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Review

Review

Exploring app features with outcomes in mHealth studies involving chronic respiratory diseases, diabetes, and hypertension: a targeted exploration of the literature

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ABSTRACT

Objectives: Limited data are available on the correlation of mHealth features and statistically significant outcomes. We sought to identify and analyze: types and categories of features; frequency and number of features; and relationship of statistically significant outcomes by type, frequency, and number of features.
Materials and Methods: This search included primary articles focused on app-based interventions in managing chronic respiratory diseases, diabetes, and hypertension. The initial search yielded 3622 studies with 70 studies meeting the inclusion criteria. We used thematic analysis to identify 9 features within the studies.
Results: Employing existing terminology, we classified the 9 features as passive or interactive. Passive features included: 1) one-way communication; 2) mobile diary; 3) Bluetooth technology; and 4) reminders. Interactive features included: 1) interactive prompts; 2) upload of biometric measurements; 3) action treatment plan/personalized health goals; 4) 2-way communication; and 5) clinical decision support system.
Discussion: Each feature was included in only one-third of the studies with a mean of 2.6 mHealth features per study. Studies with statistically significant outcomes used a higher combination of passive and interactive features (69%). In contrast, studies without statistically significant outcomes exclusively used a higher frequency of passive features (46%). Inclusion of behavior change features (ie, plan/goals and mobile diary) were correlated with a higher incident of statistically significant outcomes (100%, 77%).
Conclusion: This exploration is the first step in identifying how types and categories of features impact outcomes. While the findings are inconclusive due to lack of homogeneity, this provides a foundation for future feature analysis.

Key words: mHealth, mobile health, chronic respiratory diseases, hypertension, diabetes

BACKGROUND AND SIGNIFICANCE

The healthcare field is experiencing exponential growth in mHealth (mobile health). According to the World Health Organization (WHO), mHealth refers to the utilization of mobile devices to support medical and public health practices.[1] Currently, there are an estimated 325 000 health, fitness, and medical mobile apps available.[2] This emerging field is viewed as a mechanism to enhance patient-centered care and improve patient outcomes from the perspective of healthcare providers (HCPs) and patients.[3] For example, Ramirez and colleagues reported 86% of patients at multiple California pri-

mary care facilities expressed an interest in using mHealth for chronic health management and as a tool to learn about their health.[4] mHealth interventions focused on chronic diseases have the potential to significantly affect the overall state of health in the United States; however, an initial look at the mHealth literature revealed mixed results, with some studies reporting no statistically significant outcomes (SSOs).[5,6]

Previous reviews

An appraisal of existing mHealth systematic reviews and meta analyses revealed some notable information on mHealth features. First, bi-directional and personalized, tailored short message services (SMSs) appear to be more effective in producing SSOs than generic uni-directional SMSs in managing chronic health conditions.[7–12] Next, several reviews and meta-analyses examined how patients and HCPs communicated via a mHealth app with inconclusive results.[13–15] Other reviews examined mHealth features, but did not correlate the features to SSOs.[16–23] Stephani and colleagues identified 3 intervention categories along with personalization and interactivity of the intervention in each study; no direct correlation of outcomes with intervention was reported.[24] These reviews presented exceptional details on mHealth, but how mHealth features and categories correlate with outcomes was unclear.

Another finding from these reviews was the diverse categories of mHealth features. A lack of consensus on categories and definitions of mHealth features became apparent. Some reviews used very broad feature categories[15,16,18,24] while other reviews described very specific features.[19,21] This diversity of categories and definitions may serve as a barrier to the translation of effective mHealth features.

One must ask why the use of some mHealth apps improves patient outcomes while other mHealth apps do not. These disparate outcomes need further analysis to identify the differences between the 2 groups (ie, mHealth studies with SSOs vs mHealth studies without SSOs). One possible explanation for the differences in outcomes may depend on the categories and types of features contained within the mHealth app. Apps may include a mix of functions; for example, one weight loss app may offer features that allow weight tracking and calorie intake documentation, another may include a support group option, while still another may push daily inspirational messages to the user. A focus on an app's *specific features*, rather than the app as a whole, may yield a more complete understanding.

