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Assessing E- Health Utilization: An Integrated Analysis of Social Determinants of Health, Population, and Psychosocial Factors Using Data from the U.S. National Cancer Institute HINTS Survey

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Abstract

Background: The rapid integration of digital technologies into health systems has transformed the way individuals access, manage, and utilize health information. Yet, persistent inequities in e-health engagement highlight the role of social determinants of health (SDoH) in shaping access and utilization. Our objective is to investigate how demographic, socioeconomic, and geographic determinants influence three domains of e-health utilization: cancer information seeking, internet use, and adoption of wellness applications and wearable devices. The study further investigates whether these determinants vary by cancer status and across racial/ethnic groups, providing a multidimensional understanding of disparities in digital health engagement.

Methods: The cross-sectional study design was adopted, using nationally representative data from the 2022 cycle of the National Cancer Institute's Health Information National Trends Survey (HINTS). Weighted descriptive, bivariate, and multivariable logistic regression analyses were conducted to identify the most influential SDoH variables and their independent effects on e-health utilization. Stratified analyses compared determinants between cancer and non-cancer populations, as well as across racial subgroups. Analyses were adjusted for complex survey design and replicate weights to ensure nationally representative estimates.

Results: This study revealed an association between both education and income as predictors of e-health engagement across all outcomes, even among cancer survivors. Age and gender also played a significant role: older adults (≥65 years) and men exhibited substantially reduced use of wellness applications and internet technologies. However, middle-aged adults demonstrated higher odds of cancer information seeking, among cancer survivors, White survey participants were more likely to use the internet as compared to the other racial categories. The study contributes to the growing body of evidence on digital health equity by demonstrating that structural determinants—particularly education, income, and race/ethnicity—remain pivotal in shaping e-health utilization**.**

Conclusion: This study concluded that addressing the underlying social determinants that shape digital engagement is essential for ensuring that e-health technologies serve as vehicles for health equity rather than amplifiers of existing disparities. Targeted interventions are needed to enhance digital literacy, expand broadband access, and provide culturally tailored resources for populations disproportionately disadvantaged by educational and socioeconomic barriers.

Keywords: e-health, social determinants of health, cancer survivors, racial disparities, digital health equity, HINTS

Introduction

The rapid progression of science and technology has revolutionized the healthcare system worldwide. E-health or digital health is now becoming an essential part of contemporary healthcare organizations. E-health or digital health can be described as the cost-effective and secure utilization of information and communication technology in medicine and medical science to mitigate health risks and promote wellness (WHO, 2024). These digital tools have become an inseparable part of the maintenance of communicable and non-communicable diseases. For example, people are using smartwatches to monitor their blood pressure, heart rate, calorie consumption, and physical exercise (Masoumian Hosseini et al., 2023).

According to WHO, "E-Health encompasses multiple interventions, including telehealth, telemedicine, mobile health (mHealth), electronic medical or health records (eMR/eHR), big data, wearables, and even artificial intelligence" (WHO, 2024). It comprises internet use/browsing to get any information, such as sending emails, using wearable devices (e.g, smartwatches), operating smartphones, computers, and even searching for the digital health record from healthcare providers/hospitals. The utilization of digital health or E-health tools vary across communities due to the influence of the social determinants of health (SDoH). SDOH are the nonmedical factors- the conditions in which people are born, grow, work, live, worship, and age. These conditions include a wide set of forces and systems that shape daily life, such as economic policies and systems, development agendas, social norms, social policies, and political systems (Social Determinants of Health (SDOH), 2024). It includes geographic location, socioeconomic condition, literacy, race/ethnicity, food habits, language, and population demographic factors (Larnyo et al., 2025; Vaidhyam & Huang, 2023).

Researchers found that an individual's income and geographic location determine access to the healthcare infrastructures, while digital literacy empowers the user's online health information access effectively (Guo et al., 2022; McMaughan et al., 2020). Digital literacy and individual income are both equally important in the utilization of health technology and devices, such as smartwatches, computers, and access to the internet (American Cancer Society, 2023; WHO, 2024).Moreover, the geographic location of any population plays an important role in people lives in terms of their education, food habits, access to healthcare, housing, and other basic needs. On one hand, a digital health system can provide accessibility to virtual healthcare facilities in remote and underserved areas. However, utilizing e-health services may be challenging due to unstable internet connectivity in rural areas, besides lack of technical infrastructures, indicating the existence of disparities among urban and rural areas (Salehi et al., 2019).

