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Research Paper

A biopsy of Breast Cancer mobile applications: state of the practice review

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ABSTRACT

Background: Breast cancer is the most common cancer in women. The use of mobile software applications for health and wellbeing promotion has grown exponentially in recent years. We systematically reviewed the breast cancer apps available in today's leading smartphone application stores and characterized them based on their features, evidence base and target audiences.

Methods: A cross-sectional study was performed to characterize breast cancer apps from the two major smartphone app stores (iOS and Android). Apps that matched the keywords "breast cancer" were identified and data was extracted using a structured form. Reviewers independently evaluated the eligibility and independently classified the apps.

Results: A total of 1473 apps were a match. After removing duplicates and applying the selection criteria only 599 apps remained. Inter-rater reliability was determined using Fleiss-Cohen's Kappa. The majority of apps were free 471 (78.63%). The most common type of application was Disease and Treatment information apps (29.22%), Disease Management (19.03%) and Awareness Raising apps (15.03%). Close to 1 out of 10 apps dealt with alternative or homeopathic medicine. The majority of the apps were intended for patients (75.79%). Only one quarter of all apps (24.54%) had a disclaimer about usage and less than one fifth (19.70%) mentioned references or source material. Gamification specialists determined that 19.36% contained gamification elements.

Conclusions: This study analyzed a large number of breast cancer-focused apps available to consumers. There has been a steady increase of breast cancer apps over the years. The breast cancer app ecosystem largely consists of start-ups and entrepreneurs. Evidence base seems to be lacking in these apps and it would seem essential that expert medical personnel be involved in the creation of medical apps

1. Introduction

Breast cancer is the most common cancer in women both in the developed and less developed world [1]. It is estimated that worldwide over 508 000 women died in 2011 due to breast cancer [1]. Incidence rates vary greatly worldwide, ranging from 27 per 100,000 in Middle Africa and Eastern Asia to 92 in Northern America and 89 in Western Europe [2]. Low incidence rates from less developed regions however are probably due to a lack of early detection programmes. Fortunately, thanks to advancements in treatments, breast cancer survivorship is on a steady rise [3,4] and this cancer is no longer thought of as an acute illness but rather a chronic condition. This means that we need to treat breast cancer as such, with a focus on long term goals and wellbeing promotion [5]. Breast cancer survivors must be aware of the long-term consequences of their treatment and be given information to encourage a proactive approach to their overall health [5,6]. Many authors now claim that the ever increasing number of breast cancer survivors require new models of care. These models should include a personalized needs assessment; a self-management based care approach as well as individualized follow-up and support [7]. Also, the rising cost of

Abbreviations: App, mobile software application; Avg, average; CI, confidence Interval; DG, Diego Hernán Giunta; EG, Estefanía Guisado-Fernández; GG, Guido Giunti; IQR, interquartile range; JLB, Jackie Bender; LF, Luis Fernández-Luque; mHealth, mobile health; OS, operating system; SHF, Santiago Hors-Fraile; SE, standard error

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healthcare presents a compelling argument for developing more effective health education and communication strategies aimed at improving health outcomes [8,9].

Connected Health is a healthcare delivery model that aims to maximize healthcare resources and provide increased, flexible opportunities for patients to engage with clinicians and better self-manage their care using technology [10]. The use of mobile software applications (apps) for health and wellbeing promotion has grown exponentially in recent years [11]. Between 2013 and 2014 the global use of smartphones increased by 406 million, reaching 1.82 billion devices (up 5% in a year), and Internet usage via mobile devices has increased by 81% in one year [12]. Mobile health (mHealth) is defined as the delivery of healthcare or health related services through the use of portable devices [13]. There are currently thousands of healthcare related mobile software applications (mHealth apps) available through app stores [14]. This rapid proliferation of mHealth apps makes it increasingly difficult for users, health professionals, and researchers to identify and assess which apps may be helpful and which may be ineffective or even harmful. Concerns regarding the absence of healthcare professionals involvement in app development has been raised time and time again [15–19].

