Can mobile health apps replace GPs? A scoping review of comparisons between mobile apps and GP tasks

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Abstract

Background: Mobile health applications (mHealth apps) are increasingly being used to perform tasks that are conventionally performed by general practitioners (GPs), such as those involved in promoting health, preventing disease, diagnosis, treatment, monitoring, and support for health services. This raises an important question: can mobile apps replace GPs? This study aimed to systematically search for and identify mobile apps that can perform GP tasks.

Methods: A scoping review was carried out. The Google Play Store and Apple App Store were searched for mobile apps, using search terms derived from the UK Royal College of General Practitioners (RCGP) guideline on GPs’ core capabilities and competencies. A manual search was also performed to identify additional apps.

Results: The final analysis included 17 apps from the Google Play Store and Apple App Store, and 21 apps identified by the manual search. mHealth apps were found to have the potential to replace GPs for tasks such as recording medical history and making diagnoses; performing some physical examinations; supporting clinical decision making and management; assisting in urgent, long-term, and disease-specific care; and health promotion. In contrast, mHealth apps were unable to perform medical procedures, appropriately utilise other professionals, and coordinate a team-based approach.

Conclusions: This scoping review highlights the functions of mHealth apps that can potentially replace GP tasks. Future research should focus on assessing the performance and quality of mHealth apps in comparison with that of real doctors.

Keywords: Clinical tasks, General practitioners, Mobile health applications

Background

Mobile technology is rapidly transforming health care, education, and research [1, 2]. Globally, the number of smart phone subscriptions increased significantly from 1800 million in 2013 to 2600 million in 2014, and is estimated to reach 6100 million in 2020 [3]. Mobile health (mHealth) is defined as ‘medical and public health practice supported by mobile devices, such as mobile phones, patient-monitoring devices, personal digital assistants (PDAs), and other wireless devices’ [4]. The usage of mHealth has changed over time, since the first mobile phone was launched in the 1970s to the era of smart phones and wearable devices [5, 6]. mHealth has evolved beyond mobile devices to adopt diverse designs and perform a range of functions. Both patients and health professionals use mHealth for various reasons. According to a survey by the World Health Organization (WHO), mHealth is utilised for 1) communication between individuals and health services (e.g. health call centres); 2) communication between health services and individuals (e.g. appointment reminders); 3) consultation between health care professionals; 4) intersectoral communication in emergencies; 5) health monitoring and surveillance; and 6) access to information for health care professionals at the point of care [4]. The use of mobile devices in health care is considered to alter the delivery, quality, costs, and culture of health care [7, 8].
mHealth can reach large numbers of people and is not limited by borders; more than 100,000 health applications (apps) are available for mobile devices [9]. mHealth has grown dramatically and is beneficial for health care [10], performing numerous tasks such as diagnosing diseases, making appointments, keeping medical records, and supporting clinical decision-making [11–13]. However, the disadvantages of using mHealth in health care include the cost of technology and infrastructure, information security, lack of regulatory compliance guidelines, and the potential for serving as a workplace distraction [14, 15]. Moreover, accessibility to mHealth is a major concern in the context of equity in health care services. Evidence shows that the rate of mobile phone subscriptions among the population differs between countries worldwide. For example, in 2009, there were 202,99 subscriptions per 100 population in Estonia and 2.78 subscriptions per 100 population in Eritrea [4].

mHealth also plays important roles in primary care. A study conducted in the USA investigated the use of mobile devices and mHealth for health purposes among patients in primary care. The results showed that 90.1% of outpatients owned mobile phones, 55.3% of patients used smart phones, and 38.5% of patients (69.5% of smart phone owners) used mHealth [16]. Among all patients in this study, 35.5% sought health information from their smart phones, 22.0% accessed an mHealth app, and 20.8% tracked or managed health conditions via mobile devices [16]. Another study presented a new approach in which primary care practitioners prescribed mHealth apps to their patients and discussed the health data collected from the apps in subsequent visits [17]. A study of perceptions on mHealth in primary care in Belgium revealed that, among 111 adults from the general population, 41% used mHealth apps for general health check-ups, 18% for follow-up of chronic illnesses, 12% for post-hospitalisation monitoring, and 5% for tele-consultations instead of visiting doctors or hospitals [18]. Moreover, mHealth can contribute to the availability of more real-time and trended data instead of snapshots of the information based on serial visits [19].

