An Evaluation Tool for Agricultural Health and Safety Mobile Applications

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ABSTRACT

As the use of mobile devices and their software applications, or apps, becomes ubiquitous, use amongst agricultural working populations is expanding as well. The smart device paired with a well-designed app has potential for improving workplace health and safety in the hands of those who can act upon the information provided. Many apps designed to assess workplace hazards and implementation of worker protections already exist. However, the abundance and diversity of such applications also presents challenges regarding evaluation practices and assignation of value. This is particularly true in the agricultural workspace, as there is currently little information on the value of these apps for agricultural safety and health. This project proposes a framework for developing and evaluating apps that have potential usefulness in agricultural health and safety. The evaluation framework is easily transferable with little modification for evaluation of apps in several agriculture-specific areas.

Keywords: Health communication/methods; Program evaluation; Technology/trends; Mobile, Apps, Software, Usability

Introduction

Mobile devices and associated software applications have become nearly ubiquitous in the general population. In fact, the term "app" has become better known to the general population than the term it represents, application software. Given the popularity of mobile devices for both personal use and use in the workplace, significant efforts have been made to develop apps that allow the use of mobile technology to improve human health and safety. Many of these apps, particularly in the realm of workplace safety, have potential for use in the agricultural workplace. For example, a quick search on the Google Play apps store website[1] for a "sound meter" app resulted in 97 apps readily available for download to Android mobile devices at the time of this writing. These sound or decibel meter apps that can measure environmental noise may be used on farms in occupational hearing loss prevention strategies. However, mechanisms for evaluating apps in this context have not been described to date.

Mobile health apps have increased dramatically in availability and popularity in recent years.[2] Such apps are designed to help users manage chronic diseases, such as diabetes and heart disease,[3] or to assist in smoking cessation.[3] They vary widely in their technological sophistication, from simple text message alerts to connecting with medical records portals.[4] However, less than 5% of these mobile health apps have been tested and in such a way that the results are helpful to potential users.[5,6] A review of diabetes self-management mobile apps showed that many are lacking in functionality and content in the provision of evidence-based clinical guideline recommendations as published by health authorities.[7] In addition, mobile technologies and apps that feature industry recommendations and best practices and are designed to serve as tools for safety professionals in many industries, such as the National Institute for Occupational Safety and Health (NIOSH) Ladder Safety app and the Occupational Safety and

Health Administration (OSHA) Heat Safety Tool, lack proper evaluation.[8] Importantly, few, if any, of these tools specifically target health and safety in the context of agriculture despite a high potential for use in this arena. With the majority of farmers owning smartphones and a growing number of apps that aid in farm management available to them, it is only a matter of time that apps related to health and safety will be adopted in agriculture.[9] As such, there is a great need for mobile application evaluation tools, particularly with a specific focus on use in agriculture.

In a recent *JAMA* publication, Bridget Kuehn[10] aptly describes growing concerns regarding the many thousands of applications available for use in the realm of health and safety and the relative lack of evaluation for such apps. Paradigms for the evaluation of mobile applications have been described, including checklists and rubrics, particularly in the areas of education,[11,12] but also more recently with respect to physical and mental health.[13,14] These frameworks each vary in their evaluation criteria. For those in the area of medicine, the evaluation questions are specific to the medical specialties and are geared towards apps that are used for clinical care and management.[13,14,15] Many did not mention testing their proposed frameworks with target users. Questions also remain regarding how these paradigms can be applied to the evaluation of health and safety applications, particularly in the context of agriculture. Here, we describe development and testing of a framework for evaluating apps that have potential usefulness in the agricultural health and safety field, especially for developers, agricultural educators and health and safety professionals who work directly with producers. Usability testing suggests that the framework developed will be readily transferable across the agricultural workspace for a variety of mobile apps with little modification.

