Mobile Sensing and Engagement Features in Arabic Mental Well-Being Apps: Systematic Search and Analysis

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ABSTRACT

Various mobile apps have been released to track and promote mental health and well-being. Despite the high interest in developing these apps, they suffer from high attrition rates. These apps have limited utility if they are delivered in a manner that does not maintain individuals' engagement. Engagement features are therefore a critical factor to consider for fostering intended benefits. While there is considerable research on analysing the engagement features of these apps available in English, our understanding of engagement features in such Arabic apps is limited. Moreover, much less is known about mobile sensing in Arabic apps. To address this gap, we systematically searched app stores, identified 110 apps available in Arabic, and analyzed their features based on existing mHealth assessment frameworks. Our analysis found that available Arabic apps poorly implemented engagement features, apart from basic features such as sharing and reminders. Surprisingly, Arabic apps missed mobile sensing capabilities and AI applications. This paper highlights the importance of employing mobile sensing and persuasive design principles in the future design of Arabic apps.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

mHealth; well-being; Arabic mobile apps; mental health; app review; mobile sensing; engagement; persuasive design

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1 INTRODUCTION

Mobile devices and apps get increasingly adopted to promote mental health and well-being as they are convenient, accessible, and usually affordable to use [12, 17, 24]. In addition, mobile apps provide a means of support that mitigates stigma. Available services include mindfulness and meditation apps, passive and active self-tracking apps, assessment and screening apps, counselling apps offering online therapy and educational apps and chatbots to help people manage their mental health and well-being [3, 15, 36]. Accumulating evidence [9, 32] have shown promising outcomes for promoting individual mental health and well-being through mobile apps employing psychological interventions. Nevertheless, studies [18, 28] have demonstrated that intervention alone has limited utility if it is delivered in a manner that does not maintain individuals' engagement with the intervention. Poor user engagement is cited as the main barrier to the effectiveness of mobile apps targeting promoting mental health and well-being [13, 30].

Despite the rising number of publicly available mental health and well-being mobile apps, there are low uptake, adherence and engagement with these apps [5, 30]. In addition to interventions' content, studies [6, 30] highlighted the need for considering engagement features and other factors related to data collection and content delivery modality to support engagement with mental health and well-being apps. A number of studies [3, 5, 15, 26, 29, 35] have reviewed engagement features of existing English mental health and well-being mobile apps. However, only one study considered Arabic mental health and well-being mobile apps. Alhuwail et al. [2] reviewed Arabic apps in 2018 and subjectively assessed the engagement aspect of 23 apps. This study provided a subjective mean score only derived from the ratings of researchers based on the Mobile App Rating Scale (MARS) [27]. Nevertheless, there is still a gap in understanding engagement features and interaction styles employed by Arabic apps and further in-depth analysis is required. While mobile sensing is increasingly adopted in mHealth, to our knowledge, no study has yet explored mobile sensing in Arabic mental health and well-being mobile apps. Therefore, there is a need for a comprehensive objective data-driven review of mobile sensing and engagement features employed by existing Arabic mental health and well-being apps.

To fill these research gaps, this paper aims to identify implemented mobile sensing and engagement features of Arabic mental health and well-being mobile apps and highlight missing and potential features to inform future design. We systematically searched the

most popular mobile app stores (Apple App Store and Google Play) and identified 110 apps (iOS and Android) available in Arabic. We then conducted an in-depth analysis of their sensing and engagement features based on existing mHealth assessment frameworks (MIND and MARS).

2 BACKGROUND

Technology has been involved in health for decades, but in the last decade, a new generation of mobile technologies have been introduced and considered a powerful tool to promote, track, and visualise individuals' health. The use of mobile technology in healthcare formed the field of mobile health (mHealth), which is defined by the World Health Organization's (WHO) Global Observatory for eHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" [20].

Mobile devices surpass our expectations in the markers they can collect. Smartphones have various built-in sensors that support diverse tracking tasks. Recently, there is a growing interest in capturing behavioural, physiological and contextual data passively, without explicit input from users, taking advantage of embedded sensors in smartphones and wearable devices. For instance, the built-in accelerometer sensor was used to infer features about individuals' activity such as travelled distance, steps, speed, activity/inactivity time and periods, and sleep (duration, quality, onset latency) [1, 12]. In addition to all sensors, smartphones can track device use such as call logs, apps' usage and SMS patterns, which can be used to reflect individual mental state [10, 12]. These features are valuable, especially for mental health and wellness. The adoption of wristbands has aroused, in connection with smartphones, smartwatches allow the real-time tracking of various biomarkers and vital signs such as heart rate, and body temperature.