Mobile apps are a vital component of mHealth [20, 21]. mHealth apps have been used in health promotion and disease prevention, diagnosis, treatment, monitoring, and the provision of support for health services [5]. These are typically clinical tasks that are conventionally performed by general practitioners (GPs) [22, 23]. Each mHealth app can perform a specific task or several tasks. Accordingly, patients may use a combination of mHealth apps on their mobile devices, which can help them to receive their needs, instead of seeing a GP. This raises the following important question: can mobile apps replace GPs? Although mHealth-related technologies are well designed and constructed, the functionality of these technologies are yet to be compared to the abilities of real doctors. This article aims to comprehensively review mobile apps that can perform GP tasks, and presents a comparison of the possible capabilities of such apps with those of real doctors.

Methods
The authors conducted this scoping review following the PRISMA extension for scoping reviews (PRISMA-ScR) [24].

Identifying GP tasks
This review used the Royal College of General Practitioners (RCGP) guideline on GPs’ core capabilities and competencies as a review framework [25]. In this context, a task is defined as an action relating to doctor-patient interaction performed by a GP during a clinical consultation. Two authors (AW and CHT) independently identified the tasks that should be performed by a GP based on the description of the RCGP guideline. Another author (CJN) participated in conflict resolution between the first two authors. This guideline comprises 13 capabilities and 31 competencies, with 12 tasks identified (Table 1).

App search
Two authors (AW and SW) developed a search term for each task relating to doctor-patient interaction, and identified the final search terms via discussion with the rest of the authors. An author (AW) searched the Google Play Store and two authors (CHT and ET) searched the Apple App Store in July 2018, using the search term for each task. The authors used an Android device for searching Google Play Store and an iOS device for Apple App Store. The authors found some search terms yielded an uncountable list of apps, and most of them were irrelevant, especially the list after the first 20 apps. Thereafter, the author listed the first 20 apps for each task from each app database (Google Play Store and Apple App Store) for subsequent screening.

Screening and selection of apps
Apps that can be used to perform clinical tasks and provide information in English were included. Those that were developed as electronic textbooks, training apps, and games were excluded. Up to the first 20 apps identified based on the Google Play Store and Apple App Store search results for each task, after the exclusion of duplicates and non-English apps, were considered eligible apps. Within each task, two independent review teams reviewed the apps independently: Team 1 (AW and SW) reviewed Android apps from the Google Play Store, while Team 2 (CHT and WJW) reviewed iOS apps from the Apple App Store. Each team assessed the relevant apps based on the app names and descriptions to determine whether they were capable of performing the relevant tasks. In case of uncertainty, the full apps were downloaded and assessed.
| No. | Competency<sup>a</sup>                                                                 | Is this a GP’s task<sup>b</sup> | Search term          |
|-----|--------------------------------------------------------------------------------------|--------------------------------|----------------------|
| 1   | Develop the attitudes and behaviours expected of a good doctor                        | No                             | N/A                  |
| 2   | Manage the factors that influence your performance                                    | No                             | N/A                  |
| 3   | Treat others fairly and with respect, acting without discrimination                   | No                             | N/A                  |
| 4   | Provide care with compassion and kindness                                            | No                             | N/A                  |
| 5   | Establish an effective partnership with patients                                      | No                             | N/A                  |
| 6   | Maintain a continuing relationship with patients, carers and families                  | No                             | N/A                  |
| 7   | Apply a structured approach to data gathering and investigation                       | Yes                            | History taking       |
| 8   | Interpret findings accurately to reach a diagnosis                                     | Yes                            | Diagnosis            |
| 9   | Demonstrate a proficient approach to clinical examination                              | Yes                            | Clinical examination |
| 10  | Demonstrate a proficient approach to the performance of procedures                    | Yes                            | Medical procedures   |
| 11  | Adopt appropriate decision-making principles                                         | Yes                            | Medical decision     |
| 12  | Apply a scientific and evidence-based approach                                        | No                             | N/A                  |
| 13  | Provide general clinical care to patients of all ages and backgrounds                  | No                             | N/A                  |
| 14  | Adopt a structured approach to clinical management                                    | Yes                            | Clinical management  |
| 15  | Make appropriate use of other professionals and services                               | Yes                            | Health professionals |
| 16  | Provide urgent care when needed                                                       | Yes                            | Urgent care          |
| 17  | Enable people living with long-term conditions to improve their health                 | Yes                            | Long-term care       |
| 18  | Manage concurrent health problems in an individual patient                             | Yes                            | Health problems      |
| 19  | Adopt safe and effective approaches for patients with complex health needs            | No                             | N/A                  |
| 20  | Work as an effective team member                                                      | No                             | N/A                  |
| 21  | Coordinate a team-based approach to the care of patients                               | Yes                            | Team-based care      |
| 22  | Continuously evaluate and improve the care you provide                                 | No                             | N/A                  |
| 23  | Adopt a safe and scientific approach to improve quality of care                       | No                             | N/A                  |
| 24  | Support the education and development of colleagues                                   | No                             | N/A                  |
| 25  | Apply leadership skills to help improve your organisation’s performance               | No                             | N/A                  |
| 26  | Develop the financial and business skills required for your role                      | No                             | N/A                  |
| 27  | Make effective use of information management and communication systems                | No                             | N/A                  |
| 28  | Demonstrate the holistic mindset of a generalist medical practitioner                 | No                             | N/A                  |
| 29  | Support people through individual experiences of health, illness and recovery          | Yes                            | Health promotion     |
| 30  | Understand the health service and your role within it                                  | No                             | N/A                  |
| 31  | Build relationships with the communities with which you work                          | No                             | N/A                  |