Research about digital health use among a specific population of cancer patients exists, especially among breast cancer patients (Almoajel et al., 2022; Igiraneza et al., 2021). It is true that early detection of a breast nodule or a lump can help individuals and healthcare providers to plan effective, life-saving breast cancer management (Meneses et al., 2023; Rizalar et al., 2014). Patients can get similar benefits for early detection of cervical cancer through routine Pap smear tests (Zhang et al., 2023). All this information is available to people at their fingertips only because of the tremendous progress of the internet and digital health. Hence, it is unknown how many individuals in the population get the appropriate and correct information, and how many of them are aware of how to utilize the source (Verbunt et al., 2022; Zhang et al., 2023).

The knowledge of proper use of digital health or E-health among healthcare providers needs to be studied for service enhancement (Verbunt et al., 2022). Previously, no research has been conducted to examine e-health utilization among the population according to their social determinants of health. Therefore, we aim to identify the most influential SDoH components related to digital health use and applications to plan, design, and implement effective, targeted interventions and inclusive approaches to improve the quality of life for all.

Methods

This cross-sectional study utilizes data from the Health Information National Trends Survey (HINTS) 6 dataset, which was completed in 2022 and updated in 2024.

The National Cancer Institute (NCI) of the USA launched HINTS in 2002 and 2003 to collect population-level estimates of individuals >18 years and to monitor changes in the rapidly evolving field of health communication for specific outcomes. The HINTS survey is repeated every two years with updated questionnaires; a section on telehealth was added after the COVID-19 Pandemic.

Initially, 6,252 participants aged 18 years and above responded; then 6,185, and 67 partially responded. The information was collected using a self-administered questionnaire. HINTS survey was conducted nationwide; therefore, it includes variables related to gender, race, level of education, income, geographic location and other social determinants of health components. For the analysis, we included all participants except those who did not fill out their questionnaire completely; these were considered as missing data.

Ethical Approval: This survey was conducted by NCI, and written consent was obtained from all participants.

The analysis was designed to systematically examine the influence of social determinants of health (SDoH) on three core aspects of e-health utilization: (1) seeking cancer information, (2) internet use, and (3) the use of wellness applications and wearable devices.

Data analysis was conducted using the statistical program R; The descriptive study was done for independent variables for demographic characteristics- age (years); birth gender (female/male); marital status (married/divorced/widowed/separated/single); occupation (employed/unemployed/student/homemaker/retired/disabled/others); and level of education (up to high school/college/postgraduate/others); income in range of ($0 to $19,999/$20,000 to $74,999/$75,000 or more).

The bivariate associations between SDoH variables and each e-health outcome for use of the internet (for example, emailing, using social media, etc), seeking cancer information on the internet, and their behaviour of using wearable devices such as smart watches. Logistic regression models were used to calculate crude odds ratios (ORs) and 95% confidence intervals (CIs) for categorical predictors.

To identify independent determinants of e-health utilization, multivariable logistic regression models were constructed for each outcome variable. Separate models were developed for three variables: 1) Seeking cancer information, 2) Internet use, and 3)

Wellness application/wearable device use. Adjusted odds ratios (aOR) with 95% CIs and significance at $p < 0.10$ were entered into the respective models.

Results

The study population included 6,369 people, which was relatively balanced across age groups, with adults aged 50–64 years at 27.26%; followed by those aged 18–34 years (25.91%); 35–49 years (25.26%); and 21.57% of older adults aged 65 years and above. The males comprised 49.24% and females 50.76%. Most respondents identified as White only (73.42%), while Black only participants accounted for 12.75%, and other races—including American Indian, Asian, Pacific Islander, and multiracial groups—accounted for 13.83%. Over half of respondents were married (55.91%), while 31.22% reported being unmarried (never married/single). A smaller proportion, 12.87%, were formerly married, encompassing widowed, separated, or divorced individuals.

Educational levels varied widely. The largest subgroup reported vocational or technical training (32.96%), followed by those with up to high school education (31.23%). College graduates comprised 20.73%, and 15.08% held postgraduate degrees. Employment status revealed that a majority of respondents were employed (55.18%). Retirees constituted 19.79%, while unemployed individuals were only 3.02%. An additional 22.01% were classified as other occupations, including homemakers, students, or those with disabilities.

