, -.01]	.004
Health self-efficacy	0.29(.26)***	.02	[.25, .33]	< .001

*p < .05, **p < .01, ***p < .001.

Table 4. Mediation models

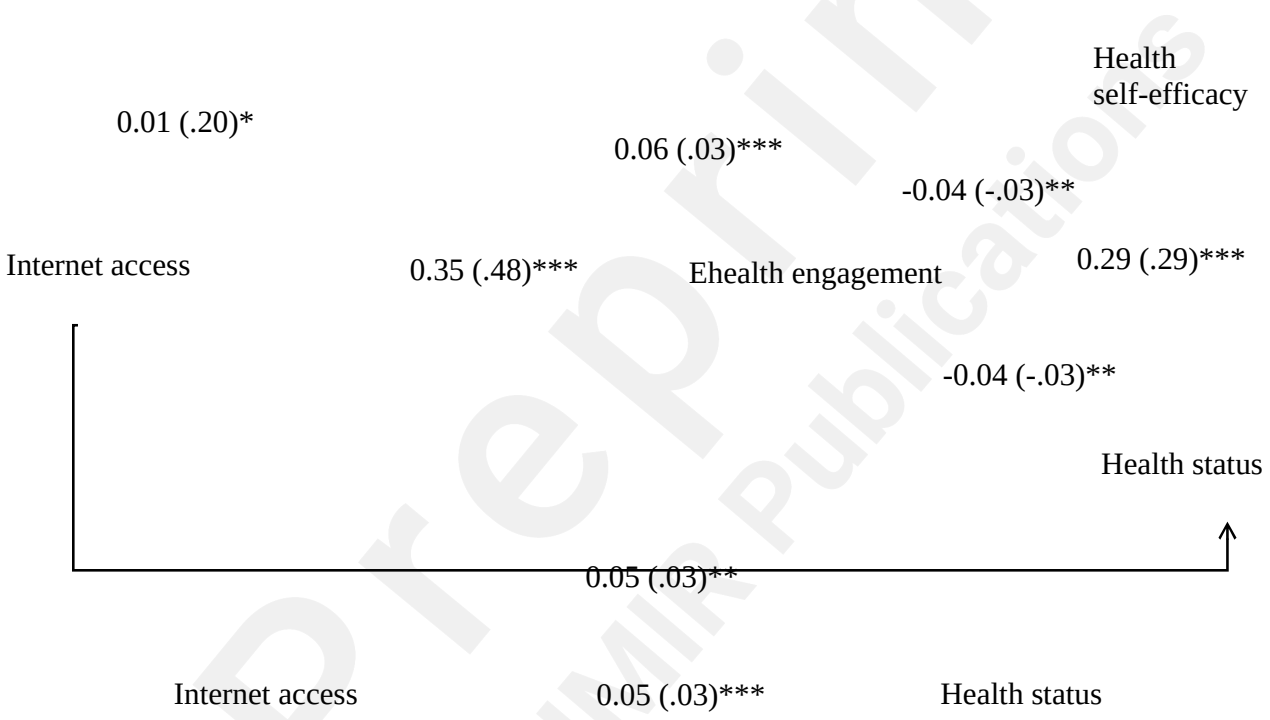
	b (b_p)	SE	95% CI
Direct effects			
Internet access→EHealth engagement	0.35(.47)	.02	[.32, .38]
Internet access→Health self-efficacy	0.06(.03)	.01	[.04, .09]
EHealth engagement→Health self-efficacy	0.02(.02)	.01	[.002, .04]
EHealth engagement→Health status	-0.04(-.03)	.01	[-.06, -.01]
Health self-efficacy→Health status	0.29(.29)	.02	[.25, .33]
Internet access→Health Status	0.05(.02)	.02	[.02, .08]
Indirect effects			
Internet access→EHealth engagement→Health status	-0.01(-.01)	.01	[-.02, -.004]
Internet access→EHealth engagement →Health self-efficacy	0.01(.01)	.004	[.01, .01]
Internet Access→EHealth engagement→Health self-efficacy→Health status	0.002(.001)	.001	[.0001, .01]
Total effect			
Internet access→Health status	0.05(.03)	.01	[.02, .08]