<sup>a</sup>GPs’ core capabilities and competencies based on the Royal College of General Practitioners (RCGP) guideline

<sup>b</sup>A task is defined as an action relating to doctor-patient interaction performed by a GP during a clinical consultation

N/A not applicable
Apps that were found to perform several tasks were counted separately. The eligible mHealth apps were those that could perform specific tasks independently without the requirement to consult a real doctor. The final list of mHealth apps was identified after removing duplicates for each task. The authors summarised the results and resolved disagreements through consensus. According to a small number of apps included, the authors identified additional mHealth apps for Android (Google Play Store) and iOS (Apple App Store) mobile devices by using the search terms to search on web browsers manually. The relevant apps were selected by the consensus of the authors.

Data charting process
The tasks were described using the search terms. The number of apps identified via a search of the Google Play Store and Apple App Store, as well as the total number, were presented. Additionally, the number of apps identified by the manual search was reported separately.

Results
Summary of app search results
The initial search performed using the search terms for the 12 tasks revealed 437 apps from the Google Play Store ($n_1 = 240$) and Apple App Store ($n_2 = 197$). A total of 419 apps were excluded due to irrelevant app names, descriptions, and functions compared with the identified tasks by two independent review teams (Additional file 1). Of the 18 eligible apps, one duplicate within the same task was removed. The final analysis of apps from the Google Play Store and Apple App Store included 17 apps. The manual search on web browsers revealed an additional 21 apps. Figure 1 presents the app review flow diagram.

Summary of the comparison between mobile apps and GP tasks
This scoping review revealed that nine out of 12 tasks could be potentially replaced by mHealth apps. The apps found by searching the Google Play Store and Apple App Store addressed the following three tasks: 1) apply a structured approach to data gathering and investigation; 2) interpret findings accurately to reach a diagnosis; and 3) support people through individual experiences of health, illness, and recovery. The manual search on web browsers identified several mHealth apps that were able to replace GPs in performing more clinical tasks (Table 2). A summary of the mHealth apps that can perform clinical tasks is presented in Table 3.
| No. | Task                                                                 | Search term         | Apps from the Google Play Store | Apps from the Apple App Store | Apps from the manual search |
|-----|----------------------------------------------------------------------|---------------------|---------------------------------|------------------------------|-----------------------------|
| 1   | Apply a structured approach to data gathering and investigation       | History taking      | N = 2                            |                               |                             |
|     |                                                                      |                     | n₁ = 1                          | n₂ = 1 n₃ = 2                 |                             |
|     |                                                                      |                     | 1. Medical history builder       | 1. Historian                 | 1. Ada 2. Babylon            |
| 2   | Interpret findings accurately to reach a diagnosis                    | Diagnosis           | N = 9                            |                               |                             |
|     |                                                                      |                     | n₁ = 7                          | n₂ = 2 n₃ = 1                 |                             |
|     |                                                                      |                     | 1. Ada                          | 1. Babylon                    |                             |
|     |                                                                      |                     | 2. Doctor Diagnose Symptoms Check |                             |                             |
|     |                                                                      |                     | 3. GBDiagnosis Medical App       |                             |                             |
|     |                                                                      |                     | 4. My diagnostic                |                             |                             |
|     |                                                                      |                     | 5. Self Diagnosis               |                             |                             |
|     |                                                                      |                     | 6. Symptomate – Symptom checker  |                             |                             |
|     |                                                                      |                     | 7. WebMD                       |                             |                             |
| 3   | Demonstrate a proficient approach to clinical examination            | Clinical examination| N = 0                           |                               |                             |
| 4   | Demonstrate a proficient approach to the performance of procedures   | Medical procedures  | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 5   | Adopt appropriate decision-making principles                         | Medical decision making | N = 0                        |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 6   | Adopt a structured approach to clinical management                   | Clinical management | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 7   | Make appropriate use of other professionals and services             | Health professionals | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 8   | Provide urgent care when needed                                      | Urgent care         | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 9   | Enable people living with long-term conditions to improve their health| Long-term care      | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 10  | Manage concurrent health problems in an individual patient           | Health problems     | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 11  | Coordinate a team-based approach to the care of patients             | Team-based care     | N = 0                           |                               |                             |
|     |                                                                      |                     | n₁ = 0                          | n₂ = 0                       |                             |
| 12  | Support people through individual experiences of health, illness, and recovery | Health promotion | N = 6⁴                          |                               |                             |
|     |                                                                      |                     | n₁ = 4                          | n₂ = 3 n₃ = 1                 |                             |
|     |                                                                      |                     | 1. Appibuddy                    | 1. HealthWatch               | 1. BECCA - Breast Cancer Support |
|     |                                                                      |                     | 2. Food (lg)                    | 2. Healthy 365               |                             |
Table 2  Tasks of a GP that can be potentially performed by mHealth apps (Continued)

