# Health Apps for Combating COVID-19: A Descriptive Review and Taxonomy

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# Health Apps for Combating COVID-19: A Descriptive Review and Taxonomy

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## Abstract

**Background:** Mobile phone applications (apps) have been leveraged in numbers to combat the spread of COVID-19. However, little is known about these technologies' characteristics, technical features, and various applications in healthcare when responding to this public health crises. The lack of understanding has led developers and governments to make poor choices about apps' design, which resulted in creating less useful apps that are overall less appealing to consumers due to their technical flaws.

**Objective:** This review aims to identify, analyse, and categorise health apps related to COVID-19 that are currently available for consumers in app stores; in particular, it focuses on exploring their key technical features and classifying the purposes that these apps were designed to serve.

**Methods:** A review on apps was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for a scoping review. The app stores "Apple Store" and "Google Play" were searched between the period of 20 April and 11 September 2020. An app was included if it was dedicated for this disease and that was listed under the health and medical related categories in these app stores. The descriptions of these apps were extracted from the apps' webpages and thematically analysed via open coding to identify both their key technical features as well as the overall purpose of using these apps. Lastly, the characteristics of the included apps were summarised and presented with descriptive statistics.

**Results:** Of 298 health apps were initially retrieved, 115 met the inclusion criteria. A total of 29 technical features were commonly found in our sample of apps which then their categorisation led to form five key purposes of apps related to COVID-19. About (67%, 77/115) of these apps were developed by governments or national authorities, and with the purpose of promoting users' tracking personal health (31%, 9/29). Other purposes were: raising awareness on how to combat COVID-19 (27%, 8/29); managing exposure to COVID19 (20%, 6/29); monitoring health by healthcare professionals (17%, 5/29) and conducting research studies (3.5%, 1/29).

**Conclusions:** This study provides an overview and taxonomy of the health apps currently available in the market to combat COVID-19 based on their differences of basic technical features and purpose of use. As the majority of apps are provided by governments or national authorities, it indicates the essential role of these apps as powerful "weapons" in public health crisis management. By involving the majority of the population to self-track their personal health and providing them with the technology to self-assess, the role of these apps is deemed to be a key driver for a participatory approach to curtail the spread of COVID-19. Further effort is required from researchers to evaluate these apps' effectiveness, and from governmental organisations to increase public awareness of these digital solutions.

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## Abstract

**Background:** Mobile phone applications (apps) have been leveraged in numbers to combat the spread of COVID-19. However, little is known about these technologies' characteristics, technical features, and various applications in healthcare when responding to this public health crises. The lack of understanding has led developers and governments to make poor choices about apps' design, which resulted in creating less useful apps that are overall less appealing to consumers due to their technical flaws.
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**Conclusions:** This study provides an overview and taxonomy of the health apps currently available in the market to combat COVID-19 based on their differences of basic technical features and purpose of use. As the majority of apps are provided by governments or national authorities, it indicates the essential role of these apps as powerful "weapons" in public health crisis management. By involving the majority of the population to self-track their personal health and providing them with the technology to self-assess, the role of these apps is deemed to be a key driver for a participatory approach to curtail the spread of COVID-19. Further effort is required from researchers to evaluate

these apps' effectiveness, and from governmental organisations to increase public awareness of these digital solutions.

**Keywords:** apps; COVID-19; Coronavirus; self-care; personal tracking; consumer health informatics; public health crisis management; data-driven disease surveillance

## Introduction

In response to the COVID-19 pandemic, a global health movement developed with country-wide campaigns providing health education. This information was widespread to educate the public on the newly discovered SARS-CoV-2, also referred to as coronavirus 2, and how to best protect themselves. These campaigns were filled with a series of prevention protocols and control interventions to contain COVID-19 such as social distancing, keeping infected individuals isolated, to self-isolate in homes or hotels after coming into contact with someone who was later found to test positive for the virus, and travel restriction [1].

During the COVID-19 pandemic, health mobile phone applications (apps) have been widely utilised for supporting these campaigns' missions; to assist in raising awareness on how the population may protect itself, and encouraging adherence to those various precaution protocols [2,3]. For example, the United Kingdom National Health Service created an app with the purpose of encouraging users to keep a safe distance from others and alert them if they come close to someone who had been diagnosed with COVID-19. Within days, the app was downloaded over ten million times, with six million of these downloads having been completed on the first day [4]. Globally, the World Health Organization (WHO) Alert app has the potential to reach two billion people [5]. A messaging service provided via social media Facebook and WhatsApp and can be accessed in 15 different languages to answer questions about COVID-19.

In addition, health apps are not limited to simply providing information about COVID-19 but are also used to facilitate data-driven disease surveillance, screening, triage, diagnosis, and monitoring by governments or health officials, healthcare professionals, and health organizations [3,6]. These interventions enable timely preventative methods and treatment procedures at the population level [7]. For example, an app named COOPERA is used to monitor trends in COVID-19 in Japan, evaluate the current Japanese epidemiological situation, and provides useful insights to assist political decisions to tackle the epidemic. COOPERA collects personal information about the users and symptoms related to COVID-19. The reported number of confirmed-infected cases are then calculated to detect and manage infectious cases.

On the other hand, at the individual level, as these health apps' popularity rises, the opportunity has increased for consumers and patients to self-manage both their risk of exposure as well as their symptom progression [8,9]. In combatting COVID-19, health self-management includes keeping safe distance from others to decrease the communal spread of the disease, completing self-assessments that monitor symptoms development or augmentation, routinely taking prescribed medication, and maintaining a healthy diet and physical activities [1,10]. In instances such as these, mobile apps can promote health self-care practice and activate a person's responsibility and accountability for preventing disease and maintaining health [9,12,11]. They can log and view the history of their health status, set useful reminders for treatment adherence, and provide vital information about their health status to the community to prevent future exposure.

Furthermore, the importance of health apps related to COVID-19 arises from their capabilities to allow for consumers to feel safe and informed in making decisions regarding their health. For instance, an app developed by the University of California San Francisco [13] for healthcare workers at the university's hospital assesses their potential COVID-19-related symptoms. This app helped the employees avoid long queues at screening points before every clinical shifts, allowed for physical distancing at hospital entrances, and prevented employees with suspected cases from coming to work. Moreover, it allowed the users to answer questions about symptoms they experience such as fever, cough, and difficulty in breathing. Then, the user can self-assess their severity and make decisions about their potential need to seek further medical treatment [14].

To ensure that apps such as these can meet the consumers' needs and preferences, it is imperative that app developers understand the various usages of these technologies and their technical features [8,15]. However, few studies have been conducted to describe COVID-19 related apps and analyse their technical features [15,16]. The lack of this understanding led developers and governments to make poor choices about health apps' design, which led to creating less useful apps that are overall less appealing to consumers due to their technical flaws [17]. Therefore, this review aims to identify, analyse, and categorise health apps related to COVID-19 that are currently available for consumers in app stores; particularly, it focuses on exploring their key technical features, and classifying the purposes that these apps were designed to serve.

# Methods

## Identification of Relevant Apps

From 20 April 2020 to 11 September 2020, the author explored the app stores "Apple Store" and "Google Play". The following search strings: COVID19, COVID, COVID-19, corona, coronavirus, corona triage, corona symptoms, SARS-CoV-2 and respiratory diseases were used to find apps dedicated for this disease and that were listed under the health and medical related categories in these app stores. Additionally, the author searched current news articles as well as Google search engine results to find apps related to COVID-19 that may not have otherwise been available in the author's regional app store.