Mobile devices are widely used in digital health, their prevalence in people's hands make them an affordable source for receiving help and collecting health data. Various mHealth apps are available to promote mental health and well-being such as self-help tools based on cognitive behavioural therapy (CBT), acceptance and commitment therapy (ACT), positive psychology interventions (PPIs), mindfulness, and meditation [9]. Furthermore, mobile apps have become a possible form of delivery of psychological consultations and peer support via remote services [16]. Mobile apps have been perceived as powerful self-tracking tools for improving individuals' awareness of their physical and psychological experiences, thereby promoting lifestyle adjustments to cope better with their conditions [33]. Some applications have gone beyond data collection and integrated machine learning and artificial intelligence (AI) methods to predict mental health states for supporting individual care and professional decision-making [12]. AI applications were also used to provide help through conversational agents (aka chatbots) for psychoeducation and supporting adherence [31].

Systematic reviews and meta-analyses [9, 32] have shown that individuals' mental health and well-being can be improved by mobile apps employing evidence-based interventions. Nevertheless, studies [18, 28] have demonstrated that interventions alone have limited utility if it is delivered in a manner that does not maintain individuals' engagement with the intervention. Active engagement with evidence-based mobile apps could foster gaining the intended associated psychological health benefits [13, 23]. Engagement is defined as "(1) the extent (e.g. amount, frequency, duration, depth) of usage and (2) a subjective experience characterised by attention, interest and affect" [23]. User engagement with mHealth interventions can be improved by employing design features including personalization, reinforcement, communication, navigation, credibility, messages, and interface aesthetics [29, 37].

Poor user engagement is a known problem among mental health and well-being mHealth apps [3, 13, 30]. Studies [13, 23] have shown that digital interventions often do not completely engage individuals, therefore limiting their effectiveness. The effectiveness of evidence-based mobile apps that target promoting health or well-being can be enhanced by focusing on the design and engagement features [29]. Systematic and clinical reviews [6, 30] of user engagement with mental health mobile apps attributed the high attrition rates among these apps to various factors. This includes technical and usability issues, a lack of trust, a lack of personalization and a lack of guidance through automated app reminders/notifications or a coach. Qualitative and quantitative studies [6, 30] also identified common facilitators including social connectedness (with peers or therapists) enabled by the app, credibility, delivering content in more than one modality, and increased insight into health. This highlights the need for considering engagement features and other factors related to data collection and content delivery modality, alongside intervention content.

Several frameworks have been created to help experts in analysing and assessing several aspects of mHealth apps including engagement features. For instance, the Mhealth Index and Navigation Database (MIND) [14] is an objective framework for the systematic assessment of app features based on the American Psychiatric Association's app evaluation framework [11]. MIND involves 105 objective questions across six categories including engagement styles and features. It aims to help experts and users understand what kind of features apps offer. Another available assessment framework is the Mobile App Rating Scale (MARS) [27]. MARS provides classification criteria to help researchers collect descriptive and technical information about apps besides providing subjective evaluation measures to assess app subjective quality including the engagement element.

3 METHODS

To address the identified research gap, we conducted an exploratory review of Arabic mental health and well-being mobile apps (n = 110), looking at what engagement features these apps employed, what mobile sensing these apps utilized and how these apps deliver content to users.

Mental health app was defined as "an application on your mobile phone or tablet device that helps you manage your mental, emotional, or psychological health or get access to resources to support your mental, emotional, or psychological health" [7]. In line with this definition and similar exploratory studies [3, 26, 35], our review includes a broad range of apps that target topics such as stress, emotions, or well-being besides mental health difficulties, particularly anxiety and depression as they are the most common mental conditions among the Arab population [4].

After identifying the relevant apps (see Data Collection), we downloaded them, analyzed and coded their engagement features objectively (with a binary response) based on the MIND framework [14]. In addition, we used the app classification in MARS [27] to collect descriptive and technical information about collected apps (see Feature Analysis).

