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Brief Report

Client-Centered Mobile Health Care Applications: Using the Mobile Application Rating Scale Instrument for Evidence-Based Evaluation

CEU

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The use of mobile devices and applications (apps) to monitor or assist in health behaviors is rapidly expanding in many areas of society. Clinicians desire evidence-based app recommendations for their clients to increase self-care and wellness management in such areas as mindfulness, weight loss and activity tracking, glycemic control, and consumer medication information. Given the constant influx of new apps into the major app repositories, clinicians need to be able to ensure the quality of information and interaction that occurs within the mobile health (mHealth) marketplace. The Mobile Application Rating Scale (MARS) and the user version of the scale are valid and reliable instruments used to examine the engagement, functionality, aesthetics, and quality of information in mHealth apps. MARS-rated apps can be readily available resources for busy clinicians to make app suggestions to assist clients on a variety of topics that promote improved outcomes. This article reviews the MARS instrument and utilization of the instrument by clinicians and summarizes several primary care and wellness apps that have been evaluated using this tool.

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Keywords: evidence-based health care, mHealth, mobile applications, midwife, women's health, Mobile Application Rating Scale, mindfulness, glycemic control, weight management, sleep management

INTRODUCTION

Mobile enhanced technology for health care (mHealth), has rapidly expanded over the past decade. mHealth technologies include a variety of informatics tools, including mobile applications (apps) for clinicians and individuals, telehealth tools for remote monitoring and access to care, and clinical decision-making tools.[1] The purpose of mHealth apps is to improve health outcomes, decrease health care costs, and improve client satisfaction.[2] As mHealth continues to proliferate across all health care specialties, it is expected that more individuals and clinicians will use this technology to monitor health and wellness. Consumers often choose mHealth apps without guidance from clinicians, opting for the highest-rated app they can find.[3] The increase in consumer adoption of mHealth apps requires evaluation for content accuracy by clinicians. Apps that are highly rated in stores may or may not contain current evidence-based information and recommendations.[3] The Mobile Application Rating Scale (MARS) is a valid and reliable instrument developed to measure the quality of mobile health care apps.[4] This tool requires training and knowledge of mHealth technologies, but it is very useful for comparing numerous apps systematically. A simplified version of the MARS tool was developed to be used without extensive training; the user version of MARS (uMARS) is valid and reliable and may be easier for the practicing clinician or consumer to use.[5] This article reviews the MARS instrument, presents a discussion of apps related to primary care and women's health that have scored highly with MARS, and discusses the implementation of the simplified app rating tool, uMARS.

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BACKGROUND

Mobile technologies in the form of apps can be excellent tools for the delivery of health care education, intervention, and management. Apps can help clinicians obtain current, evidence-based information for use in clinical practice.[1,4,6] Data show that the use of mHealth apps can improve self-management of chronic conditions[7] and empower clients to improve their self-management of disease and wellness while improving overall health care quality.[8,9] Although some apps are free and others are available for purchase, no direct correlation between app quality and cost has been found.[6] In a recent review of 17 studies of mHealth apps, the authors found that empowering the client with tools for self-management of health improved client outcomes. More than half the studies in this review noted improvements in medication adherence, disease self-management skills, and physical activity in app users.[8]

Although there are more than 160,000 mHealth apps in the major app store repositories, very few are evidence based or have been evaluated for outcomes.[3,7,8] Because of this, clinicians may hesitate to recommend mHealth apps to their clients in spite of client requests for such information.[7,10] Beyond questionable app content accuracy, mHealth apps are poorly regulated and often do not provide guidelines about content, privacy, and security of the data.[11] The lack of

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Quick Points

- Mobile health (mHealth) applications can empower clients with tools for wellness and disease self-management.
- The Mobile Application Rating Scale (MARS) is a valid and reliable instrument for evaluating clinician- and client-based mHealth applications.
- Several highly ranked mHealth apps are available for use by midwifery and women's health clients.

quality control and content evaluation can make choosing a consumer-focused mHealth app difficult.[11] The US Food and Drug Administration is aware of the concern regarding quality and integrity of mHealth apps, and legislation has been introduced that would require review of mHealth technologies for accuracy by the Food and Drug Administration.[11]