Bender et al. [20] published a review in 2013 exploring the distribution of cancer mHealth apps across the four major smartphone platforms at that time, which found that most apps (45%) focused on breast cancer. The focus of this review, however was only to assess apps for the general public. Another review published in 2014 [21] targeted apps related to breast disease but it did not provide in depth study of apps focused on breast cancer. Moreover, the past few years have seen a dramatic change in manufacturers and operating system (OS) market share, with some big players having almost disappeared today (ie: Symbian [22]). Finally, the use of game elements in non-game contexts, commonly called gamification [23] has been gaining traction in health apps and is now a popular strategy in both commercial and academic fields [24–27], however current gamification prevalence in breast cancer apps is unknown.

We systematically reviewed the breast cancer apps available in today's leading smartphone app stores and characterized them based on their features, evidence base and target audiences.

2. Methods

2.1. Study design

A cross-sectional study of breast cancer apps was performed to characterize apps from the two major smartphone app stores: iTunes App and Google Play Store, which together represent more than 98.9% of the smartphone app market share [22]. Building upon the approach used by Bender [20] we systematically searched both stores to identify all relevant apps and provide a systematic presentation and synthesis of the characteristics of the apps.

2.2. Setting

On February 24th 2016, we searched both stores from the United States using the keywords "breast cancer". The iTunes App Store is a digital distribution platform developed and maintained by Apple Inc., for mobile apps on iOS. The iTunes App Store had 2 million apps available as of June 2016 since its launch in 2008 [28]. Google Play store (originally the Android Market) is a digital distribution service operated and developed by Google. It serves as the official app store for the Android operating system. The Google Play store reached over 2.2 million apps as of June 2016 since its launch in 2008 [28]. We downloaded all apps that partially or fully matched the keywords using the software application for audience targeting called 42matters [29].

2.3. Selection criteria

Apps were included if the title and/or store description of the app was about breast cancer or breast cancer conditions, or cancer in general, but contained specific mentions about breast cancer. A small random sample (10%) was independently reviewed by two reviewers with ample mHealth experience (GG and JLB) who evaluated the eligibility of the apps against the selection criteria. In order to assess clarity of the selection criteria, inter-rater reliability was assessed using Fleiss-Cohen's Coefficient. Basic and "premium" versions of the same app were considered as separate apps as were versions of the same app for different operating systems. This distinction was considered because of the phenomenon of mobile device fragmentation in which different versions of the same app must co-exist due to version capabilities or store submission processes. This distinction is also common practice in this type of systematic app reviews [20,30]. Disagreements were resolved by consensus involving a third reviewer when necessary.

2.3.1. Inclusion criteria

- title and/or description is about breast cancer or breast cancer related conditions
- title and/or description is about cancer in general but contains information about breast cancer

2.3.2. Exclusion criteria

- description is not written in English
- duplicates from the same store
- title and/or description is not about breast cancer (ie. astrology, breastfeeding, breast augmentation, chicken breast recipes, etc.)
- title and/or description is about other specific type of cancer (ie. Pancreatic Cancer App)

2.4. Data extraction

Data was automatically extracted from the store description of the app using the software application 42matters. Data extracted included app information on: year of release, costs, downloads, ratings, title of app, app description, categories, tags, languages, app websites, screenshots, etc.

GG and EG independently manually reviewed that information extracted using structured forms by reading the store descriptions and websites of the app that had unclear store descriptions or did not provide screenshots to extract information on: origin (eg, healthcare related agencies, non-governmental organizations, universities, etc), evidence base, features and intended audiences.

2.5. Data coding and classification

Apps were classified based on their main purpose as described in the store description into only one category following Bender et al. [20] classification and our own scheme. If the purpose of the app was not clear from the description, a proper classification was discussed among reviewers until consensus was reached. To ensure classification quality, another randomly produced sample (10%) was selected from the list of included apps and two reviewers with ample mHealth experience (GG and EG) classified them. Inter-rater reliability was once again assessed using Fleiss-Cohen's Coefficient.

2.5.1. Application purpose

The application purpose classification scheme follows the work done by Bender et al. [20]:

- Awareness-raising: tools to raise public recognition of cancer as a societal problem.