Data Collection. To collect relevant Arabic mental health and well-being apps from the Apple App Store and Google Play, we used the pre-existing scripts SerpApi [25] and google-play-scraper [22] to automatically retrieve search results for the relevant Arabic keywords found in Table 1. We separately scraped apps on both stores in August 2022. Combined, 2411 records were retrieved through multiple search keywords on both stores. After excluding duplicates, 1492 distinct apps were prepared for manual screening. Next, following similar reviews [3, 26, 28], we manually screened the titles, store descriptions of the apps, and app screenshots to identify a relevant sub-set of those apps. Apps had to meet the following inclusion criteria to be included in our analysis: (1) explicitly focused on mental health or well-being (app name or description included one of our keywords), and (2) support the Arabic language. Apps were excluded if they targeted clinicians only, or were e-books . This resulted in 141 potentially relevant apps. We then downloaded these apps and manually explored them to ensure that apps are functional and accessible. Apps that were non-functional or inaccessible were excluded. Then, if an app existed in both stores, we kept one record for subsequent feature analysis as our primary goal is to explore apps' sensing and engagement strategies rather than differences between iOS and Android versions of the same app. At the end of this step, we identified 110 apps for analysis.

Feature Analysis. We analysed the mobile sensing and engagement features of the collected apps based on the features and engagement style objective metrics provided by the MIND framework [14]. In addition, we used the app classification in MARS [27] to collect descriptive and technical information about the collected apps. The first author and a collaborator (see Acknowledgments) independently coded the targeted variables for each included app, according to the MIND and MARS. We tested for inter-rater reliability using Cohen's kappa [8] and obtained 0.85. Cohen's kappa values over 0.80 indicate almost perfect agreement [19].

Table 1: Arabic Keywords used for searching apps in Apple App Store and Google Play.

English Translations	Arabic Keywords
Mental Health	الصحة النفسية
Mental Well-being	الرفاهية العقلية
Depression	الاكتئاب
Anxiety	القلق
Psychological stress	ضغط نفسي
Mood Disorders	اضطرابات المزاج
Mood	المزاج
Emotions	المشاعر
Stress	إجهاد
Tension	توتر

4 RESULTS

4.1 Descriptive of Included Apps

Most apps (81 apps, or 74%) were categorized under Health and Fitness, Medical purposes, and Lifestyle in the app stores' categories (Apple App Store and Google Play). All apps could be downloaded for free. Some apps (41%) had in-app purchases to unlock more content or provide more services. For app updates, more than half of the apps (69 apps) had been last updated within the year of data collection (2022), a quarter of the apps (n = 28) in the past year (2021), and 13 apps (12%) between 2017 and 2020.

4.2 Engagement Features

Offline mode. 53 apps (48%) supported offline mode to enable users to use apps and access the content without the requirement of an internet connection, thereby supporting user engagement.

Sharing. 47 apps (43%) allowed users to share app content, their collected data, or progress on social media (Facebook, Twitter, etc.).

Reminders. 46 apps (42%) enabled users to set and receive daily reminders and notifications of their target behaviour and tasks to support their adherence. Some apps enabled users to select preferred times of reminders and notifications such as morning, afternoon, evening or a specific daily time. One app was adapted to the local culture and allowed users to set their meditation reminders based on Islamic prayer times: Fajr, Dhuhr, Asr, Maghrib, and Isha. Some apps further allowed users to choose what services (e.g., support groups, morning affirmations, achieving uncompleted tasks, etc.) they are interested in to receive notifications on it.

Self-monitoring. 32 apps (29%) enabled users to engage with apps by inputting their own data (mood, feelings, thoughts, behaviours, goals, diaries, self-report assessments, symptoms, sleep, and physical activities) for self-monitoring tasks, which in turn support their self-awareness. Out of these active self-tracking features, 16 apps (15%) enabled users to measure and track their mental health states over time including levels of anxiety, depression, stress, self-esteem, and burnout through validated scales. 13 apps (12%) allowed users to track their mood and feelings. Common modalities implemented to record moods and feelings were emojis (i.e., pictographs that describe moods and feelings through facial expressions [34]) in 11 apps. Most of these apps offered 5 options for users to choose from. The other 2 apps, which were based on the CBT, captured feelings through text and used scales (0-100) to measure intensities by percentages. 7 apps further supported the entry of contextual and additional information to enrich the reported mood and feelings such as events (work, school, travel, family, etc.), description of issues, thoughts and notes. Other implemented self-monitoring features were related to thought tracking (n = 10), behaviours tracking (n = 2), sleep time and quality tracking (n = 2), physical exercise tracking (n = 2), symptom tracking (n = 1) and medication tracking (n = 1).