Table 5. Conditional effects of internet access → EHealth engagement path

Education	b (b_p)	SE	95%CI	p
M - 1SD	0.31(.21)	.02	[.27, .35]	< .001
M	0.35(.23)	.02	[.31, .38]	< .001
M + 1SD	0.38(.25)	.02	[.34, .43]	< .001

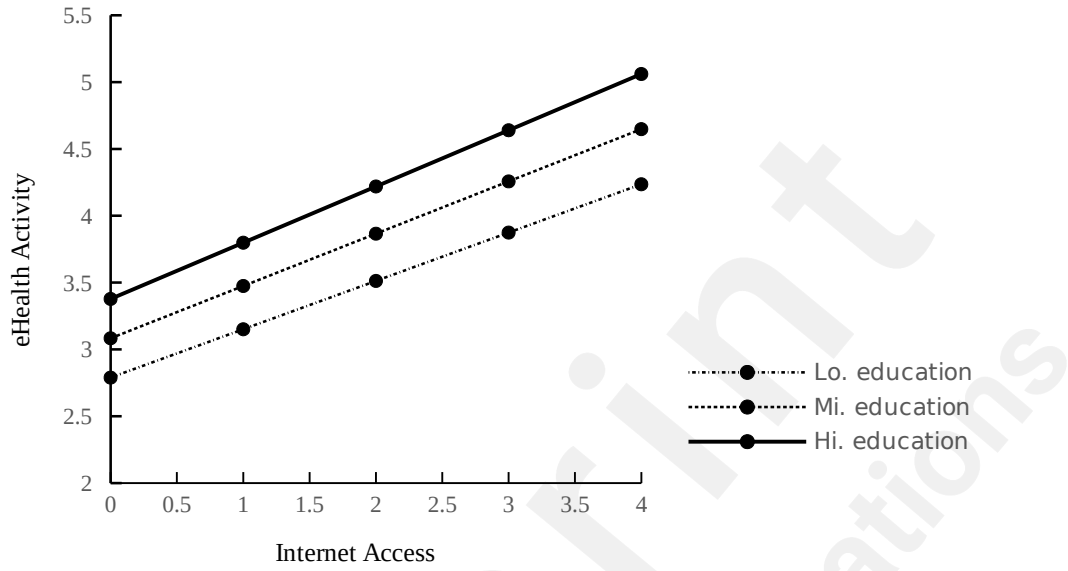
Figure 2. Effects of the mediation model

*p<.05, **p<.01, ***p<.001.



Percentage coefficients (b_p) are in the parentheses

Figure 3. Moderation effects of education on Internet access → EHealth engagement Path



Discussion

Theoretical Implications

This study used secondary data from HINTS to examine the impact of Internet access on health status through eHealth engagement and health self-efficacy. These findings of the study have important theoretical implications, especially for the digital divide theory.

First, our results are consistent with prior research indicating that owning more types of digital devices is associated with greater eHealth engagement. That is, having more types of digital devices leads to more eHealth engagement. When people have greater Internet access, they perceive the Internet more useful and finally become more involved in online activities [30,37]. It is worth noting that more than 10% of the respondents in HINTS 5, Cycle 4 did not own mobile devices to access the Internet. This underscores the importance of addressing the needs of the "10% that lagged behind" to promote public health.

Second, this study uncovered some interesting findings related to the second to the third level of the digital divide. Specifically, the analysis revealed a negative association between eHealth engagement and health status, which is contrary to the expectations outlined in Hypothesis 2. One possible explanation for this unexpected result is the negative effect of Internet use, which has been shown to impact mental health negatively when used as a coping tool, as previous studies have suggested [38]. In the case of eHealth technology, scholars have noticed that acquiring much health information with such technology may increase health anxiety or even cyberchondria, which may undermine individuals' health status [39]. Additionally, poor-quality online health information provided by some eHealth services may also negatively influence individuals' mental health due to the discomfort and confusion it causes [40].

