Smartphone apps for cancer: A content analysis of the digital health marketplace

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Abstract

Objective: The purpose of this study was to examine the state of smartphone applications for cancer intended for the general public with a focus on interactive features, content sources, and application developer affiliations. The level of health provider involvement in screening or appraising application content was also assessed.

Methods: A total of 123 apps were identified for analysis from two major mobile application marketplaces (Apple iTunes = 40; Google Play = 83). Application characteristics were collected, analyzed, and reported. These included the mobile platform, cost, application developer affiliation, date of last update, purpose of application, content sources, and interactive features.

Results: In the study sample, 50% of the applications focused on general information for cancer (62/123). Next, this was followed by applications for breast cancer (15%, 19/123) and skin cancer (7%, 8/123). Only 10% of application descriptions (12/123) identified sources for application content. Interactive features included the ability to monitor symptoms, side effects, treatments, and chronic pain (20%, 25/123). Only 3% of the applications (4/123) stated content had been evaluated by health providers.

Conclusions: This study contributes an updated analysis of applications for cancer available in the digital health marketplace. The findings have implications for information quality and supportive resources for cancer care. More transparent information about content sources, organizational affiliations, and level of health provider oversight in screening application content is warranted. Recommendations for improving the quality of cancer applications are also offered.

Keywords

Cancer, digital health, information resources, mobile applications, oncology, quality

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Introduction

Health applications (apps) are increasingly being used for patient care in oncology.[1] With the growing popularity of mobile devices, healthcare consumers have instant access to information about cancer prevention, detection, and treatment options on their handheld portable devices.[2] More specifically, health apps provide health-related services, interactive tools, and support via smartphones or tablet devices to cancer patients, their family members, and caregivers to manage life-altering cancer experiences.[2] For instance,

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patients can play a more active role in managing their cancer care by using smartphone health apps to log medications, track treatments, monitor side effects, and schedule follow-up appointments.

Indeed, health apps have the potential to positively influence self-efficacy, empowerment, and the self-management activities of patients.[3] Research further supports patient acceptance of app-assisted cancer treatment and aftercare. In one study, half of the patients reported being willing to send data to their treating clinician via an app.[4] Additionally, patients believed that regularly transmitted data would be an ideal complement to standard follow-up procedures.[4] Despite the promising advantages of health apps, consumers might have trouble identifying a trustworthy app and end up relying on faulty information.[1] Relevant information based on research evidence is an essential tool for patients and consumers to guide health care decisions in partnership with health professionals.[5]

Currently there are "no tools for cancer patients available to facilitate targeted searching of high-quality cancer apps."[1] To help address this gap, this study examined the state of cancer smartphone apps for the general public with a focus on their interactive features, content sources, app developer affiliations, and the level of health provider oversight of app content. The present study contributes an updated analysis of the digital health marketplace to the existing literature.

Previous reviews of cancer-focused apps

Several studies describe the emerging landscape for cancer-related smartphone apps. Previous reviews have characterized mobile apps for breast cancer,[1,6] prostate cancer,[1,7,8] skin monitoring and melanoma detection,[9–10] and oncology patients' medication adherence.[11–12] In particular, studies show that cancer apps are not meeting patients' needs. Jupp et al. found that facilitating connections to support groups was not a common function of medication management apps.[12] In addition, many breast cancer apps did not define key terms for mobile users.[6] Collado-Borrell et al. also summarized 166 cancer apps for patients concluding that individual self-monitoring tools were limited, such as diaries or ways to track adverse effects and treatments.[13] However, data collection for this study of cancer apps was completed in 2014.[13] Hence, a more current study is warranted.

Other studies highlight that app content sources and developer affiliations are not well documented. For instance, Bender et al. reported that a majority of cancer apps for the general public did not describe their organizational affiliation.[2] Bohme et al.

concluded that cancer apps geared towards health professionals offered better documentation for information sources including scientific sources for app content.[1] However, these authors only analyzed apps available on one platform (Apple iTunes) and apps that were free of charge.[1] Moreover, Ahmed et al. reported that very few medication adherence apps provided references to clinical trials to support app efficacy.[11]

Nevertheless, gaps concerning apps for cancer remain in the extant literature. More research is needed to extend previous studies by analyzing a wider scope of cancer apps and platforms. For instance, research is needed to examine content sources, interactive features, health provider oversight, free and fee-based smartphone cancer apps, and apps available on multiple platforms. These aspects would further contribute to the current body of literature. Therefore, the aim of this study was to assess these dimensions to characterize the state of smartphone apps for cancer on the digital health market.