Statistical information and data visualization. 20 apps (18%) presented users' collected data via the app numerically and visually in graph and chart formats to support users' self-reflection. For instance, users were provided with some information about their progress such as the number of completed sessions (e.g., meditation, mindfulness or breathing) (n = 6), the minutes count of the exercise over the day and the week (n = 8), and the longest streak (n = 3).

Some apps visualized users' self-reported moods over weekly and monthly graphs ($n = 4$).

Health professional support. 18 apps (16%) allowed direct collaboration with a health provider or clinician within the app to receive professional help. Most apps (16) allowed users to contact practitioners via video, voice or text messages based on their preferences, while 2 apps only provided text-based support.

Gamification. 11 apps (10%) employed gamification strategies to motivate users to engage with apps and complete tasks. In these apps, users can obtain level upgrades ($n = 3$), points ($n = 3$), badges ($n = 3$), and medals ($n = 1$) based on points earned from accomplishing tasks. Some other apps ($n = 4$) presented users with messages of congratulations and encouragement when achieving their tasks.

User guidance and tunneling. 11 apps (10%) guided users in their change process by providing actions and multi-step activities to help them continue and achieve their targeted long-term goal progressively. For instance, some apps offered weekly programs and gradually divided the required activities daily to support users in meeting their weekly targeted goal.

Customization. 10 apps (9%) enabled users to customize their apps' appearance and settings including backgrounds, interface colours, graphics characters (e.g., woman or man character), and background sounds.

Personalization. 8 apps (7%) tailored their provided content (affirmation, meditations, messages) based on users' personalized experience (current mood, mental state, targeted goal). For example, an app considered its users' background (Muslim) and provided messages that aligned with their beliefs and tailored to the self-tracked data such as showing the message "God will bring ease after hardship" when a user reported feeling worried. Some other apps suggested meditation and relaxation sessions based on users' self-reported mood and goals.

Social facilitation. 3 apps (3%) provided users with information about other app users who are performing the task along with them. For instance, 2 apps allowed users to recognize how many users are practising mindfulness/meditation at the same time as them.

Community networking and peer support. 2 apps (2%) had an app community where users can interact and discuss their issues and feelings with individuals having similar issues (peers), add comments and support each other with the ability to be anonymous.

Figure 1 presents a summary of engagement features implemented by the 110 included apps.

4.3 Output Modalities

Regarding the modalities used to deliver the intervention content, written text was the main output modality and part of all 110 apps. Audio output (music, scripts, etc.) presented in 33 apps (30%) and used mainly for meditation and relaxation strategies. Video output was implemented by 20 apps (18%), mostly among apps that provided a connection with mental health professionals.

4.4 Mobile Sensing

Only 2 apps of the included apps (2%) used built-in mobile sensors. One app used built-in smartphone sensors to count users' steps to promote their mental well-being by increasing their physical activity through gamification. This app allowed users to exchange their travelled distance with points. The other app used built-in smartwatch sensors to track users' motions to encourage them to maintain calm during breathing and meditation exercises. This app stopped the exercise when users get distracted and started moving around.

4.5 Data Integration

Five of the included apps (5%) integrate with the device's central repository for health and fitness data (e.g., HealthKit [1] in iOS and Health Connect [2] in Android platforms). These apps offer the feature of writing users' collected tracked data in the central repository to be accessible to users in one place alongside their other collected health-related data. All these five apps share users' tracked mindful minutes with the device's central repository, based on users' permission. Two of these five apps further enriched their tracking function and collected data about users' mindful minutes by including data from other apps that were stored in the device's central repository.

4.6 Smartwatch Support

Four apps of the included apps (4%), which targeted mainly affirmations ($n = 2$) or meditation ($n = 2$), offered smartwatch versions. They utilized smartwatch capabilities to provide some services including showing daily affirmations on the watch's face and using built-in sensors ($n = 1$) to track users' state during breathing and meditation exercises. In addition, one app provided meditation sessions independently of smartphones to support the accessibility of their content.

Figure 2 shows a summary of mobile sensing, smartwatch support, and data integration with health repositories of the included apps.