Second, chronic disease self-management relies on the use of behavior change techniques (BCTs) to successfully manage the disease.[25] BCTs originated from Michie and colleagues' seminal classification of interventions to promote behavior change within healthcare.[26,27] Some findings suggested that BCTs are unique based upon the desired outcome.[28,29] Maintaining or starting healthy behaviors such as medication adherence documentation or completion of biometric measurements may require BCTs different from stopping a negative health behavior, such as cigarette smoking. Similarly, specific app features that facilitate stopping a negative health behavior may be quite different from those relevant to stopping or maintain a positive health behavior. Previous work on mHealth may have been confounded by a failure to examine studies based on the type of BCT.

OBJECTIVE

Based upon these assumptions, we focused the current exploration on primary studies that used mHealth tools to start or maintain health behaviors in the context of chronic diseases. mHealth may enhance the self-monitoring process, especially when monitoring chronic diseases with specific biometric measurements (ie, blood glucose, blood pressure [BP], peak flow) that are recorded by the patient and shared with an HCP for review and feedback. Chronic respiratory diseases (ie, asthma, chronic obstructive pulmonary disease [COPD]), diabetes, and hypertension (HTN) are 3 chronic diseases that monitor biometric measurements. These 3 diseases affect almost 44% of the U.S. population with $271 billion in direct healthcare cost in the United States.[30–34] Furthermore, diabetes and HTN increase a patient's risk for development of cardiovascular disease, which further expands healthcare costs.[35] As the application of mHealth tools is very similar in the management of these conditions, we decided to focus on these illnesses to yield more details on mHealth app-specific features and how they may correlate with outcomes.

To address the gap involving mHealth features, we conducted a targeted exploration to identify specific mHealth features and how they potentially correlated with SSOs. We hypothesized that types and categories of mHealth features would be associated with SSOs. The purpose of the exploration was to specifically identify and analyze: 1) types and categories of mHealth features; 2) overall frequency and number of mHealth features; and 3) relationship of SSOs by type, frequency, and number of mHealth features.

MATERIALS AND METHODS

Prior to searching the literature, we defined the term mHealth feature, also known as interventions or BCTs, as a distinctive attribute or tool within a mobile app that assists patients in managing and monitoring all aspects of health.[18,36] While previous literature suggested specific features were potentially relevant to starting and maintaining healthy behaviors (eg, SMS), we did not use a circumscribed list to prevent bias. Instead we employed a thematic analysis approach to identify features within the studies.[37,38] The process required a careful and thorough analysis of the feature descriptions in each study with 1 author recording the descriptions in a spreadsheet, which was then reviewed and analyzed for themes by all authors. This method allowed the evidence to guide the identification of the mHealth features.

For studies involving 2 or more groups (ie, intervention and control), we included only outcomes reported between groups as the purpose of a control group is to isolate the independent variable's effect (ie, mHealth app). However, we reported the within-group outcomes for single group studies. All reported outcomes compared baseline data with the final data. Also, subgroup outcomes were not included in the analysis, as the subgroup methodology was not defined prior to the study onset, which does not meet best practices standards.[39] Finally, 3 studies included 2 intervention groups that introduced an additional independent variable (ie, intensive insulin therapy, bi-weekly telemedicine consultations, face-to-face health counseling).[13,40,41] While all intervention groups used mHealth, the introduction of an additional independent variable clouded the analysis of mHealth efficacy. For these studies, we included only the comparison between the standard care control group and the standard care mHealth intervention group.

Search process

The search included primary articles focused on app-based interventions for the management of chronic respiratory diseases, diabetes,

and HTN from the following databases: Cumulative Index to Nursing and Allied Health Literature, PubMed, EBSCO Academic Database, Cochrane Library, and Google Scholar. Search dates included 2002 to 2018. Two significant mobile advances occurred in 2002—SMS capability among networks and wireless email via Blackberry Smartphone—and provided researchers with new mHealth options.[42,43] The search terms included key words in multiple combinations and used medical subject headings: self-monitoring, mobile application, mobile app, mHealth, text messaging, SMS, hypertension, high blood pressure, diabetes, asthma, COPD, chronic respiratory disease, wireless communication, cell phone, mobile phone, and mobile device. Initial search results yielded 3622 studies (See Figure 1).