Methods

Rubric development

A rubric for evaluation of mobile apps for use in the agricultural workplace was proposed. The rubric was chosen to be used as a scoring guide to contribute to a sound, accurate, and fair assessment of mobile apps.[16] The evaluation rubric was tested first with several expert volunteers for appropriateness of language and content and then with a larger group of individuals representing potential app users. First, a framework was developed upon which to evaluate mobile apps, based on a review of various bodies of literature in medicine, technology and education, government and industry-based practices and investigator experience with app use. Broad characteristics agreed to be important for inclusion in the final rubric were broken down into domains and their components. The first domain was "Relevance" and included components related to content and whether the app serves to advance agricultural health and safety. The second domain was "Function" and included the components of technical performance, usability, and information delivery. Finally, the domain "Value and Privacy" was included with the components of value, advertisements, privacy disclosure, and confidentiality. Detailed descriptions of each component by domain can be found in Table 1. Each domain component is to be scored using a Likert scale ranging from 1 (poor) to 4 (excellent). Descriptions for Likert scale values specific to each component have been defined in detail in Table 2.

Mobile app calculator

A mobile app calculator was constructed to assign a point-value to the rubric-based evaluation (Figure 1). The calculator serves to mathematically manipulate the component and domain scores and to generate an overall weighted score. Domain-specific component scores are

averaged to obtain a domain summary score. Domain scores are then averaged to obtain an overall weighted average score with weighting determined as follows:. Since the Relevance criteria has the least number of components, the components of the Relevance score have the most influence towards judging the overall worth of the app. This is followed by the Function score, and lastly the Value & Privacy score. The weights are broadly based on the prevalence of components in other frameworks found in previous literature. The average was weighted toward the components of the Relevance and Function scores over Value and Privacy. In order to adapt to a 5-point scale typically used in mobile app reviews, the overall weighted average score is multiplied by a conversion factor of 1.25 and rounded up to the nearest integer. Overall point values are calculated as follows:

Relevance Score = (Content + Advances Agricultural Health and Safety)/2

Function Score = (Technical Performance + Usability + Information Delivery)/3

Value & Privacy Score = (Value + Advertisement + Privacy Disclosure + Confidentiality)/4

Overall Weighted Average Score = (Relevance + Function + Value & Privacy)/3

5-point Scale Rating = Overall Weighted Average × 1.25

Testing of the Rubric and Calculator

The mobile app evaluation rubric was piloted and then tested to assess its acceptability among ag health and safety professionals. [17] The pilot participants included a small convenience sample consisting of four experts in their field; three testers were from information technology, and one represented agricultural health and safety research. After the rubric was modified based on feedback from the pilot group, further testing was conducted. Test participants were composed of

volunteers who would be likely users of the rubric for app evaluation, including agricultural health and safety and informatics professionals. Utilizing expert panels like this has been shown to be effective in many different forms of agricultural safety and health research.[19] All testers had to have at least some familiarity using mobile devices and apps as they were required to use their own mobile devices and download the apps themselves to be able to test the rubric. Testers were responsible for costs related to internet connection and data usage during the testing. Testers were recruited via personal invitation, online groups, social media groups, and after a presentation at the International Society of Agricultural Safety and Health (ISASH). Online groups included the eXtension.org Farm and Ranch eXtension in Safety and Health (FReSH) Community of Practice and the International Society for Agricultural Safety and Health (ISASH) member listserv. Social media groups included the American Society of Safety Engineers (ASSE) Agricultural Safety Professionals LinkedIn group. A page on the National Farm Medicine Center website was developed for to house instructions, user tasks, the rubric, calculator, and online survey as described below.

Potential testers who expressed interest in testing the rubric were sent an email on how to participate. The email included the purpose of testing the rubric, instructions on how to employ the rubric, testing expectations, description of appropriate devices and operating systems, information indicating that testing could occur anywhere there was access for the mobile applications, instructions for downloading the apps, mobile app descriptions, typical user scenarios and tasks within the each app, and how to provide feedback. The email also directed them to the National Farm Medicine Center website to view and download the rubric and calculator. After reviewing each mobile app's user scenario and completing the tasks, testers were instructed to view the rubric, complete the mobile app calculator by scoring each

component on a scale from 1 (poor) to 4 (excellent) (Table 2), save the results, and email them to the administrators before moving on to the next app.

