

Original Paper

# Assessing the Quality, Privacy, and Security of Breast Cancer Apps for Arabic Speakers: Systematic Search and Review of Smartphone Apps

Dari Alhuwail<sup>1,2</sup>, PhD; Aisha Alhouti<sup>1</sup>, MSc; Latifah Alsarhan<sup>1</sup>, BS

<sup>1</sup>Information Science Department, College of Life Sciences, Kuwait University, Sabah AlSalem University City, Kuwait

<sup>2</sup>Health Informatics Unit, Dasman Diabetes Institute, Dasman, Kuwait

**Corresponding Author:**

Dari Alhuwail, PhD

Information Science Department

College of Life Sciences

Kuwait University

P.O. Box 5969

Sabah AlSalem University City, Safat 13060

Kuwait

Phone: 965 24633214

Email: [dari.alhuwail@ku.edu.kw](mailto:dari.alhuwail@ku.edu.kw)

## Abstract

**Background:** Breast cancer is a widespread disease, and its incidence is rapidly increasing in the Middle East and North Africa region. With the increasing availability of smartphone apps for various health purposes, breast cancer apps have emerged as tools for raising awareness, providing support, and empowering women affected by this disease. These apps offer many features, including information on breast cancer risk factors, self-examination guides, appointment reminders, and community support groups or hotlines. Using apps raises the risk of privacy and security issues, and we hope that examining these features of the apps will contribute to the understanding of how technology can be used to improve these apps and provide insights for future development and improvement of breast cancer apps.

**Objective:** This study aims to critically review the quality, privacy, and security of breast cancer apps available to Arabic speakers.

**Methods:** Similar to several recent studies, we used a systematic search for apps available in Google Play and Apple App stores using both the web interface and the built-in native stores installed on smartphones. The search was conducted in mid-December 2022 in Arabic using the following keywords: – – – – – (breast cancer, breast cancer treatment, breast cancer disease, breast cancer symptoms, breast cancer screening, and breast test). These preidentified search terms are based on earlier work concerning the top searched breast cancer topics by Arabic speakers through Google's search engine. We excluded apps that did not have an Arabic interface, were developed for non-Arabic speakers, were paid, needed a subscription, or were directed toward health care workers. The Mobile App Rating Scale was used to evaluate the quality of the apps concerning their engagement, functionality, aesthetics, and information. A risk score was calculated for the apps to determine their security risk factors.

**Results:** Only 9 apps were included, with most (6/9, 67%) being supported by advertisements and categorized as informational. Overall, the apps had low numbers of downloads (>10 to >1000). The majority of the included apps (8/9, 89%) requested dangerous access permissions, including access to storage, media files, and the camera. The average security score of the included apps was 3.22, while only 2 apps provided information about data security and privacy. The included apps achieved an overall average quality score of 3.27, with individual dimension scores of 4.75 for functionality, 3.04 for information, 3.00 for aesthetics, and 2.32 for engagement.

**Conclusions:** The limited availability of breast cancer apps available to Arabic speakers should be a call to action and prompt health care organizations and developers to join forces and collaboratively develop information-rich, usable, functional, engaging, and secure apps.

(*JMIR Cancer* 2024;10:e48428) doi: [10.2196/48428](https://doi.org/10.2196/48428)

**KEYWORDS**

apps; Arabic; awareness; breast cancer; consumer health informatics; education; mHealth; mobile health; privacy; quality; security; smartphone; women

## *Introduction*

Female breast cancer is among the most commonly diagnosed cancers worldwide, with a rate of approximately 2.3 million new cases [1]. Over the past decade, breast cancer incidence has been on the rise in the Middle East and North Africa (MENA) region [2]. Breast cancer is the most frequently diagnosed cancer (17.7%-19% of all types of cancer) in the region [3], and it accounts for 30% of all cancer cases [4]. The lack of cancer education and barriers to cancer screening are seen as major health problems [5]. Education is one of the most effective tools in the fight against female breast cancer; it can have positive effects on women's practices, attitudes, and knowledge of the disease [6]. However, recent studies suggest a lack of resources and poor awareness of breast cancer in women in the MENA region [7]. While the digital delivery of health education content has been on the rise through different digital media (eg, websites and social media), the quality of Arabic content for female breast cancer remains poor [8-10].

Smartphone proliferation, ubiquity, and affordability, as well as the increasing availability of mobile apps, may be the long-awaited for "digicentials" or digital therapeutics [11-13]. Today, the number of health apps in smartphone app stores exceeds 325,000 [14] and will continue to rise, with estimates of more than 200 apps being added daily to app stores [15], covering a wide spectrum of health purposes, such as well-being, education, and disease management, including chronic conditions [16]. Several apps are available that can help individuals with breast cancer manage their condition. These apps have been used for the purposes of education [17-19], care management [20,21], prevention [22-24], and well-being [25,26]. These apps can be a valuable resource for individuals with breast cancer, helping them stay informed and connected to their care team and manage the symptoms and challenges associated with the disease.

The use of mobile health (mHealth) apps contributes to improving health literacy and facilitating communication between patients and their care providers [27]. Moreover, it improves patient well-being and helps caregivers make informed clinical decisions [28]. In fact, the use of such apps not only benefits patients while receiving treatment but also provides tools such as follow-up care and self-management for breast cancer survivors [29]. Patients' need for self-management techniques is crucial, as it helps them to make their lives better by complying with the treatment needed and, as a result, accepting the disease [30].

However, despite the high number of downloads and star ratings of health apps, including those specifically targeting breast

cancer, several challenges remain with respect to their quality and security. Evidence from the literature reports on the existence of poor-quality health apps that fall short with respect to (1) following evidence-based health guidelines and best practices, (2) involving experts and consumers in their development, and (3) demonstrating effectiveness based on empirical evidence, all of which ultimately can be potentially harmful to their users [14,31-33].

Additionally, health apps have been facing critical challenges related to their privacy, confidentiality, and security [14,34,35], especially given their nature of handling sensitive, personal, and health-related data [36]. These challenges have been magnified with the rise of cyberattacks through apps and mobile devices [37] and further highlighted by recent regulations such as the General Data Protection Regulation for member states of the European Union [38]. Such a regulation assesses the privacy score of mobile apps and identifies or measures apps' privacy based on 14 components [39].

As the uptake of these apps increases, it becomes imperative for users to evaluate their quality and safety [40]. Despite the high prevalence of breast cancer among the population of the MENA region, evidence regarding the quality, privacy, and security of breast cancer apps available to Arabic speakers remains poor. This study aimed to conduct a systematic assessment of mobile breast cancer apps available for Arabic speakers to evaluate their functionality, quality, security, and data safety. To the best of our knowledge, no previous study has addressed this gap.