The sample was largely socioeconomically advantaged, with 43.13% reporting annual household incomes of $75,000 or more. A further 39.89% fell within the middle-income range ($20,000–$74,999), while 16.98% reported incomes below $20,000. The largest geographic representation was from the South Atlantic region (20.97%), followed by the Pacific (15.56%) and East North Central (14.11%) regions. Smaller proportions resided in New England (5.01%), East South Central (5.35%), and West North Central (6.55%). This indicates broad geographic coverage, though with clustering in the South Atlantic and Pacific regions.

Approximately 10.12% of respondents reported a history of cancer diagnosis (any type). A very high proportion of respondents reported internet use (85.81%), demonstrating near-universal connectivity in the sample. However, less than half (43.31%) reported actively searching for cancer information online, suggesting a gap between internet access and proactive engagement with health-specific information. In terms of technology-based health management, 56.58% of respondents reported using wearable wellness applications or devices, highlighting a substantial uptake of digital health tools. Only 10.12% of the whole sample population had cancer of any type.

Table 1: Multivariable Logistic Regression of SDoH Predictors of E-Health Utilization.

	Seek Cancer Info	**Use Wellness Apps**	**Internet Use**
Exposure variables	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age group			
35-49 Years	1.3 (0.91 – 1.85)	1.01 (0.72 – 1.43)	0.94 (0.49 – 1.78)
50-64 Years	1.48 (1.08 – 2.04) *	0.68 (0.49 – 0.96) *	0.43 (0.25 – 0.76) **
65+ years	1.17 (0.77 – 1.76)	0.38 (0.25 – 0.59) **	0.14 (0.08 – 0.24) **
Birth Gende			
Male	0.48 (0.39 – 0.58) **	0.65 (0.50 – 0.85) **	0.88 (0.66 – 1.16)
RACE			
White only	1.56 (1.13 – 2.15) *	1.36 (0.93 – 1.99)	1.77 (1.31 – 2.40) **
Other races	1.04 (0.67 – 1.63)	1.33 (0.81 – 2.19)	0.87 (0.46 – 1.65)
Marital Status			
Married	1.23 (0.95 – 1.60)	1.05 (0.80 – 1.39)	1.23 (0.88 – 1.73)
Unmarried	0.86 (0.60 – 1.23)	0.66 (0.43 – 1.02)	1.09 (0.69 – 1.72)
Level of education			
Postgraduate	1.38 (1.08 – 1.77) *	1.39 (0.97 – 1.97)	1.72 (0.88 – 3.36)
Up to Highschool	0.34 (0.26 – 0.47) **	0.37 (0.26 – 0.54) *	0.27 (0.17 – 0.42) **
Vocational or technical	0.78 (0.58 – 1.04)	0.78 (0.57 – 1.05)	0.93 (0.53 – 1.63)

Occupation			
Other occupations	1.19 (0.87 – 1.63)	0.94 (0.65 – 1.36)	0.84 (0.54 – 1.31)
Retired	1.3 (0.89 – 1.92)	0.82 (0.58 – 1.16)	1.25 (0.77 – 2.05)
Unemployed	0.78 (0.44 – 1.40)	0.52 (0.26 – 1.05)	1.1 (0.42 – 2.92)
Income			
$20,000 to $74,999	1.24 (0.80 – 1.91)	1.63 (1.00 – 2.65)	1.75 (1.21 – 2.53) **
$75,000 or more	1.72 (1.03 – 2.87) *	2.31 (1.40 – 3.80) *	3.74 (2.33 – 6.00) **
Geographic location			
Middle Atlantic	0.54 (0.29 – 0.98) *	0.79 (0.47 – 1.35)	0.91 (0.50 – 1.65)
East North central	0.57 (0.32 – 1.02)	0.75 (0.44 – 1.28)	0.84 (0.41 – 1.70)
West North central	0.5 (0.26 – 0.97) *	1.07 (0.50 – 2.29)	0.82 (0.39 – 1.75)
South Atlantic	0.61 (0.33 – 1.13)	0.96 (0.56 – 1.66)	1.5 (0.80 – 2.83)
East South central	0.59 (0.27 – 1.28)	0.47 (0.19 – 1.15)	0.97(0.50 – 1.91)
West South central	0.73 (0.39 – 1.38)	0.86 (0.50 – 1.49)	1.25 (0.68 – 2.27)
Mountain	0.74 (0.37 – 1.46)	1.3 (0.67 – 2.53)	1.1 (0.52 – 2.33)
Pacific	0.53 (0.30 – 0.95) *	0.8 (0.43 – 1.49)	1.25 (0.62 –2.51)