Testers were also asked to complete an online Survey Monkey© (2016) questionnaire developed to capture tester profiles, device type, operating system used, app of choice, and evaluation of the rubric and calculator. Questions included whether the rubric was clear, if it contained enough information, if it could be effective in evaluating mobile apps, if there were any other tools available for evaluation of apps, and any additional comments. Testers were asked about whether the calculator scoring was logical and if any improvements could be made.

Mobile apps for rubric testing

A number of mobile apps with potential for use in the agricultural workplace were reviewed, and two were chosen for testing of the evaluation rubric. Selected mobile apps included the OSHA Heat Safety Tool[19] and NIOSH Ladder Safety smart phone application[20]. The OSHA Heat Safety Tool allows calculation of the heat index for a specific worksite and displays a corresponding risk level for outdoor workers and risk level-specific protective measures that can be taken to prevent heat-related injury or illness.[19] The NIOSH Ladder Safety app uses visual and audio signals to promote the safety of workers using extension ladders.[20] The first group of pilot testers was asked to review both mobile apps and choose a third app of their preference. The second group of testers was asked to review the OSHA Heat Safety Tool and a second app of their choice.

Stakeholder engagement

In addition to usability testing, input was also solicited from interested stakeholders that would likely use this evaluation rubric. Researchers, health and safety professionals, an educator and a student were asked to evaluate the rubric by responding to an electronic survey. Comments and suggested revisions were evaluated by the development team to further refine the rubric.

Results

A total of 10 respondents tested the mobile app rubric and calculator using devices of their choice. Respondent characteristics and testing platforms are shown in Table 3. Fields of expertise varied, including research, education, and health and safety professionals from the agriculture, general industry, and technology sectors. The majority of respondents reported familiarity with mobile app use. Smartphones were the most commonly used device, with only one participant using a tablet, but operating systems were split evenly between iOS and Android platforms. The most commonly evaluated app was the OSHA Heat Safety Tool, although several others were described.

Respondents were asked to evaluate the technical merit of the rubric with respect to clarity, amount of information, effectiveness for evaluating mobile apps, and scoring system logic (Figure 2). Responses were largely favorable, with 90% rating the rubric as clear, 60% agreeing that the rubric had enough information, and 60% reporting that it was effective for evaluating mobile apps. The majority of the participants (80%) also found the scoring system to be logical. At the end of the survey, participants were asked to provide suggestions to improve the rubric. There were conflicting suggestions regarding the amount of information in the rubric, as one respondent suggested to “trim down the descriptions” while some felt that the rubric needed to

"be more specific" and definitions "should be expanded." Another area of contradiction was with regard to the scoring system. One respondent felt that the relevance was scored too high, while another felt it was too low. Several respondents had difficulty scoring apps based on components that were related to the use of personal data. For instance, one commented that with regards to the information delivery component, they were "not concerned with saving, exporting, and sharing data on most mobile apps because that is not their function." Another responded that they "have no idea how much the app might access information beyond asking for my current location." Regarding privacy disclosure and confidentiality, one respondent felt that "there should be a field for "n/a" because [they] could not find this information." When asked if they knew of other mobile app evaluation rubrics, all respondents answered No. Positive comments described the rubric as "easy to use" and "great to have."

Respondents were instructed to save their scores on the calculator and send it back to the project staff. However, many of them did not return their calculators. Some of those who returned their filled-in calculators did not identify the scores in relation to the apps. Therefore, we could not compare the similarity in scoring among the respondents.

Discussion

There is little doubt that app use in the workplace is growing, including the agricultural workplace, especially with respect to health and safety. A potential user is confronted with a plethora of choices in terms of apps available for free or at minimal cost. However, there is no peer review system for judging the worth of an app. Standardized assessment tools have only recently started to be explored. The unguided app user has little help in selecting from among the abundance of apps and may spend inordinate amounts of time trying out apps that appeal on the surface, but provide inaccurate information, are burdensome to use, or provide information of

little value.[21] Here, we present an evaluation framework and associated rubric that offers some uniformity in judging the overall worth of an app for use in the agricultural health and safety setting. Although designed to assess apps with potential or specific application to agricultural safety and health, the domains examined are not specific to this field, and the rubric may have value for general use in assessing apps related to health and safety in other fields.