Inclusion criteria

Inclusion of primary quantitative and mixed-methods studies was dependent upon the utilization of mHealth as defined by WHO—utilization of mobile devices to support medical and public health practices—in chronic respiratory diseases, diabetes, and HTN.[1] For this exploration, only the quantitative results of mixed-methods studies were included. Primary journal articles available via university library sources including inter-library loan and written in English were included. Finally, reference lists of articles and reviews were examined to ensure inclusion of all relevant literature. The exploration included randomized control trials, descriptive studies, and pilot trials that tested and reported the efficacy of mHealth interventions.

Exclusion criteria

The use of eHealth, a broader term that incorporates other technologies not exclusive to mHealth, prompted exclusion from this literature exploration (n = 191).[44] Unrelated studies (n = 902), qualitative studies (n = 49), reviews and meta-analyses (n = 163), research design and proposals (n = 90), and studies not available through university libraries (n = 9) or not available in English (n = 12) were removed from the analysis. After careful review, an additional 49 studies did not meet the inclusion criteria or had mitigating issues and were excluded (see Supplementary Material Table S1).[45–93]

Finally, 71 appropriate studies from 30 countries were included. Nundy and colleagues reported the same study in 2 separate articles.[94,95] These 2 articles were merged into a single study to prevent duplication in the analysis. Most studies (81%) included at least 1 intervention group and control group in either a randomized methodology (n = 41) or a quasi-experimental methodology (n = 16). The remaining studies followed pre/post-test methodology with a single intervention group (n = 13). Supplementary Material Table S2 provides the mHealth feature details on each study.[40,41,94–161,169]

RESULTS

Using thematic analysis, we identified 9 mHealth features used 185 times in the 70 studies. Differences in the level of interaction between the patient and the features were observed. Other researchers described the interaction as 1-way or uni-directional features and 2-way or bi-directional features.[24,97,98,104] Using these existing terms, human-computer interaction standards, and BCTs, we classified the features as passive or interactive based upon the level of interactivity between the patient and the feature.[24,162–166] For this review, *passive features were defined as features that do not require any additional response or action from the patient within the mHealth app*. With passive features, the patient completes only the initial task (ie, reading the SMS or reminder, taking the biometric measurement). Passive features included: 1) 1-way SMS; 2) mobile diary to store and graphically display biometric measurements; 3) upload biometric measurements via Bluetooth; and 4) reminders.

In contrast, *interactive features require patients to provide a response or modify the content in real time*.[163] Interactive features included: 1) interactive prompts; 2) direct upload of biometric measurements to HCP for review and timely feedback; 3) action treatment plan/personalized health goals; 4) 2-way communication (ie, texting, messaging, e-mail) between HCP and patient that is tailored to the patients' biometric measurements, health goals, or health beliefs; and 5) clinical decision support system (CDSS).

Types of features

Passive features

As defined above, passive features did not require the patient to perform any additional task or response within the mHealth app. However, they delivered essential self-monitoring elements by providing education or health tips, displaying previous biometric measurements, uploading biometric measurements, and reminding the patient of upcoming events, tasks, or medications.

One-way SMS and messaging. One-way SMSs, also known as unidirectional messaging, are messages sent from the HCP or computer to the patient.[97,98,104] The patient can only read the message. Researchers used these messages to educate, instruct, advise, increase awareness, and motivate the patient on specific health conditions and behaviors.[96,101,140,142,149] Examples included: "Physical activity helps to maintain normal blood sugar and blood pressure" and "Were there many missed walks this month? No worries, start today."[142] Bell and colleagues used a slightly different approach by sending daily video messages instead of written messages.[97] The frequency and timing of the messages varied from 1 per month to daily.[97,117,121,159] Twelve studies used 1-way SMS as the only mHealth feature with 7 (58%) reporting SSOs.[99,106,118,121,132,140,142] Ten additional studies combined 1-way SMS with other features. Only 2 studies (20%) reported no SSOs.[105,132]

Mobile diary. This feature stores biometric measurements and graphically displays the information for the patient to identify patterns and trends in the biometric measurements. Twenty studies included a mobile diary feature in addition to other mHealth features. Six studies (30%) reported no SSOs.[13,107,108,110,114,150]