The app review was conducted with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping review [18]. While PRISMA is the standard guideline to review scientific literature, some researchers have suggested it is not completely applicable to app reviews [19,20]. Nevertheless, it has been used by a number of studies to review apps as it is one of the common tools for performing systematic searches [19-21].

## Screening and Eligibility Assessment

The inclusion and exclusion criteria are illustrated in Table 1 and described in the light of a framework developed by Ramakrishnan [22]. The framework encompasses a series of key questions around COVID-19 related apps which are ordered in five levels of considerations, starting from wider into narrower considerations as the level's number gets higher. Although this framework was adapted from the M-Health Index and Navigation Database that has been previously used to evaluate mental health apps [22], in this study it was utilised to help in reporting our inclusion and exclusion criteria.

During the eligibility assessment round, the titles, descriptions, and keywords of identified apps were screened. Health apps that were available to the general public at app stores were included. In this round, an app was excluded if it removed from an app store by its developer during our specified search period, even if it was originally available at the beginning of this period. Their removal indicated that these apps were no longer available to consumers and were hence excluded from the sample.

An app was also excluded if it was only dedicated to respiratory or infectious diseases other than COVID-19, such as Severe Acute Respiratory Syndrome (SARS) or asthma without any reference to COVID-19. Examples of these apps were Clean Your Lungs app [23], Breathcount [24], and Box Breathing [25]. Additionally, duplicated apps were identified and removed. In the event of a duplication, the included app was ultimately retained if found in the "Apple Store" as it had all the required information about the app including its date of release.

Furthermore, no restrictions were made regarding the app's language, pricing, store location or country of origin, developer's types, and app's accessibility measures for gaining access to its content such as requirement of national identification codes, local country phone numbers, or research study codes. Also, no restrictions were imposed in term of the types of the apps' users. Examples of these health apps included Spectrum [26] which is intended for clinicians to help them in making clinical decisions based on COVID-19 guidelines and infection prevention protocols; Tabaud [27] intended for individuals who want to know if they have been in close proximity to an infected person; Self-quarantine [28] intended for patients or infected people who are in self-quarantine; Covid Radar [29] for researchers who want to be able to predict healthcare needs in specific regions, and finally, PreWorkScreen [30] for employers who want to manage their employee's COVID-19 self-screening.

Table 1. The inclusion and exclusion criteria of apps are presented in the light of a framework developed by Ramakrishnan [22]

| **Levels of consideration** | **The framework's questions** | **Our inclusion criteria** | **Our exclusion criteria** |
|---|---|---|---|
| 1 App origin | Where does the app come from? Who is the developer and what is the country of origin? | Health apps that were available at app stores during our search period. | No restrictions were made on the country of origin, app's language, and developers' types. |
| 2 App accessibility | On what platforms is the app available? How much does it cost and what accessibility measures are in place for a user? | Health apps that were available at "Apple Store" and "Google Play". | No restrictions were made on app's pricing and other accessibility measures for gaining access to the app's content such as requirement of national identification codes, local country phone numbers, or research study codes. |
| 3 App features | What features does the app offer and what kind of information is it providing around COVID-19? | Health apps that were related to combating COVID-19. | Health apps were excluded if they were only dedicated to respiratory or infectious diseases other than COVID-19, such as Severe Acute Respiratory Syndrome (SARS) or asthma without any reference to COVID-19. |
| 4 Privacy & Security | Are data use and security measures specified? What kind of data are collected or shared? | Health apps that were able to collect and/or share data. | No restrictions were made on the privacy and security measures (e.g., consent forms, privacy compliance standards) or kind of data collected or shared (e.g., personal information, users' locations, etc.). |
| 5 Clinical Integration | For whom is it intended? patients? self-help? essential workers? | Health apps that were available to the general public. | No restrictions were made on the types of the app's intended users. |

## Selected Apps and Data Analysis

Each app's webpage in both the "Apple Store" as well as "Google Play" was visited. Data on each app was extracted and collected as follows: the app's name, release date or version date when features related to COVID-19 added, the country of origin, author or developer's name, technical features, and source (link to the app's webpage). This information is summarised and presented in Multimedia Appendix 1.

The apps' technical features were identified by performing open coding. A qualitative data analysis application (i.e., Dedoose Version 8.3.35) was used at this stage. The app's description was first stored in a Word document which was then imported into Dedoose. Excerpts about technical features were highlighted and given a title. The code title was drawn from the excerpts' content. For example, the excerpt 'users can also engage in real-time chat with the chat feature', was placed under the title "Chatbot Feature." Multimedia Appendix 2 presents the occurrence of all extracted excerpts in each app included in this review whereas the excerpts' content can be found in Multimedia Appendix 1 within the column 'technical features'. After completion, the same process was repeated to identify the types of authors or developers creating these apps. Information about the authors or developers was summarised with some additional visits to their original websites to obtain more information.

After this, the generated codes about apps' technical features were grouped into overarching categories or dimensions. Each dimension represented a different purpose that an app could serve. To identify and validate the purposes of these apps, codes and dimensions were compared iteratively to analyse the similarities in their descriptions within a category [31]. The first author also compared the differences in codes in every other category as shown in Figure 1. If a code did not fit with the previously created dimensions, a new one was added. These generated dimensions were then summarised which led to the development of our taxonomy of apps' purposes (as shown in Figure 3 in Results section).

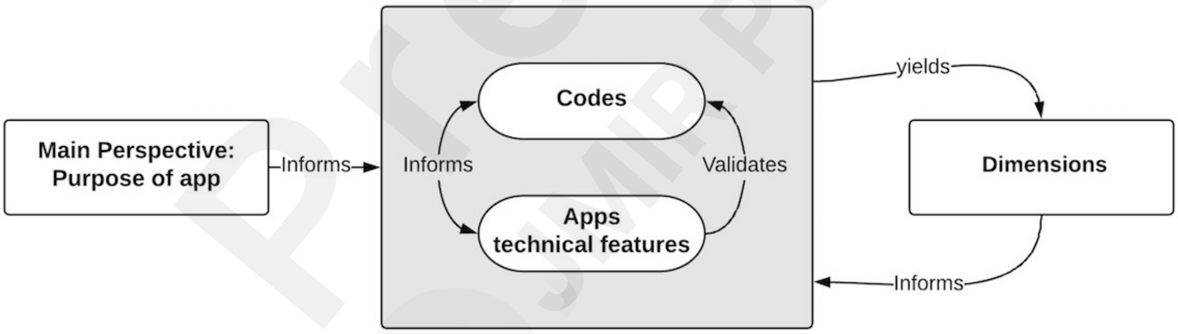


Figure 1. Approach to classification of purposes of apps based on their technical features

# Results

## App Selection

A total of 298 apps were identified through systematic searches in the “Apple Store” (n=178) and “Google Play” (n=120). Screening apps’ titles and descriptions resulted in removing the following apps: 34 apps that were duplicated; 111 apps that were related to other respiratory diseases (n=56 related to SARS, and n=55 related to asthma); and 38 apps that were no longer available in app stores. After removing duplicate and irrelevant apps, 106 apps from the “Apple Store” and 9 from “Google Play” were included and further analysed. Figure 2 illustrates the flowchart of the search strategy and app selection process.

