



The Usability and Acceptability of a Patient-Centered Mobile Health Tracking App Among a Sample of Adult Radiation Oncology Patients

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The usability and acceptability of patient-centered mobile health tracking apps among most clinical populations are unknown. This mixed-methods feasibility study evaluated the usability and acceptability of the Health Storylines app among 32 adult radiation oncology patients in a 2-week trial. Data were collected via pre- and post-app use surveys and digital analytics. Participants accessed the app platform a total of 711 times. The overall usability of the Health Storylines app was rated favorably, and 81% of participants reported the app easy to use. This study provides beginning evidence of the usability and acceptability of this type of mobile health tracking app in adult oncology patients. **Key words:** *acceptability, mobile health tracking app, radiation oncology, usability*

IN 2017, almost 1.7 million people were estimated to receive a cancer diagnosis in the United States,¹ and approximately 39.6%

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of both men and women will develop cancer at some point during their lifetime.² Of those diagnosed with cancer, an estimated 50% or more will receive radiation therapy at some point during their treatment regimen.³ Common side effects associated with radiation therapy include fatigue and skin reactions and may vary in severity.⁴ Furthermore, depending on the area being irradiated, patients may develop significant side effects such as diarrhea, nausea, vomiting, oral mucositis, and urinary tract complaints.⁴ Because oncology patients experience ongoing medical, psychosocial, and daily living needs,⁵ a patient-centered mobile health tracking app offers promise as an innovative tool for oncology patients receiving radiation therapy to track their side effects from treatment and to evaluate its impact on their overall health and wellness during and after their course of treatment.

The technological abilities and convenience of smart devices make them ideal tools

Statements of Significance

What is known or assumed to be true about this topic:

Little is known about patient-centered mobile health tracking apps, an emerging technological innovation within health care. Furthermore, there is a significant dearth of literature examining the usability of this type of mobile health app in the radiation oncology population.

What this article adds:

This study contributes to the limited body of knowledge regarding the usability and acceptability of these types of apps, as well as supporting one of the National Institute of Nursing Research's initiatives to promote innovation to improve health. Patient-centered mobile health tracking apps must be perceived to be useful and easy to use, or patients may not use these apps regardless of their intended benefits.

to track and address real-time health needs of individuals⁶ through patient-centered mobile health tracking apps. A patient-centered app involves consideration of the user at every stage of the design process.⁷ Health tracking apps are intended to allow users to monitor their own health, wellness, and self-awareness of conditions by enabling them to input and retain information in one convenient, readily available place.⁸ By enabling patients to closely and personally monitor their own health⁹ and to take responsibility for their own well-being, mobile health app technology provides better-informed and self-regulated patients.¹⁰

The National Institute of Nursing Research has articulated a scientific focus of improving quality of life for individuals with chronic illnesses through self-management and has also identified the critical role of innovative technology to improve health of patients.¹¹ Investigating the usability and acceptability of a patient-centered mobile health tracking

app in a targeted oncology population would support this scientific focus because these types of apps offer the opportunity for oncology patients receiving radiation therapy to track and recall information for improved self-management related to their continuing health care needs. In addition, the Oncology Nursing Society has affirmed the need to facilitate innovative approaches to developing individualized cancer care,¹² and patient-centered mobile health tracking apps would align with this effort.

In a recent quantitative integrative review, Birkhoff and Moriarty¹³ concluded that mobile health tracking technology has the potential to empower patients to take an interest in their well-being and contribute to their own health care. Critical factors identified through the literature that supported the use of mobile health tracking apps included demonstrated efficacy, usability, and sustained engagement. However, evidence of improved clinical outcomes has not yet been established. In addition, in a review of 11 recently published qualitative studies, Birkhoff and Smeltzer¹⁴ concluded that there is a growing interest in user-centered mobile health tracking apps among chronic illness populations, but there remains little understanding of motivating factors that promote sustained app use. Findings confirmed that mobile health tracking apps for patients with chronic conditions should have a high level of usability to motivate users to sustain engagement with their apps.

Despite the emerging knowledge of mobile health tracking apps in various patient populations, there is a near absence of empirical literature about the usability and acceptability of this innovative technology among adult oncology patients receiving radiation therapy. For a patient-centered mobile health tracking app to be an effective tool, patients must perceive that the app is usable and acceptable. Health tracking app tools require users to actively input information to self-monitor their health. Usability, therefore, is a critical prerequisite to have widespread use of patient-centered health tracking apps.¹⁵ Usability is defined as the perceived usefulness of

operating a particular technology that would enhance functioning.¹⁶ When the perceived usability of health tracking apps is suboptimal, the benefits of the app become less than ideal, leading to a gap between the potential and reality of patients actually using these apps to manage their health.^{15,17} Furthermore, user acceptability is often another critical factor in the determination of the success or failure of using technology.¹⁸ Acceptability is defined as how individuals react to an intervention¹⁹ and their perception of ease of use¹⁸ when operating mobile health app technology.

The Technology Acceptance Model (TAM) guided this study (Figure 1). The TAM is an appropriate framework for a patient-centered mobile health tracking app study because it was designed to predict and explain technology user behaviors based primarily on perceived usefulness and perceived ease-of-use constructs.²⁰ This model suggests that perceived usefulness and perceived ease of use are the primary factors influencing technology use and acceptance.²⁰ Perceived usefulness, perceived ease of use, and actual usage were 3 constructs of the TAM used to examine the usability and acceptability of the Health Storylines mobile health app among a sample of adult oncology patients receiving radiation therapy. Usability of the Health Storylines app was guided by the perceived usefulness construct in the model, and acceptability of the Health Storylines app was guided by perceived ease of use and actual usage in the model.