Methods

Mobile app search

To identify relevant cancer-focused apps for study inclusion, a search of Apple iTunes (iOS) and Google Play (Android) platforms was conducted. Keyword searches for the terms "cancer" and "oncology" were used to locate apps from the two major mobile marketplaces. These procedures were established in previous research and adopted to help identify relevant apps for study inclusion from the mobile markets.[14] In this study, the term cancer is used broadly for a collection of related diseases in which "abnormal cells divide without control and can invade nearby tissues."[15]

Selection criteria

Relevant smartphone apps available on Google Play and Apple iTunes app stores were considered for inclusion. Apps that were patient oriented and intended for health consumers were included in the study sample (i.e. general public as intended app users; this includes patients, families, caregivers). Only smartphone apps available in the English language that been updated over a 3-year period (2015, 2016, and 2017) were included in the study sample. Both free apps (no cost) and apps for a fee were included. Apps intended for health providers and those not updated within the 3-year timeframe were excluded.

Google Play and iOS app store combined keyword searches identified an initial 481 potential apps (Apple iTunes = 294; Google Play = 187). Out of these, 287 apps were deemed irrelevant and manually removed

from the sample (i.e. keyword search for "cancer" retrieved astrological apps). The remaining 194 apps were further screened. Another 71 apps were removed as duplicate versions with the same app name and developer that appeared across both platforms (Apple iTunes = 46; Google Play = 25). A total of 123 unique apps met inclusion criteria and comprised the study sample (Apple iTunes = 40; Google Play = 83).

Data collection and analysis

Text from app store descriptions was extracted from two leading app marketplaces (Google Play and Apple iTunes app stores) in December 2017. Information was collected on the following variables from the app descriptions: app name, platform (Apple iTunes or Google Play), developer affiliation, cost, date of last update, and interactive features. Ethical approval was not required because data were collected online from the two marketplaces in the public domain. Data were recorded on a Microsoft Excel spreadsheet for analysis and a coding scheme guided content analysis.[16] The coding scheme for the primary function of the apps was adapted from the following seven categories of cancer apps identified by Bender and colleagues:[2]

1. Educational: general information and tools to raise public recognition of cancer as a societal problem; includes descriptions and statistics.
2. Fundraising: tools to attract financial resources.
3. Prevention: information and practical tools to avoid cancer; including the recurrence of cancer.
4. Early detection: information and tools to assist in the identification of cancer before the emergence of symptoms or signs (i.e. breast self-examinations, mole/skin check apps).
5. Disease and treatment information: information about disease or treatment options.
6. Disease management: information and practical tools to deal with the medical, behavioral, or emotional aspects of cancer.
7. Support: access to peer or professional assistance, includes information/photo sharing.

Two researchers (DC and SH) coded the apps based on the narrative text within the online app store descriptions. The established seven categories were applied to all 123 apps in the study to represent the primary function of the apps. Any differences in the groupings of the apps into one of the seven categories were resolved by the two coders until agreement was achieved. Likewise, the type of cancer and interactive features of the apps were also drawn from the text of app descriptions. Coding for interactive features was based on capabilities reported in previous research, such as the ability to track medication usage, schedule appointments, share updates, and connect with health providers.[12] Interactive features of the cancer-focused apps were then descriptively summarized.

App marketplace descriptions were checked for content sources and statements about how information was reviewed. For example, any statements about health provider involvement or oversight of app content were captured. Health providers were defined as individuals working within the healthcare industry, including various medical professionals involved in cancer care.[11]

Findings

A total of 123 apps were identified and comprised the study sample (Apple iTunes = 40; Google Play = 83). Approximately half of the apps in the study sample focused on cancer in general (50%, 62/123). This was followed by apps for breast cancer (15%, 19/123) and skin cancer (7%, 8/123). Table 1 provides a breakdown of the cancer types targeted by the smartphone apps.

Cost (free vs. fee)

Most of the cancer apps were free to download (93%, 115/123) whereas eight (7%, 8/123) required payment. All eight apps for a fee were commercially available. The Apple iTunes store provided 35 apps for free and five apps had a fee (US$2.99–US$6.99). Likewise, the Google Play store had 80 apps available for free of charge and three had costs ranging from US$3.99 to US$28.99.

Date of last update

The study examined apps that had been updated over a 3-year period. App content was last updated in 2017 (76%, 93/123), 2016 (19%, 23/123), and 2015 (6%, 7/123).

Primary function

The primary function of the cancer-focused apps could be summarized using seven key categories. Based on the classification scheme, educational apps were the most predominant (50%, 62/123). This was followed by apps for disease management (12%, 15/123), early detection (10%, 12/123), treatment information (9%, 11/123), support (7%, 9/123), fundraising (6%, 7/123), and prevention (6%, 7/123).