Several methods for the evaluation of specific components of mHealth apps have been proposed; however, few methods provide a comprehensive and systematic review.[12] Khoja et al developed a comprehensive evaluation matrix for the appraisal of websites that also included assessment of the quality of the information provided.[13] Unfortunately, the Khoja-Durrani-Scott Framework for e-Health Evaluation was complex and time consuming and precluded use in everyday practice. The Health Information Technology Usability Evaluation Scale is a valid and reliable tool available for consumer evaluation of mHealth apps[14] and therefore does not include expert evaluation of information quality. Stoyanov et al developed MARS to provide an objective and systematic rating of mHealth apps for clients and clinicians.[4] Although each of these tools has been shown to be effective for evaluation of apps, the MARS tool was developed for clinicians and includes rating for the quality and accuracy of information provided within the app.

OVERVIEW OF MARS

Stoyanov et al developed the MARS tool to provide an objective and systematic method of rating mHealth apps for clients and clinicians, including a rating for the quality and accuracy of information provided within the app. The challenge was to develop a tool that could be translated from a mHealth website evaluation to app evaluation in a way that was easy to use with minimal training. The MARS tool developers determined the themes and domains of the MARS instrument after a comprehensive search for app quality rating criteria. The tool developers initially identified 427 criteria related to app analysis or review. Examination of these criteria and deletion of duplicates resulted in 349 criteria, which were further refined into 23 distinct subcategories. These 23 subcategories are grouped into 6 categories: 1 category addresses app classification (including target age group, technical aspects included, focus of the app, and strategies used), 4 categories relate to app characteristics (engagement, functionality, aesthetics, quality, and credibility of information), and 1 category addresses subjective app quality.[4]

Each category includes 3 to 5 individual questions. Each question has 5 possible answers, with 5 indicating "excellent" and 1 indicating "inadequate." The numeric answers to the questions in each of the subscales are totaled, then averaged; thus, the maximum mean score for each subscale is 5. Researchers who have used the MARS tool have reported scores in 3 ways: 1) scores have been reported from 0 to 1.0, indicating the portion of the possible points scored on the tool (eg, if the app scores 24/30 points, it is reported as 0.8); 2) the total sum of the subscale mean scores is reported, which can range from 0 to 30; and 3) a mean MARS score has been calculated by dividing the sum of the subscale mean scores by the number of subscales used. This generates a score that ranges from 0 to 5. The latter, mean score reporting, is what was intended by the authors.[4] Although the MARS tool developers did not specifically define a threshold for a high-quality app, some authors have used 3 out of 5 as a minimum acceptable score,[15] whereas scores greater than 4 out of 5 are preferable. The apps included in the present report are based upon systematic MARS analyses of mHealth apps on specific primary care topics in the literature.

The MARs tool has high levels of internal consistency (Cronbach's $\alpha = .9$) and interrater reliability (2-way mixed intraclass correlation coefficient, 0.79; 95% CI, 0.75-0.83) when applied to the independent rating of 50 mental health and well-being apps.[4] Users of the MARS tool are encouraged to view the training video for the use of the MARS tool[16] and to practice reviewing several apps and comparing with colleagues to increase interrater reliability.[4]

MARS REVIEWS OF PRIMARY CARE APPS

Health and wellness visits with clinicians often focus on numerous topics. In addition to diagnosis and treatment of a presenting problem, client education can be time consuming within a limited appointment visit time frame. Clients may experience difficulty with health self-management and may benefit from increased client-clinician interaction.[17] Numerous consumer-based apps increase client-clinician interaction and offer the opportunity for clients to increase their health and disease self-management. Although not all apps have been analyzed and assessed for quality, there are several mHealth topics for which thorough MARS app analyses have been performed, including mindfulness, glycemic control, medication knowledge and adherence, weight management, and sleep management.