The purpose of this feasibility study was to examine the usability and acceptability of

Health Storylines, a patient-centered mobile health tracking app, in a sample of adult oncology patients receiving radiation treatments. The research questions were as follows: (1) Which mini-app tools of the Health Storylines app are most and least useful to adult radiation therapy patients? (2) What are the most and least used mini-apps during the 2-week trial of the Health Storylines app? (3) Does the usage of the Health Storylines app change from week 1 to week 2? (4) Was the Health Storylines app easy to use?

HEALTH STORYLINES APP

The Health Storylines mobile health app is an innovative, patient-centered health tracking app that permits patients to track their health and wellness outside of the clinical setting.²¹ This app strives to engage and empower patients through the implementation of the app's various customized health tools, such as medication, symptom, and vital sign trackers.²¹ By using this app, patients are able to build their own health data to share with clinicians if they choose and to become more active participants in their own care.²¹ This app can be viewed online at www.healthstorylines.com. Figure 2 provides an illustration of the home screen, and details describing the mini-app tools are summarized in Table 1.

METHODS

To build the empirical evidence and to advance the state of the science, a feasibility

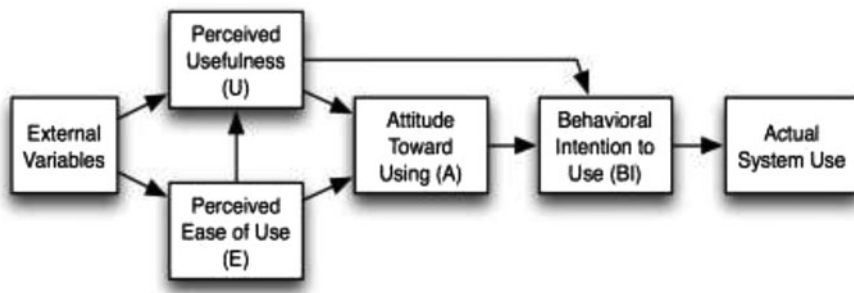


Figure 1. The Technology Acceptance Model.

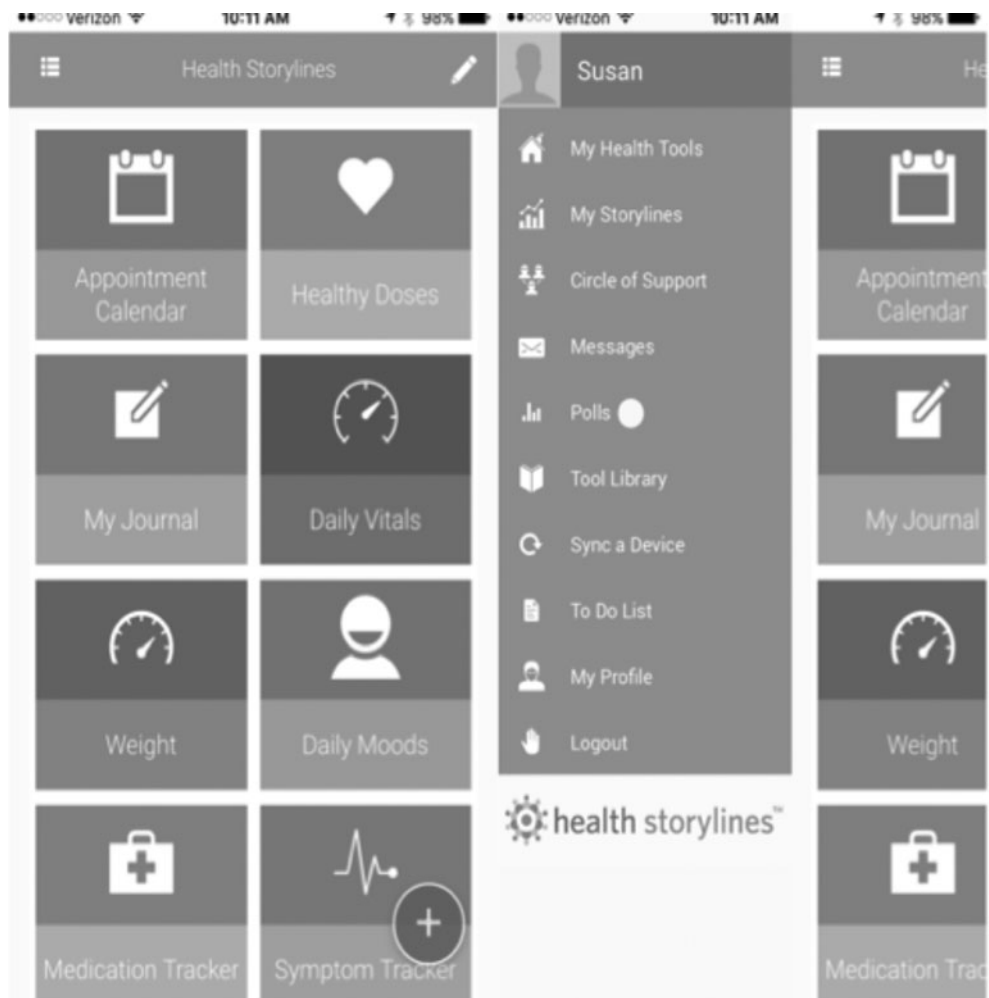


Figure 2. Health Storylines home screens.

study was conducted to examine the usability and acceptability of Health Storylines in a sample of adult oncology patients receiving radiation therapy. In this mixed-methods, concurrent, nested design, quantitative and qualitative data were collected from 32 participants who completed all phases of the study. Quantitative data assessing usability and acceptability were obtained using survey instruments and digital analytics. Qualitative data were collected from open-ended questions to complement and explain the quantitative data of participants' perceived usability of the Health Storylines app's tools. Priority was given to the descriptive quantitative data, as

addressed by the research questions of the study.