Bluetooth technology. Bluetooth technology allows medical devices (ie, glucometers, BP cuffs, scales, etc.) to automatically upload data to the mHealth app.[167] Nineteen studies incorporated Bluetooth with other features. Seven (37%) of these studies reported no SSOs.[13,107,108,110,114,122,150]

Reminders. A reminder is a message that reminds the patient about an upcoming action or task (ie, take medication, attend appointment). The patient does not respond to the reminder. Strandbygaard and colleagues used a reminder as the sole mHealth feature and reported SSOs.[151] Twenty-eight additional studies included a reminder in combination with other features. Five studies (18%) reported no SSOs.[105,107,108,122,132]

Interactive features

Interactive features differ from passive features by providing feedback based upon patient input or requiring the patient to perform a responsive action within the app. These are bi-directional features.

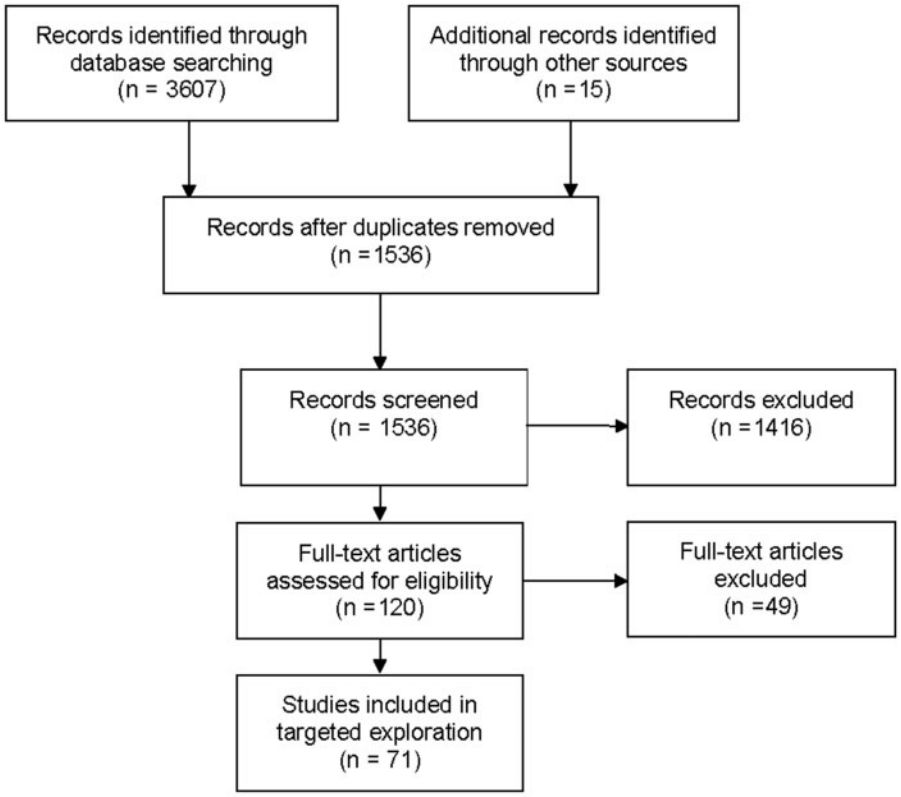

Figure 1. mHealth exploration flowchart.

The patient engages with the mHealth app by sharing health data, setting health plans/goals, responding to tailored health questions, or receiving feedback based on biometric measurements.

Interactive prompts. This feature moves beyond reminders by requiring the patient to enter an appropriate response. These prompts originate from a computer algorithm, which differentiates this feature from the personalized 2-way SMS between an individual and the patient. Most interactive prompts elicited additional information from the patient such as symptoms, medication refills, appointment changes, and biometric measurements.[101,102,104,105,129] Two studies used interactive prompts exclusively; Han and colleagues reported SSOs while Tasker and colleagues did not.[119,153] Thirteen additional studies included interactive prompts with other mHealth features, and 3 (23%) reported no SSOs.[105,141,147]