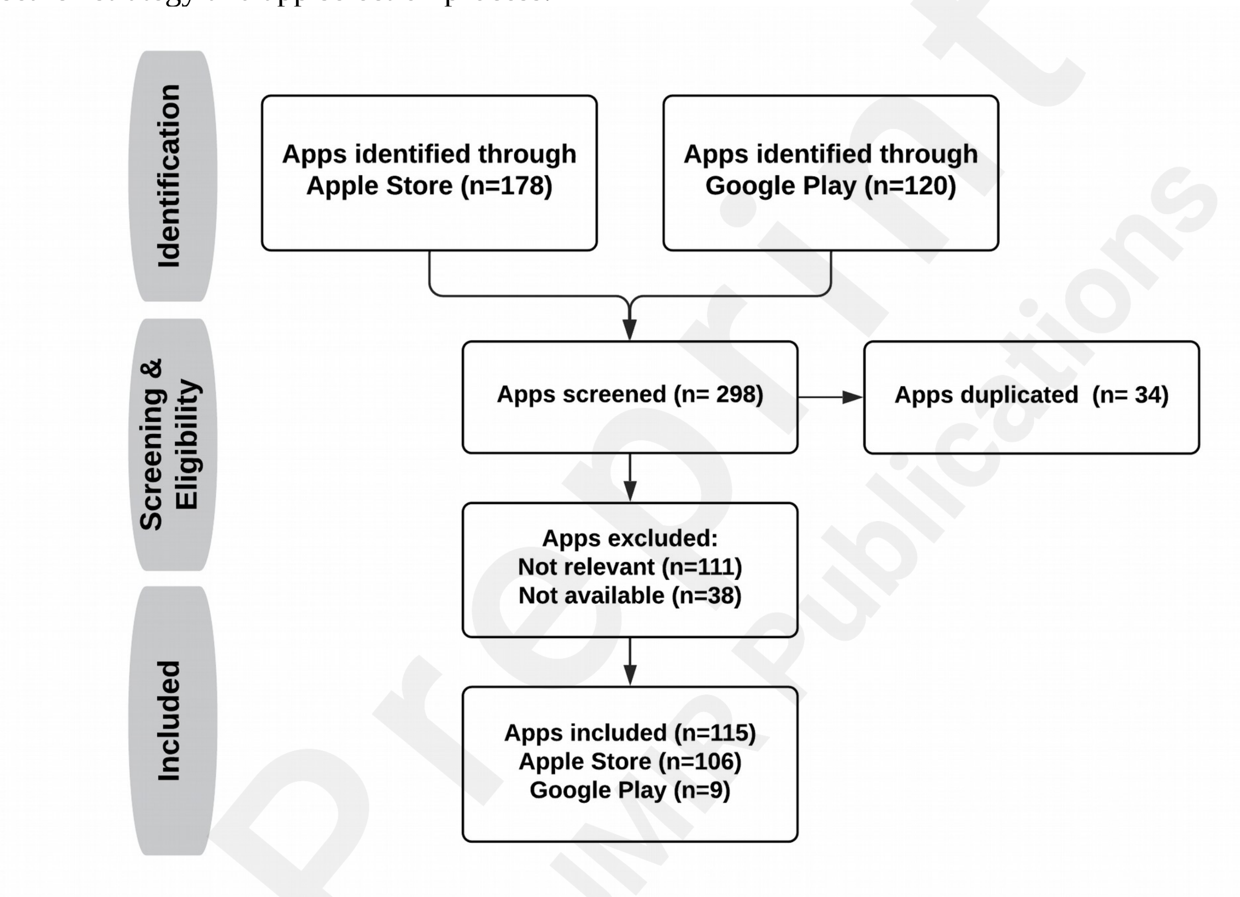


Figure 2. Flowchart of our search strategy and apps selection process

## Characteristics of Included Apps

The characteristics of included apps along examples of each are presented in Table 2. Of the 115 health apps, 114 (99%) were free. The majority of the apps (n=77, 67%) were developed by governments or national authorities such as the Ministry of Health in Saudi Arabia, and Government of Malaysia. Nearly (n=25, 22%) of apps were developed by companies such as BioneXt Lab, Paxera Health, and Webdoctor Limited. Five apps came from non-profit organisations or agencies such as the World Health Organisation (WHO), and Lay First Responders International. Four apps were built by universities or research centres such as Columbia University in the United States of America and the National Institute of Infectious Diseases in Romania. Four apps were developed by hospitals such as Merciful Brothers Hospital in Czechia.

A total of 51 countries were included in this review. The majority of the health apps (n=28, 24%) were from the United States of America (USA). Five apps came from India. Four apps belonged to each of the following countries: Italy, Kingdom of Saudi Arabia (KSA), Mexico, Spain, and Vietnam. Three apps were created in the following countries: Australia, Canada, France, Netherlands, and United Arab of Emirates (UAE). Two apps were developed in each of the following countries: Malaysia, Republic of Ireland, South Korea, Switzerland, and the United Kingdom (UK). Four apps were designed for global users, and the rest came from other countries (n=35; i.e., Armenia, Austria, Bahrain, Bolivia, Brazil, Columbia, Czechia, Denmark, Egypt, Georgia, Hungary, Indonesia, Iceland, Jamaica, Jordan, Kuwait, Lativa, Mali, Morocco, New Zealand, North Macedonia, Pakistan, Poland, Portuguese, Qatar, Republic of Cyprus, Republic of Fiji, Romania, Singapore, Sri Lanka, Switzerland, Thailand, Tunisia, Turkey, and Uruguay).

Table 2. Summary of apps' characteristics

| Characteristics | Apps (n=115) | % | Selected example of app |
|---|---|---|---|
| **Operation system** | | | |
| iOS | 106 | 92.17 | TraceCovid |
| Android | 9 | 07.82 | Tawakkalna KSA |
| **Pricing** | | | |
| Free | 114 | 99.13 | Stop Covid19 |
| Not Free | 1 | 00.87 | PreMedicus |
| **Developer/Author** | | | |
| Government or national authority | 77 | 66.95 | Covid-19 Armenia |
| Company | 25 | 21.73 | Covive |
| Non-profit organisation or agency | 5 | 04.35 | WHO Info |
| Hospital | 4 | 03.48 | Trecovid19 |
| University or research institute/centre | 4 | 03.48 | Covid Watcher |
| **The country of origin** | | | |
| USA | 28 | 24.35 | CovidWise |
| India | 5 | 04.35 | AarogyaSetu |
| Italy | 4 | 03.48 | Trecovid19 |
| KSA | 4 | 03.48 | Tabaud |
| Mexico | 4 | 03.48 | Plan Jalisco Covid-19 |
| Spain | 4 | 03.48 | GVA CoronVirus |
| Vietnam | 4 | 03.48 | Covid-19 Vietnam |
| Global | 4 | 03.48 | Covive |
| Canada | 3 | 02.61 | Canada Covid-19 |
| Australia | 3 | 02.61 | MyAus Covid-19 |
| France | 3 | 02.61 | Covidom Patient |
| Netherlands | 3 | 02.61 | COVID-19 Medisch Dossier |
| UAE | 3 | 02.61 | TraceCovid |
| Malaysia | 2 | 01.74 | MyTrace |
| Republic of Ireland | 2 | 01.74 | PatientMpower for COVID-19 |
| South Korea | 2 | 01.74 | Self-Quarantine app |
| UK | 2 | 01.74 | NHS24 Covid-19 |
| Other | 35 | 30.43 | - |

## Technical Features of Apps Related to COVID-19

After conducting the open coding of 115 apps' descriptions, 258 then-extracted excerpts were grouped into 29 technical features. Table 3 presents the key technical features with examples of apps that supported these technical features, and Multimedia Appendix 2 illustrates the occurrence of the different technical features in each app. Each technical feature is described in detail below.

The most common technical feature was 'basic health information and advice' or 'FAQ'. About (n=42, 37%) of the apps were developed to provide basic health information about the coronavirus 2, best health practices, medical advice, and frequently asked questions regarding COVID-19. This health information was given in a form of guidance documents, videos, animation clips that were curated by the respective country's government, WHO, Centres for Disease Control and Prevention (CDC), National Health Council, Johns Hopkins University and other medical institutions.