Sample and setting

After obtaining approval from all appropriate institutional and oncology review boards, 60 adult radiation oncology patients were recruited using a convenience sampling technique from a large radiation oncology treatment center in Philadelphia, Pennsylvania. Enrollment was open to any adult patient who met the following inclusion criteria: (1) undergoing proton and/or photon radiation therapy; (2) the ability to read, write, and

Table 1. Health Storylines Mini-App Tools

Tool	Description
Appointment calendar	Tracking of all doctors' appointments and treatments to stay organized.
Medication tracker	Adding medications to the list, set reminders, and document when a medication has been taken, postponed, or missed, and the reasons why.
Symptom tracker	Documentation of and rating of their general wellness or whether they are experiencing any side effects of their health condition or treatment. A graph will be generated to show trends over a period of time.
Journaling	A list of guided topics, such as what am I thank for today, and a free writing space to journal about any topic.
Daily mood diary	Tracking daily moods from a collection of 11 positive and 11 negative emotional identifiers, adapted from the PANAS (Positive and Negative Affect Schedule) mood scale.
Weight tracking	Tracking of weight and the ability to generate a graph over time for trends.
Circle of support	Adding any person to view activities or progress tracked on this app as dictated by the user.
Vital sign tracker	Tracking of common vital signs such as pulse and blood pressure and the ability to graph trends over time.
Healthy doses	A library of motivational and inspirational quotes with images on the topics of gratitude, optimism, love, humor, and mindfulness.
Tool library	An additional set of mini-apps that users can browse and pull into their home screen based on their preferences. The categories within the tool library consist of organization and reminder, tracking and monitoring, nutrition, and physical activity.
To-do list	Allows users to make a list of tasks that need to be completed.

converse in English; (3) ownership of a smartphone and/or a tablet; and (4) having a sufficient data plan of at least 500 MB per month that allowed for app download and usage when the device was not connected to a wireless Internet (WiFi) portal.

Of the 60 participants enrolled, 32 participants completed all study procedure steps; therefore, 32 complete data sets were analyzed for this study. A complete data set included completion of the pre-app use survey, digital evidence of trialing of the Health Storylines app for at least 2 days within the 2-week time frame, and completion of the post-app use survey. The rationale for at least 2 days' app use for inclusion in the analysis was to exclude data from participants who may have accidentally used the app, not meaning to record any health information. The PRISMA flow diagram in Figure 3 depicts the

screening and subsequent enrollment of participants into this study.

PROCEDURE AND MEASUREMENTS

After giving written informed consent, patients completed a brief pre-app use survey and then the Health Storylines app was loaded onto their smartphone. Once the app was loaded onto their smartphone, participants were asked to click on different mini-app tools to become familiar with their functions. Participants were encouraged to use the app during the 2-week trial period; however, there was no required amount of time for them to use the app during the trial. After 2 weeks, participants were sent a reminder e-mail to complete the post-app use survey located in the app platform or in an e-mail attachment on their smartphone. If participants did not