## *Methods*

### **Overview**

Using a similar approach to several recent studies [41-45] and to ensure scientific rigor, this study conducted a systematic search and content analysis of mobile breast cancer apps available for Arabic speakers. We searched both Google Play and Apple App stores between December 18 and 24, 2022.

### **Search Strategy**

Initially, we used the Arabic search terms highlighted in [Table 1](#) to search Google Play and Apple App stores. These search terms were selected based on earlier work that was published concerning the top searched breast cancer topics by Arabic speakers using Google's search engine [8]. To ensure rigor, the researchers searched the app stores both through (1) the web interface and (2) natively on devices running the relevant operating system, thus mimicking how end users will discover such apps.

**Table 1.** The terms used to search for breast cancer apps available to Arabic speakers and their English translations.

Arabic term	Translated term
	Breast cancer
	Breast cancer screening
	Breast cancer treatment or therapy
	Breast cancer detection or screening
	Breast cancer disease
	Symptoms of breast cancer
	Breast screening

## Eligibility

App eligibility was determined by 2 independent researchers blinded to each other's decisions, and the apps were initially screened based on the app's name, the provided screenshots, and the app's description. Discrepancies between researchers were resolved through consensus. Apps were included if they

were free of charge, provided content and support for Arabic speakers, and were designed for use by consumers or patients; all apps were considered regardless of release or last update dates (Textbox 1). Apps were excluded if they were paid or were subscription-based, did not support Arabic speakers, or were designed for use by clinicians or health care workers.

**Textbox 1.** Inclusion and exclusion criteria for the apps.

<p><b>Inclusion criteria</b></p> <ul style="list-style-type: none"> <li>• Free of charge</li> <li>• Available on Google Play or Apple App store</li> <li>• Designed for use by consumers or patients</li> <li>• Support Arabic speakers</li> <li>• Considered regardless of release or last update dates</li> </ul> <p><b>Exclusion criteria</b></p> <ul style="list-style-type: none"> <li>• Paid or subscription based</li> <li>• Designed for use by clinicians or health care workers</li> <li>• Does not support Arabic speakers</li> </ul>
--

## Data Extraction and Evaluation

Initially, all information provided by the app developers in the app stores was extracted to evaluate the descriptive features and the general characteristics of the included apps, which included the platform, developer name, update date, ratings, number of reviews, number of downloads, app category, and app permissions, as reported by the app developers. Afterward, 2 independent researchers downloaded the apps on their smartphones to assess the quality and privacy risks of the included apps.

We evaluated the quality of the included apps using a standardized form, the Mobile App Rating Scale (MARS), focusing on the following 4 dimensions: engagement, functionality, aesthetics, and information quality [46,47]. All scores were compared among 2 researchers, and the average score for each dimension was reported. To evaluate the apps' privacy risks, we assigned scores to the permissions requested by the apps as reported by the app developers. The scores were informed by previous research, where the score risk is 0 for nonthreatening, 0.5 for potentially threatening, and 1 for threatening permissions [48]. Such permissions include access

to restricted data, such as system state and user contact information, and restricted actions, such as connecting to a paired device and recording audio [49]. The 2 researchers independently carried out this evaluation and were unaware of each other's scores; any discrepancies were resolved through consensus.

## Results

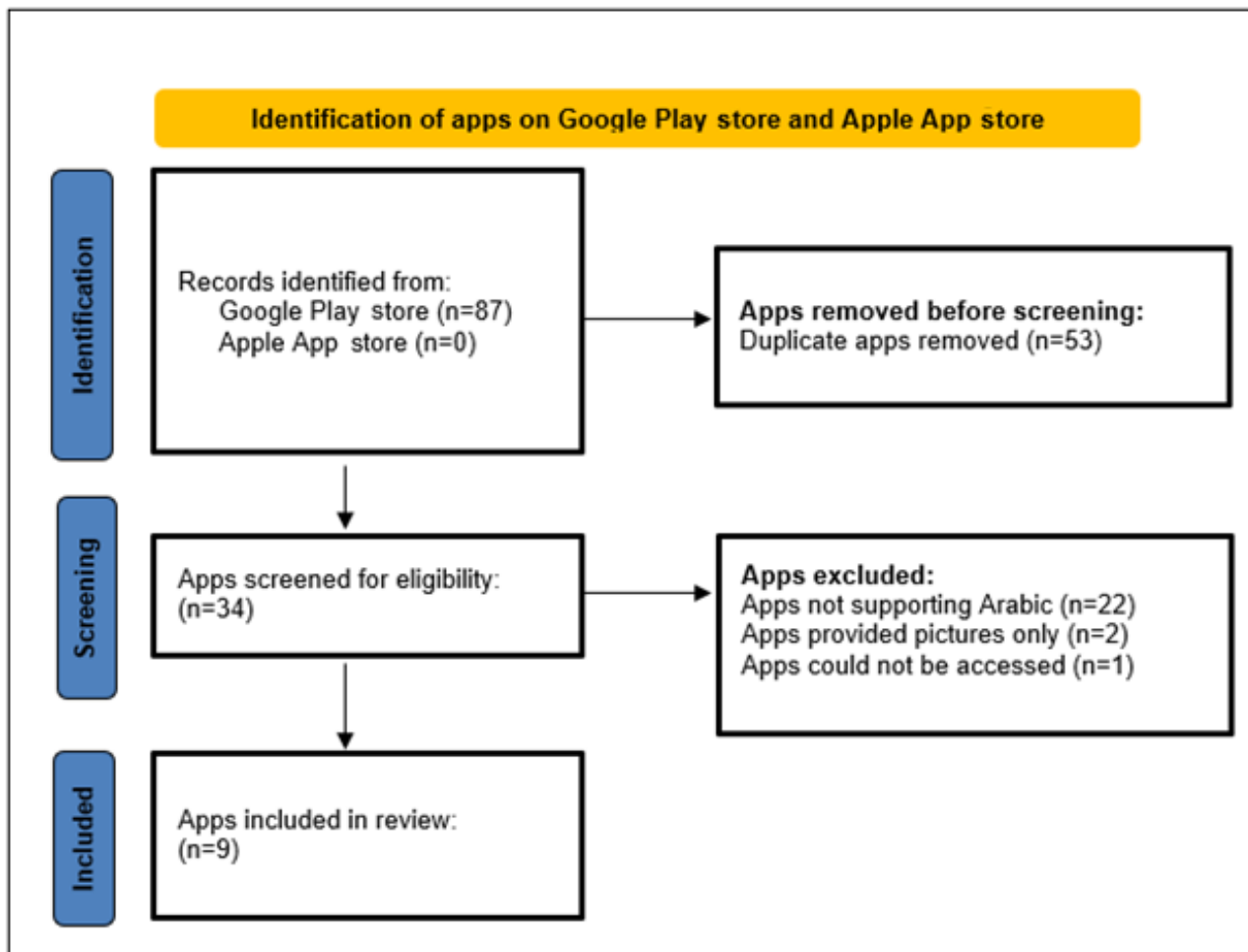
### Overview

The researchers followed the systemic steps, highlighted in Figure 1, resulting in the inclusion of 9 apps, all of which are Android apps found on the Google Play store.