The second most common technical feature in our review was 'contact tracing'. Roughly (n=32, 28%) of the apps supported contact tracing by documenting and retaining encounters with others such as friends, family or co-workers. These apps allowed users to detect other devices with the same installed app and exchange an encrypted Secure Tracing Identifier (STI). The STI is stored locally on the user's device and consists of anonymised data, timestamp, and—in some apps—the Global Positioning System (GPS) location of the phone. When any one of the users becomes infected with the coronavirus 2, authorities with authorized access to the data can request the infected users to upload the list of STI to their national data centres for further analysis in order to enable officials to respond quickly and reach out to close-contact individuals that may be requested to quarantine, thus potentially minimising the spread of the virus.

The third most common technical feature was 'alert contacts'. Nearly (n=30, 26%) of the apps provide the opportunity to alert contacts. These apps enabled users diagnosed with COVID-19 to voluntarily share their tests results with people they had come into contact with over the previous 14 days. These alerts were received through notifications, text messages and automatic calls. In contrast, some apps were configured to allow health officials to automatically and anonymously inform the user's encounters to their contacts, and here the users' consents were usually obtained at during the initial download of the app.

The fourth most common technical feature was 'gadget of self-assessment'. About (n=20, 17%) of the included apps provided self-assessment tools to examine whether the user had the possibility of having COVID-19. These tools included questionnaires that were designed according to CDC guidelines, WHO recommendations, and the country's health officials. Based on the results from these questionnaires, users were ultimately divided into three categories: users who had not tested positive for the virus and are asymptomatic; users who had not tested positive for the virus but had symptoms such as a fever, cough or shortness of breath; and users who had tested positive for the coronavirus 2. These apps' collected information was then locally or remotely processed and then made available to the country's healthcare professionals for further analysis.

The fifth most common technical feature was 'live statistics and rolling updates'. Approximately (n=19, 16.5%) of apps provided live statistics and rolling updates in two forms: Really Simple Syndication (RSS) feeds and push notifications. RSS feeds were utilised by 14 apps, as shown in Multimedia Appendix 2, to provide up-to-date information about the COVID-19 infection by number of active cases. The cases were then divided into asymptomatic, mild, moderate, severe, recovered and fatal. These statistics were grouped and illustrated per day, per week, and per month from both a countrywide as well as worldwide perspective. Additionally, some apps presented the statistics based on hospital admissions within the country rather than active cases. In this same vein, five apps used push notifications to provide updates from the government and its advisories, and updated information and subsequent instructions informing of the spread of COVID-19 aggregated by the user's state, country, and around the world.

The technical feature ‘latest news’ comes next in popularity in this review, with about (n=16, 14%). A variety of content such as stories, videos, and podcasts were advertised to present the most current global and local news feeds, and, in some apps, can be sorted by cities and countries. These apps allow their users to receive immediate COVID-related news and updates from trusted non-profit groups, international organizations, and government agencies in one place.

The technical feature ‘symptoms tracker’ was also supported by (n=16, 14%) of apps. These trackers log symptoms and vitals such as fever and cough at specific frequencies by sending text messages and emails, providing automatic fill-ins for text fields, or sending push notifications to obtain the required data. The collected data from symptoms trackers greatly assists in categorising individuals by severity and health risks into “low-risk” to “high-risk” groups. This method of grouping patients was then used to decide the healthcare needed for each case. For example, in low-risk symptoms groups, users were provided with knowledge and resources to deal with the disease at home. In higher-risk groups, patients were highly monitored in anticipation of developing symptoms.

The technical feature ‘information about health services and care lines’ comes next with 11 apps offering this feature. The apps allowed the users to search nearby hospitals, emergency services, pharmacies, and certified COVID-19 test labs. Some apps consisted of a step-by-step guide on finding testing services and centres that were available around the users’ locations as well as providing the contact information of these services.

The technical feature ‘map’ comes next, with a total of 10 apps. These maps interactively presented both the occurrence of COVID-19 cases (e.g., active, confirmed, recovered cases, etc.) as well as the density of these cases in different areas (e.g., neighbourhoods, cities, and countries). Maps were also used to indicate nearby healthcare centres and route directions to reach these centres. Moreover, these apps helped health officials to observe trends in the community and in turn take meaningful measures to handle the spread of the virus.

The technical feature ‘health or travel declaration’ comes next, with a total of 8 apps. These apps detailed health or travel declarations that were mandated by the country’s government or health officials. Upon arrival, travellers were requested to report themselves and their families through these apps and record their daily health status for 14 days. Moreover, some of these apps were used to notify users of potential exposure risk in the area where the users lived.

The technical feature ‘location monitoring’ comes next, with 7 apps. These apps provided real-time dashboards that help in identifying the next potential COVID-19 hot spots, and monitoring and advocating for resources needed in those spots. The collected data were analysed based on the geolocation of cases and then used to provide support in coordination with local, departmental and national authorities, which in turn assisted in planning optimal treatment delivery.

The technical feature ‘sharing data or story with others’ was also supported by 7 apps. These apps have the capability to build health diaries describing the users’ symptoms development and allow consumers to share their COVID-19 stories with other users as well as on social networks like Facebook. The stories and diaries can be shared by posting text-based messages, recording voice-based messages, or uploading videos. The users were also able to share these diaries with medical personnel in order to receive a faster diagnosis.

The technical features ‘remote monitoring’ and ‘virtual medical consultation’ come next, both with 6 apps. Apps that were related to remote monitoring allowed healthcare professionals to monitor patients’ health data such as heart rate and level of blood oxygen in real-time. The generated data could then inform healthcare teams on how their patients lived on a daily basis and allow them to be immediately alerted if any patient needed critical medical attention. In apps enabled virtual medical consultation, live video consultations and/or bidirectional text-audio communications were employed as a mean to provide personalised support between the users and their doctors.

The technical features ‘helplines’ and ‘chatbots’ come next, which was offered by 6 and 5 apps respectively. Helplines connect users to consultants providing useful information related to COVID-19 and facilitate the introduction of patients to health workers over a toll-free number.

Chatbots, on the other hand, are artificial intelligence (AI)-enabled agents who connect with patients through texting and/or a human-sounding voice. Chatbots offered personalised health advice via one-on-one conversations with users and help them find answers to their various questions in real-time.

The technical feature ‘distance detection’ comes next which was enabled by 3 apps. These apps were built to improve the user’s ability to avoid close contact with other people around them. These apps can show how far away the user’s device is from other devices within the same location.

The technical feature ‘recruitment of volunteers’ comes next with 2 apps. These apps were designed to enable the recruitment of volunteers for conducting scientific studies and trials pertaining to COVID-19. These apps asked users to report their symptoms and other required information daily, with each submission generated into data for research purposes.

The technical features ‘lists of products’ was also supported by 2 apps. These apps presented lists of products required for combating COVID-19 (e.g., gowns, surgical masks, respirators, face shields, hand sanitizers, etc.), and some allowed calculating the number of these products in stocks to find the average consumption rate. This was useful for informing the users about these important products, and helping to optimize the usage of these resources.

Finally, the least common technical features in this review that were present in one app were: checklists of surfaces that required disinfection; taking photos of surfaces; making medical appointments; medical check-up tracking (e.g., diagnosis time, submission of diagnosis) during self-quarantine; medical report generators; medication tracking and reminders; mood tracking and mental status (e.g., coping with stress); movement permits (e.g., during curfew); results of the COVID-19 laboratory test; and using wearable devices for symptom tracking such as pulse oximeters for tracking oxygen saturation in the blood.