In this study, the negative effect of eHealth engagement on health status was found to be alleviated by health self-efficacy, for hypotheses 4 and 6 were supported, providing a potential solution to health-related issues caused by Internet use. The alleviating effect of health self-efficacy might be due to the correlation between self-efficacy and health self-management [25,41]. It means that people with higher self-efficacy would have more frequent health management behaviors. Therefore, their health status could be maintained at a satisfactory level. This finding is quite important because it offers a possible way to deal with health-related problems of Internet use.

Additionally, the role of health self-efficacy as the motivational determinant of outcomes of the digital divide was confirmed in this study. Among the three

levels of the digital divide, the outcome is the least studied [2]. Thus, investigating its determinants and psychological mechanism is of significance. The findings concerning health self-efficacy were consistent with previous works[22,30]. Specifically, the disparity in Internet use may cause a disparity in health outcomes through unevenly distributed levels of self-efficacy it led to. Thus, this study has confirmed the role self-efficacy plays in the digital divide. As mentioned above, the findings of extant works are inconsistent regarding whether internet access is beneficial for individual health status. The findings of this study have echoed our prior argument that the mixed findings are largely due to the differences in mechanisms that link internet access and health status. Specifically, we have identified two different mechanisms. Through eHealth engagement, internet access may have a detrimental effect on health status, which may be explained by the quality of online health information that varies greatly, as discussed above. Despite this, eHealth engagement may enhance the health self-efficacy of individuals, thus improving their health status. The finding extends the existing literature regarding eHealth and the digital divide by identifying the complex process by which internet access affects health status. On this basis, this study has suggested a potential explanation for the inconsistency in previous studies and pointed out a future direction for more in-depth investigation. That is, researchers may further analyze the information and functions provided by eHealth tools to better understand the role eHealth plays in health maintenance and promotion.

Nevertheless, the study discovered a positive moderation effect of education on the association between Internet access and eHealth engagement, which is not surprising given the tight association between the digital divide and socio-demographic factors. Well-educated people can benefit more from Internet access and use eHealth technologies to manage their health and acquire health information. Taking together, this study has also confirmed that the increasing reliance on eHealth tools in accessing healthcare services has enhanced the influence of internet access on the health status of individuals. Specifically, we have found that internet access may affect health status through the mediation of eHealth engagement and health self-efficacy. By revealing this, the current study advances our understanding of internet access's role in health promotion in the (post-)pandemic era.

Practical Implications

The present study has important practical implications. Firstly, despite the perception that Internet access in developed countries is ubiquitous [2], this study highlights that disparities in Internet access still exist in America [42]. Therefore, efforts should be made to ensure that Internet access is more widely available and affordable to improve patients' eHealth engagement and ultimately contribute to positive health outcomes. Secondly, this study found negative relationships between individuals'

eHealth engagement and health conditions unexpectedly. This finding may be caused by the uneven quality of online health-related information and services. eHealth service providers and practitioners must pay particular attention to the quality of information provided by eHealth tools to avoid negative impacts on patients' health. Thirdly, to facilitate patient efficacy, health providers should pay attention to the communication quality when interacting with patients using eHealth tools. For instance, health providers use patient-centered communication to empower patients and improve their health efficacy, leading to better patient health outcomes.

Limitations

Some limitations of the study should be acknowledged. First, the data analyzed in the study is cross-sectional, which makes it impossible to establish causal relationships. Therefore, we call for longitudinal studies on the digital divide. Second, due to the limitations of the secondary data, health self-efficacy is measured by a single item, which may not capture the construct's complexity. Future studies could improve by using more sophisticated measurements. Third, the average age of HINTS respondents is over 50. Thus, future studies could pay more attention to younger age groups to increase the generalizability of the findings.