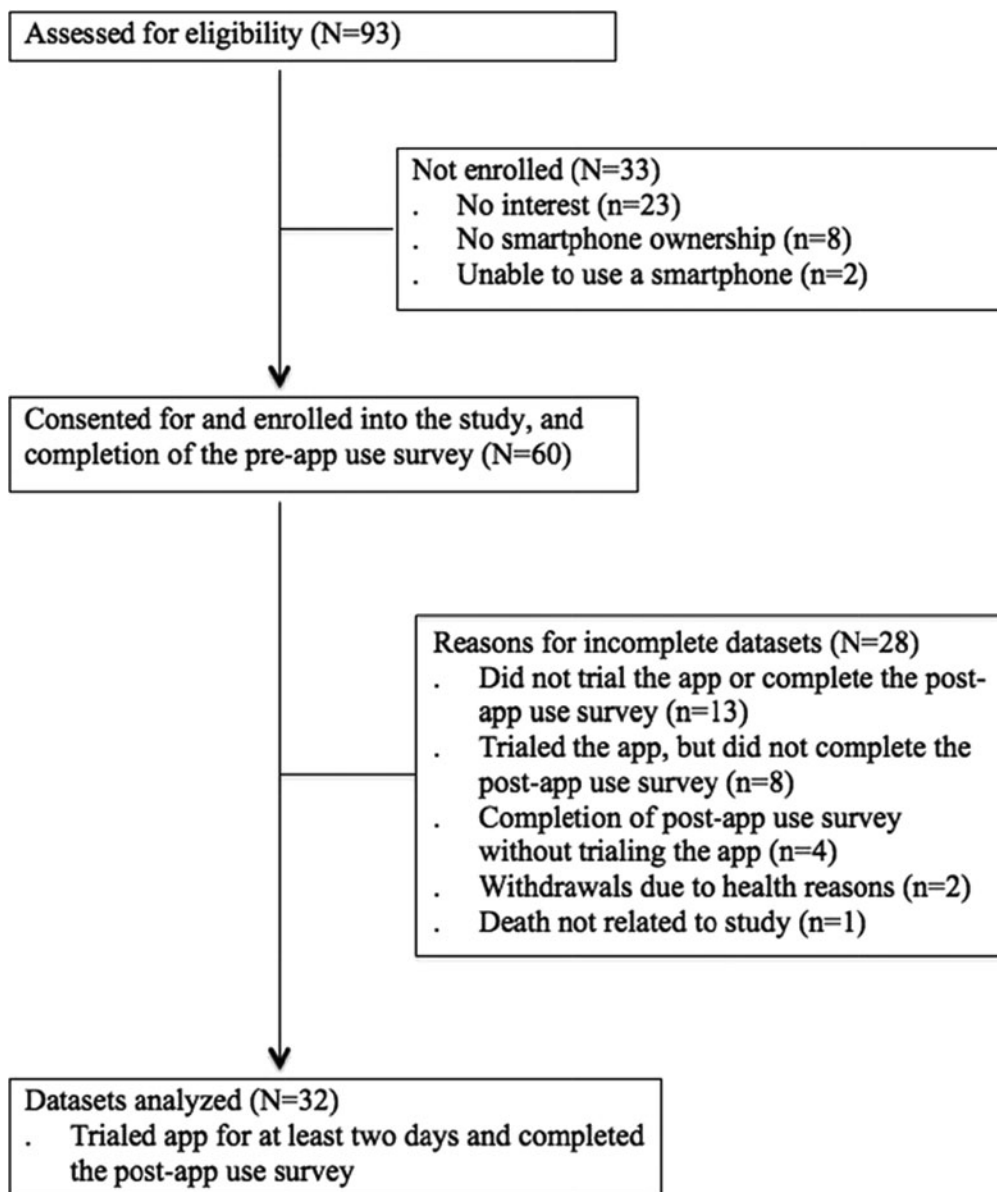


Figure 3. PRISMA flow diagram—Patient screening and enrollment.

complete the post-app use survey 1 week after the first reminder e-mail, a second and final reminder e-mail was sent. If the post-app use survey was not completed after the second e-mail reminder, data for these participants were excluded from the analysis of the findings.

Pre-app use survey

The purpose of the pre-app use survey was to obtain baseline data about each participant. This survey tool was originally created and revised by a qualitative researcher from the University of Waterloo and a mobile health market research expert working for the app

company (L. Jamison, MBA, written communication, July 2016). The purpose of the original survey was to interview patients with various medical conditions to better understand the types of mini-app tools that would be valuable to them (L. Jamison, MBA, written communication, July 2016). The survey was pretested on 50 members from various patient health advocacy groups to inform ideal tools to build for the Health Storylines app (L. Jamison, MBA, written communication, July 2016). To increase its applicability of the survey to this study population, the tool was modified with permission from the app company. The structured pre-app use survey, consisting of 23 questions, elicited information about participants' sociodemographic characteristics, their treatment management and support data, and their use of mobile apps. The treatment management and support section of the survey asked participants from whom or where they seek to obtain treatment information, what activities help them cope during the treatment regimen, and who or what supports them during their treatment regimens. The section of the survey on use of mobile apps assessed participants' use of mobile apps, the types of apps typically used, and any specific health apps that they thought would be of interest to them.

Digital analytics

Digital analytics encompass the recording and collecting of users' behaviors on Web sites, mobile sites, and apps.²² The digital analytics captured by the app company's computer system in this study recorded frequency of usage each time study participants entered data into one of the mini-app tools. Only frequency of data entries was recorded for research purposes, not content of those data entries. Participants were responsible for tracking their own health information and made decisions as to whether to use all, some, or none of the mini-app tools to suit their health and wellness needs. The digital analytics were used to measure acceptability of the Health Storylines app reflected by the actual usage

construct on the TAM. Because the digital analytics were recorded by a computer system, no error variance is associated with the data generated from them.

Post-app use survey

The post-app use survey was created and revised by the same qualitative researcher from the University of Waterloo and a mobile health market research expert working for the app company (L. Jamison, MBA, written communication, July 2016). This type of survey had been tested before in primary market research, and a 7-point Likert scale was used because it provided a better spread of numbers to identify the high and low totals (L. Jamison, MBA, written communication, December 2017). This survey was also modified with permission from the app company to increase its applicability to this study population. This structured post-app use survey, consisting of 14 questions, assessed participants' ratings about the Health Storylines app's to measure the usability of the app. These questions addressed the most and least used mini-apps, ease of app use, perceived enhanced coping ability during radiation treatment by using the Health Storylines app, helpfulness of the app, and recommendations for additional features. The usability of the app platform was assessed using a 7-point Likert scale, with possible scores ranging from 1 (entirely disagree) to 7 (entirely agree), and several open-ended questions. The open-ended questions provided qualitative data to further assess usability of this app. A dichotomous yes/no response elicited whether the Health Storylines app was easy to use, thereby assisting in the determination of the acceptability of this app platform. Another 7-point Likert scale ranging from 1 (entirely disagree) to 7 (entirely agree) and 1 open-ended question addressed the helpfulness of the app to manage different aspects of health and wellness.

Data analysis

Quantitative data consisted of items within the 2 survey instruments and the digital

analytics. Qualitative data comprised answers to open-ended questions in the survey. Descriptive and inferential statistics were calculated using Statistical Package for Social Sciences (SPSS) version 24 software. Qualitative survey responses were manually analyzed to develop a general sense of the information and to reflect upon the overall meaning of responses.²³ Through content analysis,²³ responses to open-ended questions were categorized and then clustered to identify themes. Checking transcriptions for errors, discussing biases with other 2 other nurse researchers, and comparing coding definitions with the data to avoid shifting definitions maintained methodological rigor.

Integration of quantitative and qualitative data

Integration of quantitative and qualitative data occurred during the final analytic step. Using a side-by-side comparison method,²³ usability quantitative scores were collected on the post-app use survey and compared with qualitative survey feedback. The qualitative data expanded upon the quantitative data to provide deeper insights into the usability of a patient-centered mobile health tracking app. No integration of digital analytics data could occur because all collected data were quantitative. Comparing and contrasting the quantitative and qualitative data in this study increased the likelihood of capturing the reasons why this particular patient population would or would not use and accept a mobile health tracking app during their radiation treatment regimen.

