Mobile health and behavior tracking (mHBT) among cancer survivors: results from a large and diverse sample

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Abstract: This study investigates the prevalence of mobile health and behavior tracking (mHBT) among a large and diverse sample of cancer survivors in the United States focusing on different mHBT adoption based on socio-demographic factors. Data was drawn from the 2020 to 2021 Health Information National Trends Survey (HINTS), which over-sampled cancer survivors from three cancer registries. Data analyses revealed that out of 1,234 cancer survivors studied, 39% had adopted mHBT, with 52% of these users engaging in daily tracking. A significant majority (86%) mHBT users were willing to share their data with healthcare providers. Notably, mHBT adoption was independently associated with younger age, female gender, college education, and better perceived health; but it was not significantly associated with race, income level, or state of residence after controlling for confounders. Cancer survivors' high rates of mHBT use and willingness to share data suggest the potential of using patient-generated data for personalized care and monitoring. However, caution is needed to address the digital divide and its impact on health disparities.

Keywords: Mobile health and behavior tracking (mHBT); patient-generated health data; cancer survivors; health policy

Ubiquitous access to smartphones and widely accessible consumer wearable devices have facilitated adoption of mobile health and behavior tracking (mHBT) in the general population (1). For cancer survivors, mHBT helps them better monitor functional status, symptoms, risk of adverse outcomes, and potentially enhances self-care and improves quality of life. Continuous tracking of biomarkers or health behaviors via mHBT potentially enables real-time monitoring of patients between clinical encounters, extends the coverage and reach of care, thus offers opportunities for more proactive and personalized care. In the past decade, small studies (sample sizes ranged 7 to 70) across a variety of cancer populations have shown the feasibility and potential clinical value of mHBT in oncology (2). Integrating digital data from mHBT with electronic health records (EHRs) or other clinical data requires patients' willingness to share their data, but literature is scarce on whether cancer survivors are willing to share their data. Thus this study, based on a large survey with a diverse sample of cancer survivors, has two objectives: (I) describe the current mHBT adoption, daily use, and willingness to share data among cancer survivors, and (II) examine the key sociodemographic factors independently associated with these mHBT behaviors.

Data were drawn from the Health Information National Trends Survey (HINTS), a nationally representative survey administered by the National Cancer Institute (NCI) every 2–3 years since 2003 (3). In 2021, NCI oversampled cancer survivors using cancer registries of Surveillance, Epidemiology, and End Results (SEER) from Iowa, New

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Mexico, and San Francisco Bay Area (4). The new HINTS-SEER included a total of 1,234 cancer survivors and the data were first available in December 2022.

The variable of mHBT was measured by two questions on whether the participant has: (I) used an app on tablet or smartphone to track progress on a health-related goal such as quitting smoking, losing weight, or increasing physical activity, and (II) used an electronic wearable device (e.g., Fitbit, Apple Watch) to monitor or track health or activity. Participants who answered "yes" to either of the two questions were considered mHBT users. These mHBT users were further asked about the frequency of using mobile tools to track or monitor health, and those who did so daily or almost daily were considered daily mHBT users. The mHBT users were also asked if they were willing to share their mHBT data with healthcare providers. Independent variables included in the analysis were key sociodemographic (i.e., age, gender, race, income level, and state of residence), perceived quality of cancer care, and confidence in self-care. Binary and multivariate logistic regressions were used to examine the association between dependent and independent variables. For all analyses, final sample weights and jackknife replicate weights were used to obtain all population-level point estimates, appropriate variance estimates, and P values as suggested by the HINTS-SEER methodology report (4).

Results showed that out of 1,234 cancer survivors, the mean age was 68.8 years, 55% were female, and 8% had difficulty with their current income. Approximately 39.16% (n=475) of participants had adopted mHBT. *Table 1* lists the characteristics of participants comparing mHBT users and non-users (binary relationship). Out of 475 mHBT users, 305 answered the question of how often they used it, and 52% (n=160) reported daily use. Out of 475 mHBT users, 307 answered the question of if they were willing to share mHBT data with a healthcare provider, and 86% (n=265) reported they were willing to share. *Table 2* shows the independent association between mHBT behaviors with key sociodemographic characteristics; mHBT use was associated with younger age, female gender, college education, and better perceived health, but it was not associated with race, income level, or state of residence after controlling for other covariates. Due to small sample sizes for the two multivariate models on daily use and willingness to share mHBT data, none of the sociodemographic factors showed statistical significance.