Conclusions

The digital divide is a widespread issue that affects access, usage, skills, and health outcomes of ICT even in developed countries like the U.S. Our study, based on secondary data from a representative survey in the U.S., shows that the unequal distribution of Internet access can negatively impact health status through the serial mediation of eHealth engagement and health self-efficacy. By examining associations among different levels of the digital divide, we contribute to the existing literature and identify health self-efficacy as the underlying mechanism linking technology use to health status. Our findings underscore the need for more equitable access to the Internet, eHealth technology, and high-quality health information to improve overall public health. It is essential to address the digital divide to achieve better health outcomes for all.

Acknowledgements

N/A.

Conflicts of Interest

None declared.

Declarations

This study conducts a secondary analysis using the HINTS data. The HINTS data were collected and analyzed in accordance with established ethical standards

and have obtained ethics approval. Written informed consent was also secured from participants.

References

1. Liu PL, Zhao X, Ye JF. The effects of the use of patient-accessible electronic health record portals on cancer survivors' health outcomes: cross-sectional survey study. Journal of Medical Internet Research 2022 Oct 24;24(10):e39614. doi: 10.2196/39614

2. Scheerder A, van Deursen A, van Dijk J. Determinants of internet skills, uses and outcomes. A systematic review of the second-and third-level digital divide. Telematics and Informatics 2017 Dec;34(8):1607–1624. doi: 10.1016/j.tele.2017.07.007

3. Friemel TN. The digital divide has grown old: determinants of a digital divide among seniors. New Media & Society 2016 Feb;18(2):313–331. doi: 10.1177/1461444814538648

4. Hargittai E. Second-level digital divide: differences in people's online skills. First Monday 2002 Apr 1;7(4). doi: 10.5210/fm.v7i4.942

5. Van Dijk JAGM. Digital divide research, achievements and shortcomings. Poetics 2006 Aug;34(4–5):221–235. doi: 10.1016/j.poetic.2006.05.004

6. Van Deursen AJ, van Dijk JA. The first-level digital divide shifts from inequalities in physical access to inequalities in material access. New Media & Society 2019 Feb;21(2):354–375. doi: 10.1177/1461444818797082

7. Kwan RYC, Salihu D, Lee PH, Tse M, Cheung DSK, Roopsawang I, Choi KS. The effect of e-health interventions promoting physical activity in older people: a systematic review and meta-analysis. European Review of Aging and Physical Activity 2020 Apr 21;17(1):7. doi: 10.1186/s11556-020-00239-5

8. Marasinghe RB, Edirippulige S, Smith AC, Abeykoon P, Jiffry MTM, Wootton R. A snapshot of e-health activity in Sri Lanka. Telemedicine and Telecare 2007 Dec;13(3_suppl):53–56. doi: 10.1258/135763307783247266

9. Jiang S, Hong YA, Liu PL. Trends of online patient-provider communication among cancer survivors from 2008 to 2017: a digital divide perspective. Journal of Cancer Survivorship 2019 Apr 1;13(2):197–204. doi: 10.1007/s11764-019-00742-4

10. Yu RP, Ellison NB, McCammon RJ, Langa KM. Mapping the two levels of digital divide: internet access and social network site adoption among older adults in the USA. Information, Communication & Society 2016 Oct 2;19(10):1445–1464. doi: 10.1080/1369118X.2015.1109695

11. Kalichman SC, Weinhardt L, Benotsch E, DiFonzo K, Luke W, Austin J. Internet access and internet use for health information among people living with HIV-AIDS. Patient Education and Counseline: Elsevier Ireland Ltd 2002 Feb;46(2):109–116. doi: 10.1016/S0738-3991(01)00134-3

12. Jiang S, Street RL. Factors influencing communication with doctors via the internet: a cross-sectional analysis of 2014 HINTS survey. Health Communication 2017 Feb;32(2):180–188. doi: 10.1080/10410236.2015.1110867

13. Apter AJ, Wang X, Bogen D, Bennett IM, Jennings RM, Garcia L, Sharpe T, Frazier C, Ten Have T. Linking numeracy and asthma-related quality of life. Patient Education and Counseline: Elsevier Ireland Ltd 2009 Jun;75(3):386–391. doi: 10.1016/j.pec.2009.01.003