Overall, the included apps were indicated to be appropriate for all ages and were either in the medical, education, lifestyle, personalization, or health and fitness categories as per Google Play store categorization (Table 2). Our investigation suggests that the apps were all informational in nature, mainly providing information about breast cancer. None of the included apps had a language option to make it available in more than 1 language.

At the time of data collection, the results show that the included apps had low overall downloads (>10 to >1000) and more than half (6/9, 67%) were supported by advertisements. Only 5 apps had reviews, with an average of 10.60 reviews and an average star rating of 4.78. Only 1 app was last updated in 2019, while the remaining apps were updated in the past 2 years.

**Figure 1.** The flow diagram of the systematic search process to identify the relevant apps.



**Table 2.** Characteristics of the included breast cancer apps in the Google Play store.

App number <sup>a</sup>	Stars	Reviews, n	Advertisement supported	Downloads, n	Rating <sup>b,c</sup>	Updated on <sup>d</sup>	Category <sup>b</sup>
1	5	10	No	>100	3+	May 11, 2021	Medical
2	4.9	23	Yes	>1000	3+	July 26, 2019	Medical
3	— <sup>e</sup>	—	Yes	>100	3+	April 18, 2020	Health and fitness
4	4.2	6	Yes	>1000	3+	November 3, 2020	Education
5	5	8	No	>500	3+	May 11, 2021	Medical
6	4.8	6	No	50	3+	July 11, 2022	Medical
7	—	—	Yes	500	3+	August 9, 2021	Lifestyle
8	—	—	Yes	10	3+	October 8, 2022	Personalization
9	—	—	Yes	10	3+	October 8, 2022	Personalization

<sup>a</sup>Arbitrary number to mask app name.

<sup>b</sup>Based on Google Play store.

<sup>c</sup>Content of apps considered suitable for age group indicated per Google Play store rating.

<sup>d</sup>At data collection.

<sup>e</sup>Not available.

### App Permissions and Controls

As described in the Google Play store, the majority of the included apps (8/9, 89%) were requesting dangerous access permissions, including access to storage, media files, and camera permissions (Table 3). Additional permissions were exposed after the researchers downloaded the apps on the testing devices. These permissions included receiving data from the internet; viewing network connections; having full network access; running at start-up; controlling flashlight and vibration; preventing the device from sleeping; reading badge notifications; running foreground services; advertising permissions; reading location from media; playing and installing referrer application programming interface; and lastly, pairing with Bluetooth

devices (Table S1 in Multimedia Appendix 1). The researchers considered all permissions and added them up to calculate the final risk score (Table 4).

On average, the security score for the included apps is 3.22 (total points possible: 9.5). The security scores ranged between 0 and 7.5; only 2 apps had a total security score of 0. The apps requested potentially dangerous permissions, namely full network access, advertising ID permission, read location from media collection, precise location (GPS and network-based), take pictures and videos, read the contents of the USB storage, modify or delete the contents of the USB storage, and view Wi-Fi connections.

**Table 3.** Included apps' permissions as described in the Google Play store.

App number	Location		Camera	Photos and media		Storage		Wi-Fi connection
	Approximate location (network based)	Precise location (GPS and network based)	Take pictures and videos	Read the contents of your USB storage	Modify or delete the contents of your USB storage	Read the contents of your USB storage	Modify or delete the contents of your USB storage	View Wi-Fi connections
1								
2								✓
3	✓	✓	✓	✓	✓	✓	✓	✓
4								
5								
6			✓				✓	✓
7							✓	✓
8								
9								

**Table 4.** The security score per app based on its permissions requested or declared.

Permission	Weight <sup>a</sup>	App								
		1	2	3	4	5	6	7	8	9
Receive data from the internet	0.5	0	0	1	1	0	1	1	1	1
View network connections	0.5	0	1	1	1	0	1	1	1	1
Full network access	1	0	1	1	1	0	0	1	1	1
Run at start-up	0	0	0	1	1	0	1	1	1	1
Control flashlight	0	0	0	1	0	0	0	0	0	0
Control vibration	0	0	0	1	1	0	1	1	1	1
Prevent device from sleeping	0	1	0	1	1	0	1	1	1	1
Read badge notification	0	0	0	0	1	0	1	1	1	1
Run foreground service	0	0	0	0	1	0	0	1	1	1
Advertising ID permission	1	0	0	0	0	0	1	0	1	1
Read location from media collection	1	0	0	0	0	0	1	1	0	0
Play install referrer API <sup>b</sup>	0	0	0	0	0	0	1	1	0	0
Pair with Bluetooth devices	0	0	0	0	0	0	1	1	0	0
Approximate location (network-based)	0.5	0	0	1	0	0	0	0	0	0
Precise location (GPS and network-based)	1	0	0	1	0	0	0	0	0	0
Take pictures and videos	1	0	0	1	0	0	1	0	0	0
Modify or delete the contents of your USB storage	1	0	0	1	0	0	0	0	0	0
Read the contents of your USB storage	1	0	0	1	0	0	1	1	0	0
Modify or delete the contents of your USB storage	1	0	0	1	0	0	0	0	0	0
View Wi-Fi connections	1	0	1	1	0	0	1	1	0	0
Total security score per app	9.5	0	2.5	7.5	2	0	6	5	3	3

<sup>a</sup>The threat weight was calculated following the guidance provided by Olmstead and Atkinson [48].

<sup>b</sup>API: application programming interface.

## Data Safety

Only 3 apps provided information about data safety and how the data are handled (Table S2 in [Multimedia Appendix 1](#)). Specifically, only 2 apps reported not sharing user data with other companies or organizations; the same apps reported that their apps do not collect user data. On the other hand, only 1 reported sharing information such as location, health and fitness messages, as well as photos and videos. The 3 apps that declared information about data safety reported that the data are encrypted in transit. Only 1 app reported that the users can request to delete the data.

## Apps' Quality Rating

The researchers used MARS to evaluate the included apps' quality. MARS uses 4 dimensions to assess the apps: engagement, functionality, aesthetics, and information. The average overall score rating of the included apps was 3.27 (Table 5). Notably, the evaluation showed that all the apps had a high rate in the functionality dimension, where they all scored 4.75; as for the engagement dimension, all apps had a meager score with an average of 2.32. Considering the other 2 dimensions, aesthetics and information, we can see that the scores vary between apps, where some have a high score and others have a low score, with an average of 3.00 and 3.04, respectively.