Action treatment plan/personalized health goals with HCP. This process includes defining a behavior goal into quantifiable measurements with re-evaluation and modifications as goals are achieved.[26] Twelve studies utilized an action treatment plan or personalized health goals with other features. All 12 studies (100%) reported statistically significant outcomes.[40,41,109,111,129,130,143–146,152,161]

Two-way or tailored communication between HCP and patient. Two-way communication includes SMS and e-mail between the HCP and patient. This interaction is dynamic, as it involves 2 or more individuals, which is different from the computer-based algorithms used in interactive prompts. HCPs provided feedback on biometric measurements or changed the patient's health regime. In addition, content-tailored SMS messages encouraged changes in health beliefs and behaviors based upon the patients' health beliefs and understanding of the disease process and management, which originated from surveys and questionnaires.[26] Examples of personalized, 2-way SMSs included: "Your fasting blood glucose level is very high compared with the appropriate target level for type 2 diabetes (< 7.2 mmol / l). If this high level recurs often, diabetic complications might result. Reduce your calorie intake and avoid foods high in fat. In addition, plan for regular exercise after your meals" and "Hi <patient name>- Another pretty good week—just a bit concerned about some odd higher levels in the morning—looks like some of these are forgotten doses - would that be right? Otherwise all are getting better and no real hypos. Be aware you may need to tweak basal if those highs are not related to forgotten doses. Your thoughts?"[125,160] This personalization recognized the patient as a unique individual with unique health needs and goals. Petrie and colleagues exclusively used 2-way communication with SSOs.[139] Twenty additional studies used 2-way communication in conjunction with other mHealth features with 1 (5%) study reporting no SSOs.[108]

Upload biometric measurements to HCP for review and real-time feedback. This feature includes the transfer of health data directly to the HCP for review and feedback in a timely manner. Twenty-six studies included this mHealth feature in combination with other features. Four studies (15%) reported no SSOs.[107,108,141,147]

CDSS. The CDSS provides patient-specific feedback on biometric measurements to assist the patient with self-management.[168] The patient receives relevant feedback on biometric parameters, disease specific information such as insulin or medication doses, and timely advice on when to call the HCP or go to the emergency department. The CDSS complexity varied from very basic color-coated alerts to complex insulin algorithms.[147,160] Orsama and colleagues utilized only CDSS, and reported SSOs.[135] Twenty additional studies

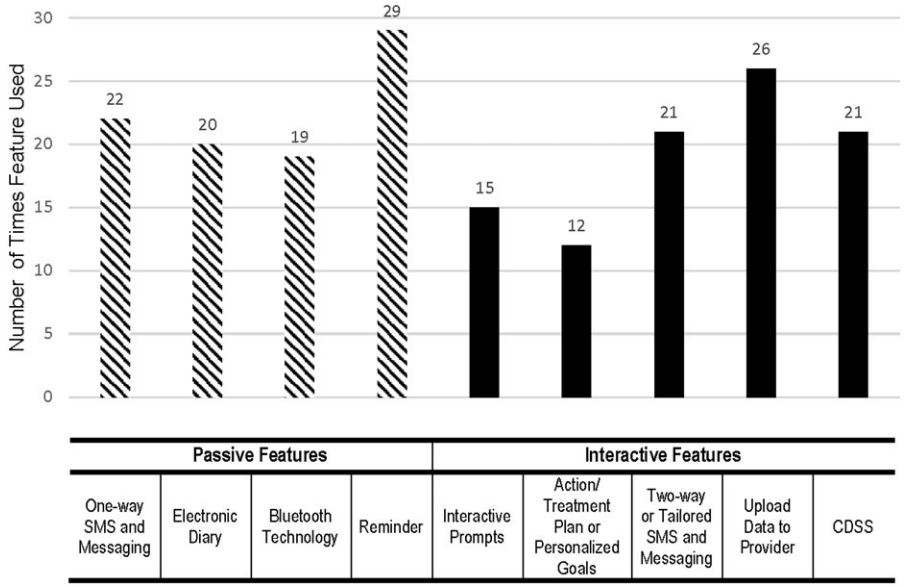

Figure 2. Frequencies of features in all studies.

combined CDSS with other features and 3 (14%) reported no SSOs.[147,150,169]

Frequency of features

The most frequently included feature was reminders (n = 29), and the least frequent was action treatment plan/personalized health goals (n = 12). The overall average feature frequency was 20.6 times, which indicates that each feature was used in less than one-third of the studies. Researchers used interactive features slightly more frequently (51.4%) than passive features (48.6%). Figure 2 provides the frequency analysis.