Mindfulness

Mindfulness has a variety of psychological benefits, including reduced rumination, improved memory, and improved cognitive function, as well as health benefits, including improved immune function, improvement in well-being, and reduction in psychological distress.[18–20] Mani et al[15] conducted a

systematic review to rate the quality of available mindfulness-based apps. The authors identified 700 apps available in the Apple and Google stores. Of those initially identified, 440 were excluded and 260 were screened for specific mindfulness topics, resulting in 23 total apps that met the inclusion criteria of being secular, presenting mindfulness practice, and including guided meditation training. These 23 apps were then rated using the MARS tool by 2 independent researchers. The highest-rated app was Headspace, which had a total mean MARS score of 4.0. Smiling = Mind was the second-best-rated app and had a MARS score of 3.7.[15] The clinician choosing to recommend a mindfulness app may choose one or both of these apps with confidence, especially after reviewing the app independently.

Glycemic Control

Monitoring glycemic control is an important component of care for persons with diabetes. The interaction between the clinician and the client can help to improve glycemic control, and many apps are available for monitoring blood sugar values. Consistent self-monitoring blood glucose has been shown to improve glycemic control in persons with type 2 diabetes.[21] Apps are available to help individuals log, track, and manage their self-monitoring blood glucose results. Functions of blood glucose tracking apps include tracking glucose, insulin, carbohydrates, and activity, as well as tracking weight and blood pressure and the ability to synchronize data with a clinician. Some apps are free, whereas others cost a small amount.[22] Glucose monitoring apps that cost a small amount often have more features and are more customizable than those that are free.[22] Chavez and colleagues identified 89 free apps related to management of diabetes from the Google Play and iTunes stores. By choosing the 30 top-rated free apps in the iTunes and Google Play stores, the authors were able to review a variety of widely distributed apps. The authors then analyzed the apps using the MARS tool and used 10 randomly chosen apps to assess their MARS tool interrater reliability, which was found to be excellent (intraclass correlation coefficient, 0.95; 95% CI, 0.91-0.97).[23] The app Tactio Health received a high rating using the MARS instrument, having received a score of 4.77 out of 5, followed by Accucheck 360 Diabetes Mgmt with a score of 4.32 out of 5. These apps included a large number of functions, and the MARS analysis had excellent interrater reliability upon review.[23] The authors did not report individual subscale scores.[23] A women's health care clinician can feel confident recommending the use of these apps to a woman with diabetes or gestational diabetes to improve glycemic control.

Medication Knowledge and Adherence

Clients may be prescribed numerous medications, which can increase the risk of drug-drug interactions, adverse side effects, and medication adherence. Kim et al[24] identified 1152 apps available through the Apple and Google stores that teach consumers about potential drug-drug interactions. The search yielded 247 apps once duplicates were removed. Of these, 117 did not meet inclusion criteria. A total of 130 apps were then screened for exclusion criteria, yielding 44. Another 21 were excluded for factors related to language, target audience, and issues with function. The authors reviewed the remaining 23 medication apps using the MARS tool. Epocrates Plus received the highest MARS score of all assessed apps, earning a mean score of 4.25 out of 5, followed by the app CVS Caremark, which had a score of 4.1 out of 5, followed by drugs.com, which had a score 4.06 out of 5.[24]

Medication adherence apps are designed to improve the ability of the client to take the correct medications at the correct times. For some, a daily pill box or unit-of-use packaging may be a sufficient reminder to take medications.[25] Others may choose to set up a daily repeated alarm on their mobile device. Finally, some individuals may benefit from a specific app designed for medication adherence. Features of various medication adherence apps are numerous and include databases of medications, the ability of the clinician to input data, reminders that are generated without internet connectivity, tracking of missed and taken doses, and multilingual options.[25] Santo et al identified a sample of 1471 apps, of which 1199 were excluded secondary to factors such as limited information, limited focus, language, or the app being proprietary in nature.[9] The authors screened 272 mobile apps for medication self-management for additional features and identified 10 apps that were then reviewed using the MARS instrument. From this evaluation, Medisafe demonstrated the highest scores in the engagement and aesthetic domains, which relate to visual appeal, customization, and interactivity, with a mean MARS score of 4.6 out of 5, followed by MedicineList+c, which scored 4.2 out of 5, and CareZone, which scored 4.15 out of 5.[9]