**Table 5.** Mobile App Rating Scale evaluation for Arabic breast cancer apps.

App number	Engagement	Functionality	Aesthetics	Information	Overall
1	2.30	4.75	3.67	3.87	3.60
2	2.40	4.75	3.00	3.00	3.30
3	2.40	4.75	3.00	2.25	3.10
4	2.40	4.75	3.33	2.50	3.20
5	2.40	4.75	3.33	3.50	3.50
6	2.40	4.75	3.67	4.00	3.70
7	2.20	4.75	3.00	2.75	3.20
8	2.20	4.75	2.00	2.75	2.90
9	2.20	4.75	2.00	2.75	2.90
Total mean score	2.32	4.75	3.00	3.04	3.27

## Discussion

### Principal Findings

To the best of our knowledge, this work summarizes the most extensive collection of the currently available free-of-charge breast cancer apps for Arabic speakers on the Google Play and Apple App stores. Interestingly, this systematic investigation reveals that, at the time of data collection, no breast cancer apps were identified as available to Arabic speakers in the Apple App store. Additionally, none of the apps at the time of data collection provided language options, which can hinder the possibility of translating to multiple languages. Overall, the results of this research showed a lack of breast cancer apps available to Arabic speakers compared to apps available in Turkish [50] and Korean [51] for example.

The analyzed apps in this study are available for free, with the majority of these apps (6/9, 67%) being supported by advertisements. The apps varied in what they are able to access and control on the devices, as shown in Table 3. A total of 44% (4/9) apps use Wi-Fi, 33% (3/9) can access the device's storage, 22% (2/9) have access to the device's camera, and 11% (1/9) are able to access the media as well as the location. Only 33% (3/9) of the apps stated how the collected data would be used (Table S2 in Multimedia Appendix 1), while the rest of the apps did not specify any information.

The results of this study demonstrate that the quality of the considered apps is highly "functional" but less "engaging" (Table 5). The average overall score rating of the included apps (3.27) is slightly above average, suggesting that the majority of the apps may not be considered exceptional by consumers. While there seem to be positive aspects to the included apps, there is still room for improvement. Considering Arabic content related to breast cancer, recent evidence suggests the low quality of informational videos available on YouTube despite the high number of views [9]. Our findings provide evidence suggesting that nearly average-quality information content about breast cancer is available to Arabic speakers.

A recent Spanish study tested 6 apps (2 on iOS, 5 on Android, and 1 on both) using the MARS framework. The results of the study showed relatively diverse scores, with an objective quality

mean score of 3.06 and a subjective quality mean score of 1.96 [52]. Another study evaluated the quality of mHealth apps for educational purposes in Iran using the MARS framework. The study reported a mean score of 4.01 for quality and 3.08 for subjective quality [53]. Turkish apps were also evaluated using the MARS framework, and the study found an average score of 3.31 [50], which is similar to the Spanish study's results.

Although many research papers have addressed the importance of using mHealth apps to improve patients' health, provide educational materials, enhance communication between patients and caregivers, and achieve a successful recovery, these studies have stated that such apps are exposed to several challenges and threats as well. For instance, middle- and high-income households had more access to the internet on their mobile devices compared to those with low incomes [28]. Therefore, patients and caregivers who have no or limited access to the internet may not be able to use the app's features effectively, or they might not prefer to use a mobile phone for health-related purposes in general.

Another concern is that the process of storing and transferring personal health data through a mobile app could be insecure and might cause serious security and privacy issues [28,54]. Thus, mobile apps should be designed to accommodate a wide range of possible users while considering health knowledge, different levels of cultural needs, and linguistic requirements. Additionally, recent research suggests that assessing the apps' quality, safety, and usability by involving patients and health care professionals will result in an ideal app that meets patients' requirements and enhances the app's overall safety as well [20].

The literature on breast cancer smartphone apps suggests that these apps can be a valuable resource of information for individuals with the disease [55]. These apps provide information on treatment options, support groups, and local resources. The apps also allow individuals to track their symptoms, set reminders for appointments, and record their progress throughout treatment [56]. Such features can significantly contribute to enhancing patients' well-being [57]. Additionally, studies have found that these apps can improve communication with health care providers and improve self-efficacy and quality of life [30,58]. However, it is important to note that the quality and accuracy of the information provided

by these apps can vary, and it is recommended to consult with a health care professional before using any app for managing a medical condition.

A recent study on breast health and breast cancer apps notes that although apps appear to be competitive and useful for patients, some major features have to be considered while developing these apps [59]. The features include notifications, reminders, symptoms tracking, and recording. The study also suggests designing the apps to be user-friendly, even for low-literacy patients, by adding an audio feature (text-to-speech). Developing features with audio support will not only help patients with low literacy but can also support multiple languages.

## Recommendations and Implications for Practice

### *Privacy and Security*

We would recommend that the developers of the apps be more transparent and state how the data will be used and that they should not have access to unnecessary data. We recommend that future breast cancer apps be available to Arabic speakers to justify the need for the permissions requested while also transparently disclosing the data safety handling measures to the app users. Security and privacy of apps are considered major requirements as they are accountable for sensitive patient data such as prescriptions, treatments, etc. Thus, to come up with robust apps that could ensure privacy and security appropriately, more evaluation techniques, as well as security mechanisms, should be analyzed and implemented on Arabic apps, in particular, to assess, measure, and control the apps' security and privacy [60].

### *Quality and Engagement*

Involving patients and health professionals in the app design phase is crucial. Several studies have addressed the idea that health applications should be developed and designed based on the combined efforts of health professionals, related academics, and patients [61]. To raise the quality of breast cancer apps, the inclusion of utility features such as appointment booking for mammograms and web-based consultations becomes necessary. In addition, it is recommended to improve health apps' engagement by focusing on specific components such as personalized content, data visualization, reminders and notifications, educational material, self-management functions, and goal-setting features [62]. Providing users and patients with proper communication features and a well-designed interface leads to an ideal user experience as a result [30].

---

## Data Availability

All data generated or analyzed during this study are included in this paper and its supplementary information files.

---

## Authors' Contributions

DA conceptualized the study design and supervised the study. DA and AA participated in data assembly, analysis, and interpretation, and in the writing of the paper. LA contributed to data interpretation and in the writing of the paper. All authors read and approved the final paper.

---

## Conflicts of Interest

None declared.

## Study Strengths and Limitations

Similar to other studies, a rigorous multistep methodology mimicking systematic reviews is used in this study to assess the breast cancer apps that are available to Arabic speakers. Apps were thoroughly searched through both the web interface as well as the app stores natively on the devices, mimicking how end users will discover such apps. While the results provide an indication of the quality of the evaluated apps, additional investigations are required to consider patients' perspectives about their views about the quality as well as the utility of such apps. Future studies can also involve rigorous assessments with respect to the security measures applied by breast cancer apps available to Arabic speakers.