| No. | Task                                      | Search term       | Apps from the Google Play Store | Apps from the Apple App Store | Apps from the manual search |
|-----|-------------------------------------------|-------------------|--------------------------------|--------------------------------|----------------------------|
| 3.  | Healthy 365                               |                   | 3. HealthHub Track              | 3. The circle of health        |                            |

*Total number of apps, n1, number of apps from the Google Play Store, n2, number of apps from the Apple App Store, n3, number of apps from the manual search

N: total number of apps

Discussion

This scoping review identified mobile apps that are capable of performing GP tasks. mHealth apps were found to exhibit the potential to replace GPs in taking medical history and making a diagnosis; performing some physical examinations; supporting clinical decision-making and management; assisting in urgent, long-term, and disease-specific care; and performing health promotion. However, mHealth apps were unable to perform medical procedures, appropriately utilise other professionals, and coordinate a team-based approach.

mHealth apps serve diverse purposes and perform a range of functions for both patients and health care providers [26, 27]. This scoping review focused on mHealth apps utilised by patients for health purposes. The findings suggest that mHealth apps have the potential to perform several specific clinical tasks that are conventionally performed by a GP. Previous studies have reported the roles of mHealth apps for patients with specific clinical goals, such as pain self-management and weight management [28, 29]. Such mobile app functions may replace several GP tasks, for example, an app for diagnosis could help users make decisions regarding further treatment options, therefore potentially replacing a GP for this purpose. However, most apps, especially apps for history taking and diagnosis, have been found to lack the potential to replace a consultation with a GP. The apps were only found to be suitable for providing primary information and health-related suggestions.

Some GP tasks could not be performed by mHealth. For example, mHealth apps could not perform medical procedures. However, mHealth apps, together with other supportive technologies, have the potential to support clinical tasks. Examples of technologies capable of supporting mHealth approaches include near-field communication (NFC) (a short-range, wireless connectivity technology), accelerometers (a technology used to measure gravitational forces and accelerations), gyroscopes (a micro-electromechanical system sensor used to measure body movement), artificial intelligence (AI), and machine learning [30–32]. For example, NFC can be used to monitor human’s physiological information (e.g. heart rate, body temperature) [33]. Accelerometers and gyroscopes can function as motion sensors to monitor daily activities, falls, and sleep patterns [34].

The other competencies of GPs comprise personal attributes, including attitudes, practical skills, and soft skills, which mHealth apps cannot currently replace. Nevertheless, mHealth apps may support GPs in terms of training and referencing. In the future, the development of technologies could contribute to more efficient functions of the mHealth. For example, AI and machine learning may enable machines to learn essential skills, as well as develop attitudes and a mindset similar to those of a good doctor.