RESULTS

Sociodemographic characteristics of the 32 participants with complete data sets are summarized in Table 2. Twenty-eight of 60 participants (47%) did not complete all the study procedure steps. The mean age of study participants was 53.59 years, with the range be-

Table 2. Sociodemographic Characteristics of the Sample (N = 32)

	Mean (SD)	Range
Age	53.59 (13.687)	22-77
	n (%)	
Male	13 (40.6)	
Female	19 (59.4)	
Education		
High school	8 (25)	
College	9 (28.1)	
Graduate school or more	15 (46.9)	
Residence		
Pennsylvania	16 (50)	
New Jersey	10 (31.1)	
Delaware	2 (6.3)	
Other	4 (12.4)	
Treatment area		
Brain/neck/spine	12 (37.5)	
Lung/breast	10 (31.3)	
Bladder/prostate	6 (18.8)	
Other	4 (12.4)	
0-3 wk into treatment	23 (71.9)	
4-6 wk into treatment	9 (28.1)	
Chemotherapy		
Pre-radiation therapy	6 (18.8)	
Concurrent therapy	8 (25)	
Post-radiation therapy	2 (6.3)	

tween 22 and 77 years. More female participants completed this study. Both men and women were highly educated and had a variety of cancer sites. Most (71.9%) of the participants were 0 to 3 weeks into their treatment course compared with those late in their treatment course (28.1%) at 4 to 6 weeks.

Sociodemographic characteristics of the 28 participants who did not complete all the data collection points are summarized in Table 3. Based on the descriptive analyses, the mean age, gender, state residence, educational level, and treatment areas were very similar to the participants with complete data sets.

Table 3. Sociodemographic Characteristics of Participants Who Did Not Complete the Study (N = 28)

	Mean (SD)	Range
Age	53.29 (13.419)	32-73
	n (%)	
Male	16 (57%)	
Female	12 (43%)	
Education		
High school	7 (25)	
College	9 (32.1)	
Graduate school or more	12 (49.9)	
Residence		
Pennsylvania	21 (75)	
New Jersey	6 (21.4)	
Delaware	1 (3.6)	
Treatment area		
Brain/neck/spine	11 (39.3)	
Lung/breast	7 (25)	
Bladder/prostate	8 (28.6)	
Other	1 (3.6)	
0-3 wk into treatment	11 (39.29)	
4-6 wk into treatment	17 (60.7)	
Chemotherapy		
Pre-radiation therapy	14 (50)	
Concurrent therapy	8 (28.6)	
Post-radiation therapy	3 (10.7)	

Usability

The post-app use survey addressed the usability of the Health Storylines app and its 11 mini-app tools. Study participants rated the overall usability of the Health Storylines app favorably ($M = 4.69$, $SD = 1.62$; range, 2-7) on a 1 (entirely disagree) to 7 (entirely agree) Likert scale. High school-educated participants, in particular, scored the overall usability of this app very high ($M = 6.38$, $SD = 1.11$; range, 5-7), and college-educated participants ($M = 4.56$, $SD = 1.82$; range, 2-7) scored the app favorably as well; however, graduate school-educated participants rated the overall usability of the app less favorably ($M = 3.87$, $SD = 2.44$; range, 2-6). These results

coincide with a strong negative correlation ($r_s = -0.612$, $P < .01$) between educational levels and usability scores.

Using this Likert scale, study participants rated the medication ($M = 3.94$, $SD = 2.45$; range, 1-7), appointment ($M = 3.81$, $SD = 2.32$; range, 1-7), and symptom trackers ($M = 3.94$, $SD = 2.23$; range, 1-7) most favorably. Participants marked symptom tracking ($n = 17$), journaling ($n = 15$), and mood tracking ($n = 12$) as their most used mini-app tools. Conversely, participants identified the to-do list ($n = 19$), medication tracking ($n = 19$), and circle of support ($n = 18$) as the least used mini-app tools. These results are presented in Table 4.

The qualitative data in the post-app use survey addressed the usability of the Health Storylines app in participants' own words. For example, one participant stated, "I think it was a great, useful app that included many things to track, even things I did not think of." Another participant felt entirely different about the usability of the app and stated, "I found writing in my journal to be easier and faster." Key usability themes and exemplar quotes are provided in Table 5. In addition, participants responded that they found specific mini-app tools useful and helpful in tracking their health-related treatment needs. Themes identified as reasons participants used particular mini-app tools more than others included the following: the app being most relative to their needs; ease of app use; and current apps they use do not offer certain features found in the Health Storylines app. In contrast, reasons given for nonuse of different mini-app tools included the following: certain types of tracking tools were used elsewhere in different app platforms or were preferred in a paper format; not needed; poor understanding of the tool; and too much of a user burden. One participant stated, "I have a different app for To-Do lists that does not relate to my medical journey, I reach my circle of support in different ways, [and] I track my weight with an electric scale and FitBit." Another participant noted, "I already have very good ways to accomplish all the things apps

Table 4. Ranking of Self-reported Most/Least Used Mini-App Tools and Usability Rating on 7-Point Likert Scale