The HINTS-SEER data showed relatively high rates of mHBT use (nearly 40%), daily use (52% out of users),

and willingness to share data (86% out of users) among cancer survivors; these rates were even higher than the general population. Our analyses also revealed significant disparities in mHBT use among cancer survivors. Younger age, female gender, higher level of education, and better perceived health were associated with mHBT use. Targeted interventions are needed to address the new form of digital divide amid the ubiquitous access to Internet and smartphones to prevent further exacerbation of health disparities (5,6).

The high rates of mHBT use and willingness to share data with healthcare providers suggest substantive opportunities for improved cancer care. Digital data collected from mHBT complement snapshots of health data gathered during clinical visits and can enable symptom management, prevent adverse events or deterioration, support informed-decision making, and facilitate patient-provider communication, leading to better quality of care and better quality of life among cancer survivors (2,7).

The current mHBT use among cancer survivors also suggest potential challenges on policy making, healthcare technology, and clinical practice, for example, HIPAA compliance while integrating patient-generated mHBT data into EHR or other clinical dashboards and sending timely feedback, technical challenges in summarization and visualization of large quantity of mHBT data, and potential biases in interpretation and decision-making given the existing digital health divide. In 2019, Center for Medicare and Medicaid Services (CMS) introduced new CPT codes to allow reimbursement for communication with patients on remote monitoring of physiological data from mHBT (8). NCI is leading Electronic Symptom Management (eSyM), an EHR-integrated PRO-based cancer symptom management program (9). These efforts at the federal level suggest the commitment from policy makers to embrace the opportunities and challenges presented by accelerative technology development.

There are several limitations in this study. First, the cross-sectional design of the HINTS-SEER data prohibits causal interpretation of the data. Second, the measurement of mHBT behaviors was limited to adoption, daily use and willingness to share data, purposes and patterns of use, and health outcomes of the use remain unknown. It is also desirable to have cancer survivor-specific mHBT measures. Third, we examined the association of mHBT behaviors with key sociodemographic factors only, important social determinants of health factors were not included. And fourth, all participants were selected from three cancer

Table 1 Sociodemographic characteristics comparing mHBT users and non-users (binary analysis)

Characteristics	Total sample, n=1,234 (100.00%)	mHBT user, n=475 (39.16%)[†]	Non-user, n=738 (60.84%)[†]	P value
Age				<0.001
≥75 years	40.38	26.69	49.44	
65–74 years	31.15	33.87	28.67	
50–64 years	22.89	29.70	18.98	
18–49 years	5.58	9.73	2.91	
Sex				0.012
Male	45.06	40.61	48.35	
Female	54.94	59.39	51.65	
Race				0.509
Non-Hispanic White	76.07	76.47	76.17	
Non-Hispanic Black	2.83	3.58	1.86	
Hispanic	11.94	10.21	13.49	
Non-Hispanic other	9.16	9.74	8.49	
Education				<0.001
High school or less	14.65	7.80	19.39	
Some college	26.30	24.48	27.09	
College	59.05	67.72	53.52	
Income level				0.002
Difficult or very difficult	7.92	4.47	10.41	
Getting by	28.20	25.65	29.28	
Live comfortably	63.89	69.88	60.31	
State of residence[‡]				0.549
Iowa	28.83	27.70	29.90	
New Mexico	14.44	14.11	15.12	
San Francisco Bay Area	56.73	58.19	54.98	
County of residence				0.029
Metro	82.49	85.56	80.31	
Non-metro	17.51	14.44	19.69	
Quality of cancer care				0.180
Excellent & very good	98.49	99.09	98.03	
Fair or poor	1.51	0.91	1.97	
Overall perceived health				<0.001
Excellent & very good	43.91	51.58	38.15	
Good	41.41	39.46	43.14	
Fair or poor	14.68	8.96	18.71	
Confidence in self-care				0.002
Completely or very	68.29	73.04	64.90	
Somewhat	27.21	25.05	29.03	
A little or not at all	4.50	1.91	6.07	

Data are presented as percentages. [†], these percentages do not include the sample with missing in mHBT data (n=21 or 1.7% out of total sample); [‡], participants reported county of residence. The counties were designated as rural to urban according to USDA rural-urban continuum code. mHBT, mobile health behavior and tracking; USDA, United States Department of Agriculture.