Table 3. Summary of the apps’ technical features with examples

| **Technical features (n=29)** | **Apps (n=115)** | **%** | **Selected example of app** |
|---|---|---|---|
| Basic health info and advice or FAQ | 42 | 36.52 | Covid-19 Czechia |
| Contact tracing | 32 | 27.83 | TraceCovid |
| Alert contacts | 30 | 26.08 | Tabaud |
| Gadget of self-assessment | 20 | 17.39 | Covive |
| Live statistics and rolling updates | 19 | 16.52 | NCOVI |
| Latest news | 16 | 13.91 | CDC |
| Symptoms tracker | 16 | 13.91 | Corona Care |
| Info about health services and care lines | 11 | 09.57 | CoronApp-Colombia |
| Map | 10 | 08.69 | Corona Map |
| Health or travel declaration | 8 | 06.96 | Covid-19 Vietnam |
| Location monitoring | 7 | 06.08 | Private Kit: Safe Paths |
| Sharing data or story with others | 7 | 06.08 | Corona FACTS |
| Remote monitoring | 6 | 05.21 | Covidom Patient |

| | | | |
|---|---|---|---|
| Virtual medical consultation | 6 | 05.21 | Laziodr Covid |
| Helpline | 6 | 05.50 | Covid-19 UAE |
| Chatbot | 5 | 04.35 | HealthLynked COVID-19 |
| Distance detection | 3 | 02.61 | VírusRadar |
| Recruitment of volunteers | 2 | 01.74 | Covid Radar |
| List of products for combating COVID-19 | 2 | 01.74 | NIOSH PPE Tracker |
| Checklist of disinfected surfaces | 1 | 00.87 | Disinfection Checklist |
| Making medical appointments | 1 | 00.87 | GVA CoronVirus |
| Medical check-up tracking | 1 | 00.87 | Self-Quarantine app |
| Medical report generator | 1 | 00.87 | Premedicus |
| Medication tracking and reminders | 1 | 00.87 | Patientsphere for Covid19 |
| Mood tracking and mental status | 1 | 00.87 | Covid Coach |
| Movement permits | 1 | 00.87 | Tawakkalna KSA |
| Results of COVID-19 laboratory test | 1 | 00.87 | Tatamman |
| Taking photos of surfaces | 1 | 00.87 | Disinfection Checklist |
| Wearable devices for symptoms tracking | 1 | 00.87 | PatientMpower for COVID-19 |

## Purposes of Apps Related to COVID19

The identified technical features (n=29) were then analysed and organised into five dimensions that represented purposes of these health apps. This led to the development of our taxonomy for health apps related to COVID-19, as shown in Figure 3. These purposes were: Tracking personal health; Raising awareness; Monitoring health by healthcare professionals; Managing exposure to COVID-19; and Conducting research studies. The majority of technical features were related to the two first-mentioned purposes. Each purpose is described in detail below.

For tracking personal health, a total of nine technical features out of twenty-nine (31%) were found relevant as the data generated from these apps help their users to look after their health. These technical features were: gadgets of self-assessment used as an initial triage of possible infection; symptom trackers to check oneself for corona symptoms on a daily basis; medication trackers and reminders; mood trackers; distance detectors to maintain a safe distance from others; diagnosis recorders used during self-quarantine; integrated cameras for taking photos of surfaces that have been disinfected; checklists of surfaces that have to be disinfected for tracking their hygiene practices; and wearable devices for tracking symptoms.

For raising awareness about COVID-19, eight technical features out of twenty-nine (28%) were categorized under this dimension as these apps were concerned with providing various data and information to help users stay informed about this disease. These technical features included: providing basic health information and advice or FAQ; presenting live statistics and rolling updates;

showing the latest news; offering information about health services and care lines; providing interactive maps of active cases and nearby medical facilities to help users learn about this information; chatbots to answer the user's questions; incorporating lists of products needed for combating COVID-19 to learn about this important precaution; and allowing users to share data and stories with others such as family members and doctors to inform them about their health status and the most current healthcare information and practice.

For managing exposure to COVID-19, six technical features (21%) were classified under this dimension as these apps help users to avoid being exposed to this virus. These features were: contacts tracing; alerting contacts users within close proximity of someone who had tested positive for the virus; reporting suspected cases and declaring travel after arrival; granting movement permits during curfews; monitoring the location of consenting users to further understand trends of COVID-19 within various communities; and tools for sharing results of certified COVID-19 examinations with users.

For health monitoring, five technical features (17%) were placed under this dimension as these apps help users to seek medical assistance from their healthcare professionals. These features were: remote monitoring by healthcare professionals; virtual medical consultations with clinicians via video or audio calls; medical report generators; tools for making appointments to visit health centres; and helplines to obtain necessary medical help.

Finally, for conducting research studies, many features such as symptoms tracker, distance detector and self-assessment gadgets enabled this dimension but one technical feature (3%) uniquely supported it. This feature was intended to enable researchers to recruit volunteers and take part in COVID-19-related studies and clinical research across countries.

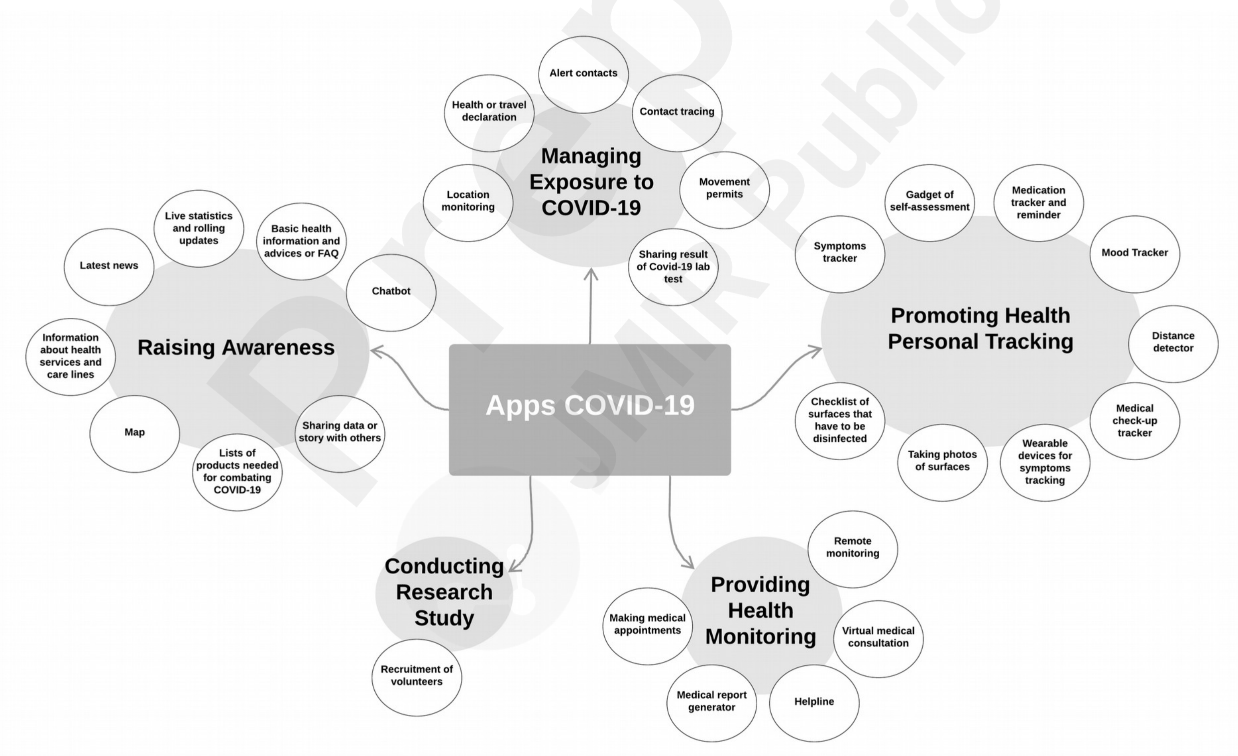


Figure 3. Taxonomy of health apps' purposes

# Discussion

## Principal Findings and Comparison to Prior Studies

The present apps review shows that the health apps related to COVID-19 vary in terms of their developer's types, basic technical features and purposes of use to combat coronavirus 2. Regarding the developer's types, this review reveals the high number of apps developed by governments or national authorities to fight this infectious disease. In comparison with non-communicable diseases like diabetes and hypertension, apps are mostly developed by nongovernmental entities such as healthcare providers and hospitals [19,20]. This indicates the essential role that apps could play as powerful "weapons" in public health crisis management [32].