This study only considered the publicly available apps and may have missed apps that are "prescribed" to patients or consumers or those that are developed locally by health care organizations. Another limitation, which is inherent to the search strategy used in this work as well as similar other work [63], is the fact that the search algorithms used by the app stores are nontransparent and can change without the public's knowledge, potentially undermining the reproducibility of the outcomes. Lastly, the current state of the results as revealed by this work is likely to change quite rapidly since apps are regularly released, updated, and retired.

## Conclusions

The battle against breast cancer is not over yet, and breast cancer apps can serve as valuable resources in this ongoing fight. The results of this systematic and thorough examination of breast cancer apps available for Arabic speakers reveal their limited existence at the time of study. The investigations evaluated these apps through the lenses of quality, privacy, and security, revealing that the included apps are rated as highly "functional" but at the same time are less "engaging." The investigations also reveal that some apps were accessing unnecessary data and collecting information that was not relevant to the purpose of the app.

Developers of breast cancer apps that cater to Arabic speakers must focus on consumers' preferences, demographics, usability, and the interface of their apps, as well as enhance measures and mechanisms of privacy and security for their apps. The low number of breast cancer apps available to Arabic speakers, as revealed in this study, should be a call to action for many health care organizations and developers to collaboratively develop information-rich, usable, functional, engaging, and secure apps.



## Multimedia Appendix 1

Included apps' declared permission and safety declarations.

[\[DOCX File , 17 KB-Multimedia Appendix 1\]](#)

## References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2021;71(3):209-249. [FREE Full text] [doi: [10.3322/caac.21660](https://doi.org/10.3322/caac.21660)] [Medline: [33538338](https://pubmed.ncbi.nlm.nih.gov/33538338/)]
2. Hashim MJ, Al-Shamsi FA, Al-Marzooqi NA, Al-Qasemi SS, Mokdad AH, Khan G. Burden of breast cancer in the Arab world: findings from Global Burden of Disease, 2016. *J Epidemiol Glob Health*. 2018;8(1-2):54-58. [FREE Full text] [doi: [10.2991/j.jegh.2018.09.003](https://doi.org/10.2991/j.jegh.2018.09.003)] [Medline: [30859788](https://pubmed.ncbi.nlm.nih.gov/30859788/)]
3. Fearon D, Hughes S, Brearley SG. Experiences of breast cancer in Arab countries. a thematic synthesis. *Qual Life Res*. 2020;29(2):313-324. [FREE Full text] [doi: [10.1007/s11136-019-02328-0](https://doi.org/10.1007/s11136-019-02328-0)] [Medline: [31646417](https://pubmed.ncbi.nlm.nih.gov/31646417/)]
4. Johnson RH, Anders CK, Litton JK, Ruddy KJ, Bleyer A. Breast cancer in adolescents and young adults. *Pediatr Blood Cancer*. 2018;65(12):e27397. [FREE Full text] [doi: [10.1002/pbc.27397](https://doi.org/10.1002/pbc.27397)] [Medline: [30156052](https://pubmed.ncbi.nlm.nih.gov/30156052/)]
5. AlHarthi FS, Qari A, Edress A, Abedalthagafi M. Familial/inherited cancer syndrome: a focus on the highly consanguineous Arab population. *NPJ Genom Med*. 2020;5:3. [FREE Full text] [doi: [10.1038/s41525-019-0110-y](https://doi.org/10.1038/s41525-019-0110-y)] [Medline: [32025336](https://pubmed.ncbi.nlm.nih.gov/32025336/)]
6. Alsaraireh A, Darawad MW. Impact of a breast cancer educational program on female university students' knowledge, attitudes, and practices. *J Cancer Educ*. 2019;34(2):315-322. [doi: [10.1007/s13187-017-1304-6](https://doi.org/10.1007/s13187-017-1304-6)] [Medline: [29230686](https://pubmed.ncbi.nlm.nih.gov/29230686/)]
7. Madkhali NA, Santin O, Noble H, Reid J. Breast health awareness in an Arabic culture: a qualitative exploration. *J Adv Nurs*. 2019;75(8):1713-1722. [doi: [10.1111/jan.14003](https://doi.org/10.1111/jan.14003)] [Medline: [30895639](https://pubmed.ncbi.nlm.nih.gov/30895639/)]
8. Jasem Z, AlMeraj Z, Alhuwail D. Evaluating breast cancer websites targeting Arabic speakers: empirical investigation of popularity, availability, accessibility, readability, and quality. *BMC Med Inform Decis Mak*. 2022;22(1):126. [FREE Full text] [doi: [10.1186/s12911-022-01868-9](https://doi.org/10.1186/s12911-022-01868-9)] [Medline: [35534816](https://pubmed.ncbi.nlm.nih.gov/35534816/)]