The rubric for app evaluation was developed with domains based on literature and stakeholder input as important criteria in evaluating an app in the context of agricultural health and safety. The rubric was reviewed with a small expert group of developers and content specialists and then with another sample of potential users from several fields related to agricultural safety and health to assess both the usability and content validity of the rubric itself. Participants were presented with the task of using the online computerized rubric to evaluate an assigned app as well as an app of their choosing with the device of their preference. A majority of the participants rated the rubric as clear and easy to use. As a result of additional feedback, updates to the rubric will be related to supplying enough information to allow an experienced user to evaluate apps without having to read through excessive material, but also to keeping accessible some of the more detailed descriptions in supporting documents for further study for those users that need more detailed descriptions. Another point of clarification to add to the review process is that app reviews will vary depending on the platform, language, and device type (e.g., phone, tablet) on which the app is tested. Therefore, one review of an app will not suffice if it is available across multiple platforms, languages, and devices. This rubric can be used to create a minimum standard of quality for evaluating apps across various operating systems and devices.

The Function and Value and Privacy domains of the rubric include components such as technical performance, usability, and confidentiality that can be useful in the app development stages. Hence, this framework could be used not only as an evaluation tool to help select apps in the context of agricultural health and safety, but also to assist in developing apps that may be more helpful to users.

One major concern that arose from this study is the lack of knowledge by agricultural safety and health experts on data privacy and user information collection on mobile devices. A majority of the experts did not know how to respond when asked questions related to privacy policies and personal information collection. In this context, the rubric would serve as an educational tool for developers and users alike to inform them of mobile app components that may impact users' confidentiality and use of their personal data.

The rubric and calculator are available to the public for free at the National Farm Medicine Center webpage within the Marshfield Clinic Research Foundation website.[22]

Limitations

With the diversity of agricultural safety and health professionals used as experts in this study, there were great variations in experience with mobile devices, knowledge of mobile device software, and knowledge of agricultural safety and health topics, which could lead to lack of depth in some review areas. The rubric was designed to evaluate informational and tool type apps as opposed to edutainment apps, those meant for entertainment, but with an educational aspect. Use of the rubric on other types of apps is probably not appropriate. Users also have to be cautious when posting ratings from the rubric when new versions of apps or updated safety and health information are released. For example, an app based on current cardiopulmonary

resuscitation (CPR) techniques would receive a lower rating if new CPR techniques are released, and the app is not updated appropriately. We also acknowledge that the rubric will need to be continually updated to reflect changes in technology.

A next step for this tool is to go through the process of developing a consensus standard or standard best practice, an agreement developed by industry stakeholders, to be used to evaluate ag health and safety apps. The objective components of the rubric may further be refined through future testing and reporting of evaluation scores with a larger group of respondents to determine inter-rater reliability of the rubric.

Conclusion

Apps are ubiquitous, abundant, and generally inexpensive. Many have very valuable information to impart or can do calculations, measurements, or evaluations quickly and accurately. However, this abundance comes with the challenge of identifying apps that truly are of value. Here we present an attempt to standardize the evaluation of agricultural health and safety apps. We believe this attempt at standardization could prompt the examination of our tool and innovation of others that will assist the busy health and safety specialist to economize on the time required to select wisely when faced with this embarrassment of riches. We also trust that mobile app developers will find this evaluation framework insightful and practical.

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Table 1. Agriculture-Specific Mobile Application Evaluation Framework