Although the findings revealed that mHealth apps were able to perform some GP tasks, it could not be concluded that mHealth apps could replace GPs. Being a medical doctor requires integrative skills, art, values, and ethics [35, 36]. For example, taking history without physical examination may lead to unnecessary investigations and a misdiagnosis. From the results of this review, some apps were able to perform multiple tasks. Their integrative functionality could not replace the comprehensive functions of GPs. Using modern technologies such as mHealth can facilitate the quality of care. Many mHealth apps offer platforms for telemedicine to facilitate doctor-patient communication, which is cost-effective and timely [37]. A study explored doctor-patient communication through screen-to-screen versus face-to-face consultations showed no significantly different results regarding the quality of doctor-patient communication [38]. However, using mHealth apps without human interactions cannot replace seeing a GP.

mHealth apps may additionally present several risks to the user, including loss of privacy, poor-quality patient data, and inappropriate clinical management of the user [39]. To address these risks, basic standards should be met, including accessibility, appropriate privacy, accuracy and credibility of content, and ethical obligations [40, 41]. The differing views in regard to medical technology among patients and doctors are also an area of concern [42]. Such differing perceptions may lead to misunderstandings and arguments between patients and doctors in general practice. GPs should aim to serve as expert sources of digital health information for their patients [43]. Therefore, ‘expertise in the use of appropriate mHealth-related technologies’ should be recognised as an additional competency of GPs.

The present scoping review was conducted based on the UK RCGP guideline as a framework. This approach
Table 3 Summary of the apps

| No. | App               | Source          | Objective of the app                                                                 | Function of the app                                                                 |
|-----|-------------------|-----------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|     |                   |                 | Data gathering and interpretation                                                     |                                                                                     |
|     |                   |                 | Task: Apply a structured approach to data gathering and investigation                 |                                                                                     |
| 1   | Ada               | Manual search   | The app provides a personalised interactive chat to find possible explanations for illnesses. | The app can interview patients by using a series of questions, including those addressing the chief complaints and associated symptoms. |
| 2   | Babylon           | Manual search   | The app uses AI to analyse health problems and provide health advice.                 | The app collects patients' information through a series of interactive questions.     |
| 3   | Historian         | Apple App Store | The app enables patients to enter a comprehensive psychiatric history and generate a detailed self-report of their mental state. | The app enables patients to evaluate their own mental health.                         |
| 4   | Medical history builder | Google Play Store | The app guides users in compiling their medical history in a systematic manner before seeing a doctor. | The app eliminates the need for a doctor to obtain a medical history from patients. |
|     |                   |                 | Data gathering and interpretation                                                     |                                                                                     |
|     |                   |                 | Task: Interpret findings accurately to reach a diagnosis                               |                                                                                     |
| 5   | Ada               | Google Play Store | See no.1                                                                            | The app produces a list of provisional and differential diagnoses based on the information collected by AI. |
| 6   | Babylon           | Manual search   | See no.2                                                                            | The app enables the identification of possible causes of the symptoms entered by the user. |
| 7   | Doctor Diagnose Symptoms Check | Google Play Store | The app intends to inform and make patients more aware of their conditions.          | The app can assist with symptom analysis and diagnosis.                             |
| 8   | GBDiagnosis Medical App | Google Play Store | The app identifies a suspected diagnosis based on the interaction and responses of users. | The app offers a simulated conversation between doctor and patient to collect symptoms and individual information to make a diagnosis. |
| 9   | My diagnostic     | Google Play Store | The app aims to identify diseases in a database based on the symptoms entered by users. | The app requires user information regarding their symptoms to make a diagnosis.      |
| 10  | Rapid diagnosis- mental health | Apple App Store | The app is designed to assist with the diagnosis of mental, emotional, or psychological conditions that can be differentiated based on symptoms. | The app is used as a symptom checker, and a probable diagnosis can be established. |
| 11  | Rapid diagnosis- STD | Apple App Store | The app is designed to assist with the diagnosis of sexually transmitted diseases.   | The app is used as a symptom checker, and allows a probable diagnosis to be established. |
| 12  | Self Diagnosis    | Google Play Store | The app enables the user to identify their condition                                 | The app can make a diagnosis based on the responses of the user.                     |
| 13  | Symptomate – Symptom checker | Google Play Store | The app provides an evaluation of users' health.                                    | The app indicates possible causes of symptoms, treatment options, and suggested lab tests. |
| 14  | WebMD             | Google Play Store | The app offers doctor-reviewed health information and interactive tools.            | The app includes the function 'Symptom Checker' and provides a list of possible diagnoses based on a major symptom and a brief set of general questions (current medications and current and past illnesses). |
|     |                   |                 | Clinical examinations and procedures                                                 |                                                                                     |
|     |                   |                 | Task: Demonstrate a proficient approach to clinical examination                       |                                                                                     |
| 15  | Runtastic Heart Rate | Manual search   | The app is used for checking heart rate anytime and anywhere.                        | The app measures heart rate by tapping a finger on the smart phone camera.            |
| 16  | SkinVision        | Manual search   | The app checks the skin for signs of skin cancer.                                   | The app uses the phone camera to capture an image of a skin lesion and evaluate the user's risk of skin cancer. |
|     |                   |                 | Making decisions                                                                    |                                                                                     |
Table 3 Summary of the apps (Continued)