Further analysis evaluated the number of mHealth features used in each study (see Figure 3). A higher number of studies used a lower number of mHealth features. Closer examination showed 55 (79%) studies utilized 3 or fewer mHealth features.

Analysis of mHealth categories and outcomes

An essential element of this exploration was to examine potential relationships between categories of mHealth features and SSOs ($P \leq .05$). The studies were divided into 2 groups—studies with SSOs (n = 53) and studies without SSOs (n = 17).

A comparison of the 2 groups revealed the studies without SSOs used a higher number of passive features (67%) than interactive features (44%). In contrast, the group with SSOs used fewer passive features (44%) and a slightly higher number of interactive features (56%). This group also used a higher number of features per study. The group with SSOs included 4 or more features in 25% of the studies compared to 12% in the group without SSOs. See Table 1 and Figure 4 for additional details.

Further investigation identified the number of studies that used passive features, interactive features, or a combination of passive and interactive features (see Table 2). Studies without SSOs exclusively used passive features at a higher incident (46%) than studies with SSOs (17%). A slightly different trend was observed in studies with SSOs, which predominately used a combination of passive and interactive features (69%).

DISCUSSION

This exploration expanded on the existing mHealth literature and attempted to identify how mHealth features impact patient outcomes. Previous reviews and meta-analyses exploring the efficacy of SMS suggested that 2-way SMS was more effective than 1-way SMS.[7–12] Our analysis also revealed a difference between 1-way and 2-way SMS outcomes. Overall, 68% (n = 15) of studies with 1-way SMS reported SSOs. In comparison, 95% (n = 20) of studies using 2-way SMS reported SSOs. Further comparison between studies using 1-way SMS exclusively vs studies with 1-way SMS in conjunction with other features revealed additional variances. When 1-way SMS was the exclusive feature, 58% (n = 7) of the studies reported SSOs.[99,106,115,118,121,140,142] However, when used with other features, 80% (n = 8) of the studies reported SSOs.[40,96,98,100,101,104,131,138] These 8 studies used 1-way SMS with at least 1 interactive feature.

Several mHealth features correlated with Michie and colleagues' work on BCTs, such as the mobile diary—an essential element of self-monitoring.[25–27] Less than one-third (n = 20) of the studies included a mobile diary. Of these 20 studies, 17 used a mobile diary with at least 1 interactive feature, and 77% (n = 13) reported SSOs.[41,109,111,116,125,126,128,137,144–146,152,158]

Another BCT feature is goals/planning, which allows the patient to actively participate in the health process by collaborating with the HCP to develop achievable health goals.[26] These goals/plans merge the HCP's medical expertise with the patient's abilities and objectives. Only 12 (17%) studies included this mHealth feature in conjunction other interactive and/or passive features. All 12 (100%) reported SSOs.

Overall, the inclusion of CDSS appears to correlate with SSOs (86%). A closer examination of the 3 studies without SSOs revealed all 3 used basic color-coated CDSS. Furthermore, 2 of these studies combined the CDSS with only passive features.[13,150] These studies do not provide sufficient details to explain the relationship between the CDSS complexity and passive features.

An essential element of uploading biometric measurements is real-time communication with the patient. Accessibility to timely