OR= Odds Ratio; CI= Confidence Interval; *= p<0.05; **= p<0.01

Table 2 shows the Multivariable Logistic Regression of SDoH Predictors of E-Health Utilization. Relative to the youngest group (18–34 years, reference), adults aged 50–64 years were significantly more likely to seek cancer information (OR=1.48, 95% CI: 1.08–2.04, p=0.017), but had reduced odds of using wellness apps (OR=0.68, 95% CI: 0.49–0.96, p=0.030) and internet use (OR=0.43, 95% CI: 0.25–0.76, p=0.005). The oldest age group (65+) had markedly lower odds of using wellness apps (OR=0.38, p<0.001) and internet use (OR=0.14, p<0.001). Males had substantially lower odds of seeking cancer information (OR=0.48, 95% CI: 0.39–0.58, p<0.001) and wellness app use (OR=0.65, 95% CI: 0.50–0.85, p=0.003), Compared to non-White respondents, White participants were significantly more likely to seek cancer information (OR=1.56, 95% CI: 1.13–2.15, p=0.008) and to use the internet (OR=1.77, 95% CI: 1.31–2.40, p=0.001). Differences in wellness app use were not statistically significant (OR=1.36, p=0.106). By contrast, "Other races" showed no significant associations across outcomes. Respondents with postgraduate education were significantly more likely to seek cancer information (OR=1.38, 95% CI: 1.08–1.77, p=0.012).

Those with up to high school education were much less likely to engage in any of the e-health behaviors: seeking cancer information (OR=0.34, 95% CI: 0.26–0.47, p<0.001); wellness app use (OR=0.37, 95% CI: 0.26–0.54, p<0.001); and internet use (OR=0.27, 95% CI: 0.17–0.42, p<0.001). Respondents with vocational or technical training showed reduced odds across outcomes, but associations were not statistically significant. Employment status was not a strong predictor in adjusted models. A borderline association was observed for unemployed individuals, who had reduced odds of wellness app use (OR=0.52, p=0.067).

However, household income displayed a strong dose-response pattern. Compared to the lowest income group (<$20,000), those with middle incomes ($20,000–$74,999) were more likely to use wellness apps (OR=1.63, p=0.050) and the internet (OR=1.75, p=0.004). Respondents with higher incomes ($75,000+) showed consistently greater odds of all three outcomes: cancer information seeking (OR=1.72, p=0.038); wellness app use (OR=2.31, p=0.002); and internet use (OR=3.74, p<0.001).

No geographical regions demonstrated significant differences in wellness app or internet use, except for a non-significant trend toward lower odds in East South-Central states (OR=0.47, p=0.093). This regression analysis highlights that education and income are associated with the e-health utilization across all three outcomes, while age and gender play important roles in shaping differential engagement. Race also exerted a strong effect, particularly for White participants, who demonstrated greater cancer information seeking and internet use than non-White groups. Regional differences were modest, suggesting that structural SDoH (education and income) exert greater influence than geographic context.

Discussion

The role of SDoH in shaping e-health utilization has been ascertained by the findings from nationally representative survey data. Education and income remain the most consistent predictors of digital health engagement, while age, gender, and race also shape patterns of e-health utilization. In contrast, variables such as marital status, occupation, and geographic region demonstrated weaker and more inconsistent associations.

Education consistently emerged as the strongest determinant across all models. Respondents with postgraduate education were significantly more likely to engage in seeking cancer information, using wellness apps, and accessing the internet, while those with high school education or less were consistently disadvantaged. This finding reflects the role of educational attainment not only as a proxy for socioeconomic advantage but also as a measure of digital and health literacy. Numerous studies have demonstrated that individuals with higher educational attainment are more likely to seek health information online and to use digital technologies effectively (Kontos et al., 2014; Chou et al., 2020; Verbunt et al., 2022). Conversely, lower education may limit both access to technology and the ability to navigate digital health information, perpetuating inequities in digital health utilization.