The most common technical features in this review focused on offering basic health information and advice on COVID-19 followed by contact tracing. However, the author noticed that, over the review period, the number of health apps related to contact tracing was increasing. For examples, health apps released at the early stages of the COVID-19 pandemic (i.e., February, March, April, and May 2020) tend to be concerned with raising awareness more than other purposes. Apps released in June, July, August and early September 2020 tended to offer COVID-19 exposure notifications more than any other purpose; see Multimedia Appendix 1. Moreover, it is also expected that contact-tracing apps will continue to rise [33,34]. As COVID-19 is highly contagious, digital contact tracing is preferred by many health agencies and governments to expand their capacity for fighting the rapid spread of the virus [34,35]. Contact tracing via apps is also deemed more effective in compared with traditional data collection [36]. In traditional contact tracing, tracing is performed through hired tracers and notifications are made by phone-calls, which is costly and time consuming, and the chance of missing potential exposures is high [36].

This review also observes the rise in using AI-based technical features for providing customised support to fight against the novel coronavirus 2 outbreak. For example, AI-enabled health education agents are offered through chatbots. Although four apps included in this review had chatbots within their technical features, the number of chatbot apps and their popularity are expected to continue to rise [37]. Health chatbots can provide knowledge about the symptoms caused by the novel SARS-CoV-2, teach their users how to detect if they have been affected by or infected with the virus, and present them with the recommendations based on CDC guidelines and advice to reduce the risk of infection [10,38].

Moreover, some researchers are concerned about future lasting effects of the virus, which can be somewhat mitigated with currently available app technology [39]. For instance, Neubeck et al. [40] conducted a review of the effectiveness of remote care to cardiovascular patients during the era of COVID-19. They found that there were two specific limitations that cannot quite yet be answered by current mobile apps: rapidly-changing symptoms, and social isolation. This review found similar limitations in current technology. While chatbots are excellent in the initial stages of assessing symptoms or answering questions, they are not advanced enough to, in some cases, provide a sense of human contact that isolated and/or immunocompromised users may be interested in.

Regarding the purposes of apps, tracking personal health and raising awareness were found dominant in this review as well as in other relevant reviews of COVID-19 apps [41,42]. As the COVID-19 outbreak has progressed, monitoring peoples' health and adherence to prevention procedures—including mobility, early detection of mild symptoms and providing necessary psychological support—by health officials and national healthcare providers has become increasingly difficult to maintain and is anticipated to become even more challenging with an ever-increasing number of cases [43,44]. To combat these likely upcoming issues as well as under the request of health officials, the majority of the apps identified in this review had personal health tracking capabilities. These apps support public health officials' emphasis on the importance of personal health tracking as a participatory approach to curtail further spread of the coronavirus 2 in the community [45]. By involving the majority of the population to self-track their personal health and providing them with the technology to self-assess, the population can work in tandem with healthcare providers to combat the effects of the virus.

Additionally, in the 51 countries that are presented in this review, informing the community on how to mitigate their exposure to COVID-19 has been provided by digital health technologies [2]. The authorities in these countries and other stakeholders (e.g., healthcare providers, policy makers) have utilised apps that provide services such as contact tracing and widespread alerts. Additionally, these apps assist in restricting travel and keeping contact with users, which shows the imperative need for these apps in order to keep the community safe. Likewise, as healthcare providers can use these apps to become well-informed on the community's needs, they can in turn plan on how to best deliver treatment services. Each of these groups is responsible for their duty to combat the virus; in using this technology, various stakeholders could feel confident in knowing what to do for reducing the risk of COVID-19 [2,6].

## Implications of Findings

This study provides a holistic review of the technical features that are common in health apps related to COVID-19 and identifies the most utilised ones for various purposes as shown in Figure 3. Knowledge of both these technical features as well as their applications in combating COVID-19 may help developers in making informed decisions when designing apps for various stakeholders.

For governments and health officials, our review shows that not only can health apps support several different methods in which to mitigate the effects of COVID-19, but that its information can be accessed rapidly and inexpensively [6]. This review shows the ability of COVID-19 related apps to quickly and easily transmit data to both public health centres and treatment providers as well as epidemiologists, virologists, and clinicians. These health apps are equipped with different technical features such as contact tracing, where information can be uploaded and transmitted, privately held and maintained by healthcare authorities, yet still accessible to the public [46]. Individuals can use these apps to provide their own information about themselves or their social circle, and can be alerted when approaching an area where the risk of exposure is high. These insights may encourage governments and health officials to request building apps in a way that can expand consumers' capabilities to feel educated, protected, and informed of their own health information and their community during pandemics.

For researchers in public health and medical informatics, there is enormous potential for future research and app-based development with regards to how mobile apps have so far been used to combat COVID-19 as shown in this review, and will, ideally, be used in the future [47]. One of the most frequent questions about these apps is related to their acceptability [48] and effectiveness [49]. These assessments, which are based on the apps' technical features (e.g., the medication reminders, information on COVID-19 that the users can take advantage of), can inform not only successful individual adoption of these technologies, but also effectiveness of overall services that apps can provide [47,50]. Our taxonomy of health apps purposes, illustrated in Figure 3, can be utilised as a guidance tool in categorising apps and then assessing their functionalities and evaluating these apps' acceptability and/or effectiveness in each different category.

Lastly, for average consumers, as health apps related to COVID-19 are low-cost and publicly-available resources, this study provides a holistic reference of apps that are currently available in the market across 51 countries. Multimedia Appendix 1 is rich with information about the health apps' specifications and include their web-links for convenient access. This appendix may help to educate consumers about various apps available for them and their different functionalities, and then improve their abilities to choose the best suitable app based on their needs and requirements [42].

## Recommendations for Future Studies

As countries who are actively collecting data are better equipped to make decisions on how to best combat the coronavirus 2, it is recommended to investigate and find approaches for encouraging as many people as possible to utilize these apps [17,50,51]. With an app, a user can at any time conduct a self-assessment to evaluate any symptoms they may have and take appropriate measures to keep themselves and their community safe. However, poor choices made by developers and governments about apps' design have led to technical flaws and security concerns that could make the apps less powerful and may hinder consumers' willingness to use them [17]. Therefore, these types of apps should be developed with health informatics experts in order to improve collaboration between government, healthcare organizations and apps' developers, and to achieve the best quality of data collection and protection [32].