9. Ayoub G, Chalhoub E, Sleilaty G, Kourie HR. YouTube as a source of information on breast cancer in the Arab world. *Support Care Cancer*. 2021;29(12):8009-8017. [doi: [10.1007/s00520-021-06403-6](https://doi.org/10.1007/s00520-021-06403-6)] [Medline: [34224018](https://pubmed.ncbi.nlm.nih.gov/34224018/)]
10. Alnaim L. Evaluation breast cancer information on the internet in Arabic. *J Cancer Educ*. 2019;34(4):810-818. [doi: [10.1007/s13187-018-1378-9](https://doi.org/10.1007/s13187-018-1378-9)] [Medline: [29923058](https://pubmed.ncbi.nlm.nih.gov/29923058/)]
11. Jongerius C, Russo S, Mazzocco K, Pravettoni G. Research-tested mobile apps for breast cancer care: systematic review. *JMIR Mhealth Uhealth*. 2019;7(2):e10930. [FREE Full text] [doi: [10.2196/10930](https://doi.org/10.2196/10930)] [Medline: [30741644](https://pubmed.ncbi.nlm.nih.gov/30741644/)]
12. Wu X, Guo X, Zhang Z. The efficacy of mobile phone apps for lifestyle modification in diabetes: systematic review and meta-analysis. *JMIR Mhealth Uhealth*. 2019;7(1):e12297. [FREE Full text] [doi: [10.2196/12297](https://doi.org/10.2196/12297)] [Medline: [30664494](https://pubmed.ncbi.nlm.nih.gov/30664494/)]
13. Alhuwail D. Diabetes applications for Arabic speakers: a critical review of available apps for Android and iOS operated smartphones. *Stud Health Technol Inform*. 2016;225:587-591. [Medline: [27332269](https://pubmed.ncbi.nlm.nih.gov/27332269/)]
14. Grundy Q. A review of the quality and impact of mobile health apps. *Annu Rev Public Health*. 2022;43:117-134. [FREE Full text] [doi: [10.1146/annurev-publhealth-052020-103738](https://doi.org/10.1146/annurev-publhealth-052020-103738)] [Medline: [34910582](https://pubmed.ncbi.nlm.nih.gov/34910582/)]
15. Adam R, McMichael D, Powell D, Murchie P. Publicly available apps for cancer survivors: a scoping review. *BMJ Open*. 2019;9(9):e032510. [FREE Full text] [doi: [10.1136/bmjopen-2019-032510](https://doi.org/10.1136/bmjopen-2019-032510)] [Medline: [31575584](https://pubmed.ncbi.nlm.nih.gov/31575584/)]
16. Kalke K, Ginossar T, Bentley JM, Carver H, Shah SFA, Kinney AY. Use of evidence-based best practices and behavior change techniques in breast cancer apps: systematic analysis. *JMIR Mhealth Uhealth*. 2020;8(1):e14082. [FREE Full text] [doi: [10.2196/14082](https://doi.org/10.2196/14082)] [Medline: [32012084](https://pubmed.ncbi.nlm.nih.gov/32012084/)]
17. Kim HJ, Kim SM, Shin H, Jang JS, Kim YI, Han DH. A mobile game for patients with breast cancer for chemotherapy self-management and quality-of-life improvement: randomized controlled trial. *J Med Internet Res*. 2018;20(10):e273. [FREE Full text] [doi: [10.2196/jmir.9559](https://doi.org/10.2196/jmir.9559)] [Medline: [30578205](https://pubmed.ncbi.nlm.nih.gov/30578205/)]
18. Ghanbari E, Yektatalab S, Mehrabi M. Effects of psychoeducational interventions using mobile apps and mobile-based online group discussions on anxiety and self-esteem in women with breast cancer: randomized controlled trial. *JMIR Mhealth Uhealth*. 2021;9(5):e19262. [FREE Full text] [doi: [10.2196/19262](https://doi.org/10.2196/19262)] [Medline: [34003138](https://pubmed.ncbi.nlm.nih.gov/34003138/)]
19. Yusuf A, Iskandar YHP, Ab Hadi IS, Nasution A, Keng SL. Breast awareness mobile apps for health education and promotion for breast cancer. *Front Public Health*. 2022;10:951641. [FREE Full text] [doi: [10.3389/fpubh.2022.951641](https://doi.org/10.3389/fpubh.2022.951641)] [Medline: [36324460](https://pubmed.ncbi.nlm.nih.gov/36324460/)]
20. Petrocchi S, Filipponi C, Montagna G, Bonollo M, Pagani O, Meani F. A breast cancer smartphone app to navigate the breast cancer journey: mixed methods study. *JMIR Form Res*. 2021;5(5):e28668. [FREE Full text] [doi: [10.2196/28668](https://doi.org/10.2196/28668)] [Medline: [33970120](https://pubmed.ncbi.nlm.nih.gov/33970120/)]
21. Wanchai A, Anderson EA, Armer JM. A systematic review of m-health apps on managing side effects of breast cancer treatment. *Support Care Cancer*. 2022;31(1):86. [doi: [10.1007/s00520-022-07464-x](https://doi.org/10.1007/s00520-022-07464-x)] [Medline: [36574048](https://pubmed.ncbi.nlm.nih.gov/36574048/)]
22. Houghton LC, Howland RE, McDonald JA. Mobilizing breast cancer prevention research through smartphone apps: a systematic review of the literature. *Front Public Health*. 2019;7:298. [FREE Full text] [doi: [10.3389/fpubh.2019.00298](https://doi.org/10.3389/fpubh.2019.00298)] [Medline: [31781525](https://pubmed.ncbi.nlm.nih.gov/31781525/)]