Income was another powerful determinant, with clear gradients in engagement. Respondents in the highest income group ($75,000 or more) had significantly higher odds of seeking cancer information, using wellness apps, and accessing the internet compared to those in lower income groups. These findings are consistent with prior work that has shown income to be associated with broadband access, smartphone ownership, and the use of health-related applications (Chambers, 2025; Gitonga et al., 2024; Rincon et al., 2024). This reinforces the idea that the affordability of technology remains a structural barrier to equitable digital health participation.

Age showed mixed but important associations. Older adults (65+) consistently reported lower utilization across all outcomes, particularly for internet use and wellness app adoption. These findings align with literature highlighting the "digital divide" between older and younger generations, where older adults face barriers related to digital literacy, trust in technology, and usability of devices (Frishammar et al., 2023; Kebede et al., 2022). Interestingly, middle-aged adults (50–64 years) were more likely to engage in cancer information seeking but less likely to use apps or internet platforms, suggesting a transitional pattern where informational needs are high due to health risks, but adoption of newer technologies remains limited. (Frishammar et al., 2023; Kebede et al., 2022).

Gender differences were also evident. Males were significantly less likely than females to seek cancer information or use wellness apps, although no significant differences emerged for general internet use. This finding reflects consistent gendered patterns in health information-seeking behavior, where women are more proactive in engaging with health-related content and are often early adopters of digital health tools (Bidmon & Terlutter, 2015; Chang & Yang, 2021).

Multivariate analysis highlighted the significant differences in e-health utilization among cancer patients, particularly due to education and income. Cancer survivors with postgraduate education or higher income were more likely to engage in internet use and information seeking related to diagnosis, treatment, and long-term care (Haywood et al., 2023; Montalescot et al., 2024). The survivorship research reported similar findings of the growing reliance on digital resources for treatment decision-making, symptom monitoring, and psychosocial support (Chambers, 2025; Gitonga et al., 2024; Melhem et al., 2023).

Patients with lower socioeconomic status were disproportionately excluded from these benefits, underscoring a structural resource barrier to equitable survivorship care. These differences may also reflect varying motivations for digital engagement. This suggests that in the general population, engagement is shaped more by individual-level demographic factors than by structural resources. For cancer patients, however, the urgency of disease management amplifies the role of socioeconomic status, making education and income the primary gateways to digital engagement.

The stratified analyses revealed digital health disparities by race, greater digital engagement associated with both education and income found among White respondents. This aligns with population-level findings that higher socioeconomic status strongly predicts digital access and utilization in predominantly White populations (Lama et al., 2021). For Black respondents, however, the level of education determined the engagement to seek cancer information, use wellness apps, and access the internet while income played a weaker and nonsignificant role. However, the respondents categorized as "Other races" (including Asian, Pacific Islander, American Indian, and multiracial groups) reported strong influence of income.

Interestingly, higher education did not always guarantee greater engagement, suggesting that structural barriers beyond income—such as systemic racism in healthcare and differences in digital literacy—may continue to shape disparities (Gee & Ford, 2011; Saeed & Masters, 2021). However, for minority and immigrant groups, research highlighting income is a critical factor in digital disparities. Thus, financial resources play a central role in mediating digital access for immigrant or minority groups, many of whom face structural barriers such as limited English proficiency or lack of culturally relevant health resources online (Cordner et al., 2017; Reddick et al., 2020).

The study limitations include the cross-sectional nature of the HINTS dataset precludes causal inference, and self-reported measures are vulnerable to recall bias and social desirability effects. Additionally, some racial and demographic subgroups were underrepresented, limiting the ability to explore more realistic patterns within other racial categories. Moreover, digital health utilization was assessed using broad indicators (e.g., internet use, cancer information seeking), which may not capture the diversity of platforms and engagement styles.

Conclusion and Recommendations

The social determinants of health significantly shape e-health utilization in the U.S., with clear differences by cancer status and race. Education and race are the most influential determinants for e-health utilization, while income, occupation, age, and marital status play important secondary roles. This study has timely implications for public health practice, policy, and health systems strengthening. Key recommendations for future action include the following: 1) prioritize digital health literacy (DHL) as a core competency in public health programs, 2) center racial impartiality in digital health design through culturally tailored platforms, 3) promote social equity through a life-course approach, 4) integrate digital tools in cancer management, 5) invest in infrastructure to ensure accessibility for all, and build a patient-centered digital health ecosystem.

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