Domain	Component	Description
Relevance[11,12,17,23,24,25]	Content	Content is accurate, relevant, consistent, clear, grouped, regularly updated, reliable, engaging, language is non-offensive, and complies with regulatory requirements.
	Advances Agricultural Health and Safety	App can be used for reference, information access, prevention, education, awareness, calculations, gaming, or entertainment and serves the overall purpose of reducing agricultural workplace incidents, injuries, and illness in or advancing agricultural health and safety.
Function[6,12,17,23,24,25]	Technical Performance	App has no technical issues, functions well, works across platforms, processes quickly, is accurate, 508 compliant, functional, customizable for specific apps, measurement tool is calibrateable, support is housed within the app, and technical team available for issues.
	Usability	Visual elements are appealing, cognitive burden for determining functionality is low, instructions for use are clear, app is intuitive, navigation is consistent, app has a real feel connecting the data to the user, app is tested, efficient, effective, complete, readable, and easy to learn, app is developed for the end user.
	Information Delivery	Effective presentation of data back to the user/second party/development team, has options for reporting, users can share information across platforms or with other parties and information can be exported to print or copy.
Value & Privacy[21,24,26,27]	Value	Relates to the cost of the app to download, upgrade, and control ad behavior.
	Advertisement	Ads, if provided, are delivered to the user with context and control. User may have option to control ads through Do Not Track (DNT) mechanisms that prevent or limit access of ad tracking networks. Ad delivery techniques are discussed which may include standard “push” notification, add new icons to the mobile desktop, and modifying user browser settings.
	Privacy Disclosure	Transparency of the app developer in accessing user data, such as geolocation, contact lists, calendar information, photos, mobile usage history, audio and video recordings, unique user identifiers, etc. A privacy policy may include the type and amount of data being collected or shared, how the data will be used, and to whom it will be shared.
	Confidentiality	Relates to unique user identifiers and its encryption. In general, these identifiers should not be used for advertising purposes. Permanent identifiers are ones that the user cannot change, such as device-specific International Mobile Equipment Identity (IMEI), Unique Device Identifier (UDID) in iOS devices, and device-specific Media Access Control (MAC) address. Impermanent identifiers may be resent by the user and includes Android ID in Android devices, and subscriber-specific International Mobile Subscriber Identity (IMSI) and MSISDN.

Table 2. Proposed Agriculture Health and Safety Mobile App Evaluation Rubric

	Component	1 (Poor)	2 (Fair)	3 (Good)	4 (Excellent)
RELEVANCE	Content	Content is not reliable, accurate, and error-free	Some of the content is reliable, accurate, and error-free	Content is generally accurate, reliable, and error-free	Content is accurate, reliable, and error-free
	Advances Agricultural Health and Safety	The app has no value in providing information to advance agricultural health and safety	The app has limited value in providing information to advance agricultural health and safety	The app has good value in providing information to advance agricultural health and safety	The app has great value and is ideal in providing information to advance agricultural health and safety
FUNCTION	Technical Performance	Multiple technical issues and does not function as described	Occasional technical issues, functions somewhat as described	Rare technical issues, generally functions as described	No technical issues and functions well as described
	Usability	Difficult to operate, demonstration and instruction are consistently required	Demonstrate is required to operate, instruction is sometimes required and may be available	User can launch app, instruction is initially required and available, but is not needed thereafter	User can launch and operate the app independently, no demonstration or instruction is needed
	Information Delivery	Cannot save, share, or export data	May not save, share, or export data	May not save, but can share and export data	Can save, share, and export data
VALUE & PRIVACY	Value	Costs to download, access, and upgrade, and ads may be present	Free to download and access, in-app purchased required and ads are present	Free to download and access, no in-app purchases required, ads are present	Free to download and access, no in-app purchases are required and no ads
	Advertisement	Aggressive ads that modify settings without consent, has third-party tracking, no limit/block option	Ads modify settings without consent, third-party tracking, option to limit/block for a fee	Limited ads modify settings with consent, third party tracking, free option to limit/block	Limited or no ads or third party tracking, free option to limit/block
	Privacy Disclosure	No consent or disclosure, accessed data beyond what app needs to function, no privacy policy	No consent or disclosure, accessed data beyond what app needs to function, privacy policy complex and hard to find	No consent but has disclosure, only accesses data that app needs to function, privacy policy is accessible	Consent and disclosure, only accesses data that app needs to function, privacy policy is easy to read and accessible
	Confidentiality	Permanent and impermanent identifiers are collected for advertising purposes, identifiers are not encrypted	Impermanent identifiers are collected for advertising purposes, identifiers are not encrypted	Impermanent identifiers are collected for advertising purposes, identifiers are encrypted	Identifiers are no collected for advertising purposes

