A Systematic, Multi-domain Review of Mobile Smartphone Apps for Evidence-Based Stress Management

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Contex: Chronic stress presents a growing, pervasive burden in healthcare, and mobile smartphone applications (apps) have the potential to deliver evidence-based stress management strategies. This review identified and evaluated stress management apps across domains of (1) evidence-based content; (2) transparency in app development; and (3) functionality of the app interface.

Evidence acquisition: The iOS App Store was systematically searched. Apps with descriptions indicating that they targeted the intended audience and included evidence-related terminology, at least one evidence-based stress management strategy, and behavior change components were downloaded and evaluated by two independent raters across the three domains of evidence-based content, transparency, and functionality.

Evidence synthesis: A total of 902 apps were identified based on 21 searches. Of these, 60 met study criteria and were downloaded and evaluated between April and June 2015. Twenty (33%) ultimately did not deliver an evidence-based strategy. Of the delivered strategies, the most common were mindfulness and meditation (73%) and diaphragmatic breathing (25%). On average, apps addressed half of the transparency criteria, and nearly all (85%) were acceptable across usability criteria. A total of 32 apps included both evidence-based content and exhibited no problems with usability or functionality; apps affiliated with a non-profit, research-engaged institution comprised 31% of these.

Conclusions: This review evaluated 60 iOS apps for stress management across domains of evidence-based content, transparency, and functionality; these apps have the potential to effectively supplement medical care. Findings further indicate that a comprehensive, multi-domain approach can distinguish apps that use evidence-based strategies from those that do not.

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Context

Chronic psychosocial stress indisputably contributes to costly health conditions and poor medical adherence[1–9]; thus, its increasing rate in the U.S. presents a growing and pervasive clinical challenge to the current healthcare system. In a 2014 survey, 75% of U.S. adults perceived themselves to be significantly stressed, 29% reported their stress had increased over the past year compared with 18% reporting that it had decreased, and 42% believed they should be more actively managing their stress.[10] Indeed, the monetary impact of stress is high, with estimates that work-related stress alone costs the U.S. economy $402 billion.[11]

Mobile smartphone applications (apps) have strong potential as accessible, adaptable stress management tools that could supplement clinic-based care and possibly reduce this burden.[12] As of 2014, nearly 64% of U.S. adults owned a smartphone, and ownership rates were highest in populations most likely to experience both high rates of chronic stress and barriers to accessing healthcare.[13–15] However, despite this increasing "burden of stress in America,"[10] and the potential for app-based interventions to ameliorate it, no systematic reviews of stress management apps are available.

Importantly, there is evidence that 95% of patients believe that the use of mobile apps to access evidence-based stress management strategies (diaphragmatic

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breathing, meditation, mindfulness, progressive muscle relaxation, visualization and the use of imagery, cognitive restructuring, problem solving, coping and behavioral activation, building or activating social supports, or some combination of these strategies[16–22]) would be helpful.[23] Similarly, 90% of surveyed physicians reported that stress management strategies would likely improve patient outcomes; however, the majority (76%) felt they lacked the resources to effectively deliver them.[24]

Despite the potential that these perspectives illustrate, the challenges faced by providers and patients in identifying evidence-based apps are substantial. A search for apps based on the aforementioned strategies generates thousands of results. Given this problem of "app overload,"[25] combined with unsophisticated app search tools and issues of truth in advertising,[12,26] it is unlikely that patients, or even clinicians well versed in stress management, could efficiently identify evidence-based apps. Further complicating the app-identification process is the need to also focus on domains of app transparency and functionality, which can also influence app usage and utility, rather than focusing solely on health-related app content.[27]

The primary aim of this study was to identify, evaluate, and present evidence-based, commercially available apps for promoting effective stress management. Because there is no consensus on the use of any specific methodology for evaluating apps, the current review methods were based largely on core clinical standards that any treatment or intervention should be (1) evidence-based; (2) transparent in its purpose, development, and content; and (3) functional and user-friendly for the purpose of patient adherence; these domains are consistent with the principles of biomedical ethics.[28,29] The secondary aim of this review was therefore to aggregate and expand beyond previous reviews of health-related apps[26,30–40] by evaluating three domains that are consistent with these standards, rather than focusing solely on the presence of evidence-based, health-related content. The key outcomes achieved in this study include a list of evidence-based, transparent, and usable apps that were commercially available at the time of review, and a multidomain methodology and rubric for comprehensively identifying and evaluating health-related apps, in order to contribute to the developing maturity of the field.

Evidence Acquisition

Overview

This review systematically identified, selected, and evaluated apps that included evidence-based strategies for stress management. This method involved distinct phases planned a priori (Figure 1), with provider and patient end-users in mind, and it was consistent with Preferred Reporting Items for Systematic Reviews guidelines.[41] App descriptions were first reviewed and then eligible apps were downloaded. The iOS App Store was searched and apps were downloaded using iPhone 5c and iPhone 6 devices that were running up-to-date versions of the operating system. Smartphones were selected for use over mobile tablets because 64% of U.S. adults own a smartphone whereas 44% of adults own a tablet; smartphone apps may be useful to a greater number of consumers.[13] Evidence-based stress management strategies were selected based on literature reviews and textbooks in the field of health psychology, in the absence of a national governing body that has produced specific stress management guidelines. The seven selected strategies[16–23] are outlined in Table 1.

Identification of Apps

Apps were identified by combining the term *stress* with terms related to evidence-based strategies, including *management, diaphragmatic breathing, breathing, progressive muscle relaxation, biofeedback, visualization, imagery, visual imagery, guided imagery, social support, support, time management, problem, problem solving, communication, cope, coping, cognitive, thought, mindfulness, and meditation,* resulting in 21 searches. When the results of a search exceeded 200, only the first 200 apps were retained for review.

Inclusion of Apps for Review: Levels 1, 2, and 3

A multilevel process was used for selecting apps (Figure 1), whereby at the first level of review app descriptions were assessed to determine if an app would be appropriate for the target population (English-speaking adults seeking guidance in stress management), and whether it was a unique result within the searches (i.e., not a duplicate app). At the second level, apps were included if their descriptions indicated a link between the app's development and an evidence base, by use of terms such as *evidence*, *scientific*, or *research*. At the third level of assessment, apps were included if their descriptions reported delivery of one of the seven targeted evidence-based strategies. Information in the form of directly quoted feedback from consumers or medical sources that were not affiliated with an app's development was not reviewed as part of the app description.

App identification and selection was completed by a primary reviewer (SMC) between January and March 2015. A secondary reviewer (CMM) independently searched and reviewed a randomly selected 10% sample of apps to assess reliability of the decisions made at Levels 1, 2, and 3. Cohen's weighted kappa was calculated to quantify reliability, with agreement achieved if the pattern of exclusion/inclusion across the three levels was identical between reviewers. When discrepancies occurred, the reviewers engaged in a discussion and if consensus was not achieved, a third party (DSW) made a final determination.

Evaluation of Apps: Level 4

Apps that met inclusion criteria at Levels 1–3 were downloaded, and each was independently evaluated by the two reviewers to determine the degree to which each app was (1) evidence-based; (2) transparent in its development and presentation; and (3) functional and user-friendly (Figure 1). Reviewers discussed evaluation discrepancies for all apps and reached consensus to assign final ratings. Each of these three domains was composed of