| No. | App                                           | Source         | Objective of the app                                                                 | Function of the app                                                                 |
|-----|-----------------------------------------------|----------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 17  | Gout Decision Aid                            | Manual search  | The app provides information and education to patients with gout.                    | The app can function as a patient decision aid and a tool to help the user become involved in decision making. |
| 18  | Rapid diagnosis- mental health                | Manual search  | See no.10                                                                            | The app offers information on patient management related to the diagnosis of mental illnesses. |
| 19  | Rapid diagnosis- STD                          | Manual search  | See no.11                                                                            | The app offers information on patient management related to the diagnosis of sexually transmitted diseases. |
| 20  | Google Assistant                              | Manual search  | The app provides AI to assist users in utilising phone functions and searching for information on the internet. | The app can provide information on urgent and emergency conditions and can navigate users to the nearest hospital. |
| 21  | Siri                                          | Manual search  | The app runs on the iOS platform (Apple devices); its AI functions as a virtual assistant. | The app can provide information on urgent and emergency conditions and can navigate users to the nearest hospital. |
| 22  | Asthma Manager                                | Manual search  | The app is used to manage asthma.                                                    | The app can help track symptoms and manage medications.                          |
| 23  | Blood Pressure Companion                      | Manual search  | The app is designed for monitoring blood pressure.                                    | The app can record and analyse blood pressure as well as generate graphs, charts, and tables of the results. |
| 24  | mySugr                                       | Manual search  | The app is a diabetes logbook for type 1, type 2, and gestational diabetes mellitus. | The app can record and analyse diabetes parameters as well as provide feedback.  |
| 25  | forDiabetes: diabetes self-management app     | Manual search  | The app is designed for managing diabetes.                                           | The app can track and monitor key diabetes data, including blood glucose level, HbA1c, blood pressure, and medications. |
| 26  | Pill Reminder and Medication Tracker by Medisafe | Manual search  | The app is used as a medication reminder and enables medication tracking.            | The app reminds users to take medications and produces daily and monthly medication progress reports. |
| 27  | Asthma Manager                                | Manual search  | See no.22–26                                                                         | See no.22–26                                                                      |
| 28  | Blood Pressure Companion                      | Manual search  | See no.22–26                                                                         | See no.22–26                                                                      |
| 29  | mySugr                                       | Manual search  | See no.22–26                                                                         | See no.22–26                                                                      |
| 30  | forDiabetes: diabetes self-management app     | Manual search  | See no.22–26                                                                         | See no.22–26                                                                      |
| 31  | Pill Reminder and Medication Tracker by Medisafe | Manual search  | See no.22–26                                                                         | See no.22–26                                                                      |

Practising holistically and promoting health

Task: Support people through individual experiences of health, illness and recovery

| App               | Source     | Objective of the app                   | Function of the app               |
|-------------------|------------|----------------------------------------|-----------------------------------|
| Appibuddy         | Google Play Store | The app is a healthy lifestyle | The app enables users to record |
enabled specification of the functions of mHealth apps compared with GP tasks, which was a major strength of this study. However, there were three limitations of this review. First, the search terms used may have limited the search results. This review used only one search term for each task and did not use any alternative terms. Second, the review did not include all mHealth apps from the Google Play Store and Apple App Store because an exhaustive list of all apps for some tasks was not possible to obtain. The authors resolved these problems by including only the first 20 apps found for each task from each app database. Additionally, to identify additional apps for each task, the authors performed a manual search based on discussion. Finally, this scoping review focused on the functions of apps, however, it was unable to evaluate the quality and credibility of the apps. This reflected a characteristic of scoping review, which primarily focused on identifying knowledge gaps and key characteristics related to a concept [44].

### Conclusions

mHealth apps have the potential to replace some GP tasks (nine out of 12 tasks), whereas a GP is expected to be competent in all tasks and respect to all attributes. Innovative technologies, such as AI and machine learning, are anticipated to play important roles in improving mHealth apps to achieve the capability to perform additional GP tasks and possess more of their attributes. There is a need to balance the advantages and disadvantages of the use of mHealth in health care. GPs should understand and prevent the risks of using mHealth apps. Expertise in the use of appropriate mHealth-related technologies should be recognised as an essential competency of GPs. Future research should focus on assessing the performance and capabilities of mHealth apps compared with those of real doctors.

### Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s12911-019-1016-4.

### Additional file 1

Summary of screening and selection of apps.