Table 3. Tester Characteristics

	N (%)
Total Respondents	10 (100)
Agricultural Health and Safety Expertise	
Research	3 (30)
Education	1 (10)
Student	1 (10)
General health and safety	4 4 (40)
Technology	1 (10)
Familiarity with Mobile Apps	
Slightly/Somewhat	2 (20)
Moderately	5 (50)
Extremely	3 (30)
Device Type	
Smartphone	9 (90)
Tablet	1 (10)
Operating System	
iOS	5 (50)
Android	5 (50)
Evaluated Apps[a]	
OSHA Heat Safety Tool	
3M Hearing Protection Sound Meter	
NIOSH Ladder Safety	
Agriculture Information	

[a]Testers were asked to evaluate multiple apps, including at least one of their own choosing.
Abbreviations: OSHA, Occupational Safety and Health Administration; NIOSH, National Institute for Occupational Safety and Health; DCBS, Department of Consumer and Business

Figure Legends

Figure 1. Screenshot of mobile app evaluation calculator

Figure 2. Rubric Technical Evaluation. Testers were asked to evaluate the technical merit of the rubric with respect to (A) rubric clarity, (B) amount of information in rubric, (C) rubric effectiveness in evaluating mobile apps, and (D) scoring system logic. Responses from the 10 testers are shown.

CRITERIA	CATEGORY	Poor 1	Fair 2	Good 3	Excellent 4
RELEVANCE	Content	☐	☐	☐	☐
	Advances Agricultural Health & Safety	☐	☐	☐	☐
FUNCTION	Technical Performance	☐	☐	☐	☐
	Usability	☐	☐	☐	☐
	Information Delivery	☐	☐	☐	☐
VALUE & PRIVACY	Value	☐	☐	☐	☐
	Advertisement	☐	☐	☐	☐
	Privacy Disclosure	☐	☐	☐	☐
	Confidentiality	☐	☐	☐	☐

Raw Score	0
Relevance Score	0.0
Function Score	0.0
Value & Privacy Score	0.0
Overall Score	0.0
5-point scale rating	0

Figure 1. Screenshot of mobile app evaluation calculator

165x133mm (300 x 300 DPI)

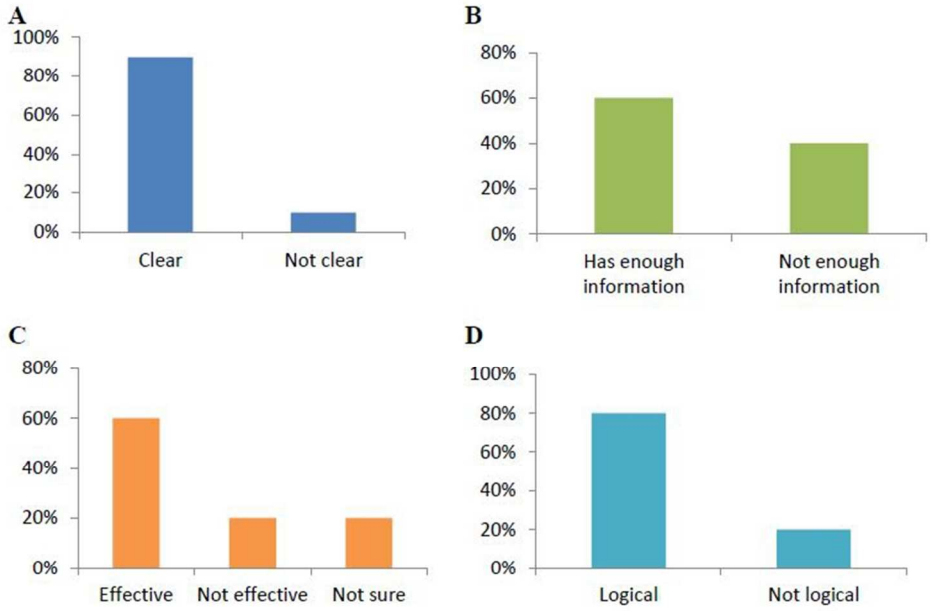

Figure 2. Rubric Technical Evaluation. Testers were asked to evaluate the technical merit of the rubric with respect to (A) rubric clarity, (B) amount of information in rubric, (C) rubric effectiveness in evaluating mobile apps, and (D) scoring system logic. Responses from the 10 testers are shown.

214x147mm (96 x 96 DPI)