Type of Mini-App Tool	Most Used, n (%)	Least Used, n (%)	Usability Rating	
			Mean (SD)	Range
Symptom tracking	17 (53.1)	7 (21.9)	3.94 (2.23)	1-7
Journaling	15 (46.9)	11 (34.4)	3.19 (2.33)	1-7
Mood tracking	12 (37.5)	8 (25)	4.09 (2.39)	1-7
Appointments	10 (31.3)	14 (43.8)	3.81 (2.32)	1-7
My Storylines	10 (31.3)	14 (43.8)	2.63 (2.97)	1-7
Vital sign tracking	7 (21.9)	12 (37.5)	3.31 (2.24)	1-7
Weight tracking	7 (21.9)	16 (50)	3.44 (2.55)	1-7
Medication tracking	4 (12.5)	19 (59.4)	3.94 (2.45)	1-7
Circle of support	2 (6.3)	18 (56.3)	2.31 (2.02)	1-7
To-do list	2 (6.3)	19 (59.4)	2.56 (2.02)	1-7
Tool library	0 (0)	24 (75)	... ^a	... ^a

^aThe tool library was not on the Likert scale but was included for most and least used tools on the survey.

are supposed to help with so I do not need them.” Recommendations to improve participants’ experiences included the ability to edit tracked data, print health data, and

customize the apps to suit one’s needs; participants also suggested the addition of more reminders to use the mini-app tools.

Table 5. Key Themes About Usability With Examples From the Survey Responses

Usability of the Health Storylines App Themes	Relevant Quotes
Only certain apps were useful to me	“I felt that the parts of the app I used were useful, but I really only regularly used the medicine tracker, symptom tracker, and stool section.” “I only used three apps. I used the appointment calendar, the questions to ask, and the medication tracker apps. Found the first two extremely helpful. However, I found the medication tracker app a bit cumbersome.”
Helpful to track health	“I like that everything I need to speak with the doctor is right in my hands and easily accessible.”
Good reminders	“I’m not one to journal and this helped me to keep track of things.” “It helped remind me about medicine, track symptoms, and recall appointments that I would otherwise forget.” “It reminded me to take my meds.”
Did not use much	“I’m not really into apps. Too busy to use them and not technologically savvy [sic].”
Customization is important	“Tracking was something I was doing on my own and was redundant.” “App is very helpful, but each tool can add more features.” “It would have been helpful to be able to control the date/time of each symptom.”

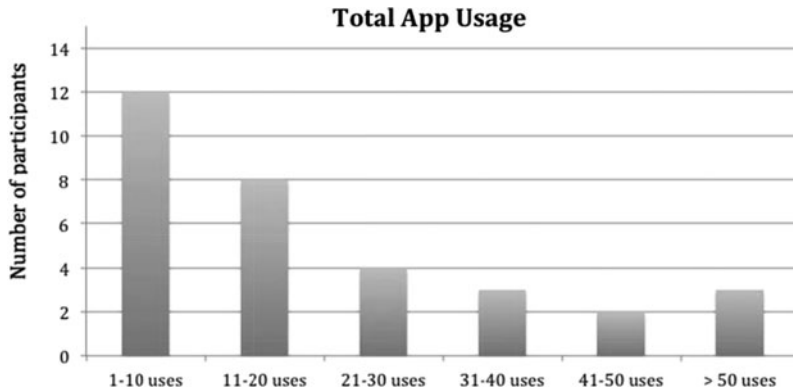


Figure 4. Total Health Storylines platform usage.

Acceptability

To assess the acceptability of the Health Storylines app, 26 of 32 participants (81%) responded on the post-app use survey that the Health Storylines app was easy to use. The digital analytics recorded that the 32 participants opened the Health Storylines app platform a total of 711 times over the 2-week trial period. Twenty participants (63%) used the app 20 times or less, 7 participants (23%) used the app 20 to 40 times, and 5 (16%) participants used the app more than 40 times. Figure 4 provides an illustration of frequency of total app usage. Of the 711 times participants entered their data into one of the mini-app tools, the most to least used mini-app tools were as follows: tool library ($n = 160$; 22.5%), moods

($n = 153$; 21.5%), appointments ($n = 121$; 17%), symptom tracker ($n = 101$; 14.2%), medication tracker ($n = 71$; 10%), journaling ($n = 53$; 7.5%), healthy doses ($n = 36$; 5.1%), and vital signs ($n = 26$; 3.7%); weight, to-do list, my storylines, and circle of support were not used by participants. Figure 5 provides a depiction of the frequency of mini-app use.

During the 2-week trial, differences in the number of entries of each participant's mini-app tool usage between week 1 and week 2 were analyzed. In week 1, 25 participants used the app 20 times or less, 5 participants used the app 21 to 40 times, and 2 participants used the app more than 50 times. In comparison with week 2, 29 participants used the

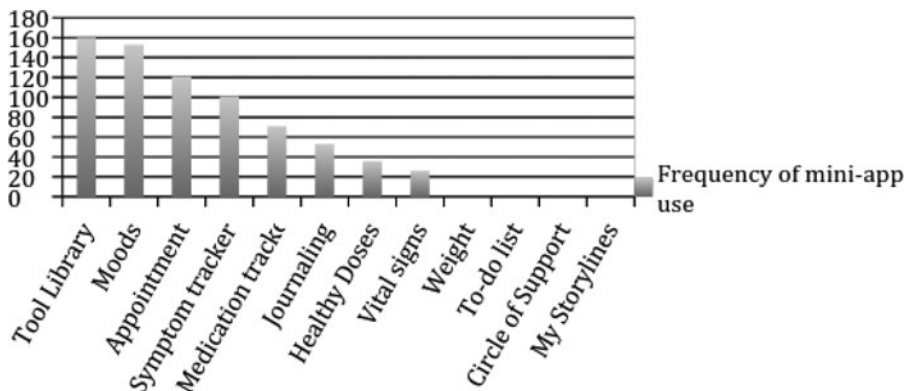


Figure 5. Frequency of mini-app tool use.

app 20 times or less, 2 participants used the app 21 to 40 times, and 1 participant used the app more than 50 times. Figure 6 provides a comparison illustration. A dependent *t* test was used to examine usage differences within participants between the 2 time periods. The Health Storylines app was used more frequently in week 1 ($M = 14.22$, $SD = 16.81$) than in week 2 ($M = 8$, $SD = 14$); however, no significant difference between frequency of use was detected ($t_{31} = 1.96$, $P = .059$).