### Abbreviations

AI: Artificial intelligence; Apps: Applications; GPs: General practitioners; mHealth: Mobile health; NFC: Near-field communication; PDAs: Personal digital assistants; RCGP: Royal College of General Practitioners; UK: United Kingdom; USA: United States of America; WHO: World Health Organization

### Acknowledgments

We wish to thank Ms. Atchara Aidwang for her assistance with the search results.

### Authors’ contributions

AW, CHT, and SW initiated and developed the review strategy. AW, CHT, SW, ET, and WJW performed searches and screenings. AW, CHT, and CJN contributed to data charting process. AW, CHT, SW, CJN wrote the first draft of the manuscript. All authors approved the final draft of the manuscript.
Funding
This work was partially supported by Walaikul University under the new strategic research (P2P) project (grant number: CGS-2019-047). The funding body had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Availability of data and materials
All data analysed during this study are included in this published article and its additional files.

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 23 July 2019 Accepted: 26 December 2019
Published online: 06 January 2020

References
1. Marcelino SM, Oliveira QA, D’Agostino M, Ribeiro LA, Akkinni MMB, Novillo-Ortiz D. The impact of mHealth interventions: systematic review of systematic reviews. JMIR Mhealth Uhealth. 2016;3(1):23.
2. Mohapatra D, Mohapatra M, Chittoria R, Frijj M, Kumar S. The scope of mobile devices in health care and medical education. Int J Adv Med Res. 2015;3(1–3):8.
3. Ericsson. Ericsson Mobility Report: On the pulse of the networked society. 2015. https://www.ericsson.com/assets/local/mobility-report/documents/2015ericsson-mobility-report-june-2015.pdf. Accessed 11 July 2018.
4. World Health Organization. mHealth: new horizons for health through mobile technologies: second global survey on eHealth. Geneva: World Health Organization; 2011.
5. Ali EE, Chew L, Yap KY-L. Evolution and current status of mhealth research: a systematic review. BMJ Innov. 2016;2(1):33.
6. Bradway M, Cantion C, Vallespin B, Saadafard O, Puigdomènech E, Esplangues M, et al. mHealth assessment: conceptualization of a global framework. JMIR mhealth and uHealth. 2017;5(5):e60.
7. Mebs D, Drobní Z, Béneyi E, Gergely B, Győrfi B. Digital health: a cultural transformation of traditional healthcare. mHealth. 2017;3:38.
8. West D. How mobile devices are transforming healthcare. Issues Technol. Innov. 2011;2:181–14.
9. Carroll JK, Moorhead A, Bond R, LeBlanc WC, Petrella RJ, Fiscella K. Who uses mobile phone health apps and does use matter? A secondary data analytics approach. J Med Internet Res. 2017;19(4)125.
10. Klasnja P, Pratt W. Healthcare in the pocket: mapping the space of mobile-health interventions. J Biomed Inform. 2012;45(1):194–98.
11. Boulos MNK, Brewer AC, Karimkhani C, Buller DB, Delvalle RP. Mobile medical and health apps: state of the art, concerns, regulatory control and certification. Online J Public Health Inform. 2014;3(3):229.
12. Huo J, Liu D, Yu YM, Zhao HT, Chen ZR, Li J, et al. The top Chinese mobile health apps: a systematic investigation. J Med Internet Res. 2016;18(8):e222.
13. Mosa ASM, Yoo L, Sheets L. A systematic review of healthcare applications for smartphones. BMC Med Inform Decis Mak. 2012;12:67.
14. Bajwa M. mHealth security. Pak J Med Sci. 2014;30(4):904–7.
15. Katz-Sid low RJ, Ludwig A, Miller S, Sid low R. Smartphone use during inpatient attending rounds: prevalence, patterns and potential for distraction. J Hosp Med. 2017;12(8):509–9.
16. Bauer AM, Rue T, Keppel GA, Cole AM, Baldwin LM, Katon W. Use of mobile health (mHealth) tools by primary care patients in the WWAMI region practice and research network (WPRN). J Am Board Fam Med. 2014;27(6):780–8.
17. Lopez Segui F, Pratdepau da Buñol C, Abdon Gimenez N, Martinez Roldan J, Garcia CF. The prescription of mobile apps by primary care teams: a pilot project in Catalonia. JMIR Mhealth Uhealth. 2018;6(6):e10701.
18. Mutbei I, Devroey D. Perceptions on mobile health in the primary healthcare setting in Belgium. mHealth. 2018;4:44.