Self-monitoring-related apps have played a large role in healthcare provision, treating patients without being overwhelmed by in-person visits, enabling treatment providers and patients to utilize symptom progression tracking in real time [11]. However, health monitoring has to be distinguished as a concept from health tracking [52]. In health monitoring, the healthcare professionals, not users, take the initiative and provide guidance for their patients through the treatment course. In health tracking, the user takes initiative to complete actionable steps for health self-management [52]. Therefore, it is recommended that this difference to be taken into considerations when the evaluation of apps functionalities and applications is performed.

Additionally, while daily or even more frequent reminders of medication adherence, filling out self-assessments, and recommendations to self-quarantine may be incredibly effective for some users, others need more specialty care [53]. People who are at risk for rapidly-changing symptoms must be informed that when a new symptom suddenly develops, it is imperative that they immediately seek in-person treatment. Most of the apps that included in this review did not explicitly have this type of technical feature. While it has been important that these initially developed apps can answer to a universal audiences' questions, there is a need for apps to be nationally accessible but exceptionally customizable.

Furthermore, one of the most pressing questions in clinical treatment and research is how to prevent the feelings of social isolation that quickly developed in a large portion of the population – particularly in elder and immunocompromised populations [54]. There has been little research on using of mobile applications to combat symptoms such as loneliness in a worldwide lockdown like the one COVID-19 enacted [51]. Considering the individual and social effects of the virus that apps are not yet answering, in anticipation of future public health emergencies, medical experts and app developers looking to create innovative and useful products may want to consider amplifying a more personalized experience with more opportunity for human interaction. Future research can then be conducted both on how feelings of depression, isolation, and loneliness may be reduced with the use of mobile health apps as well as if a personalized experience leads to beneficial, cost-effective in-person treatment [44].

Lastly, few health apps were used for conducting research studies. In this review, this was found to be the overall least common purpose of health apps related to COVID-19. Obtaining informative data on the novel SARS-CoV-2 from consumers is essential for public health specialists and medical researchers to successfully carry out their studies – which will inform future understanding the infection and risk factors for adverse outcomes, characterise the virus transmission patterns, identify high-risk patients, and eventually assist clinicians in fighting COVID-19 [43,55]. Therefore, further effort is required from governmental organisations to promote the conduct of participatory disease-based studies of the COVID-19 pandemic through the development of these digital solutions [45].

## Limitations of the Present Study

This review has its own limitations. Our search for health apps was limited to the major app stores “Apple Store” and “Google Play.” However, these stores are considered to be the largest global platforms for app distribution with 4.41 million apps as per May 2020, and accounted for about 80% of apps in the market [56]. Additionally, as searching all national apps stores from a single country is difficult as international apps are not visible, other apps may have been missed [41,42]. Thus, other sources (e.g., news and the Google search engine) were used to search for apps to overcome this problem. Furthermore, the quality of these apps was not examined and rated as suggested by Stoyanov et al. [57], but rather, the apps’ information retrieved from the app stores was thoroughly described and presented in Multimedia Appendix 1 and 2. In addition, as 67% of the included apps were developed by national health officials or governments, accessing some of these app’s content required national identification codes and/or local country phone numbers; this led the authors making the decision to not perform an assessment of these apps’ quality as most information would be inaccessible [36,42].

## Conclusions

This study provides an overview and taxonomy of the health apps currently available in the market to combat COVID-19 based on their differences in terms of basic technical features and purposes of use. The analysis of 115 health apps related to COVID19 led to extracting 258 excerpts that were grouped into 29 technical features as shown in Table 3. These technical features were then categorised which led to form 5 overarching dimensions or purposes of apps for fighting COVID-19 as shown in Figure 3. Further effort is required from researchers to evaluate these apps’ effectiveness and acceptability, and from governmental organisations to increase public awareness of these digital solutions. Our taxonomy of these apps’ purposes can be utilised as a guidance tool in categorising apps and then assessing their functionalities, as well as to evaluate their effectiveness in each different category.

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## Authors Contributions

M.A. conceived the work and acquired funding for this study. M.A. designed the study, reviewed apps included in this review, analysed and interpreted the data, and wrote the first draft of the manuscript including the creation of all tables, figures and Multimedia Appendix 1 and 2. A.G. assisted in shaping the literature review with input from M.A. Both authors contributed to the final version of the manuscript. Both authors have read and agreed to the published version of the manuscript.

## Conflicts of Interest

None declared.

## Abbreviations

CDC: Centres for Disease Control and Prevention
FAQ: Frequently Asked Questions
GPS: Global Positioning System
KSA: Kingdom of Saudi Arabia
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping review
RSS: Really Simple Syndication
SARS: Severe Acute Respiratory Syndrome
STI: Secure Tracing Identifier
UAE: United Arab Emirates
UK: United Kingdom
USA: United States of America
WHO: World Health Organisation

("Multimedia Appendix 1: [Summary of the included apps in this review]").
("Multimedia Appendix 2: [The occurrence of the different technical features in each app included in this review]").