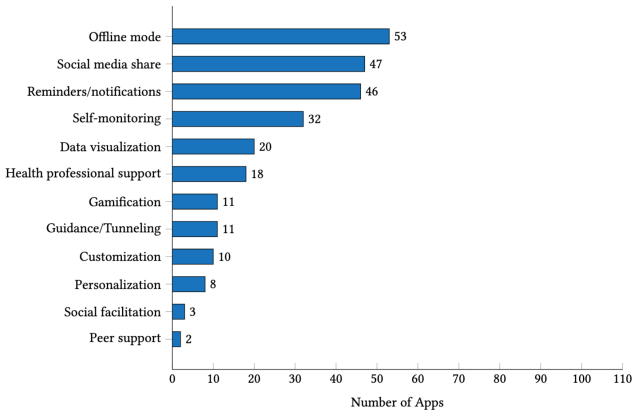

Figure 1: Engagement features of the 110 included apps.

5 DISCUSSION

Despite the high interest in mental health and well-being mobile apps, to our knowledge, this is the first study to in-depth examine

[1] https://developer.apple.com/documentation/xcode/configuring-healthkit-access
[2] https://developer.android.com/guide/health-and-fitness/health-connect

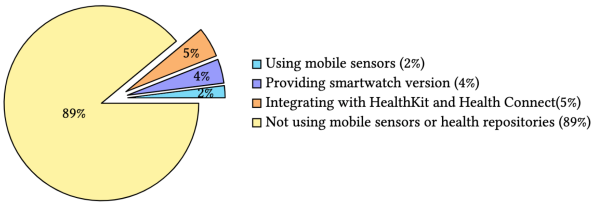

Figure 2: Mobile sensing, smartwatch support, and data integration with health repositories of the 110 included apps.

mobile sensing and engagement features of publicly available Arabic mental health and well-being mobile apps. Our results showed that available apps poorly implemented engagement features apart from basic features such as offline mode, social media sharing and reminders. Arabic apps mostly relied on text modality to deliver their content. Likewise, mobile sensing was rarely utilized among Arabic mental health and well-being mobile apps.

Persuasive technologies [21] have been widely used in HCI to design technology that supports individuals in positive behavioural changes, mainly towards promoting their health and well-being. In the mental health area, these technologies are often used to improve intervention efficacy and user engagement [38]. In our reviewed apps, a number of persuasive design features were employed in some apps such as reminders, self-monitoring, rewards, tunneling, customization, personalization and social support (e.g., sharing progress via social media, contacting therapists or peers, and recognizing a number of users who are practising meditation at the moment). However, most apps lack such interactive design features which may hinder user engagement and sustained use.

Mobile sensing in the context of mental health has shown its effectiveness in various applications [12]. This includes (1) the benefits associated with passively collecting and visualizing data to users to raise self-awareness about their psychological state, (2) the ability to monitor users' health and personalize app content based on the user's mental state, (3) the possibility of predicting future users' mental states based on historically sensed data using machine learning models. Surprisingly and despite the mentioned benefits, developers of Arabic mental health apps overlooked the importance of using mobile sensors to promote mental health.

While artificial intelligence (AI) applications such as chatbots have been increasingly used in mental health care [31], our review emphasises the absence of employing AI techniques in the Arabic available mental health apps. There is a need to investigate the use of AI applications for Arabic users in future research.

Developers who target the Arabic app market need to utilize mobile sensors in collecting data besides employing engagement features to maintain users' continuous use and thereby gain the associated benefits. Developers also need to utilize persuasive design principles, especially features related to peer support as they are highly aligned with collectivist societies' values but rarely employed in Arabic mental health apps. In addition, the perspectives of end users of Arabic speakers need to be investigated in the future as understanding their experience with these apps is crucial for the success of developing well-being apps that promote mental health.

6 CONCLUSION

Engagement is critical in fostering the intended benefits of mental health and well-being apps. While engagement features and mobile sensing received considerable attention in well-being apps available in English, there is a scarcity of research on these features among Arabic mental health and well-being mobile apps. To address this gap, we systematically searched app stores (Apple App Store and Google Play Store), identified 110 apps (iOS and Android) available in Arabic, and analyzed their features based on existing mHealth assessment frameworks: Mhealth Index and Navigation Database (MIND) and the Mobile App Rating Scale (MARS). Our results showed that most Arabic apps lack interactive design features, apart from basic features such as sharing and reminders, which may hinder user engagement and sustained use. Moreover, Arabic apps missed mobile sensing capabilities and AI applications. This paper highlights the importance of utilizing persuasive design principles in future Arabic mental well-being apps especially features related to social support and tailoring. In future, the perspectives of Arabic speakers around mental health and well-being mobile apps need to be investigated to better support their needs.

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