23. Salmani H, Ahmadi M, Shahrokhi N. The impact of mobile health on cancer screening: a systematic review. *Cancer Inform.* 2020;19:1176935120954191. [[FREE Full text](#)] [doi: [10.1177/1176935120954191](https://doi.org/10.1177/1176935120954191)] [Medline: [33116352](#)]
24. Błajda J, Barnaś E, Kucab A. Application of personalized education in the mobile medical app for breast self-examination. *Int J Environ Res Public Health.* 2022;19(8):4482. [[FREE Full text](#)] [doi: [10.3390/ijerph19084482](https://doi.org/10.3390/ijerph19084482)] [Medline: [35457349](#)]
25. Egbring M, Far E, Roos M, Dietrich M, Brauchbar M, Kullak-Ublick GA, et al. A mobile app to stabilize daily functional activity of breast cancer patients in collaboration with the physician: a randomized controlled clinical trial. *J Med Internet Res.* 2016;18(9):e238. [[FREE Full text](#)] [doi: [10.2196/jmir.6414](https://doi.org/10.2196/jmir.6414)] [Medline: [27601354](#)]
26. Monteiro-Guerra F, Signorelli GR, Tadas S, Zubiete ED, Romero OE, Fernandez-Luque L, et al. A personalized physical activity coaching app for breast cancer survivors: design process and early prototype testing. *JMIR Mhealth Uhealth.* 2020;8(7):e17552. [[FREE Full text](#)] [doi: [10.2196/17552](https://doi.org/10.2196/17552)] [Medline: [32673271](#)]
27. Cruz FOAM, Vilela RA, Ferreira EB, Melo NS, Reis PEDD. Evidence on the use of mobile apps during the treatment of breast cancer: systematic review. *JMIR Mhealth Uhealth.* 2019;7(8):e13245. [[FREE Full text](#)] [doi: [10.2196/13245](https://doi.org/10.2196/13245)] [Medline: [31456578](#)]
28. Kim H, Goldsmith JV, Sengupta S, Mahmood A, Powell MP, Bhatt J, et al. Mobile health application and e-health literacy: opportunities and concerns for cancer patients and caregivers. *J Cancer Educ.* 2019;34(1):3-8. [doi: [10.1007/s13187-017-1293-5](https://doi.org/10.1007/s13187-017-1293-5)] [Medline: [29139070](#)]
29. Kapoor A, Nambisan P, Baker E. Mobile applications for breast cancer survivorship and self-management: a systematic review. *Health Informatics J.* 2020;26(4):2892-2905. [[FREE Full text](#)] [doi: [10.1177/1460458220950853](https://doi.org/10.1177/1460458220950853)] [Medline: [32842830](#)]
30. Jebraeily M, Eghtedar S, Ayatollahi H, Mohammadzadeh Z. Identifying educational contents and technical features of a self-management smartphone application for women with breast cancer. *J Adv Med Biomed Res.* 2022;30(139):129-137. [doi: [10.30699/jams.30.139.129](https://doi.org/10.30699/jams.30.139.129)]
31. Larsen ME, Nicholas J, Christensen H. A systematic assessment of smartphone tools for suicide prevention. *PLoS One.* 2016;11(4):e0152285. [[FREE Full text](#)] [doi: [10.1371/journal.pone.0152285](https://doi.org/10.1371/journal.pone.0152285)] [Medline: [27073900](#)]
32. Nicholas J, Larsen ME, Proudfoot J, Christensen H. Mobile apps for bipolar disorder: a systematic review of features and content quality. *J Med Internet Res.* 2015;17(8):e198. [[FREE Full text](#)] [doi: [10.2196/jmir.4581](https://doi.org/10.2196/jmir.4581)] [Medline: [26283290](#)]
33. Alnasser AA, Amalraj RE, Sathiseelan A, Al-Khalifa AS, Marais D. Do Arabic weight-loss apps adhere to evidence-informed practices? *Transl Behav Med.* 2016;6(3):396-402. [[FREE Full text](#)] [doi: [10.1007/s13142-015-0347-7](https://doi.org/10.1007/s13142-015-0347-7)] [Medline: [27528528](#)]
34. Dehling T, Gao F, Schneider S, Sunyaev A. Exploring the far side of mobile health: information security and privacy of mobile health apps on iOS and Android. *JMIR Mhealth Uhealth.* 2015;3(1):e8. [[FREE Full text](#)] [doi: [10.2196/mhealth.3672](https://doi.org/10.2196/mhealth.3672)] [Medline: [25599627](#)]
35. Benjumea J, Roper J, Rivera-Romero O, Dorronzoro-Zubiete E, Carrasco A. Privacy assessment in mobile health apps: scoping review. *JMIR Mhealth Uhealth.* 2020;8(7):e18868. [[FREE Full text](#)] [doi: [10.2196/18868](https://doi.org/10.2196/18868)] [Medline: [32459640](#)]
36. Alfawzan N, Christen M, Spitale G, Biller-Andorno N. Privacy, data sharing, and data security policies of women's mHealth apps: scoping review and content analysis. *JMIR Mhealth Uhealth.* 2022;10(5):e33735. [[FREE Full text](#)] [doi: [10.2196/33735](https://doi.org/10.2196/33735)] [Medline: [35522465](#)]
37. Almaiah MA, Al-Zahrani A, Almomani O, Alhwaitat AK. Classification of cyber security threats on mobile devices and applications. In: Maleh Y, Baddi Y, Alazab M, Tawalbeh L, Romdhani I, editors. *Artificial Intelligence and Blockchain for Future Cybersecurity Applications.* Cham. Springer International Publishing; 2021;107-123.
38. Papageorgiou A, Strigkos M, Politou E, Alepis E, Solanas A, Patsakis C. Security and privacy analysis of mobile health applications: the alarming state of practice. *IEEE Access.* 2018;6:9390-9403. [[FREE Full text](#)] [doi: [10.1109/ACCESS.2018.2799522](https://doi.org/10.1109/ACCESS.2018.2799522)]
39. Benjumea J, Dorronzoro E, Roper J, Rivera-Romero O, Carrasco A. Privacy in mobile health applications for breast cancer patients. Presented at: 2019 IEEE 32nd International Symposium on Computer-Based Medical Systems (CBMS); June 05-07, 2019, 2019;634-639; Cordoba, Spain. [doi: [10.1109/cbms.2019.00131](https://doi.org/10.1109/cbms.2019.00131)]
40. Roberts AE, Davenport TA, Wong T, Moon HW, Hickie IB, LaMonica HM. Evaluating the quality and safety of health-related apps and e-tools: adapting the mobile app rating scale and developing a quality assurance protocol. *Internet Interv.* 2021;24:100379. [[FREE Full text](#)] [doi: [10.1016/j.invent.2021.100379](https://doi.org/10.1016/j.invent.2021.100379)] [Medline: [33777705](#)]
41. Lau N, O'Daffer A, Colt S, Yi-Frazier JP, Palermo TM, McCauley E, et al. Android and iPhone mobile apps for psychosocial wellness and stress management: systematic search in app stores and literature review. *JMIR Mhealth Uhealth.* 2020;8(5):e17798. [[FREE Full text](#)] [doi: [10.2196/17798](https://doi.org/10.2196/17798)] [Medline: [32357125](#)]
42. Wu KL, Alegria R, Gonzalez J, Hu H, Wang H, Page R, et al. Characteristics and quality of mobile apps containing prenatal genetic testing information: systematic App Store search and assessment. *JMIR Mhealth Uhealth.* 2021;9(10):e30404. [[FREE Full text](#)] [doi: [10.2196/30404](https://doi.org/10.2196/30404)] [Medline: [34647898](#)]
43. Merolli M, Francis JJ, Vallance P, Bennell KL, Malliaras P, Hinman RS. Patient-facing mobile apps to support physiotherapy care: protocol for a systematic review of apps within app stores. *JMIR Res Protoc.* 2021;10(12):e29047. [[FREE Full text](#)] [doi: [10.2196/29047](https://doi.org/10.2196/29047)] [Medline: [34889767](#)]