Weight Management and Exercise

Weight management and physical activity are important for supporting health. A variety of apps are available that offer assistance with nutrition and exercise management. Bardus et al[26] reviewed 23 apps related to weight management using the MARS instrument. Although specific apps were not identified, the major finding was that the apps that allowed for multiple types of change techniques (including goal setting, self-monitoring, and feedback) were found to have higher functionality, aesthetics, and engagement scores.[26]

Discussions of weight management and daily physical activity are a vital part of conversations with all types of clients. Patel et al reviewed 60 apps related to weight loss, of which 30 were Android and 30 were Apple. Each app was examined by 2 reviewers using the MARS tool.[27] Of the Android apps, Noom Coach: Weight Loss Plan by Noom Inc earned a mean MARS score of 4.15 out of 5. The next-highest-rated app was Lidesum, which received a score of 3.95 out of 5. Of the Apple apps, Calorie Counter and Food Diary by MyNetDiary Inc earned a mean MARS score of 4.1 out of 5. Another highly rated app included MyFitnessPal, which scored differently in the Android (4.3/5) and iOS (3.9/5) platforms.[27]

Sleep Management

Sleep can be a major factor affecting health and well-being.[28,29] Sleep deprivation is associated with anxiety, adverse effects on cognition, and several chronic health

Table 1. Summary of Mobile Application Rating Scale, User Version[a]

	Score				
Subscale Area	**1**	**2**	**3**	**4**	**5**
A. Engagement					
Entertainment	Not entertaining	Mostly boring	Fun for a brief time	Moderately entertaining	Highly entertaining
Interest	Not interesting	Mostly uninteresting	Neither interesting or uninteresting	Moderately interesting	Very interesting
Customization	Does not allow customization	Allows little customization	Basic customization to function	Allows numerous customization	Allows complete tailoring
Interactivity	No interactive features	Insufficient number of interactive features	Basic interactive features	Offers a variety of interactive features	High level of responsiveness
Target group	Completely inappropriate	Somewhat inappropriate	Acceptable; may be inappropriate	Minor issues	Specific, no issues
B. Functionality					
Performance	Broken	Major technical problems	Some technical problems	Minor technical problems	No technical problems
Ease of use	No or limited instruction	Takes a lot of time	Takes some time	Easy to learn	Able to use immediately
Navigation	Difficult	Requires a lot of effort	Requires some effort	Easy to navigate	Perfectly logical
Gestural design	Completely inconsistent	Often inconsistent	Okay, sometimes inconsistent	Mostly consistent	Perfectly consistent
C. Aesthetics					
Layout	Very bad design	Bad design, random	Satisfactory	Mostly clear	Professional
Graphics	Amateur	Low quality, resolution	Moderate quality	High quality	Very high quality
Visual appeal	Ugly, unpleasant	Bad, boring	Okay, average	Pleasant	Beautiful
D. Information					
Quality of information	Irrelevant, inappropriate, incorrect	Poor	Moderately relevant, appears correct	Relevant	Highly relevant, correct
Quantity of information	Minimal	Insufficient	Okay, not comprehensive	Broad range, some gaps	Appropriate, correct
Visual information	Completely unclear, confusing	Mostly unclear	Okay, but often unclear	Mostly clear	Perfectly clear
Credibility	Unknown source	Lacks credibility	Legitimacy unclear	Probably legitimate	Definitely legitimate

[a]Scoring: To calculate total mean score, add mean score for each subscale (A, B, C, and D), then divide by 4. Score also includes evaluation of subjective quality with subscores for recommendation, rate of use, cost, and overall star rating.
Source: Adapted from Stoyanov et al.[5]

conditions, including obesity, increased risk for stroke, and osteoporosis.[30,31] In addition, sleep deprivation increases the risk of motor vehicle crashes[32] and reduces quality of life.[31] Poor sleep quality plays a role in antepartum and postpartum anxiety and depression[33] as well as antepartum suicidal ideation.[34] In addition, during pregnancy, sleep deprivation increases the risk of intrauterine growth restriction, gestational diabetes, and preeclampsia.[31] The use of technology for sleep self-management interventions can improve health care outcomes in persons with sleep deficiency.[35] Choi et al identified 2431 apps potentially related to sleep, sleep management, sleep monitoring, and sleep tracking.[35] Of these, 2283 were excluded as duplicates or for other reasons, such as lack of sleep-related focus, acting as an alarm clock only, or requiring other external devices. The authors assessed 148 apps by description and downloaded them, then excluded 75 additional apps because of duplication and additional indicators. The researchers included 73 unique apps for MARS evaluation by 2 independent evaluators. Three apps scored 4.0 out of 5 overall, including Sleep as Android Unlock, Alarm Clock Xtreme & Timer, and Sleep Center Free. Clinicians may feel comfortable recommending one or more of these for a client who is experiencing sleep deprivation or is asking for help with sleep management.