DISCUSSION

Guided by the TAM, this feasibility study provided evidence for the usability and acceptability of the Health Storylines app. Participants rated the overall usability of the Health Storylines app favorably, which reflected perceived usefulness on the TAM. Interestingly, the more education participants had, the less favorably they rated the overall usability of the app. This is a contrasting finding to other mobile health app studies where higher education levels were associated with increased health app usage.^{24,25} Based on our study, the reasons why educational level influenced overall usability scores are unknown. Because of this differing finding from other studies, our study highlights the need for additional, larger

studies to examine the impact of educational levels on the usability of mobile health tracking apps.

Medication, appointment, mood, and symptom trackers received the highest usability ratings, and appointment, mood, and symptom tracking tools were used most according to the digital analytics. Based on the qualitative feedback, these mini-app tools had the highest ratings and were used most frequently because they were most relative to participants' needs, easy to use, and offered features not available in apps they currently use. Our findings are consistent with the qualitative findings of Goodwin et al²⁶ that described the viewpoints of 8 mental health patients interested in using mobile technology to inform future development of a mobile health tracking app. These researchers found that using certain mini-app tools relative to personal needs (mental health triggers, anxiety levels) was of paramount importance to participants with mental health disorders. Similarly, our qualitative data provided explanations as to why certain mini-app tools were used in this patient population and thus helped explain our quantitative data.

Symptom tracking in particular received higher usability scores and was a frequently used tracking tool. Symptom monitoring is especially important for oncology patients

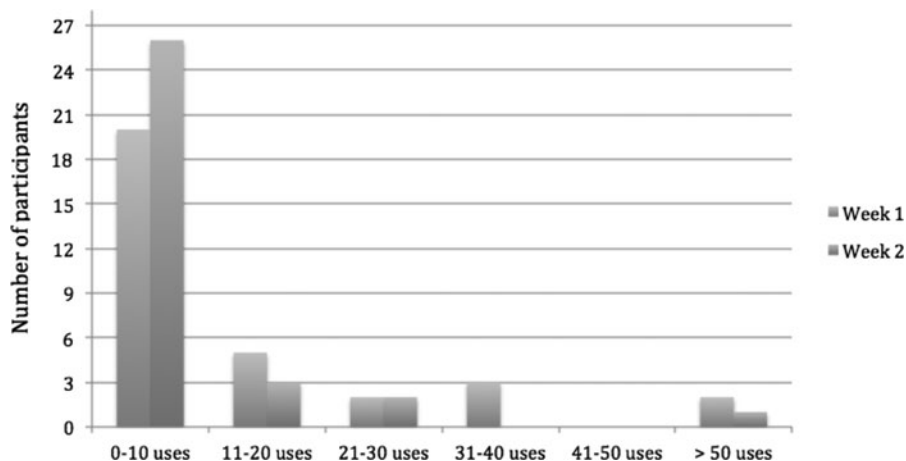


Figure 6. Comparison of total Health Storylines usage between week 1 and week 2.

because they can experience varying acute and chronic side effects from their treatment regimen.⁴ In a previous oncology study, Egbring and colleagues²⁷ conducted a 3-arm randomized controlled trial for 6 weeks among 139 patients with early breast cancer undergoing chemotherapy. Participants were randomly assigned to a control group, an unsupervised group that used a mobile app to record data without physician review, or a supervised group that recorded data in the app with physician review. The results revealed that participants who had physician collaboration when using the health tracking app demonstrated increased reporting of chemotherapy adverse effects, more precise health data entries, and stabilization of daily functional activities measured by the ECOG (Eastern Cooperative Oncology Group) scale. Our study affirms the importance of symptom monitoring in the oncology population receiving radiation therapy, as these patients can also experience significant side effects from their treatment regimen that influence their overall health during and after their course of therapy.⁴

Tracking one's mood had favorable usability scores and was one of the most frequently used mini-app tools. Self-monitoring of mood is another important aspect of oncology care because the prevalence of depression ranges from 8% to 24% depending on measuring instrument, cancer type, and treatment phase.²⁸ In a mobile health study conducted in the breast cancer patient population, a mobile health tracking app was used to screen for depression by recording participants' daily mental health ratings.²⁹ The researchers found that patients' recording of their daily mental health rating was a useful depression screening tool for clinicians. Our findings add another dimension to the literature in which radiation oncology patients may have an interest in tracking this aspect of their health and well-being during treatment because of the popularity of this particular mini-app tool.

Although the entire Health Storylines platform was rated favorably, many of the indi-

vidual mini-app tools' usability mean scores were rated as neutral or less, with a mean score ranging from 2 to 4 (out of a possible 7). Circle of support, to-do list, and my storylines mini-app tools received the lowest usability scores, consistent with the nonuse by the digital analytics, leading to the conclusion that these mini-app tools were not perceived as useful and, ultimately, not used. This lack of use and low perceived usability scores could be attributed to the placement of these tools within the design layout of the app platform. These 3 mini-app tools were located under a submenu and were not readily visible on the main home screen. However, another plausible reason for nonuse reported by participants was that certain mini-app tools did not meet specific needs or they already used these types of tools elsewhere, such as in a different app or in a nonelectronic format. In a previous mobile health app study, participants reported that the specific features and functionality of their apps were of vital importance to maintain their engagement with the app.³⁰ Our findings highlight the need for further customization of each individual mini-app tool to meet the health tracking needs of this particular patient population. When apps are tailored to each user, it increases the level of usability and decreases user burden, thus increasing engagement with the app.¹⁴ In addition, increased visibility and intuitive navigation of all available mini-app tools on the home screen are needed to encourage use of all health tracking features.