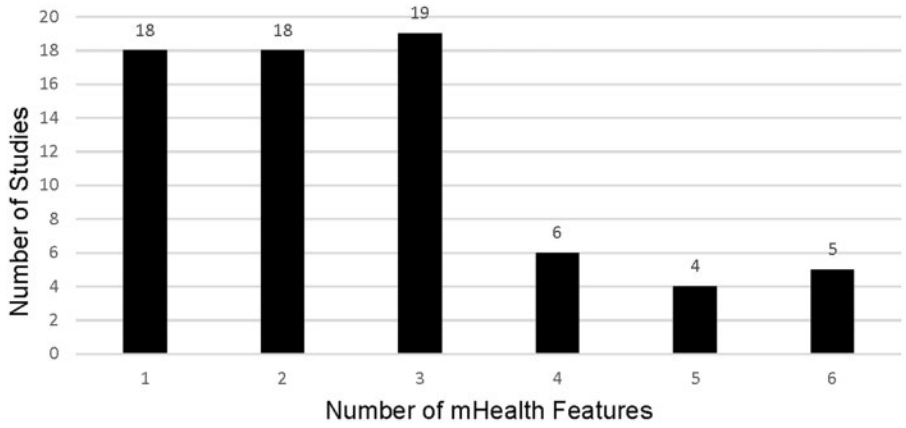

Figure 3. Number of features used in each study.

Table 1. Feature frequencies by outcomes

mHealth features	Studies without significant outcomes		Studies with significant outcomes	
	Number	Percentage	Number	Percentage
Passive features				
One-way SMS and messaging	7	18.9%	15	10.1%
Mobile diary	6	16.2%	14	9.5%
Bluetooth technology	7	18.9%	12	8.1%
Reminder	5	13.6%	24	16.2%
Passive feature totals	**25**	**67.6%**	**65**	**43.9%**
Interactive features				
Interactive prompts	4	10.8%	11	7.4%
Action treatment plan/personalized goals	0	0.0%	12	8.1%
Two-way or tailored SMS and messaging	1	2.7%	20	13.5%
Upload data to HCP	4	10.8%	22	14.9%
CDSS	3	8.1%	18	12.2%
Interactive feature totals	**12**	**32.4%**	**83**	**56.1%**

data allows the HCP to provide feedback and judicious changes to the health regime to promote improved disease management and prevent costly hospital visits. This phenomenon was particularly evident in 2 studies.[133,136] In the first study, McGillicuddy and colleagues reported the intervention group had twice the number of medication changes and successfully achieved an optimal BP compared to the control group.[133] Next, Ostojic and colleagues reported the control group had >3 times the number of asthma-related hospital visits (n = 7) compared to the intervention group (n = 2).[136] In contrast, 2 studies provided feedback via a written letter mailed to the patient.[114,122] Both studies reported no SSOs. It is unclear why traditional mail was used rather than quick, secure mHealth communication methods (ie, SMS, e-mail), and if the delayed communication impacted the absence of SSOs.

Bluetooth technology to upload biometric measurements into the app was used in 19 studies with 63% reporting SSOs. An analysis revealed 3 studies used only passive features in combination with the Bluetooth feature.[13,107,122] All 3 studies (100%) reported no SSOs. In comparison, 16 studies used Bluetooth in combination with at least 1 interactive feature, and 75% reported SSOs. No pattern between Bluetooth and the types of interactive features was identified.

Limitations

One limitation was the lack of consistency in describing mHealth features in the articles, which potentially resulted in missed interventions. The intervention description did not always include clear details of the mHealth features with some features located in the screen shots provided in the article.[125] Thematic analysis allowed a methodical review of the studies with each feature recorded and analyzed to ensure all mHealth features were identified.

Another limitation was the lack of homogeneity among the studies, which restricts the generalizability of the findings. This broad examination of the mHealth literature was necessary for a thorough exploration and identification of mHealth features. Next steps will include more rigorous methods and homogenous studies to refine and confirm these initial findings.

Directions for future research

We recognize this is a first step in examining the correlation of the 9 mHealth features with outcomes. Isolating the efficacy of specific features is difficult, as 74% of the studies used 2 or more features. Therefore, we examined efficacy based on a feature's interaction with categories of features. While these initial findings require further exploration on how the types and combination of features impact outcomes, it provides a foundation to guide a more rigorous analysis.

Additional areas for future research include the evaluation of mHealth features for other chronic health conditions and overall health and wellness (eg, weight loss, smoking cessation). Expanding the number of studies along with types of health conditions will assist in corroborating these initial findings.