CLINICAL IMPLICATIONS

Clients seek app recommendations for a variety of purposes, including to understand their condition and treatment choices, to find support, and to track and monitor symptoms to benchmark their progress.[36] Clinicians should be prepared to advise clients on the effective use of apps, and when clinicians encourage clients, the rate of retention of app use is improved.[36] Clinician choice of apps may depend on ease of use, cost, and utility in clinical practice.[10] It is important also to understand that clinician willingness to endorse and integrate mHealth solutions affects client choice. Perceived negativity toward mHealth tools can be a barrier to client use.[37] mHealth apps can empower the client to engage in self-management of disease and wellness and can assist with behavior modification that improves health outcomes. The evidence-based mHealth apps described in this article are examples and a possible starting point for clinicians who wish to make suggestions to clients about commonly discussed primary care health concerns. These types of resources can help reinforce in-office teaching by allowing clients to initiate self-monitoring practices and behavior modifications that will support improved long-term health outcomes and improved client satisfaction.[17]

Structured standardized evaluations of large numbers of mHealth apps using the MARS tool are scant in the published literature. Many topics and apps have not been analyzed systematically. Because the MARS tool requires training and expertise in mHealth, Stoyanov and colleagues simplified the tool, thereby allowing clinicians without extensive mHealth training to evaluate individual mHealth apps.[5] This adapted tool, uMARS, is a 20-item measure that contains 4 subscales, including engagement, functionality, aesthetics, and information quality, and a subjective quality subscale. The uMARS tool instructions suggest that after downloading the app to be reviewed, the user engage in or play with the app for at least 10 minutes to ensure a complete review and exposure to the app and its content. The reviewer is encouraged to evaluate the content and to utilize the available links and navigation to assess ease of use and functionality. Once the reviewer has had the opportunity to use the app, the 20-item tool is applied. The 5 score types (engagement, functionality, aesthetics, information quality, and subjective quality) are averaged to determine subscale mean scores, which are then averaged to determine an overall mean uMARS score.[5] (See Table 1.)

The uMARS was tested with 164 eligible participants aged 16 to 25 years (mean age, 19.8) who did not have mHealth experience. The uMARS was found to have excellent internal consistency (Cronbach's $\alpha = .90$), and internal consistencies of its subscales were also very high.[5] This simplified version of the MARS tool does not require specialized training in the utilization of the tool, making it an effective and efficient choice for practicing clinicians. Clinicians bring content knowledge and expertise to the app evaluation. They may desire to use the uMARS tool to rate apps that their clients bring to them or that they learn of through other means. The clinician who is ready to recommend specific apps can feel confident when a client asks for help with certain health maintenance topics. Practice and experience with the uMARS tool makes app analysis easier, and evaluation of apps using the uMARS tool can be accomplished using these steps.[5]

CONCLUSION

The importance of mHealth and technology-based solutions for improved health and wellness is well established. A 2009 review of 146 research studies on the impact of informatics-based solutions for health outcomes demonstrated that mHealth apps can engage clients, enhance interventions, and improve outcomes.[37] The 3 most influential factors in mHealth technologies that facilitate improvement of health outcomes are tailoring of apps to individuals, personalization of the app, and the availability of behavioral feedback.[37] These criteria are included as components of the MARS and uMARS instruments, thereby giving the clinician the ability to evaluate apps for clients. High-quality, device-agnostic (ie, meant to work on any platform) apps are needed in this technology-driven world to help improve health care services and outcomes.[1,8,9] mHealth app integration is not a replacement for the outpatient setting interactions; instead integration should focus on the elevation of the interventions that are initiated in the client-clinician interaction.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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