44. Wu X, Xu L, Li P, Tang T, Huang C. Multipurpose mobile apps for mental health in Chinese app stores: content analysis and quality evaluation. *JMIR Mhealth Uhealth*. 2022;10(1):e34054. [FREE Full text] [doi: [10.2196/34054](https://doi.org/10.2196/34054)] [Medline: [34982717](https://pubmed.ncbi.nlm.nih.gov/34982717/)]
45. Paripoorani D, Gasteiger N, Hawley-Hague H, Dowding D. A systematic review of menopause apps with an emphasis on osteoporosis. *BMC Womens Health*. 2023;23(1):518. [FREE Full text] [doi: [10.1186/s12905-023-02612-9](https://doi.org/10.1186/s12905-023-02612-9)] [Medline: [37731333](https://pubmed.ncbi.nlm.nih.gov/37731333/)]
46. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile App Rating Scale: a new tool for assessing the quality of health mobile apps. *JMIR Mhealth Uhealth*. 2015;3(1):e27. [FREE Full text] [doi: [10.2196/mhealth.3422](https://doi.org/10.2196/mhealth.3422)] [Medline: [25760773](https://pubmed.ncbi.nlm.nih.gov/25760773/)]
47. Terhorst Y, Philippi P, Sander LB, Schultchen D, Paganini S, Bardus M, et al. Validation of the Mobile Application Rating Scale (MARS). *PLoS One*. 2020;15(11):e0241480. [FREE Full text] [doi: [10.1371/journal.pone.0241480](https://doi.org/10.1371/journal.pone.0241480)] [Medline: [33137123](https://pubmed.ncbi.nlm.nih.gov/33137123/)]
48. Olmstead K, Atkinson M. Chapter 3: an analysis of Android app permissions. Pew Research Center. 2015. URL: <https://www.pewresearch.org/internet/2015/11/10/an-analysis-of-android-app-permissions/> [accessed 2023-01-30]
49. Permissions on Android. Android Developers. URL: <https://developer.android.com/guide/topics/permissions/overview> [accessed 2023-01-25]
50. Aydin A, Gursoy A. Breast cancer-related apps in Google Play and App Store: evaluate their functionality and quality. *J Cancer Surviv*. 2023;17(4):1251-1257. [doi: [10.1007/s11764-022-01290-0](https://doi.org/10.1007/s11764-022-01290-0)] [Medline: [36447005](https://pubmed.ncbi.nlm.nih.gov/36447005/)]
51. Yang S, Bui CN, Park K. Mobile health apps for breast cancer: content analysis and quality assessment. *JMIR Mhealth Uhealth*. 2023;11:e43522. [FREE Full text] [doi: [10.2196/43522](https://doi.org/10.2196/43522)] [Medline: [36821352](https://pubmed.ncbi.nlm.nih.gov/36821352/)]
52. Martín-Payo R, Ferreras-Losilla L, González-Méndez X, Leirós-Díaz C, Martínez-Urquijo A, Del Mar Fernández-Álvarez M. Apps for individuals diagnosed with breast cancer: a preliminary assessment of the content and quality of commercially available apps in Spanish. *Mhealth*. 2021;7:2. [FREE Full text] [doi: [10.21037/mhealth-19-191](https://doi.org/10.21037/mhealth-19-191)] [Medline: [33634185](https://pubmed.ncbi.nlm.nih.gov/33634185/)]
53. Rezaee R, Asadi S, Yazdani A, Rezvani A, Kazeroon AM. Development, usability and quality evaluation of the resilient mobile application for women with breast cancer. *Health Sci Rep*. 2022;5(4):e708. [FREE Full text] [doi: [10.1002/hsr2.708](https://doi.org/10.1002/hsr2.708)] [Medline: [35782301](https://pubmed.ncbi.nlm.nih.gov/35782301/)]
54. Wright A. Evaluation of two mobile health apps for patients with breast cancer using the mobile application rating scale. *Mhealth*. 2021;7:60. [FREE Full text] [doi: [10.21037/mhealth-20-161](https://doi.org/10.21037/mhealth-20-161)] [Medline: [34805391](https://pubmed.ncbi.nlm.nih.gov/34805391/)]
55. Nasution A, Yusuf A, Iskandar YHP, Soon LK, Ab Hadi IS. Mobile health application applying the health belief model for breast cancer awareness: what is missing? *Malays J Med Health Sci*. 2021;17(4):384-398. [FREE Full text]
56. Mobasheri MH, Johnston M, King D, Leff D, Thiruchelvam P, Darzi A. Smartphone breast applications—what's the evidence? *Breast*. 2014;23(5):683-689. [FREE Full text] [doi: [10.1016/j.breast.2014.07.006](https://doi.org/10.1016/j.breast.2014.07.006)] [Medline: [25153432](https://pubmed.ncbi.nlm.nih.gov/25153432/)]
57. Sohrabei S, Atashi A. The impact of mobile health on breast cancer patient's life and treatment: a systematic review. *Front Health Inform*. 2021;10(1):88. [FREE Full text] [doi: [10.30699/fhi.v10i1.295](https://doi.org/10.30699/fhi.v10i1.295)]
58. Dougan M, Korani T, Castle A, Dang K. Developing a mobile application to improve the quality of life among breast cancer survivors. Research Square. Preprint posted online on November 2, 2021. [FREE Full text] [doi: [10.21203/rs.3.rs-992412/v1](https://doi.org/10.21203/rs.3.rs-992412/v1)]
59. Kanodia S, Thalabard JC, Lhoste K. Categorization and analysis of primary care mHealth apps related to breast health and breast cancer: systematic search in App Stores and content analysis. *JMIR Cancer*. 2023;9:e42044. [FREE Full text] [doi: [10.2196/42044](https://doi.org/10.2196/42044)] [Medline: [37676704](https://pubmed.ncbi.nlm.nih.gov/37676704/)]
60. Nurgalieva L, O'Callaghan D, Doherty G. Security and privacy of mHealth applications: a scoping review. *IEEE Access*. 2020;8:104247-104268. [FREE Full text] [doi: [10.1109/access.2020.2999934](https://doi.org/10.1109/access.2020.2999934)]
61. Cai T, Huang Y, Zhang Y, Lu Z, Huang Q, Yuan C. Mobile health applications for the care of patients with breast cancer: a scoping review. *Int J Nurs Sci*. 2021;8(4):470-476. [FREE Full text] [doi: [10.1016/j.ijnss.2021.07.003](https://doi.org/10.1016/j.ijnss.2021.07.003)] [Medline: [34631997](https://pubmed.ncbi.nlm.nih.gov/34631997/)]
62. Oakley-Girvan I, Yunis R, Longmire M, Ouillon JS. What works best to engage participants in mobile app interventions and e-health: a scoping review. *Telemed J E Health*. 2022;28(6):768-780. [FREE Full text] [doi: [10.1089/tmj.2021.0176](https://doi.org/10.1089/tmj.2021.0176)] [Medline: [34637651](https://pubmed.ncbi.nlm.nih.gov/34637651/)]
63. Kim BY, Sharafoddini A, Tran N, Wen EY, Lee J. Consumer mobile apps for potential drug-drug interaction check: systematic review and content analysis using the Mobile App Rating Scale (MARS). *JMIR Mhealth Uhealth*. 2018;6(3):e74. [FREE Full text] [doi: [10.2196/mhealth.8613](https://doi.org/10.2196/mhealth.8613)] [Medline: [29592848](https://pubmed.ncbi.nlm.nih.gov/29592848/)]

## Abbreviations

- MARS:** Mobile App Rating Scale  
**MENA:** Middle East and North Africa  
**mHealth:** mobile health

*Edited by T de Azevedo Cardoso; submitted 23.04.23; peer-reviewed by L Alnaim, CL Sánchez Bocanegra, B Alaa; comments to author 18.09.23; revised version received 13.11.23; accepted 20.11.23; published 16.01.24*

*Please cite as:*

*Alhuwail D, Alhouti A, Alsarhan L*

*Assessing the Quality, Privacy, and Security of Breast Cancer Apps for Arabic Speakers: Systematic Search and Review of Smartphone Apps*

*JMIR Cancer 2024;10:e48428*

*URL: <https://cancer.jmir.org/2024/1/e48428>*

*doi: [10.2196/48428](https://doi.org/10.2196/48428)*

*PMID:*

©Dari Alhuwail, Aisha Alhouti, Latifah Alsarhan. Originally published in JMIR Cancer (<https://cancer.jmir.org>), 16.01.2024. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Cancer, is properly cited. The complete bibliographic information, a link to the original publication on <https://cancer.jmir.org/>, as well as this copyright and license information must be included.