19. Shaw RJ, Bonner JP, Modarai F, George A, Shahsahabi M. Mobile health technology for personalized primary care medicine. Am J Med. 2015;128(6):555–7.
20. Lu C, Hu Y, Xie J, Fu Q, Leigh L, Governor S, et al. The use of mobile health applications to improve patient experience: cross-sectional study in Chinese public hospitals. JMIR mHealth and uHealth. 2018;6(1):e126.
21. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. P T. 2014;39(5):356–64.
22. Grol SM, Molleman GRM, Kuijpers A, van der Sande R, Fransen GAJ, Assendelft WJJ, et al. The role of the general practitioner in multidisciplinary teams: a qualitative study in elderly care. BMC Fam Pract. 2018;19(1):40.
23. Math R, Ogunbanjo GA, Naidoo S, Hellenberg D. The contribution of family physicians to district health services: a national position paper for South Africa. S Afr Fam Pract. 2015;57(5):54–61.
24. Tricco AC, Lillie E, Zarin W, O’Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med. 2018;169(7):467–73.
25. Royal College of General Practitioners. Core capabilities and competencies. http://www.rcgp.org.uk/training-exams/training/gp-curriculum-overview/online-curriculum/1-being-a-gp/core-capabilities-and-competencies.aspx. Accessed 31 July 2018.
26. Mendiola MF, Kalnicki M, Lindenauser S. Valuable features in mobile health apps for patients and consumers: content analysis of apps and user ratings. JMIR Mhealth Uhealth. 2015;3(2):e40.
27. Seabook HJ, Stomer JN, Shevkenek C, Bhavnani A, de Grood J, Ghali WA. Medical applications: a database and characterization of apps in apple iOS and android platforms. BMC Res Notes. 2014;7:73.
28. Laícco C, Shah U, Birnie KA, Davies-Chalmers C, Rivera J, Stinson J, et al. Commercially available smartphone apps to support postoperative pain self-management: scope review. JMIR Mhealth Uhealth. 2017;5(10):e162.
29. Rivera J, McPherson A, Hamilton J, Birken C, Coons M, Iyer S, et al. Mobile apps for weight management: a scoping review. JMIR Mhealth Uhealth. 2016;4(3):e87.
30. Bravo J, Hervás R, Fonteña J, González I. M-health: lessons learned by m-experiences. Sensors (Basel). 2018;18(15):1569.
31. Guo J, Li B. The application of medical artificial intelligence technology in rural areas of developing countries. Health Equity. 2018;1(2):174–81.
32. Wahi B, Cossy-Gantner A, Germann S, Schwalbe NR. Artificial intelligence (AI) and global health: how can AI contribute to health in resource-poor settings? BMJ Glob Health. 2018;3(4)000796.
33. Guo Z, Chen P, Ma Z, Li S, Gao X, Wu RK, et al. Near-field communication: an experimental study with simulated patients. J Med Internet Res. 2017;19(12):e421.
34. Majumder S, Deen MJ. Smartphone sensors for health monitoring and engagement: a scoping review. Sensors (Basel). 2018;18(6):1569.
35. Faustinella F, Jacobs RJ. The decline of clinical skills: a challenge for medical education. J Med Internet Res. 2015;17(9):e215.
36. Gallagher S, Little M, Hooker C. The values and ethical commitments of doctors engaging in macroallocation: a qualitative and evaluative analysis. BMC Med Ethics. 2018;19(1):75.
37. Di Corso A, Morales-Medina JC, Palmieri B, Lianetti T. Narrative review of telemedicine consultation in medical practice. Patient Prefer Adherence. 2015;9:65–81.
38. Bates K, Antheneus ML, Kanters S, Neboer TE, Genitse MB. The effect of screen-to-screen versus face-to-face consultation on doctor-patient communication: an experimental study with simulated patients. J Med Internet Res. 2017;19(12):e241.
39. Lewis TL, Wyatt JC. mHealth and mobile medical apps: a framework to assess risk and provide safer use. J Med Internet Res. 2014;16(9)210.
40. Larson RS. A path to better-quality mHealth apps. JMIR Mhealth Uhealth. 2018;6(7):e10414.
41. Cybul T. The ethics of mHealth: moving forward. J Dent. 2018;47:515–20.
42. Bodoil DT, Wineinger NE, Wailen J, Gollombiu S, Grossberg A, Steinhulb SR, et al. How consumers and physicians view new medical technology: comparative survey. J Med Internet Res. 2015;17(9):e215.
43. Baird A, Nowak S. Why primary care practices should become digital health information hubs for their patients. BMC Fam Pract. 2014;15(1):190.
44. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Med Res Methodol. 2018;18(1):143.

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