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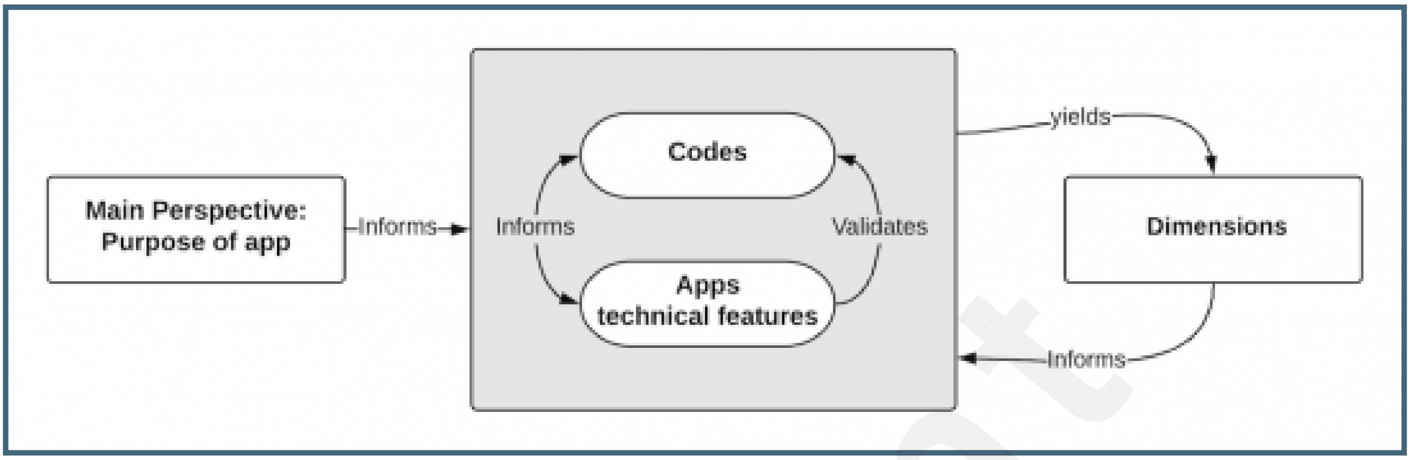
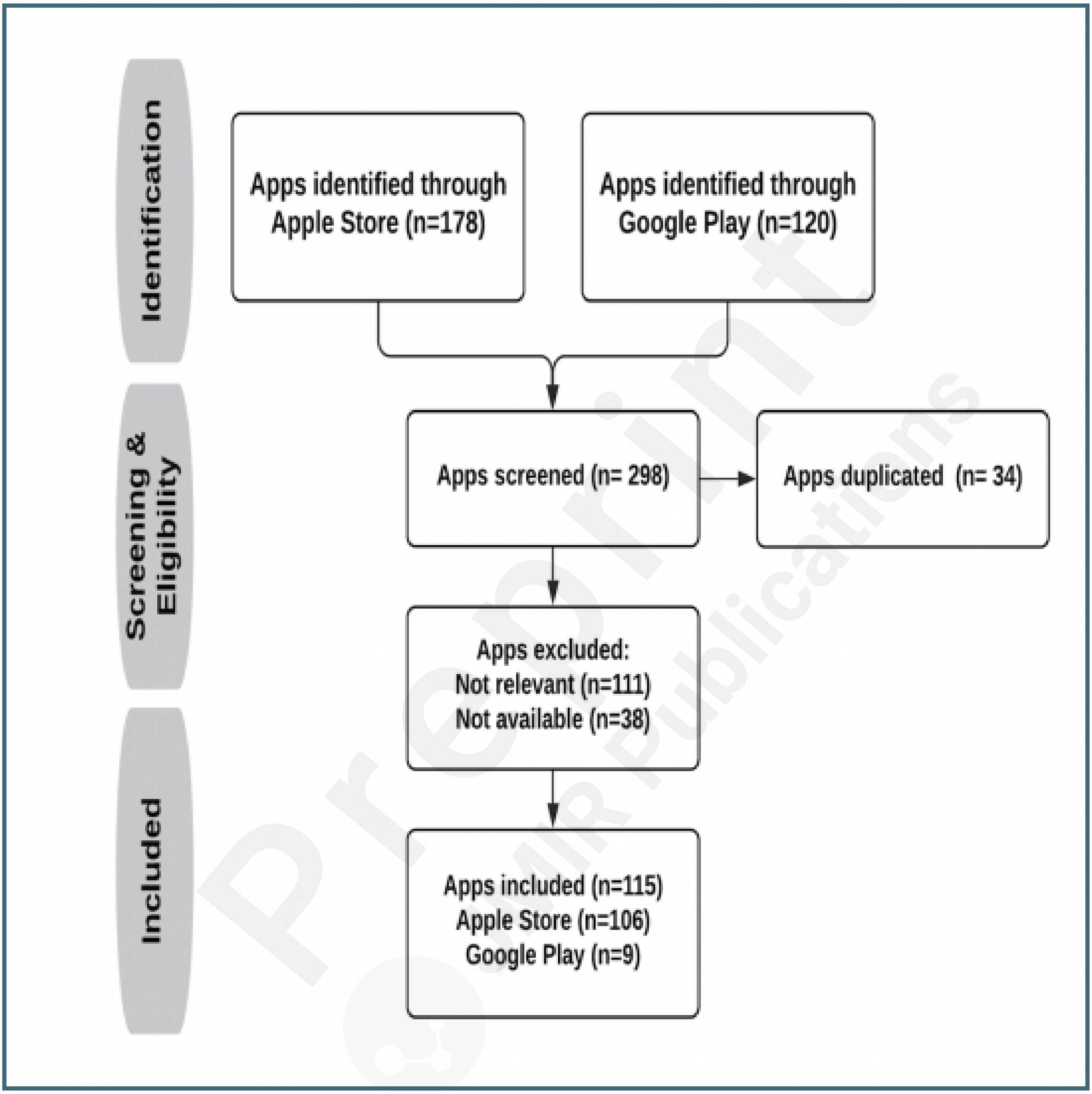
# Supplementary Files

# Figures

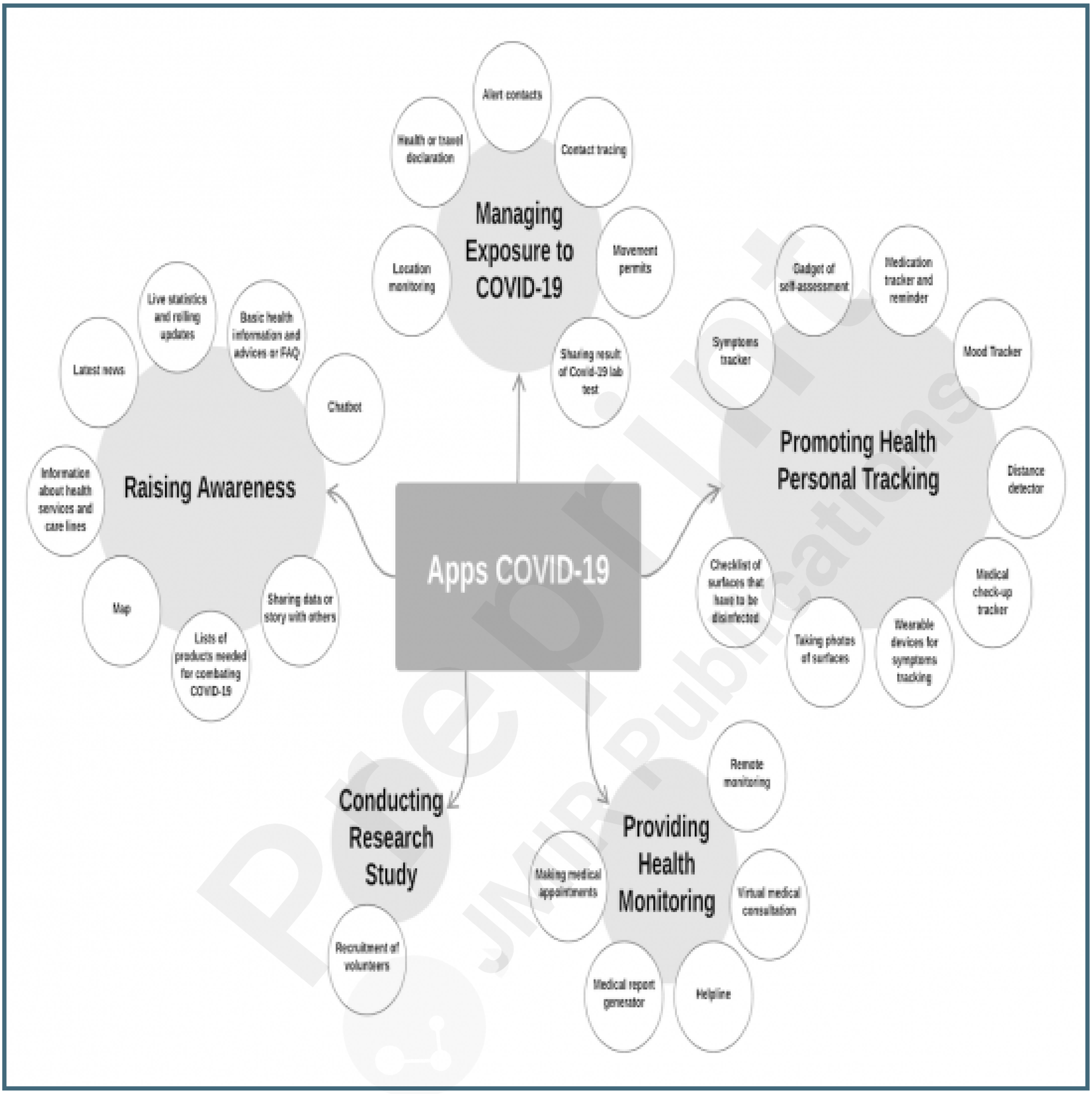
Our approach to define purposes of apps related to COVID19 (adapted from [13]).



Flowchart of our search strategy and apps selection process.



Taxonomy of COVID-19 apps’ purposes.



# Multimedia Appendixes

Summary of the apps included in the review.
URL: https://asset.jmir.pub/assets/a1b01a884b24a687c10e791003fae451.pdf

The occurrence of excerpts or technical features in each app.
URL: https://asset.jmir.pub/assets/c5e87ada628144188544b2caa4a12d7e.pdf