14. Bandura A. Social cognitive theory: an agentic perspective. Annual Review of Psychology 2001 Feb;52(1):1–26. doi: 10.1146/annurev.psych.52.1.1

15. Niu Z, Willoughby J, Zhou R. Associations of health literacy, social media use, and self-efficacy with health information–seeking intentions among social media users in China: cross-sectional survey. Journal of Medical Internet Research 2021 Feb 25;23(2):e19134. doi: 10.2196/19134

16. Jiang S, Liu J. Examining the relationship between internet health information seeking and patient-centered communication in China: taking into account self-efficacy in medical decision-making. Chinese Journal of Communication 2020 Oct 1;13(4):407–424. doi: 10.1080/17544750.2020.1769700

17. Bass SB, Ruzek SB, Gordon TF, Fleisher L, McKeown-Conn N, Moore D. Relationship of internet health information use with patient behavior and self-efficacy: experiences of newly diagnosed cancer patients who contact the national cancer institute's cancer information service. Journal of Health Communication 2006 Mar;11(2):219–236. doi: 10.1080/10810730500526794

18. Yuan H. Internet use and mental health problems among older people in shanghai, China: the moderating roles of chronic diseases and household income. Aging & Mental Health: Routledge Journals, Taylor & Francis Ltd 2021 Apr 3;25(4):657–663. doi: 10.1080/13607863.2020.1711858

19. Li A, Zhang F, Zhu T. Brain and health informatics: international conference. Cham, CH: Springer; 2013. ISBN: 3319027522

20. Hunsaker A, Hargittai E, Micheli M. Relationship between internet use and change in health status: panel study of young adults. Journal of Medical Internet Research: Jmir Publications, Inc 2021 Jan 13;23(1):e22051. doi: 10.2196/22051

21. Wang J, Liang C, Li K. Impact of internet use on elderly health: empirical study based on Chinese general social survey (CGSS) data. Healthcare 2020 Nov 12;8(4):482. doi: 10.3390/healthcare8040482

22. Ju Q, Gan Y, Rinn R, Duan Y, Lippke S. Health status stability of patients in a medical rehabilitation program: what are the roles of time, physical fitness level, and self-efficacy? International Journal of Behavioral Medicine 2021 Dec 23;9(25):624-637. doi: 10.1007/s12529-021-10046-6

23. Emery KA, Robins J, Salyer J, Thurby-Hay L, Djira G. Type 2 diabetes self-management variables and predictors. Clin Nurs Res Thousand Oaks: Sage Publications Inc 2022 Jan 7;32(7):1250-1262. doi: 10.1177/10547738211067322

24. Como JM. Health literacy and health status in people with chronic heart failure. Clin Nurse Spec Philadelphia: Lippincott Williams & Wilkins 2018 Feb;32(1):29–42. doi: 10.1097/NUR.0000000000000346

25. Sarkar U, Ali S, Whooley MA. Self-efficacy and health status in patients with coronary heart disease: findings from the heart and soul study. Psychosom Med Philadelphia: Lippincott Williams & Wilkins 2007 May;69(4):306–312. doi: 10.1097/PSY.0b013e3180514d57

26. Abel T. Health and modernity: the role of theory in health promotion. Atlanta, US: DV McQueen; 2007. ISBN: 0387377573

27. Drainoni M-L, Houlihan B, Williams S, Vedrani M, Esch D, Lee-Hood E, Weiner C. Patterns of internet use by persons with spinal cord injuries and relationship to health-related quality of life. Archives of Physical Medicine and Rehabilitation 2004 Nov 1;85(11):1872–1879. doi: 10.1016/j.apmr.2004.07.350

28. Hall AK, Bernhardt JM, Dodd V, Vollrath MW. The digital health divide: evaluating online health information access and use among older adults. Health Education & Behavior: Sage Publications Inc 2015 Apr;42(2):202–209. doi: 10.1177/1090198114547815