Table 1. Cancer type of apps ($N = 123$).

	Google Play (Android)	Apple iTunes (iOS)	Number of apps (percentage)
Cancer in general	37	25	62 (50%)
Breast	12	7	19 (15%)
Skin	3	5	8 (7%)
Colorectal	4	0	4 (3%)
Pediatric	2	2	4 (3%)
Lung	4	0	4 (3%)
Prostate	4	0	4 (3%)
Throat	3	1	4 (3%)
Kidney	1	1	2 (2%)
Oral/mouth	2	0	2 (2%)
Appendix	1	0	1 (1%)
Balder	1	0	1 (1%)
Bone	1	0	1 (1%)
Brain	1	0	1 (1%)
Cervical	1	0	1 (1%)
Eye	1	0	1 (1%)
Liver	1	0	1 (1%)
Pancreatic	1	0	1 (1%)
Stomach	1	0	1 (1%)
Thyroid	1	0	1 (1%)
Total	83	40	123

App: application.

Table 2. Interactive features of apps for cancer.

Feature	Percentage (number of apps)
Ability to track symptoms, side effects, treatments, and chronic pain	20% (25/123)
Self-exams and skin/mole tracking	10% (12/123)
Ability to track appointments	9% (11/123)
Ability to upload and share photos	4% (5/123)
Ability to connect with health providers	4% (5/123)
Supports sharing updates on social media	4% (5/123)
Ability to share medical records via app	3% (4/123)

App: application.

Interactive features

Apps were further analyzed to assess interactive features. Cancer apps supported overall cancer management with the ability to monitor symptoms, side effects, treatments, and chronic pain (20%, 25/123). A number of cancer apps had self-examinations and skin/mole tracking abilities (10%, 12/123). Apps also supported treatment and aftercare with the ability to track appointments (9%, 11/123). As shown in Table 2, few apps allowed mobile users to upload and share photos (4%, 5/123). The capabilities to share medical records via mobile devices (3%, 4/123) and to connect with health professionals (4%, 5/123) were further minimally supported.

Organizational affiliations and content sources

Regarding organizational affiliations, most cancer apps were developed by commercial entities (90%, 111/123). Pharmaceutical companies, private, and for-profit organizations were included in this group. Only 10% of apps (12/123) identified organizational affiliations other than commercial companies. Out of these, five apps (4%) were associated with medical institutions. Examples of these affiliations included the Dana-Farber Cancer Institute and MD Anderson Cancer Center. Another 4% of the apps (5/123) noted that content was based on the opinion of one individual. Finally, two apps (2%) were affiliated with medical societies (i.e. the American Cancer Society and American Society of Clinical Oncology).

Health provider involvement

Few app descriptions stated if health providers were involved in screening or appraising app content. Only 3% of the app descriptions (4/123) stated content had been developed or evaluated by health providers (i.e. working groups or multiple health providers). For example, apps that stated content was developed and approved by oncologists as well as nutritionists who are registered dietitians were considered to have some level of health provider involvement.

Other features

Out of the 123 apps, 15% (19/123) claimed to offer advice about "cancer fighting foods" and nutrition. Additionally, 7% (9/123) of the apps furnished preventative tips. Another 3% of the apps (4/123) provided a glossary of terms for mobile users.

Discussion

The aim of this study was to assess the state of cancer-focused smartphone apps on the digital health market. The investigation focused attention on interactive features, content sources, developer affiliations, and health provider oversight of app content. This study illuminated a number of important findings.

First, the interactive nature of smartphone apps offers the potential for users to upload photos, post updates, exchange information with peers or family members, and monitor treatment side effects. It was surprising that a limited number of the cancer apps supported tracking appointments, medications, treatments, side effects, and chronic pain. For apps to assist with prevention, detection, and self-management behaviors, apps that focus solely on raising awareness or delivering information about cancer will not be sufficient.[2] To be effective, apps that teach skills for self-management and the social support necessary for the maintenance of the desired behaviors need to be integrated features.[2] Likewise, the ability to post photos and share status updates on social media platforms was also limited. Moreover, there is a need for more app features to support joint decision making as very few cancer apps in the study supported sharing medical records and connecting with a health provider.