Comparison of participants' app usage between week 1 and week 2 was important to assess in terms of acceptability because a previous mobile health app tracking study found that health app use significantly decreased when tracked data provided no new health information to the user.³⁰ The Health Storylines app was used numerous times over the course of the 2-week trial period, which reflected actual usage in the TAM. The app was used less in the second week, but this was not a significant change. This finding suggests that the app continued to serve a purpose and was accepted by the participants during the

second week of the app trial; however, participants may have used the app less during the second week when no new health trends were revealed.

Most participants responded that the Health Storylines app was easy to use, which reflected perceived ease of use of the app in the TAM and also addressed acceptability of this app. Qualitative themes, such as the app serving as good reminders and useful to track health, also reinforce that the app was easy to use. Perceived ease of use of this app was essential to examine because if the participants believed the app was too hard to use, then the benefits gained by using this app would be outweighed by the burden to use it.¹⁶ Similarly, in the Scheibe et al³¹ qualitative study, the perceived ease of use was identified as a primary factor associated with the use and acceptance of a diabetes tracking health app among 32 middle-aged participants with diabetes. Our study findings extend those of Scheibe et al by describing acceptability of these types of apps in an oncology population receiving radiation therapy.

Limitations

Because this study was a feasibility study,¹⁹ the aim was to determine whether a patient-centered mobile health tracking app would be accepted and used by a sample of adult oncology patients receiving radiation therapy and not generalization to other patient populations. The sample size was small, about three-fourths of participants had a college education, and almost half of the enrolled participants did not complete all the study procedure steps, although both sets of participants who completed and those who did not had very similar sociodemographic characteristics. The recruitment site had a diverse oncology treatment population, and these varied patients were approached to join the study. Eight patients, though, did not meet the inclusion criterion of owning a smart device and therefore could not enroll into the study, possibly affecting the sample's education level.

Patients with less education may have declined the invitation to join this study because of their lack of experience using mobile health tracking apps. Patients need to have a certain level of eHealth literacy, defined as "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem,"³² to be comfortable using a health tracking app.³³ Patients have different levels of ability when using health apps and therefore patients with higher levels of eHealth literacy would be more likely to perceive they have a stronger aptitude to use health apps.³³

The large attrition size may have impacted the usability and acceptability outcomes because only participants who completed the study were factored into the results. In addition, the time period of 2 weeks to trial the app was short and thus it is not known whether usability and acceptability would change over a longer time period. The Health Storylines app is a specific type of mobile health tracking app with customized mini-app tools. Using a different health tracking app in the same population may produce different results, thereby limiting generalizability of these findings to other health tracking apps. Furthermore, the survey instruments used only had face validity related to the constructs of usability and acceptability.

Recommendations for future research

Because mobile health tracking apps are in the early stages of development and research testing, there are tremendous opportunities to move the state of the science forward. More research is necessary to determine which types of mini-app tools would optimally meet the needs of oncology patients during and after radiation treatment. Not every patient using a mobile health tracking app has the same needs; the actionable information should be personalized for each user.³⁴ Health care providers, especially nurses, would be instrumental in collaborating with patients to identify the best

type of app tools to meet individual needs. Nurses are the providers who have the most contact with patients and would be in the best position to build a strong rapport with them.³⁵ The nursing discipline could also champion best practices in patient-centered mobile health tracking apps both by actively participating in the development and testing of these types of apps and by publishing original research depicting their clinical effectiveness³⁶ to establish credibility within the mobile health technology space.

When additional customized mini-app tools are identified for this patient population, randomized controlled trials could be conducted to investigate the efficacy of apps in improving specific clinical outcomes, such as quality of life, self-efficacy in the self-management of patients' health-related needs, or communication with health care providers. However, more research is needed to determine how best to integrate these types of apps into the conventional health care delivery system.³⁷

Conducting feasibility studies that examine the usability and acceptability of the use of mobile health tracking apps among other chronically ill populations is also warranted. Most, if not all, chronically ill populations have ongoing medical management needs that should be addressed to maintain optimal health and wellness.

Additional research is also critical to examine how to maintain sustained patient engagement with mobile health apps in clinical populations and to investigate the relationship between sustained patient engagement with apps and clinical outcomes. If patients

do not maintain engagement with the app, then the technology becomes worthless, no matter how well designed.³⁸ Therefore, partnering with diverse patient groups to evaluate best app designs would be a key direction for future research, especially if the targeted population includes older adults. Health tracking tools must be simple to use with understandable menu guidance and easy navigation,³¹ as well as have enhanced visibility of the different buttons and symbols to avoid user burden.³⁹

CONCLUSIONS

This study contributed to the virtually nonexistent body of knowledge about the usability and acceptability of patient-centered mobile health tracking apps in the adult oncology population receiving radiation therapy. It was an important first step to better understand whether patients are likely to use this type of health tracking app to monitor their health and wellness during a course of radiation therapy. Findings revealed that oncology patients receiving radiation therapy found the overall Health Storylines app platform usable and acceptable; however, individual mini-app tools need more customization to increase their usability and to meet the individual user's unique needs. Mobile health technology, such as health tracker apps, appears to be a beneficial innovation for patients to use during radiation therapy, but more research is needed to generate new knowledge about its potential benefits and limitations in managing health and wellness.

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