29. Wei K-K, Teo H-H, Chan HC, Tan BCY. Conceptualizing and testing a social

cognitive model of the digital divide. Information System Research: Informs 2011 Mar;22(1):170–187. doi: 10.1287/isre.1090.0273

30. Jiang S, Liu PL. Digital divide and internet health information seeking among cancer survivors: a trend analysis from 2011 to 2017. Psycho-Oncology 2020 Jan;29(1):61–67. doi: 10.1002/pon.5247

31. Anca E-B, Cruz-Jesus F, Oliveira T, Coelho PS. Assessing the role of age, education, gender and income on the digital divide: evidence for the European Union. Information Systems Frontiers New York, Netherlands: Springer Nature B.V. 2021 Aug;23(4):1007–1021. doi: 10.1007/s10796-020-10012-9

32. Ma JK-H, Link to external site this link will open in a new tab, Vachon TE, Cheng S. national income, political freedom, and investments in R&D and education: a comparative analysis of the second digital divide among 15-year-old students. Social Indicators Research Dordrecht, Netherlands: Springer Nature B.V. 2019 Jul;144(1):133–166. doi: 10.1007/s11205-018-2030-0

33. Estacio EV, Whittle R, Protheroe J. The digital divide: examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. Journal of Health Psychol 2019 Oct;24(12):1668–1675. doi: 10.1177/1359105317695429

34. Hong YA, Cho J. Has the digital health divide widened? Trends of health-related internet use among older adults from 2003 to 2011. The Journals of Gerontology: Series B 2017 Sep 1;72(5):856–863. doi: 10.1093/geronb/gbw100

35. Ratcliff CL, Krakow M, Greenberg-Worisek A, Hesse BW. Digital health engagement in the US population: insights from the 2018 health information national trends survey. American Journal Public Health 2021 Jul;111(7):1348–1351. doi: 10.2105/AJPH.2021.306282

36. Hayes AF. Introduction to mediation, moderation, and conditional process analysis, second edition: a regression-based approach. Guilford Publications; 2017. ISBN:1462534651

37. Xiao N, Sharman R, Rao HR, Upadhyaya S. Factors influencing online health information search: an empirical analysis of a national cancer-related survey. Decision Support Systems 2014 Jan;57:417–427. doi: 10.1016/j.dss.2012.10.047

38. Panova T, Lleras A. Avoidance or boredom: Negative mental health outcomes associated with use of information and communication

technologies depend on users' motivations. Computers in Human Behavior 2016 May;58:249–258. doi: 10.1016/j.chb.2015.12.062

39. Peng X-Q, Chen Y, Zhang Y-C, Liu F, He H-Y, Luo T, Dai P-P, Xie W-Z, Luo A-J. The status and influencing factors of cyberchondria during the COVID-19 epidemic. A cross-sectional study in nanyang city of China. Front Psychol 2021 Nov 11;12:712703. doi: 10.3389/fpsyg.2021.712703

40. Visser K, Slattery M, Stewart V. Help or hinder? An assessment of the accessibility, usability, reliability and readability of disability funding website information for Australian mental health consumers. Health and Social Care in the Community 2021 Sep;29(5):1378–1390. doi: 10.1111/hsc.13192

41. Bernal H, Woolley S, Schensul JJ, Dickinson JK. Correlates of self-efficacy in diabetes self-care among Hispanic adults with diabetes. Diabetes Educ Chicago: Amer Assoc Diabetes Educators 2000 Aug;26(4):673–680. doi: 10.1177/014572170002600415

42. Calhoun PS, Wilson SM, Hicks TA, Thomas SP, Dedert EA, Hair LP, Bastian LA, Beckham JC. Racial and sociodemographic disparities in internet access and eHealth intervention utilization among veteran smokers. Journal of Racial and Ethnic Health Disparities: Springer International Publishing Ag 2017 Oct;4(5):846–853. doi: 10.1007/s40615-016-0287-z

Supplementary Files