Second, very few cancer apps stated that a glossary of terms was available for mobile users. This feature can help define key terms for health consumers looking for cancer-related information and offers the potential to help individuals build their medical vocabulary, yet very few cancer apps provided this feature. Although previous research has noted that breast cancer apps often failed to define words for mobile users,[6] this finding suggests the lack of dictionaries and glossaries may extend more broadly to other cancer apps. A glossary of cancer terms can be an instrumental resource for facilitating consistent information and for clarifying the language used in cancer research and oncology practice.[17]

Third, most cancer apps did not identify organizational affiliations and content sources. The credentials and qualifications of authors or organizations providing content are needed to help health consumers assess the reliability and authority of information. Health information should also have proper attribution and be supported by clear references to scientific evidence.[2,18] To illustrate this point, it was observed that 15% of the cancer apps claimed to provide information about "cancer fighting foods" and nutrition, yet none of these apps provided scientific evidence to support the efficacy of these claims. Any claims or medical advice should be supported and backed up by references to scientific clinical evidence. More transparency about content sources, organizational affiliations, and any financial support is needed to help users assess the quality of app content. This raises a safety concern given that the apps also advertise information for cancer prevention, screening, and treatment.

Finally, there was a significant lack of critically appraised app content. Given that very few app descriptions stated the level of health provider involvement in screening or evaluating app content, this gap could potentially present a challenge for health consumers to identify quality information from cancer apps. App reviews focusing on medication adherence have reported similar findings about the lack of clinically sound information.[11] One approach to ensure quality app content for healthcare consumers is to establish a peer-review process for content such as instituting an advisory board or scientific panel to evaluate app content. Additionally, it was difficult to discern if a participatory process was used in the development and testing of apps based on app store descriptions alone. If a participatory process was employed involving both patients and health providers, then this should be made more explicit in app online store descriptions. Overall, a greater focus on how apps are being used to promote cancer self-management, more indication about the reliability of information, and documentation about how app content is reviewed by health providers is needed.

Recommendations

There are a number of additional recommendations that could help enhance cancer smartphone apps. Inadequate or insufficient online app store descriptions continue to plague the health app marketplace.[1,11] Some researchers have suggested that categorizing apps under the legislation for medical products may be one way to regulate and control app quality.[1] Without any regulations in place at the present time for health apps that provide education or monitor health, one important step would be to improve app store descriptions by providing better documentation about how app content is compiled and evaluated. The American Cancer Society encourages patients to look for information about how health content is compiled to determine if it is based on scientific facts or

unsubstantiated claims.[19] Mobile app marketplace descriptions could incorporate this guidance to more clearly state if health app content is based on research evidence and if content has been reviewed by health providers along with their credentials. As noted above, one approach likely to result in more reliable and higher quality app content is to have a scientific board evaluate the content.

Further, cancer-related knowledge contributes to how individuals understand, appraise, and apply health information to make decisions regarding their healthcare.[20] Mobile apps that include a glossary of clearly defined cancer terms have the potential to help healthcare consumers build knowledge of new concepts and terminologies often used within the oncology community.[17] A final recommendation for app improvement includes more fully utilizing social networking and self-monitoring capabilities.[21] Smartphone apps that leverage social media to provide real-time social support and facilitate the sharing of health-related data with health providers or peers have been reported as key benefits of health apps by mobile users in previous studies.[21–22] Users have also reported that apps providing convenient tools to set goals found these self-tracking features interesting and insightful to monitor their progress.[23]

Limitations and future directions

This study had a few limitations. First, keyword searches for "cancer" and "oncology" were used to identify relevant apps for study inclusion. It is possible that other apps may be useful to individuals with cancer but were not located easily by using these search terms. Analysis was also based on app marketplace descriptions and the study was restricted to the app descriptions provided in the two stores. In addition, the cancer apps were not downloaded and tested. A more thorough app evaluation would be useful in future studies. Nevertheless, this exploratory study provides a useful foundation for future research activities. Future research could examine the usability of the apps and accuracy of medical content. Focus groups could provide insight into navigation and other usability features of the cancer apps. Likewise, a panel of health experts could assess the quality of medical content for apps based on the best available clinical evidence.

Conclusions

The aim of this review was to characterize the state of cancer-focused smartphone apps for healthcare consumers. Among the 123 apps for cancer, education was the largest category for the primary function of the targeted apps followed by disease management.

Interactive features of cancer apps included the ability to track appointments, share medical records, or connect with a health provider. However, these interactive features were not fully utilized and there is room for more improvement in this regard to support self-monitoring functions. Content sources were not consistently identified and very few cancer apps on the marketplace indicated health provider oversight of app content. These findings have implications for information quality and supportive resources for cancer care. To improve resources for smartphone users, more comprehensive information about both organizational affiliations and the level of health provider involvement or oversight would be enhancements to the digital health marketplace.

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