Table 2 Multivariate relationship of mHBT behaviors and key sociodemographic characteristics

Variables	mHBT use (n=1,234)	Daily mHBT (n=305)[†]	Willing to share mHBT data (n=307)[‡]
Age			
≥75 years	Reference	Reference	Reference
65–74 years	2.28 (1.61, 3.21)*	0.91 (0.49, 1.68)	0.49 (0.16, 1.55)
50–64 years	2.83 (1.89, 4.22)*	1.32 (0.50, 3.50)	0.42 (0.09, 2.03)
18–49 years	5.28 (2.66, 10.48)**	0.90 (0.32, 2.54)	0.42 (0.07, 2.71)
Sex			
Male	Reference	Reference	Reference
Female	1.36 (1.05, 1.78)*	0.59 (0.31, 1.10)	0.93 (0.40, 2.13)
Race			
Non-Hispanic White	Reference	Reference	Reference
Minority	1.15 (0.69, 1.91)	0.83 (0.27, 2.52)	1.59 (0.30, 8.52)
Education			
High school or less	Reference	Reference	Reference
Some college	1.82 (0.99, 3.34)*	0.76 (0.19, 3.04)	4.62 (0.84, 25.58)
College	2.61 (1.47, 4.64)*	0.93 (0.25, 3.46)	1.01 (0.22, 4.68)
Income level			
Difficult or very difficult	Reference	Reference	Reference
Getting by	2.07 (0.92, 4.62)	0.88 (0.22, 3.48)	0.75 (0.10, 5.60)
Live comfortably	2.31 (0.99, 5.39)	1.64 (0.36, 7.45)	1.61 (0.24, 10.81)
State of residence			
Iowa	Reference	Reference	Reference
New Mexico	1.15 (0.76, 1.75)	0.54 (0.27, 1.08)	0.59 (0.17, 1.97)
San Francisco Bay Area	1.15 (0.80, 1.64)	0.91 (0.46, 1.82)	1.08 (0.33, 3.57)
Overall perceived health			
Poor or fair	Reference	Reference	Reference
Good	1.56 (0.94, 261)	2.89 (0.73, 11.41)	1.17 (0.29, 4.73)
Excellent & very good	2.23 (1.34, 2.61)*	3.41 (0.81, 14.38)	0.79 (0.20, 3.04)

Data are presented as adjusted odds ratio (95% confidence interval). [†], number of participants who reported daily usage of mHBT; [‡], number of participants who reported willingness to share mHBT data; *, P value <0.05; **, P value <0.01. mHBT, mobile health behavior and tracking.

registries at New Mexico, Iowa, and San Francisco Bay Area, and might not represent all cancer survivors in the nation.

Despite these limitations, this study represents one of first reports of mHBT behaviors among cancer survivors using a large and diverse sample. Our data highlight significant disparities in mHBT use that require targeted interventions. The high rates of mHBT use and willingness to share data with healthcare providers suggest good opportunities of integrating patient-generated mHBT data with other data collected at clinical encounters for continuous, proactive, and precise oncology care. We also advocate for more research to address potential challenges on ethics, technology development, policy making, and

clinical practice brought by growing mHBT among cancer survivors.

Footnote

References

1. Griffin AC, Chung AE. Health Tracking and Information Sharing in the Patient-Centered Era: A Health Information National Trends Survey (HINTS) Study. AMIA Annu Symp Proc 2019;2019:1041-50.
2. Low CA. Harnessing consumer smartphone and wearable sensors for clinical cancer research. NPJ Digit Med 2020;3:140.
3. National Cancer Institute. Health Information National Trends Survey (HINTS). Accessed September 29, 2023. Available online: https://hints.cancer.gov/
4. National Cancer Institute. HINTS-SEER (2021) Methodology Report. Accessed September 29, 2023. Available online: https://hints.cancer.gov/data/methodology-reports.aspx
5. Hong YA, Cho J. Has the Digital Health Divide Widened? Trends of Health-Related Internet Use Among Older Adults From 2003 to 2011. J Gerontol B Psychol Sci Soc Sci 2017;72:856-63.
6. Jiang S, Hong YA, Liu PL. Trends of online patient-provider communication among cancer survivors from 2008 to 2017: a digital divide perspective. J Cancer Surviv 2019;13:197-204.
7. Hong YA, Juon HS, Chou WS. Social media apps used by immigrants in the United States: challenges and opportunities for public health research and practice. Mhealth 2021;7:52.
8. Center for Medicare and Medicaid Services. Final Policy, Payment, and Quality Provisions Changes to the Medicare Physician Fee Schedule for Calendar Year 2019. Accessed September 29, 2023. Available online: https://www.cms.gov/newsroom/fact-sheets/final-policy-payment-and-quality-provisions-changes-medicare-physician-fee-schedule-calendar-year
9. Hassett MJ, Cronin C, McCleary NJ, et al. Strategies for implementing an ePRO-based symptom management program (eSyM) across six cancer centers. J Clin Oncol 2022;40:12017.