As previously stated, each feature was included in approximately 20 studies, which is less than one-third of the studies with a mean of 2.6 features per app. For patients, the inclusion of only 2 or 3 features may translate into limited selection of apps with available technology to assist in self-management of chronic respiratory disease, diabetes, and HTN. For example, goals/planning, an essential element of self-management, was used in only 12 studies (17%); and the mobile diary, another self-management BCT, was included in less than one-third of studies. Furthermore, Bluetooth technology, which is widely available, was used in only 19 (27%) studies.

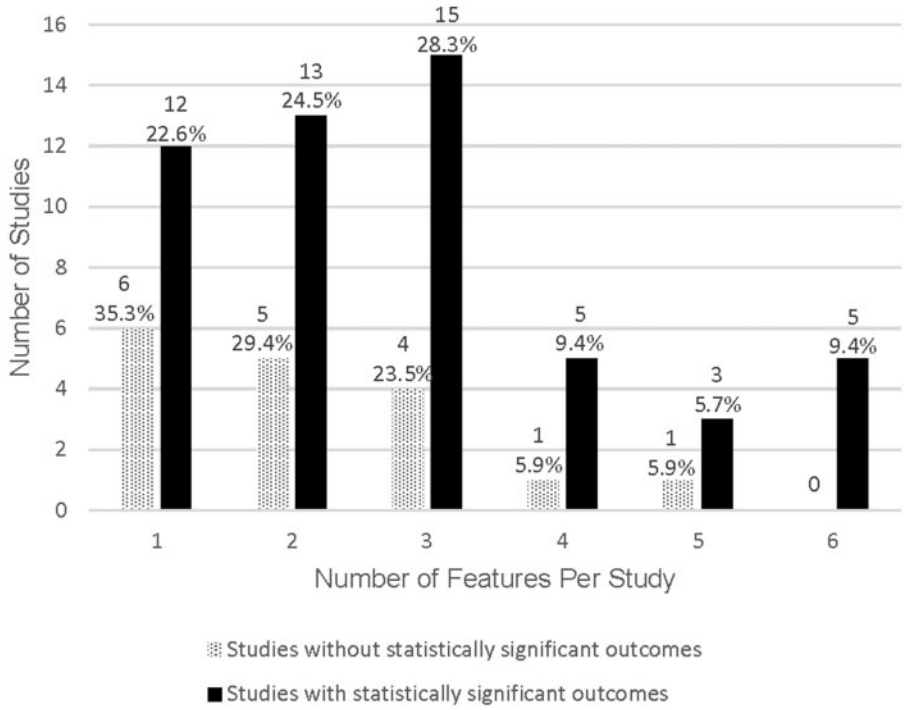

Figure 4. Number of features per study by outcomes.

Table 2. Comparison of studies by classification of features

Classifications of features	Studies without significant outcomes		Studies with significant outcomes	
	Number	Percentage	Number	Percentage
Used only passive features	9	45.5%	8	16.7%
Used only interactive features	3	18.2%	7	14.6%
Used combination of both	5	36.3%	33	68.7%

This finding appears to correlate with prior findings that mHealth is not harnessing the available technology to assist self-monitoring and not including evidence-based self-management recommendations.[5,19] Additional exploration is necessary to identify why more mHealth features are not included in apps for chronic respiratory diseases, diabetes, and HTN. Focus group discussions with mHealth developers are one option to investigate barriers to the inclusion of mHealth features.

CONCLUSION

To our knowledge, this is the first targeted exploration using thematic analysis to identify mHealth features and to specifically examine categories of mHealth features related to SSOs. Thematic analysis revealed 9 unique features separated into 2 categories—passive and interactive. Overall, each feature was included in only one-third of the studies. Studies with SSOs used a higher combination of passive and interactive features compared to studies without SSOs. This phenomenon was observed when Bluetooth, 1-way SMS, or goals/planning was combined with at least 1 interactive feature. There may be a synergist effect between specific features and types of categories.

This targeted exploration is a first step in identifying and defining features used in mHealth. We hope this exploration initiates a discussion on mHealth features that may result in universal definitions and categories to advance the adoption of mHealth to improve patient outcomes.

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CONTRIBUTORS

All authors contributed to the conception and development of concept, drafting, and revising of the article, and final approval of the article, and agree to be accountable for the content of the article.

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SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

Conflict of interest statement. None declared.

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